



SAF-T-LINER C2 SCHOOL BUS

Maintenance Manual



SAF-T-LINER C2 SCHOOL BUS MAINTENANCE MANUAL

**Models: C2
C2 G
C2 HEV**

Foreword

Performing scheduled maintenance operations is important in obtaining safe, reliable operation of your vehicle. A proper maintenance program will also help to minimize downtime and safeguard warranties.

IMPORTANT: The maintenance operations in this manual are **not all-inclusive**. Also refer to other component and body manufacturers' instructions for specific inspection and maintenance instructions.

Perform the pretrip inspection and daily maintenance as outlined in the *Saf-T-Liner C2 School Bus Driver's Manual*. Perform the maintenance operations in this manual at scheduled intervals based on the distance the vehicle has traveled or hours of operation. Your Freightliner dealership has qualified technicians and equipment to perform this maintenance.

IMPORTANT: Descriptions and specifications in this manual were in effect at the time of printing. Thomas Built Buses reserves the right to discontinue models and to change specifications or design at any time without notice and without incurring obligation. Descriptions and specifications contained in this publication provide no warranty, expressed or implied, and are subject to revision and editions without notice.

Refer to www.Daimler-TrucksNorthAmerica.com and www.ThomasBus.com for more information, or contact Daimler Trucks North America LLC at the address below.

Environmental Concerns and Recommendations

Whenever you see instructions in this manual to discard materials, you should attempt to reclaim and recycle them. To preserve our environment, follow appropriate environmental rules and regulations when disposing of materials.

NOTICE: Parts Replacement Considerations

Do not replace suspension, axle, or steering parts (such as springs, wheels, hubs, and steering gears) with used parts. Used parts may have been subjected to collisions or improper use and have undetected structural damage.

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Descriptions of Service Publications

Daimler Trucks North America LLC distributes the following major service publications in paper and electronic (via ServicePro®) formats.

Workshop/Service Manual	Workshop/service manuals contain service and repair information for all vehicle systems and components, except for major components such as engines, transmissions, and rear axles. Each workshop/service manual section is divided into subjects that can include general information, principles of operation, removal, disassembly, assembly, installation, and specifications.
Maintenance Manual	Maintenance manuals contain routine maintenance procedures and intervals for vehicle components and systems. They have information such as lubrication procedures and tables, fluid replacement procedures, fluid capacities, specifications, and procedures for adjustments and for checking the tightness of fasteners. Maintenance manuals do not contain detailed repair or service information.
Driver's/Operator's Manual	Driver's/operator's manuals contain information needed to enhance the driver's understanding of how to operate and care for the vehicle and its components. Each manual contains a chapter that covers pre-trip and post-trip inspections, and daily, weekly, and monthly maintenance of vehicle components. Driver's/operator's manuals do not contain detailed repair or service information.
Service Bulletins	Service bulletins provide the latest service tips, field repairs, product improvements, and related information. Some service bulletins are updates to information in the workshop/service manual. These bulletins take precedence over workshop/service manual information, until the latter is updated; at that time, the bulletin is usually canceled. The service bulletins manual is available only to dealers. When doing service work on a vehicle system or part, check for a valid service bulletin for the latest information on the subject. IMPORTANT: Before using a particular service bulletin, check the current service bulletin validity list to be sure the bulletin is valid.
Parts Technical Bulletins	Parts technical bulletins provide information on parts. These bulletins contain lists of parts and BOMs needed to do replacement and upgrade procedures.
Web-based repair, service, and parts documentation can be accessed using the following applications on the AccessFreightliner.com website.	
ServicePro	ServicePro® provides Web-based access to the most up-to-date versions of the publications listed above. In addition, the Service Solutions feature provides diagnostic assistance with Symptoms Search, by connecting to a large knowledge base gathered from technicians and service personnel. Search results for both documents and service solutions can be narrowed by initially entering vehicle identification data.
PartsPro	PartsPro® is an electronic parts catalog system, showing the specified vehicle's build record.
EZWiring	EZWiring™ makes Thomas Built Buses, Freightliner, Freightliner Custom Chassis Corporation, Sterling, and Western Star products' wiring drawings and floating pin lists available online for viewing and printing. EZWiring can also be accessed from within PartsPro.

Descriptions of Service Publications

Warranty-related service information available on the AccessFreightliner.com website includes the following documentation.

Recall Campaigns

Recall campaigns cover situations that involve service work or replacement of parts in connection with a recall notice. These campaigns pertain to matters of vehicle safety. All recall campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Field Service Campaigns

Field service campaigns are concerned with non-safety-related service work or replacement of parts. All field service campaigns are distributed to dealers; customers receive notices that apply to their vehicles.

Page Description

For a page example of the printed manual, see [Fig. 1](#).

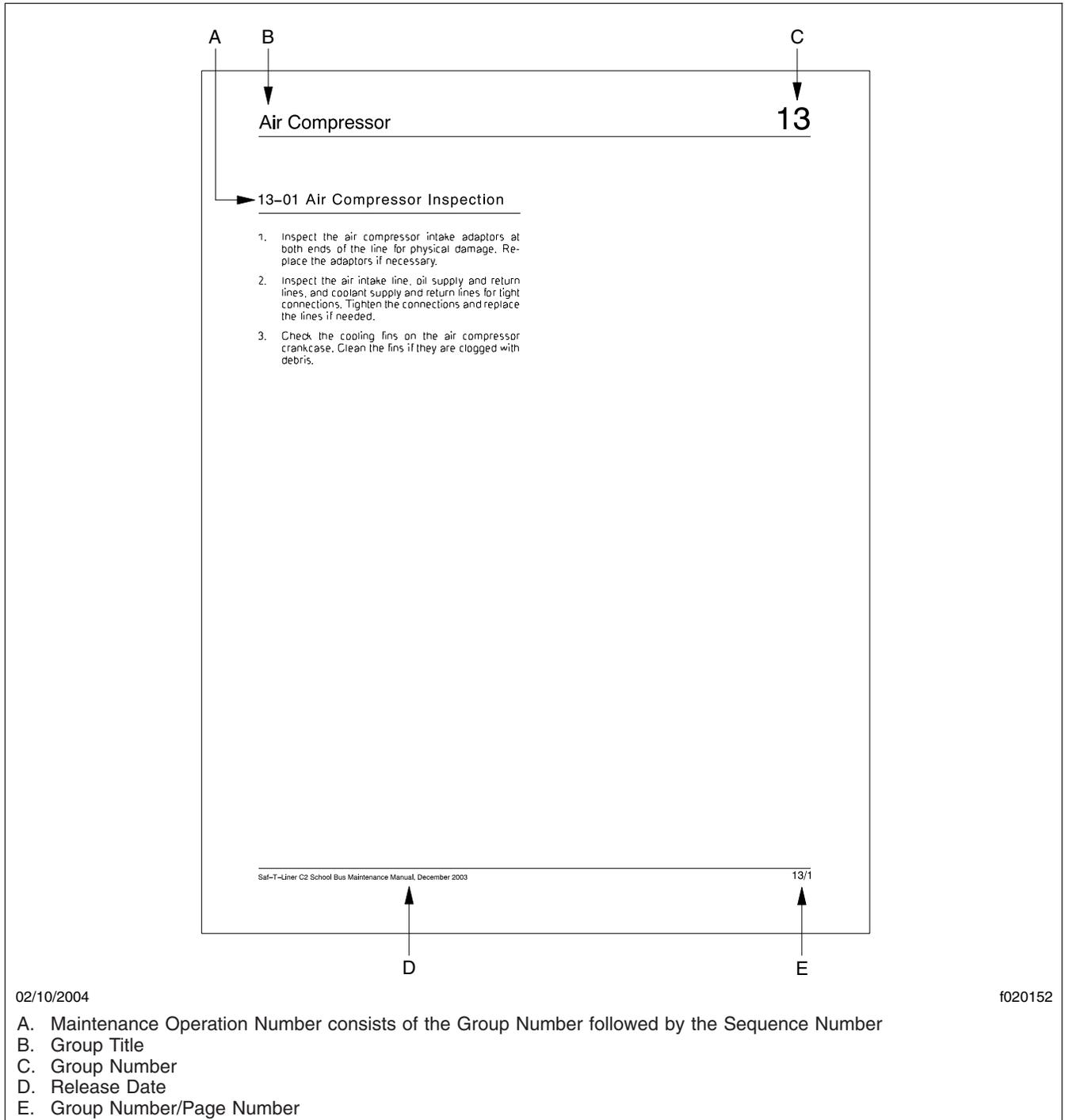


Fig. 1, Page Example of the Printed Manual

Group No.	Group Title
00	General Information
01	Engine
09	Air Intake
13	Air Compressor
15	Alternators and Starters
20	Engine Cooling/Radiator
25	Clutch
26	Transmission
31	Frame and Frame Components
32	Suspension
33	Front Axle
35	Rear Axle
40	Wheels and Tires
41	Driveline
42	Brakes
46	Steering
47	Fuel
49	Exhaust
54	Electrical, Instruments, and Controls
72	Doors
83	Heater and Air Conditioner
88	Hood, Grille, and Cab Fenders

Title of Maintenance Operation (MOP)	MOP Number
Determining Scheduled Maintenance Intervals.	00-01
Maintenance Intervals for Schedule I.	00-03
Maintenance Intervals for Schedule II.	00-04
Maintenance Schedules.	00-02
Noise Emission Controls.	00-06
Overview of Maintenance Operations.	00-05
Verification of Inspections Log.	00-07

Determining Scheduled Maintenance Intervals

Performing regular maintenance will help ensure that your vehicle delivers safe, reliable service and optimum performance. A proper maintenance program will also help to minimize downtime and safeguard warranties.

To determine the correct maintenance intervals for your vehicle, you must first determine the type of service or conditions the vehicle will be operating in. Most vehicles operate in conditions that fall within one of two schedules. Before placing your vehicle in service, determine whether schedule I or II applies to your vehicle.

Schedules I and II

Schedule I applies to vehicles that travel up to 20,000 miles (32 000 kilometers) annually. Examples of Schedule I usage are:

- frequent short-distance travel
- operation primarily in cities and densely populated areas
- local transport with infrequent freeway travel
- high percentage of stop-and-go travel

Schedule II applies to vehicles that travel over 20,000 miles (32 000 kilometers) annually. An example of Schedule II usage is:

- less frequent stop-and-go travel

Maintenance Schedules

After determining the schedule appropriate to your vehicle, refer to the **Maintenance Schedules** to determine when to perform the Initial Maintenance (IM) and the frequency of performing subsequent maintenance intervals for each schedule.

Maintenance Intervals

Refer to **Maintenance Intervals for Schedule I** or **Maintenance Intervals for Schedule II** to determine which maintenance interval(s) should be performed when your vehicle reaches the mileage or months of operation listed in these subjects.

Maintenance Operations

Groups 01 through 83 in this manual have an index at the beginning of each Group. The index lists the Title of Maintenance Operations and the Maintenance Operation (MOP) Numbers for that Group. Follow the instructions under the MOP number to perform the required maintenance.

In addition to the maintenance operations required for the maintenance interval, perform all the daily maintenance procedures in **Chapter 11** and **Chapter 12**, "Pre- and Post-Trip Checklists" and Pre- and Post-Trip Inspections and Maintenance," in the *Saf-T-Liner C2 School Bus Driver's Manual*.

IMPORTANT: Maintenance operations appearing in italics in the following table are for noise emission control components. Numbers in the table are reference numbers matching those in the text of this manual.

Maintenance Schedules: 00–02

Maintenance Schedules					
Schedule	Maintenance Intervals				
	Maintenance Interval	Frequency	Mileage*	km	Months*
Schedule I vehicles that annually travel up to 20,000 miles (32 000 km)	Initial Maintenance (IM)	first	4000	6400	6
	Maintenance 1 (M1)	every	4000	6400	6
	Maintenance 2 (M2)	every	8000	12 800	12
	Maintenance 3 (M3)	every	16,000	25 600	18
	Maintenance 4 (M4)	every	32,000	51 200	24
	Maintenance 5 (M5)	every	48,000	77 200	30
Schedule II vehicles that travel over 20,000 miles (32 000 km) annually	Initial Maintenance (IM)	first	4000	6400	6
	Maintenance 1 (M1)	every	8000	12 800	6
	Maintenance 2 (M2)	every	16,000	25 600	12
	Maintenance 3 (M3)	every	32,000	51 200	18
	Maintenance 4 (M4)	every	48,000	77 200	24
	Maintenance 5 (M5)	every	64,000	103 000	36

* Use mileage or months, whichever comes first.

Table 1, Maintenance Schedules

Maintenance Intervals for Schedule I: 00–03

Maintenance Intervals for Schedule I					
Maintenance Sequence	Maintenance Interval	Service Date	Miles*	km	Months*
1st	IM and M1		4000	6400	6
2nd	M1 and M2		8000	12 800	12
3rd	M1		12,000	19 200	—
4th	M1, M2, and M3		16,000	25 600	18
5th	M1		20,000	32 000	—
6th	M1 and M2		24,000	38 400	—
7th	M1		28,000	44 800	—
8th	M1, M2, M3, and M4		32,000	51 200	24
9th	M1		36,000	58 000	—
10th	M1 and M2		40,000	64 300	—
11th	M1		44,000	70 800	—
12th	M1, M2, M3, and M5		48,000	77 200	30

* Use mileage or months, whichever comes first.

Table 2, Maintenance Intervals for Schedule I

Maintenance Intervals for Schedule II: 00–04

Maintenance Intervals for Schedule II					
Maintenance Sequence	Maintenance Interval	Service Date	Miles*	km	Months*
1st	IM		4000	6400	6
2nd	M1		8000	12 800	6
3rd	M1 and M2		16,000	25 600	12
4th	M1		24,000	38 400	—
5th	M1, M2, and M3		32,000	51 200	18
6th	M1		40,000	64 300	—
7th	M1, M2, and M4		48,000	44 800	24
8th	M1		56,000	90 100	—
9th	M1, M2, M3, and M5		64,000	103 000	36
10th	M1		72,000	115 800	—
11th	M1 and M2		80,000	128 700	42
12th	M1		88,000	141 600	—
13th	M1, M2, M3, and M4		96,000	154 400	48

* Use mileage or months, whichever comes first.

Table 3, Maintenance Intervals for Schedule II

Overview of Maintenance Operations: 00–05

Maintenance Operation Procedures and Intervals							
Maintenance Operation No.	Title of Maintenance Operation	Maintenance Intervals					
		IM	M1	M2	M3	M4	M5
01–01	Engine Drive Belt Inspecting				•	•	•
01–02	Engine Support Fastener Checking					•	
09–01	Air Cleaner Element Inspecting and Replacing*	•	•	•	•	•	•
13–01	Air Compressor Inspection			•	•	•	•
13–02	Air Compressor Filter Replacement, Propane Engine				•		
15–01	Alternator, Battery, and Starter Connections Check					•	
20–01	Radiator Cap Inspection			•	•	•	•
20–02	Radiator Pressure Flush and Coolant Change†						
20–03	<i>Fan Drive Inspection (Noise Emission Control)</i>			•	•	•	•
20–04	Coolant Heater Check, Webasto			•	•	•	•
20–05	Hybrid Electric System Coolant Change				•	•	•
25–01	Eaton® Fuller® Clutch Release Bearing Lubricating	•	•	•	•	•	•
25–02	Eaton Fuller Clutch Release Cross-Shaft Lubricating	•	•	•	•	•	•
25–03	Clutch Hydraulic Fluid Level Checking		•	•	•	•	•
25–04	Clutch Hydraulic Fluid Changing					•	
25–05	Electronic Clutch Actuator (ECA) Lubrication	•	•	•	•	•	•
26–01	Manual Transmission Oil Level Checking		•	•	•		•
26–02	Eaton Fuller Transmission Fluid Changing and Magnetic Plug Cleaning‡						
26–03	Allison and Eaton Fuller Transmission Breather Checking		•	•	•	•	•
26–04	Allison Transmission Fluid and Filter Changing§						
26–05	Eaton Fuller Hybrid Transmission Fluid Changing¶						
31–01	Frame Fastener Torque Check	•				•	
31–02	Automatic Tire Chain System Checking**						
31–03	Off-Season Chain Wheel Removal††						
32–01	Suspension Inspecting		•	•	•	•	•
32–02	Suspension Lubricating		•	•	•	•	•
32–03	Suspension U-Bolt Torque Checking	•			•	•	•
33–01	Kingpin Lubricating, Detroit™ Axle‡‡		•	•	•	•	•
33–02	Tie Rod End Lubricating‡‡		•	•	•	•	•
33–03	Draw Key Nut Inspecting	•			•	•	•
33–04	Tie Rod End Inspecting		•	•	•	•	•
35–01	Axle Lubricant Level Checking		•	•	•	•	•
35–02	Axle Breather Checking	•	•	•	•	•	•
35–03	Axle Lubricant Changing and Magnetic Plug Cleaning§§						

Overview of Maintenance Operations: 00–05

Maintenance Operation Procedures and Intervals							
Maintenance Operation No.	Title of Maintenance Operation	Maintenance Intervals					
		IM	M1	M2	M3	M4	M5
40–01	Wheel Nut Checking				•	•	•
41–01	Driveline Inspection		•	•	•	•	•
41–02	Driveline Lubrication		•	•	•	•	•
42–01	Bendix Air Dryer AD-9 or AD-IP Desiccant Replacing ^{¶¶}						•
42–02	Governor D-2A Checking					•	
42–03	Hydraulic Brake Lining Wear Checking	•	•	•	•	•	•
42–04	Slack Adjuster Lubricating	•	•	•	•	•	•
42–05	Meritor Camshaft Bracket Lubricating			•	•	•	•
42–06	Air Dryer AD-9, AD-IP Checking			•	•	•	•
42–07	Brake Lines and Fittings Inspecting, Hydraulic Brakes	•	•	•	•	•	•
42–08	Brake Pedal Linkage and Mounting Plate Inspecting			•	•	•	•
42–09	Air Brake Inspecting and Leakage Testing				•	•	•
42–10	ABS Tone Rings Cleaning	•	•	•	•	•	•
42–11	Bendix Hydro-Max® Brake System Inspecting	•	•	•	•	•	•
42–12	Brake Caliper Slide Pin Lubricating, Hydraulic Brakes ^{***}						
42–13	Drum Brake Shoe Roller Lubricating			•	•	•	•
42–14	Foot Brake Valve Actuator Lubricating, Bendix E-6	•		•			•
42–15	Brake Inspecting	•	•	•	•	•	•
42–16	WABCO System Saver Air Dryer Desiccant Cartridge Replacing ^{¶¶}						•
46–01	Drag Link Inspecting				•	•	•
46–02	Power Steering Fluid and Filter Changing					•	
46–03	Power Steering Fluid Level Inspecting	•	•	•	•		•
46–04	Power Steering Gear Lubricating	•	•	•	•	•	•
46–05	Drag Link Lubricating	•	•	•	•	•	•
47–01	Fuel Tank Band Nut Tightening	•					
47–02	Fuel/Water Separator Element Replacing					•	
47–03	Inline Fuel Strainer Replacing			•	•	•	•
47–04	Fuel Sender Checking			•	•	•	•
47–05	Fuel Tank and Line Inspecting, Propane Engine					•	
47–06	Fuel Rail Fitting and Injector Inspecting, Propane Engine					•	
47–07	Fuel Filter Replacing, Propane Engine					•	
47–08	CNG Fuel System Inspection			•	•	•	•
47–09	CNG Fuel Filter Replacement		•	•	•	•	•
47–10	CNG Fuel Cylinder Inspection				•	•	•

Overview of Maintenance Operations: 00–05

Maintenance Operation Procedures and Intervals							
Maintenance Operation No.	Title of Maintenance Operation	Maintenance Intervals					
		IM	M1	M2	M3	M4	M5
49–01	Exhaust System Inspecting (Noise Emission Control)			•	•	•	•
54–01	Battery Voltage Checking	•	•	•	•	•	•
54–02	Power Electronic Carrier (PEC) Air Filter Inspecting and Replacing†††						
72–01	Door Seals Lubrication	•	•	•	•	•	•
72–02	Air Door Inspection‡‡‡						
83–01	Air Conditioner Inspection		•	•	•	•	•
83–02	HVAC Air Filter Cleaning§§§			•		•	
88–01	Hood Rear Support Lubrication		•	•	•	•	•

* Inspect the air filter every 6 months. Replace the air filter every 12 months, or when filter restriction reaches 25 inH₂O (if equipped with an air restriction gauge).

† Replace the organic acid technology (OAT) coolant every 600,000 miles (965 400 km); supplemental coolant additives (SCAs) are not used with OAT coolant. Replace nitrated organic-acid technology (NOAT) and SCA pre-charge ethylene glycol coolants every 30,000 miles (48 270 km). You must check and, if necessary, recharge the SCA levels and freeze point every 25,000 miles (40 225 km) or 6 months, whichever comes first. See the applicable engine operation and maintenance manual for further information.

‡ For oil change intervals, see the applicable Eaton Fuller Driver Manual or Service Manual.

§ For oil and filter change intervals, see the applicable Allison Operator’s Manual.

¶ The hybrid transmission fluid should be changed every five years or 500,000 miles (804 500 km), whichever comes first.

** The system check should be completed every 500 hours of operation.

†† The chain wheels should be removed during the spring and summer months.

‡‡ For Detroit axles, complete this procedure once a year or at the following applicable interval, whichever comes first: every 5000 miles (8000 km) for Schedule I vehicles; or every 10,000 miles (16 000 km) for Schedule II vehicles.

§§ For Detroit rear axles with petroleum-based oil, change the lubricant every 100,000 miles (161 000 km) or every 12 months, whichever comes first; if synthetic oil is used, change the lubricant every 250,000 miles (402 000 km) or every 36 months, whichever comes first. For Meritor rear axles with petroleum-based oil, change the lubricant at 100,000 miles (161 000 km) or at 12 months of service, whichever comes first, and every 24 months thereafter; if synthetic oil is used, change the lubricant every 250,000 miles (402 000 km) or every 36 months, whichever comes first.

¶¶ If equipped with an oil-coalescing desiccant cartridge, replace the cartridge once a year, regardless of mileage.

*** For lubricating intervals, see the Bosch Pin Slide Disc Brakes Service Manual.

††† Inspect the PEC air filter every four months, and replace if needed.

‡‡‡ Inspect the air door every 60 days or 4000 miles (6436 km), whichever comes first.

§§§ Clean the HVAC air filter every 12 months or 8000 miles (12 872 km), whichever comes first.

Table 4, Maintenance Operation Procedures and Intervals

Noise Emission Controls: 00–06

Noise Emission Controls

Federal Law, Part 205: Transportation Equipment Noise Emission Controls

Part 205, Transportation Equipment Noise Emission Controls, requires the vehicle manufacturer to furnish each new vehicle with written instructions for the proper maintenance, use, and repair of the vehicle by the ultimate purchaser to provide reasonable assurance of the elimination or minimization of noise emission degradation throughout the life of the vehicle. In compliance with the law, the Noise Emission Control Systems maintenance located in each applicable group within this manual, in conjunction with the vehicle workshop manual, provides these instructions to owners.

Recommendations for Replacement Parts

Replacement parts used for maintenance or repair of noise emission control systems should be genuine Freightliner parts. If other than genuine Freightliner parts are used for replacement or repair of components affecting noise emission control, the owner should be sure that such parts are warranted by their manufacturer to be equivalent to genuine Freightliner parts in performance and durability.

Freightliner Noise Emissions Warranty

Refer to the vehicle owner's warranty information book for warranty information concerning noise emission control systems.

Tampering With the Noise Control System is Prohibited

Federal law prohibits the following acts or the causing thereof:

1. The removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use,

2. The use of the vehicle after such device or element of design has been removed or rendered inoperative by any person.

Among those acts presumed to constitute tampering are the acts listed below:

1. Removal of engine noise-deadening panels, including cab or hood liners.
2. Removal of or rendering inoperative the engine speed governor so as to allow engine speed to exceed the manufacturer's specifications.
3. Removal of or rendering inoperative the fan clutch, including bypassing the control on any thermostatic fan drive to cause it to operate continuously.
4. Removal of the fan shroud.
5. Removal of or rendering inoperative exhaust system components, including exhaust pipe clamping.
6. Removal of air intake system components.

Title of Maintenance Operation (MOP)	MOP Number
Engine Drive Belt Inspecting	01-01
Engine Support Fastener Checking	01-02
Safety Precautions	01-00

01–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

01–01 Engine Drive Belt Inspecting

Worn or loose drive belts may cause premature pulley bearing failure or engine overheating. Too much or too little tension on the belt may result in excessive or premature belt wear. Replace the engine drive belt if any conditions described under "Visual Inspection" are found.

Visually inspect all drive belts. To inspect a belt, gently twist the belt to view the belt sidewalls and the underside of the belt. When replacing a matched set of belts, always replace both belts at the same time. Matched belts must be from the same manufacturer.

Visual Inspection

For examples of drive belt conditions, see [Fig. 1](#).

1. Inspect the belt for glazing. Shiny sidewalls are evidence of glazing, which is caused by friction created when a loose belt slips in the pulleys. It can also be caused by oil or grease contamination on the pulleys.
2. Check for tensile breaks or breaks in the cord body. Cuts in a belt are usually caused by foreign material in the pulley or by prying or forcing the belt during removal or installation.
3. Check the belt for ply separation. Oil, grease, or belt dressing can cause the belt to fall apart in layers. Repair any oil or coolant leaks that are affecting the belts before replacing the drive belts. Do not use belt dressing on any belt.
4. Check for uneven ribs on serpentine (poly-V) belts. Foreign material in the pulley will erode the

undercord ribs causing the belt to lose its gripping power.

5. Check the belt for a jagged or streaked sidewall. Jagged or streaked sidewalls are the result of foreign material, such as sand or gravel, in the pulley, or a rough pulley surface.
6. Check the drive belts for cracks. Small, irregular cracks are usually an indication of an old belt.
7. Visually inspect the pulleys for excessive play or wobble. Excessive play or wobble indicates a failure of the pulley bearing. Check for belt squealing or squeaking. Replace the bearings as necessary.

NOTE: If it is difficult to distinguish the location of a supposed bearing noise, obtain a stethoscope and place it on the component being checked, not the pulley, to isolate the area from outside interference.

8. Inspect all pulleys for foreign material, oil, or grease in the grooves.

If the engine drive belt needs to be replaced, see **Group 01** of the *Saf-T-Liner C2 School Bus Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

Belt Tension Inspection

Drive belts on Mercedes-Benz engines have belt tensioners that automatically adjust the tension on the belt. These belts do not require adjustment.

Cummins Engines

Inspect the belt tensioner for unusual noise and excessive looseness or shaking of the pulley bearings. If the belt tensioner requires disassembly, refer to the engine service manual.

01–02 Engine Support Fastener Checking

1. Check the engine support fasteners at the rear of the engine for tightness. Tighten the fasteners 241 lbf·ft (327 N·m).
2. Check the engine support fasteners at the front of the engine for tightness. Tighten the fasteners 136 lbf·ft (184 N·m).

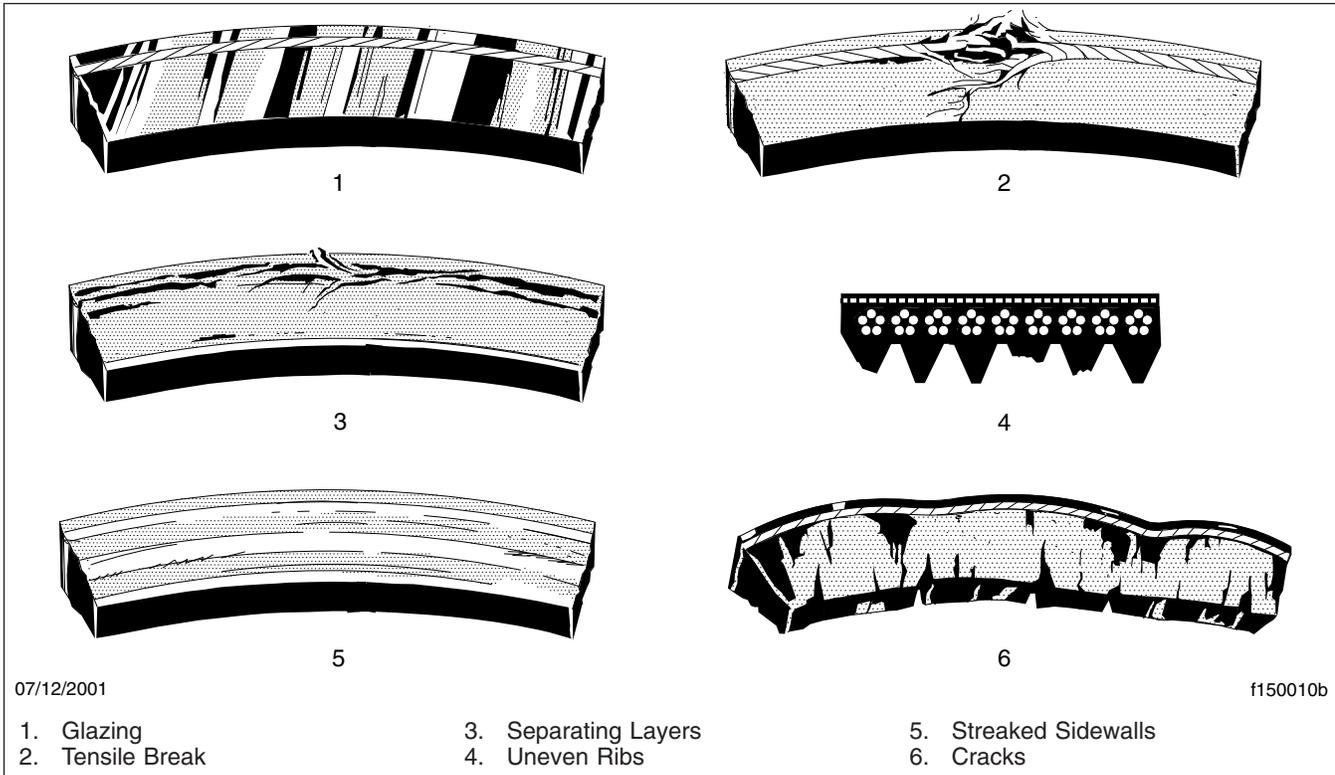


Fig. 1, Drive Belt Replacement Conditions

NOTE: Mounts should be inspected when the engine is removed for service. Whenever the engine is removed, inspect the lower and upper isolators for wear. Replace the isolators if necessary.

Title of Maintenance Operation (MOP)	MOP Number
Air Cleaner Element Inspecting and Replacing	09-01

09–01 Air Cleaner Element Inspecting and Replacing

IMPORTANT: Due to the variety of possible driving conditions (dirt roads, paved roads, etc.), it is critical to check the air restriction indicator, if so equipped. If the vehicle is not equipped with an air restriction indicator, inspect all components of the air intake system and air filter every six months. Replace the air filter every 12 months, or when filter restriction reaches 25 inH₂O for diesel engines, or when the air restriction indicator is completely red for propane engines (if equipped with an air restriction indicator). **More frequent inspections and/or filter replacement may be needed if the vehicle is being operated in a dusty environment, to avoid damaging the vehicle.**

Inspecting

Remove and visually inspect the air filter for holes, tears, cracks, or other damage at the recommended interval. Remove loose debris, such as leaves or pine needles, from the filter housing. If the air filter is damaged, replace it. See **Group 09** of the *Saf-T-Liner C2 School Bus Workshop Manual* for removal and installation instructions, or take the vehicle to an authorized Freightliner dealer.

Engine damage can occur if the air intake system is not properly maintained. Use the air intake restriction indicator to check for air intake system damage or leaks. See **Fig. 1** and **Fig. 2**. Make sure the engine is off and note the existing reading on the indicator. Reset the indicator by pushing it down. See **Fig. 1** and **Fig. 2**. Start the engine and take a short test drive. Check the indicator again and note the level of restriction on the indicator. A decrease from the previous level of restriction or a very low air restriction indicator reading (0 to 4 inH₂O) could indicate an air intake system problem such as a damaged air filter, loose or disconnected air intake piping, or a disconnected or damaged air restriction indicator.

Replacing

NOTICE

Do not use aftermarket air-cleaner elements. Aftermarket air-cleaner elements may not seal the housing correctly, which can lead to engine damage and potentially the loss of warranty. When replacing an air-cleaner element, use only the part listed in PartsPro for the serial number of the vehicle.

Replace the air filter every 12 months, or when filter restriction reaches 25 inH₂O for diesel engines, or when the air restriction indicator is completely red for propane engines (if equipped with an air restriction indicator). See **Group 09** of the *Saf-T-Liner C2 School Bus Workshop Manual* for removal and installation instructions, or take the vehicle to an authorized Freightliner dealer.

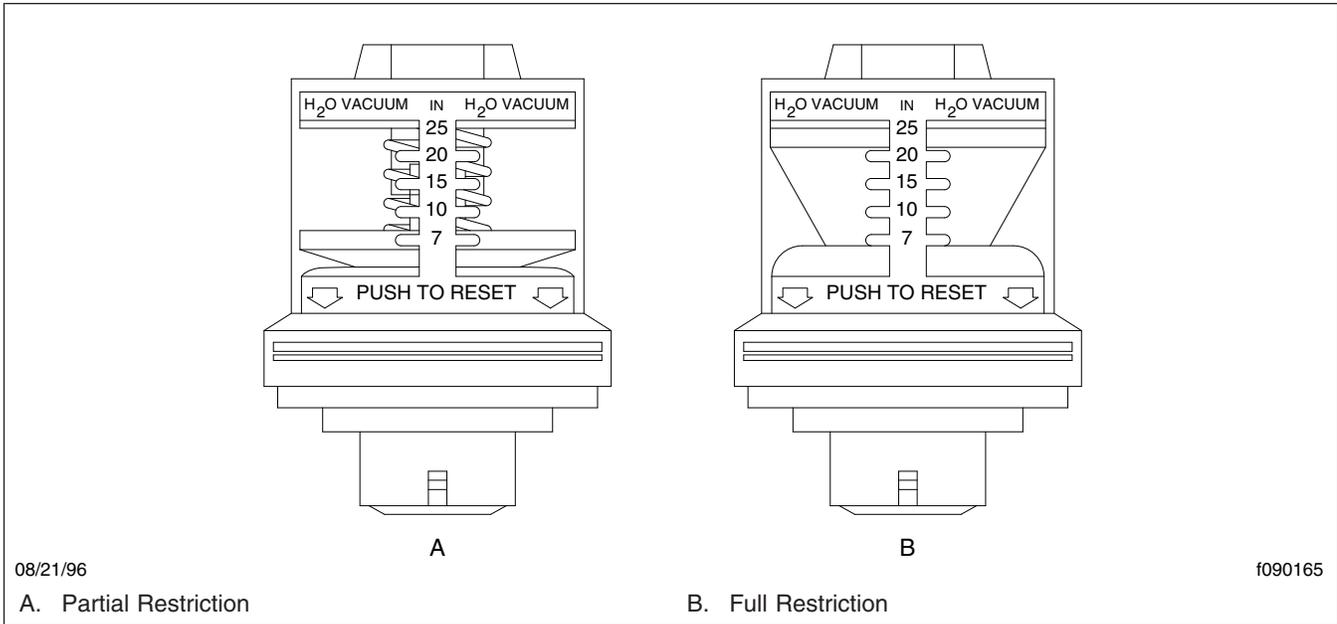


Fig. 1, Air Restriction Indicator, Diesel Engines

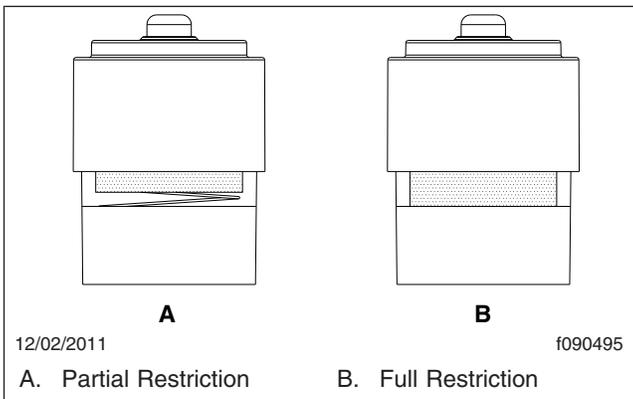


Fig. 2, Air Restriction Indicator, Propane Engines

Title of Maintenance Operation (MOP)	MOP Number
Air Compressor Filter Replacement, Propane Engine	13-02
Air Compressor Inspection	13-01
Safety Precautions	13-00

13–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

13–01 Air Compressor Inspection

1. Inspect the air compressor intake hoses and connections at the air intake and air compressor for physical damage. If needed, change the hoses, and/or tighten or replace the connections.
2. Inspect the coolant supply and return lines for tight connections. Tighten the connections and replace the lines and fasteners if needed.
3. For the air governor, inspect the piping and connections for leaks. Replace gaskets and faulty components as needed.

13–02 Air Compressor Filter Replacement, Propane Engine

1. Loosen the spring clip from the unhinged side of the mounting baffle and open the cover. See [Fig. 1](#).
2. Remove the pleated paper filter.
3. Install the new pleated paper filter and make certain it is correctly positioned.

IMPORTANT: If the entire air strainer is removed from the compressor intake, replace the air strainer gasket.

4. Install the cover, then tighten the spring clip.

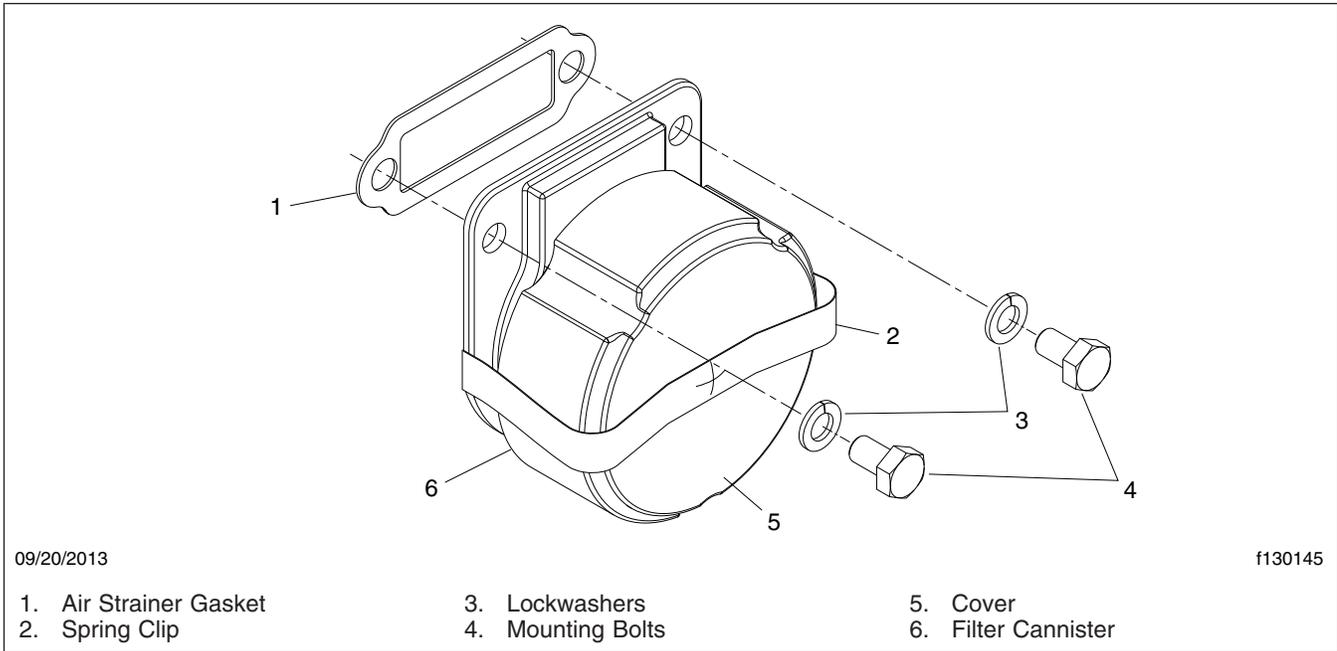


Fig. 1, Pleated Paper Filter Assembly

Title of Maintenance Operation (MOP)	MOP Number
Alternator, Battery, and Starter Connections Check	15-01
Safety Precautions	15-00

15–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

15–01 Alternator, Battery, and Starter Connections Check

WARNING

Batteries release explosive gas as a by-product of their chemical activity. Do not smoke when working around batteries. Put out all flames and remove any source of sparks or intense heat. Make sure the battery compartment is completely vented before disconnecting or connecting the battery cables.

Battery acid is extremely harmful if splashed in the eyes or on the skin. Always wear a face shield and protective clothing when working around batteries.

Damaged, chafed, or kinked wiring can cause electrical short-circuits and lead to fires, causing property damage, injury, or death. Clean, inspect, and maintain wiring and connections carefully.

1. Disconnect the batteries.
2. Check the tightness of the alternator bracket fasteners and alternator mounting fasteners; tighten the fasteners as needed. For torque values, see **Group 15** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
3. Check that all electrical connections at the alternator and starter are clean. Clean and tighten all charging system electrical connections as needed. Spray each electrical connection at the alternator and starter with dielectric red enamel.

Trace and inspect all wiring and cables connected to:

- alternator
 - starter and depopulation studs
 - batteries
 - magnetic switch
 - cab
 - jump-start studs
 - battery isolation relays
 - battery shutoff switches
4. Check wires and cables for wear, chafing, kinks, discolored insulation, or loose clamps or ties. Find the cause of any problems and repair, replace, and reroute wires and clamps as necessary.
- IMPORTANT:** Ensure that wires and cables are not near any heat sources; if they are, reroute them.
5. Clean all circuit breakers and relays.
 6. Check the alternator wiring for missing insulation, kinks, and heat damage. Replace or repair as needed.
 7. On the bundled cable that runs from the batteries to the starter, ensure that tie straps are installed at least every 12 inches (30 cm). Replace any missing tie straps, and add tie straps where spacing between them exceeds 12 inches (30 cm).
 8. Ensure that all cables have sufficient slack to allow for engine movement, and that there is no force on any wiring connectors.
 9. If any convoluted tubing is damaged, check the wiring inside it. Replace any damaged or missing convoluted tubing.
 10. Inspect the battery cables for wear, and replace as needed. Clean the cable connector terminals with a wire brush. See **Group 54** of the vehicle *Workshop Manual* for troubleshooting instructions, and for adjustment, repair, or replacement instructions, or take the vehicle to an authorized Freightliner dealer.
 - 10.1 Clean and tighten the battery ground cable, terminal, and clamps.

- 10.2 Inspect the retainer assembly (or battery hold-downs) and the battery box. Replace worn or damaged parts. Remove any corrosion with a wire brush, and wash with a weak solution of baking soda and water. Rinse with clean water, then dry. Paint the retainer assembly, if needed, to prevent rusting.
 - 10.3 Check that foreign objects, such as stones, bolts, and nuts, are removed from the battery box.
 - 10.4 After cleaning, connect the cables to the batteries, and tighten them to the torque specifications listed on the battery, generally 10 to 15 lbf·ft (14 to 20 N·m).
 - 10.5 Coat the battery terminals with dielectric grease.
11. Check the terminals on the battery shut-off switch and the starter relay. Make sure that the terminal connections are clean and tight. Coat the terminal connections with dielectric red enamel after cleaning.

Title of Maintenance Operation (MOP)	MOP Number
Coolant Heater Check, Webasto	20-04
Fan Drive Inspection (Noise Emission Control)	20-03
Hybrid Electric System Coolant Change	20-05
Radiator Cap Inspection	20-01
Radiator Pressure Flush and Coolant Change	20-02
Safety Precautions	20-00

20–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

20–01 Radiator Cap Inspection



Do not remove or loosen the radiator cap until the engine and cooling system have completely cooled. Use extreme care when removing the cap. A sudden release of pressure from removing the cap prior to the system cooling can result in a surge of scalding coolant that could cause serious personal injury.

NOTICE

The radiator cap currently installed may not be the same one installed when the vehicle was built. If the radiator cap must be replaced, make sure that it is the correct cap for the cooling system of the vehicle. Because the radiator cap pressure rating affects the operating temperature of the engine, installing an improperly rated radiator cap may have adverse effects on the cooling system, and engine operating temperatures. This could cause premature engine wear or damage.

1. Using a radiator-cap tester, check the pressure cap to see if it maintains pressure to within 10 percent of the pressure rating marked on the cap. If it doesn't, replace the cap. Make sure that the replacement radiator cap is correctly rated for the cooling system of the vehicle.
2. There is a second valve in the radiator cap that opens under vacuum. This prevents the collapse of hoses and other parts that are not internally supported when the system cools. Inspect the vacuum-relief valve to be sure it is not stuck.

3. Make sure that the cap seals properly on the coolant filler neck seat, and that the radiator cap gasket is not damaged. On vehicles with screw-on caps with O-rings, make sure that the O-ring is not cracked or deteriorated. Replace the cap if the gasket shows deterioration or damage.

20–02 Radiator Pressure Flush and Coolant Change

NOTE: For additional instructions on cleaning and flushing the cooling system, see the engine manufacturer's maintenance and operation manual.

1. Place a large container under the radiator.
2. Remove the surge tank cap.

IMPORTANT: If the vehicle is equipped with heater circuit valves, the valves should be closed to prevent the loss of coolant.

3. Open the petcock at the bottom of the radiator to drain the engine coolant.
4. Disconnect the radiator inlet and outlet hose connections.
5. Attach a flushing gun nozzle to the radiator outlet.
6. Add water to the radiator until it is full.

NOTICE

When flushing the radiator, do not apply more than 20 psi (138 kPa) air pressure. Excessive pressure can damage the radiator or heater core.

7. Apply no more than 20 psi (138 kPa) air pressure intermittently to help dislodge sediment buildup in the core.
8. Drain the radiator, then flush the radiator until clean water flows from the radiator. Remove the flushing gun.
9. Close the petcock.
10. Using clamps, connect the hoses to the radiator. Torque the clamps 33 to 38 lbf·in (370 to 430 N·cm).

IMPORTANT: On vehicles with EPA07-compliant engines, the coolant capacity varies depending on the engine and accessory installation. After servicing the cooling system, always verify that the coolant level is between the MIN and MAX lines on the surge tank.

- Fill the radiator with coolant. Use a 50/50 mixture of antifreeze and water. Refer to the engine manufacturer's service literature for approved coolants.

See **Table 1** for engine cooling system capacities.

Coolant Capacities*	
Engine Make and Model	Coolant Volume: quarts (liters)
Cummins ISB	30.5 (28.9)
MBE900 (6.4L)	37 (35)

* The total coolant volume is dependent on the number and location of optional passenger heaters.

Table 1, Coolant Capacities

IMPORTANT: If the heater circuit valves were closed earlier, open the valves now.

20–03 Fan Drive Inspection (Noise Emission Control)

Horton Advantage® Fan Clutch

- Disconnect the batteries at the negative terminals. Drain all air from the air system.

WARNING

Make sure the batteries are disconnected before checking the fan clutch. If the engine starts during this procedure, the fan could engage, which could result in serious personal injury.

- Check the fan for loose rivets and missing weights. Check for bent, cracked, or missing blades. Tighten loose components. Replace the fan if necessary.
- Check the fan belt condition and the belt alignment. Replace or correct as necessary.

- Connect the battery cables. Start the engine, and charge the air system to 120 psi (827 kPa). Manually engage and disengage the fan clutch.

Check the fan and the fan clutch from a distance. Look for vibration, fan blade contact, fan clutch slippage, and overall fan clutch operation.

If the fan clutch does not operate correctly, see **Group 20** of the *Saf-T-Liner C2 School Bus Workshop Manual* for troubleshooting and repair procedures, or take the vehicle to an authorized Freightliner dealer.

- Check for adequate clearance between the fan and the fan shroud or other engine compartment components in both the engaged mode and the disengaged mode. If the clearance is not adequate, make the necessary adjustments.

Horton EC450™ Fan Clutch

NOTE: The Horton EC 450 fan clutch does not require any maintenance. If the fan drive is damaged, replace the unit. Do not attempt to repair it.

Horton HT650™ Fan Drive

Check for friction facing wear condition. Replace when worn to 1/16-inch (1.5-mm) thick, when oil-spotted, or when burn marks are visible.

Horton EC450™ Fan Drive

The Horton EC450 fan drive does not require maintenance. If the fan drive fails, it should be replaced with a new unit. Repair work should not be attempted.

Borg Warner Viscous Fan Drive

NOTE: The Borg Warner viscous fan drive does not require any maintenance. If the fan drive is damaged, replace the unit. Do not attempt to repair it.

NOTICE

If the fan drive assembly is damaged, replace the unit as soon as possible. Operating a seized or otherwise damaged clutch reduces fuel economy, and could cause serious engine damage.

See **Section 20.07** of the *Saf-T-Liner C2 School Bus Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer.

1. With the engine shut down, rotate the fan at least one full turn by hand. It should have a smooth, steady drag. If it does not, replace the fan clutch.
2. Check for physical damage to the fan or fan shroud.
3. Check for correct drive belt alignment and tension. For specifications, see **Group 01** of the *Saf-T-Liner C2 School Bus Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
4. Check for wear of the fan clutch bearings. There should be no side-to-side or in-and-out movement of the fan clutch.
5. Do all of the checks in **Section 20.00** of the *Saf-T-Liner C2 School Bus Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

20–04 Coolant Heater Check, Webasto

1. Using compressed air, clean any accumulated debris or dust from the heater and enclosure box. Inspect all components for wear or damage.
2. Check that the batteries are in good condition. If the voltage is too low or too high, the heater will automatically shut down. Check the wiring harnesses for damage. Replace the harnesses if necessary.
3. Check the air intake port for obstructions. Carefully check the air intake tube for any restrictions or damage, and repair or replace the tube if necessary.
4. Check the exhaust system for restrictions or corrosion. Replace any damaged parts.
5. Change the fuel filter, if so equipped. Inspect the fuel line for damage, restrictions, or loose connections. Repair or replace the line if it is damaged.
6. Inspect all coolant lines and clamps for leakage, restrictions, or damage. Replace the lines as

needed. Inspect the coolant circulation pump for leakage. Repair or replace the pump if it is damaged.

7. Run the heater at least once a month for 10 minutes.
8. Check the water and fuel connections for leakage. Tighten the hose clamps if needed.

20–05 Hybrid Electric System Coolant Change

1. Disconnect the 12-volt vehicle batteries to isolate the high voltage power source.

IMPORTANT: If the vehicle is equipped with heater circuit valves, the valves should be closed to prevent the loss of coolant.

2. Drain the hybrid radiator, as follows.
 - 2.1 Place a large container under the hybrid radiator.
 - 2.2 Remove the cap from the coolant reservoir.
 - 2.3 If equipped with a petcock at the bottom of the hybrid radiator, open it to drain the coolant.
 - 2.4 Disconnect the lower radiator hose, and drain the remaining coolant.
 - 2.5 Close the petcock, if equipped.
3. Install the lower radiator hose.
4. Fill the system with a coolant mixture of 50 percent ethylene glycol and 50 percent water.

IMPORTANT: If the heater circuit valves were closed earlier, open the valves now.

NOTE: ServiceRanger is a service and diagnostic software program available from Eaton Corporation. See the Eaton website, www.roadranger.com for more information.

5. Using ServiceRanger, activate the HEV coolant pump to purge any air that may be trapped in the system. Run the cooling pump until the air bubbles stop appearing in the reservoir tank.
6. Check the coolant level, and add coolant as needed. The system should be filled to the mid level of the reservoir.

Title of Maintenance Operation (MOP)	MOP Number
Clutch Hydraulic Fluid Changing	25-04
Clutch Hydraulic Fluid Level Checking	25-03
Eaton Fuller Clutch Release Bearing Lubricating	25-01
Eaton Fuller Clutch Release Cross-Shaft Lubricating	25-02
Electronic Clutch Actuator (ECA) Lubrication	25-05
Safety Precautions	25-00

25-00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

25-01 Eaton Fuller Clutch Release Bearing Lubricating

The standard clutch release bearing is sealed, and does not require lubrication. If the vehicle is not equipped with a maintenance-free sealed clutch release bearing, lubricate the bearing as follows:

1. Park the vehicle on a level surface. Apply the parking brake, and chock the rear tires.
2. Remove the clutch inspection plate.

NOTE: Some clutch release bearings are equipped with a lubrication extension that extends outside of the clutch housing. It is not necessary to remove the clutch inspection plate when the lubrication extension is used.

For lubricating the release bearing, Eaton Fuller recommends a lithium-base high-temperature grease that meets the NLGI Grade 1 or 2 specification.

3. Wipe the dirt away from the grease fitting. See [Fig. 1](#). Use a low-pressure-type grease gun equipped with the recommended grease, and lubricate the bearing until excess grease purges from the rear of the release bearing (toward the transmission).

CAUTION

Do not over-lubricate the clutch release bearing. Over-lubrication could contaminate the clutch internally, causing clutch slippage and premature

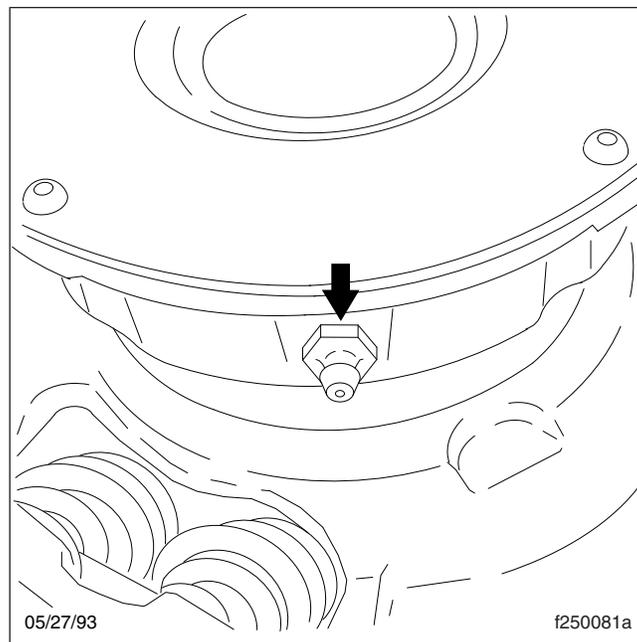


Fig. 1, Release Bearing Grease Fitting

failure. Do not use chassis grease or multipurpose lubricants.

4. Wipe off excess grease and apply to both the yoke finger and sleeve bushing contact points. See [Fig. 2](#).

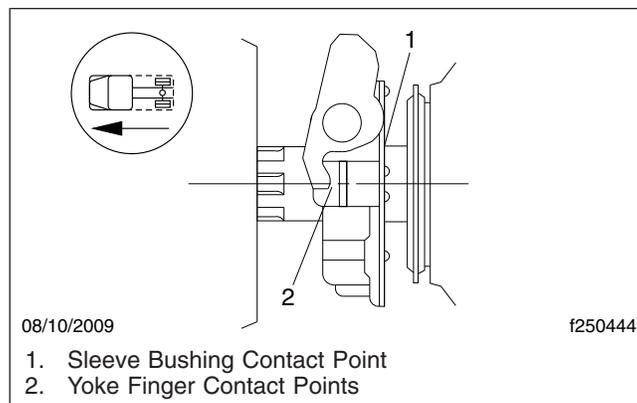


Fig. 2, Contact Points Requiring Grease

5. Install the clutch inspection plate.
6. Remove the chocks.

25-02 Eaton Fuller Clutch Release Cross-Shaft Lubricating

IMPORTANT: This maintenance operation pertains only to vehicles equipped with mechanical (not hydraulic) linkages.

The clutch release cross-shaft is equipped with two grease fittings in the transmission clutch housing. See **Fig. 3** and **Fig. 4**. Wipe the dirt from the grease fittings and lubricate with multipurpose chassis grease.

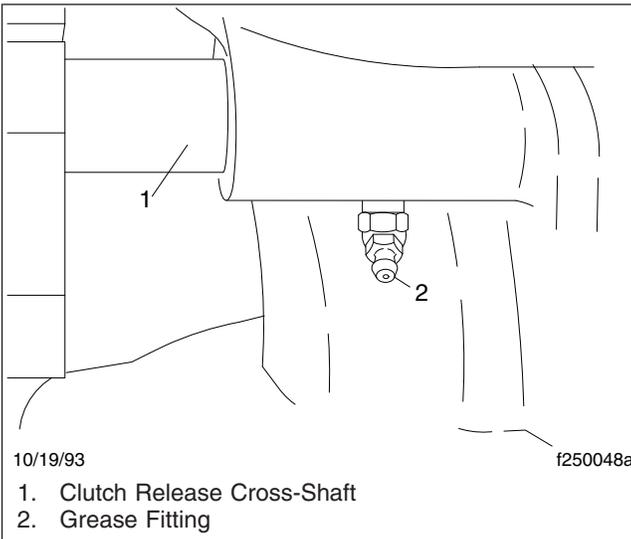


Fig. 3, Cross-Shaft Grease Fitting, Left Side

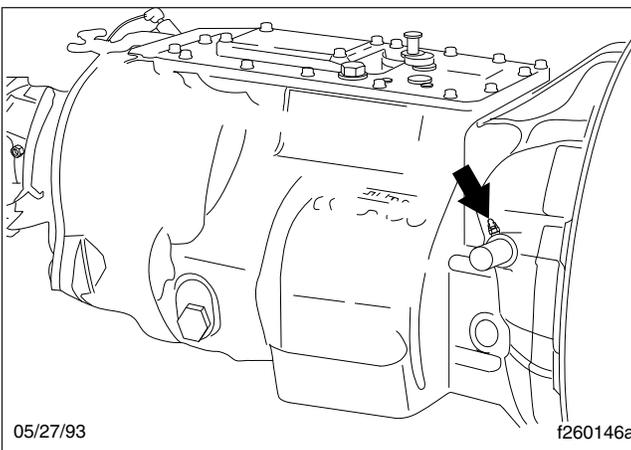


Fig. 4, Cross-Shaft Grease Fitting, Right Side

25-03 Clutch Hydraulic Fluid Level Checking

WARNING

Use only approved clutch hydraulic fluid (DOT 4 brake fluid) in the clutch hydraulic system. Do not mix different types of brake fluid. The wrong fluid will damage the rubber parts of the system, causing loss of clutch function and the risk of serious personal injury.

CAUTION

Do not allow the fluid level in the reservoir to go below the MIN line. If too much air enters, the hydraulic system will not operate correctly, and the clutch could be damaged.

If the fluid level is below the MIN line, fill the reservoir with DOT 4 brake fluid until the level reaches the MAX line. See **Fig. 5**.

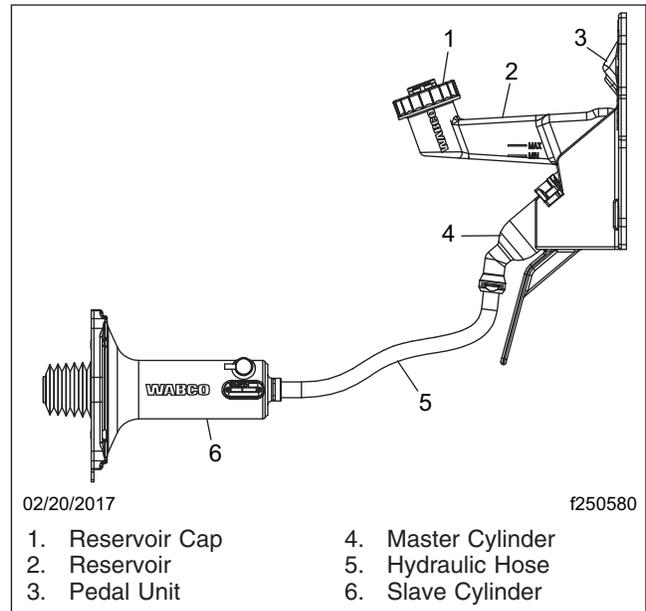


Fig. 5, Clutch Components

25–04 Clutch Hydraulic Fluid Changing

Replace the clutch hydraulic fluid every two years to ensure clutch function is reliable and correct. Use the procedures below. Fluid replacement must be done at an authorized Freightliner service facility.

Flushing

1. Shut down the engine.
2. Apply the parking brake, chock the front and rear tires, and raise the hood.

WARNING

Clutch hydraulic fluid (DOT 4 brake fluid) is hazardous. It may be a skin irritant and can cause blindness if it gets in your eyes. Always wear safety glasses when handling clutch hydraulic fluid or bleeding hydraulic lines. If you get clutch hydraulic fluid on your skin, wash it off as soon as possible.

3. Prepare the pressure bleeding equipment according to the manufacturer's instructions. Use DOT 4 brake fluid. Pressurize the bleed adaptor to 15 psi (103 kPa).

CAUTION

Do not spill clutch hydraulic fluid (DOT 4 brake fluid) on the body paint. Clean it off immediately if any is spilled. DOT 4 brake fluid can damage paint.

4. Remove the reservoir lid and install the pressure bleed adaptor on the reservoir.
5. Pressurize the reservoir, filling the system. Open the bleed valve on the bleed tank of the adaptor.

NOTE: A pressure bleeder hose (J-29532) and a bleed adaptor (J-35798) for the fluid reservoir are available through SPX Kent-Moore Tools and may be used to complete the following procedure. To order these parts, call Kent-Moore at 1-800-328-6657.

6. Flush the hydraulic system, as follows. See [Fig. 6](#).

- 6.1 Open the bleed screw on the slave cylinder.
 - 6.2 Using a drain pan or other suitable container, collect the fluid that drains from the slave cylinder bleed valve, at least 0.5 quarts (0.5 liters).
 - 6.3 When all the old fluid has passed through the system and only new, clean fluid is coming out, close the bleed screw.
7. Check the fluid level in the reservoir and bleed the system according to the procedure under the heading "Bleeding the Clutch." See [Fig. 7](#).

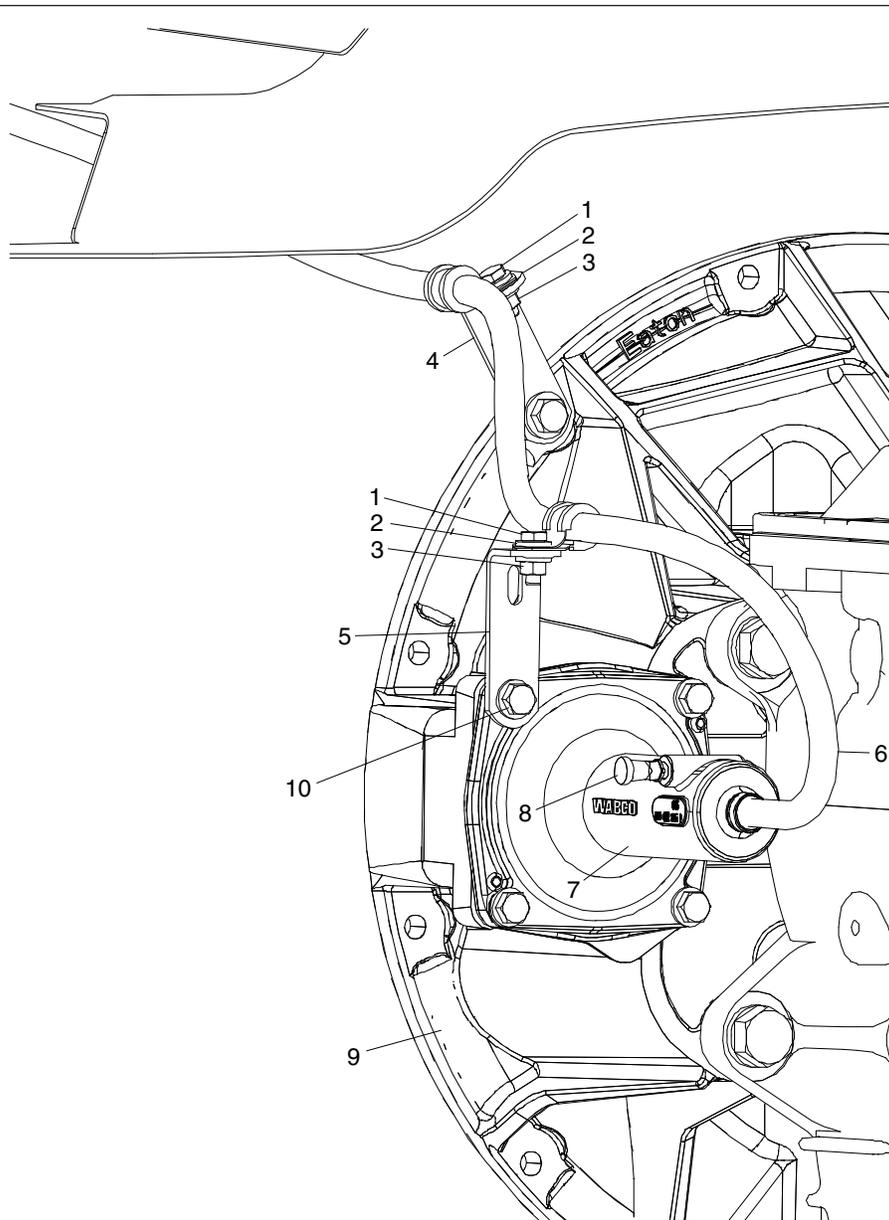
Bleeding the Clutch

1. Remove the cap from the bleed valve. Install a transparent drain hose on the bleed valve of the slave cylinder.
2. Open the slave cylinder bleed screw. Observe the flow of clutch hydraulic fluid through the drain hose. When no bubbles appear in the fluid, close the slave cylinder bleed screw.
3. Disconnect the transparent hose. Tighten the bleed screw 88 lbf-in (1000 N-cm) and install the cap on the slave cylinder bleed valve.
4. Close the valve on the bleed tank of the pressure bleed adaptor. Remove the pressure bleed adaptor.
5. Check the fluid level in the reservoir. If necessary, add or remove clutch hydraulic fluid to bring the fluid level to the MAX line. Install the reservoir lid.

CAUTION

When removing fluid from the reservoir, use a clean tool that is used only for brake fluid. Using a tool contaminated with oil or chemical residue will destroy hydraulic system parts and cause the system to malfunction.

6. Depress the clutch pedal a few times. There should be resistance over the full pedal stroke.
7. Check the entire system for leaks. Tighten the connections between the components if necessary. Check the fluid level in the reservoir again.
8. Make sure the reservoir lid is tight.



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|----------------------------------|------------------------------------|--|
| 1. Clamp Mounting Bolt, 1/4–20 | 5. Slave Cylinder Standoff Bracket | 8. Bleed Valve |
| 2. Plated Steel Washer | 6. Hydraulic Hose | 9. Bell Housing |
| 3. Locknut, 1/4–20 | 7. Slave Cylinder | 10. Slave Cylinder Mounting Capscrew, M8 |
| 4. Bell Housing Standoff Bracket | | |

Fig. 6, Clutch Slave Cylinder

9. Lower the hood and remove the chocks from the front and rear tires.

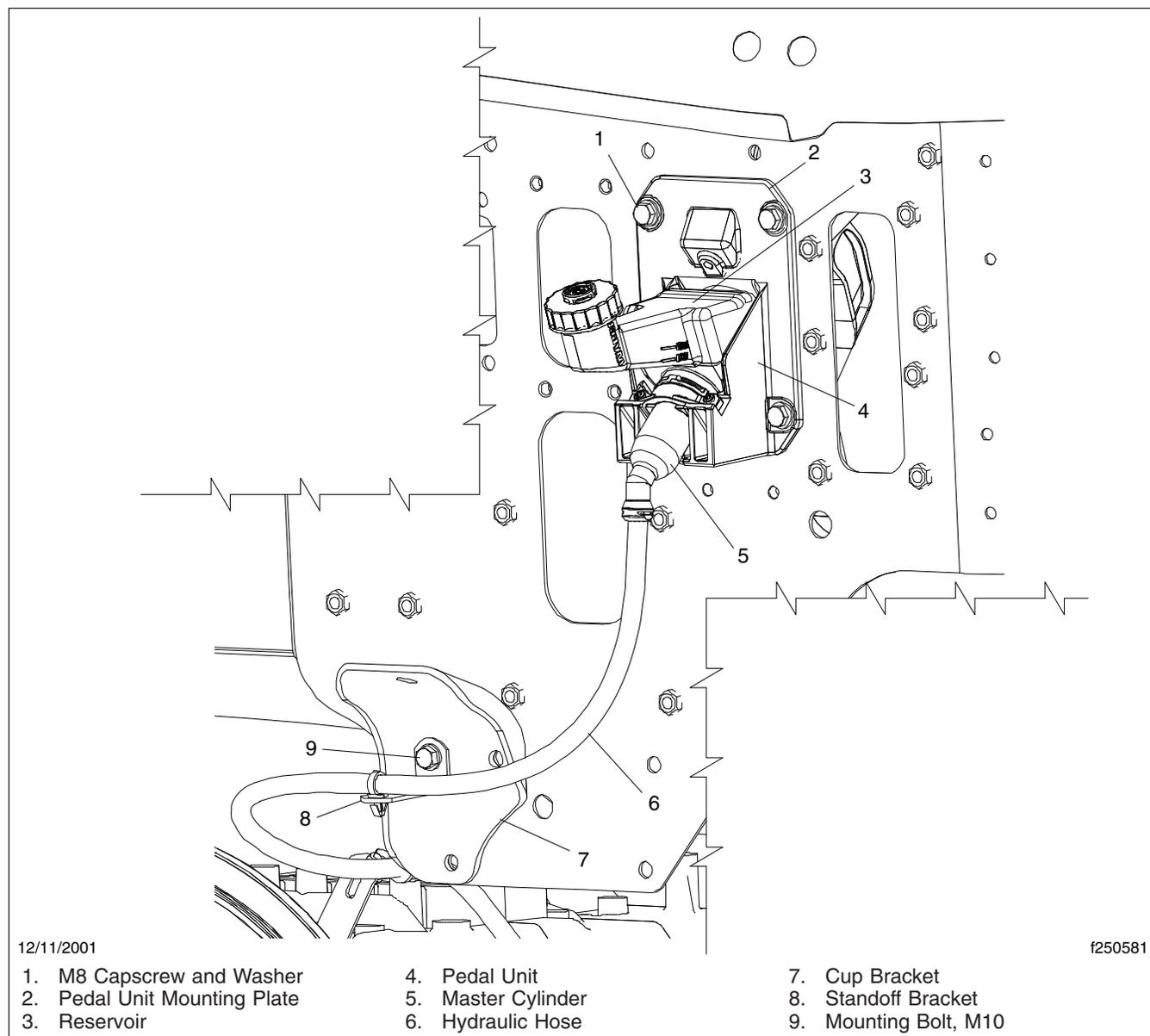


Fig. 7, Clutch Master Cylinder

25-05 Electronic Clutch Actuator (ECA) Lubrication

Hybrid electric vehicles (HEVs) are equipped with a grease fitting near the transmission clutch housing. See **Fig. 8**. Wipe the dirt from the grease fitting and lubricate with Eaton® Roadranger® CD50 or equivalent E500 synthetic.

IMPORTANT: For the most up-to-date Eaton approved lubricants, go to www.roadranger.com.

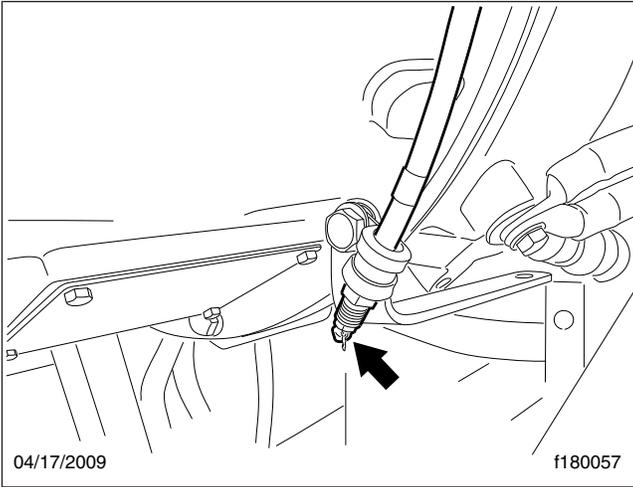


Fig. 8, Cross Shaft Grease Fitting for HEVs

Title of Maintenance Operation (MOP)	MOP Number
Allison Transmission Fluid and Filter Changing	26-04
Allison and Eaton Fuller Transmission Breather Checking	26-03
Eaton Fuller Hybrid Transmission Fluid Changing	26-05
Eaton Fuller Transmission Fluid Changing and Magnetic Plug Cleaning	26-02
Manual Transmission Oil Level Checking	26-01
Safety Precautions	26-00

26–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

26–01 Manual Transmission Oil Level Checking

1. Park the vehicle on a level surface. Apply the parking brake and chock the rear tires.
2. Clean the area around the fill plug, then remove the plug from the side of the case.
3. Check that the oil is level with the lower edge of the transmission fill opening. See [Fig. 1](#).

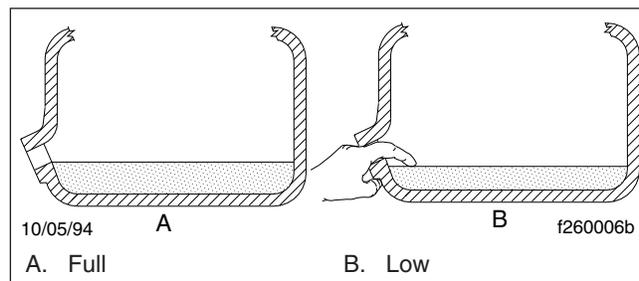


Fig. 1, Transmission Oil Level Checking

IMPORTANT: A lubricant level close enough to be seen or touched is not sufficient. It must be level with the lower edge of the fill opening.

4. If needed, fill the transmission with oil until level with the lower edge of the fill opening. See [Table 1](#) for approved lubricants.

For more information and a complete listing of approved lubricants, refer to the Eaton website, www.roadranger.com.

Eaton Approved Manual Transmission Lubricants		
Lubricant Type*	Temperature: °F (°C)	SAE Viscosity
Synthetic transmission lubricant meeting Eaton PS-386 lubricant specification	All	—
Heavy-duty engine oil meeting MIL-L-2104D or Caterpillar TO-4 Specification	Above 10 (–12)	40 or 50
	Below 10 (–12)	30

* Lubricants listed in order of preference. Do not mix types of oil.

Table 1, Eaton Approved Manual Transmission Lubricants

CAUTION

Operating a manual transmission with the fluid level higher or lower than recommended can result in transmission damage. Do not overfill the transmission; overfilling will force fluid out of the case through the main shaft openings. Fluid overflow may also drain onto the clutch or clutch brake, causing additional problems.

IMPORTANT: Do not mix types of oil, because of possible incompatibility. Do not use oil additives or friction modifiers. Do not use multi-viscosity oils or EP (Extreme Pressure) gear oils. If switching from a petroleum-based lubricant to a synthetic, all areas of each affected component must be thoroughly drained. Switching to a synthetic lubricant, when a petroleum-based lubricant has been used for 50,000 miles (80 000 km) or longer may affect transmission performance. Monitor all seal areas for the first 10,000 miles (16 000 km) after changing to a synthetic from a petroleum-based lubricant.

5. Clean the fill plug, then install it in the transmission. Tighten the plug as follows:
 - 25 to 35 lbf·ft (34 to 48 N·m) for transmissions with 3/4-inch pipe threads.
 - 60 to 75 lbf·ft (81 to 102 N·m) for transmissions with 1-1/4-inch pipe threads.

26–02 Eaton Fuller Transmission Fluid Changing and Magnetic Plug Cleaning

IMPORTANT: For oil change intervals, see the applicable Eaton Fuller Driver Manual or Service Manual.

Eaton Fuller has a complete listing of approved lubricants for its transmissions on its internet website. Refer to the Eaton website for additional information, www.roadranger.com.

Draining

IMPORTANT: Manual transmissions filled with approved synthetic lubricants require a lubricant drain and fill, and a magnetic plug cleaning every 500,000 miles (800 000 km), regardless of the service or vocation of the vehicle. Manual transmissions with petroleum-based lubricants require a lubricant drain and fill, and a magnetic plug cleaning at each Maintenance 2 (M2) interval. All transmissions, regardless of lubrication used, also require a check of the transmission breather at each Maintenance 1 (M1) interval.

1. Park the vehicle on a level surface. Apply the parking brake and chock the rear tires.
2. Drain the fluid while the transmission is warm.
 - 2.1 Clean the area around the drain plug(s). Remove the drain plug(s) from the gear case.
 - 2.2 Clean the area around the fill plug. Remove the fill plug from the gear case.
3. Clean the magnetic plug(s) before installing it. Use a piece of key stock, or any other convenient steel slug, to short the two magnetic poles and divert the magnetic field.
4. Install and tighten the drain plug(s) 50 lbf-ft (68 N-m).

Filling



CAUTION

Operating a manual transmission with the fluid level higher or lower than recommended can result in transmission damage. Do not overfill the transmission; overfilling will force fluid out of the case through the main shaft openings. Fluid overflow may also drain onto the clutch or clutch brake, causing additional problems.

IMPORTANT: Do not mix types of fluid, because of possible incompatibility. Do not use multi-viscosity fluids or EP (Extreme Pressure) gear fluids. Do not use fluid additives or friction modifiers. If switching from a petroleum-based lubricant to a synthetic, all areas of each affected component must be thoroughly drained. Switching to a synthetic lubricant, when a petroleum-based lubricant has been used for 50,000 miles (80 000 km) or longer may affect transmission performance. Monitor all seal areas for the first 10,000 miles (16 000 km) after changing to a synthetic from a petroleum-based lubricant.

NOTE: The correct fluid level is established by checking at the fill plug opening.

1. Add fluid until it is level with the lower edge of the fill opening. See [Fig. 1](#). If the transmission has two fill openings, add fluid to the level of both fill openings. See [Table 1](#) for approved transmission lubricants, and [Table 2](#) for lubricant capacities.
2. Clean the fill plug, then install it in the transmission. Tighten the plug as follows:
 - 25 to 35 lbf-ft (34 to 48 N-m) for transmissions with 3/4-inch pipe threads.
 - 60 to 75 lbf-ft (81 to 102 N-m) for transmissions with 1-1/4-inch pipe threads.

Eaton Fuller Transmission Lubricant Capacities*	
Transmission Model	Capacity: qt (L)
<i>5-Speed</i>	
FS-5205A/B	6.25 (5.9)
FS-6305A/B	9.75 (9.2)
<i>6-Speed</i>	

Eaton Fuller Transmission Lubricant Capacities*	
Transmission Model	Capacity: qt (L)
FS-5406A	9.75 (9.2)
FS-6406A, FSO-6406A	9.75 (9.2)
FSO-8406A	9.75 (9.2)

* Quantities listed are approximate. Fill the transmission until the lubricant is level with the bottom of the fill hole, with the vehicle in normal operating position.

Table 2, Eaton Fuller Transmission Lubricant Capacities

26-03 Allison and Eaton Fuller Transmission Breather Checking

Transmission housing breathers (if so equipped) must remain clear. A plugged breather could result in pressure build-up, which could cause oil leakage.

If the breather is plugged, clean or replace it. See [Fig. 2](#). Check more often if the vehicle is operating under very dusty conditions.

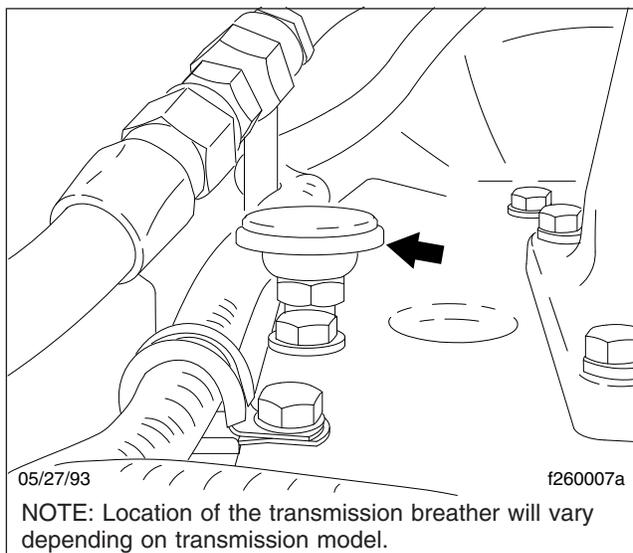


Fig. 2, Transmission Breather (Eaton Fuller shown)

26-04 Allison Transmission Fluid and Filter Changing

IMPORTANT: For oil and filter change intervals, see the applicable Allison Operator's Manual.

When draining transmission fluid, check for evidence of dirt or water contamination. A small amount of condensation will appear in the fluid during operation.

Water contamination is normally characterized as a milky discoloration of the transmission fluid. Obvious contamination of the transmission fluid indicates a leak between the water and fluid areas of the transmission cooler. Inspect and pressure-test the cooler to confirm the leak; replace leaking transmission coolers.

2100/2200/2500 Series

1. Park the vehicle on a level surface and apply the parking brake.
2. Run the engine until the transmission fluid reaches the operating temperature of 160 to 200°F (71 to 93°C). Shift the transmission to neutral (N) and shut down the engine.

CAUTION

To prevent dirt from entering the transmission, use only clean containers and fillers for the transmission fluid. Do not use fillers or containers that have been used for water or antifreeze. Dirt, water, or antifreeze could damage the transmission.

3. Clean the area around the drain plug. Place a drain pan under the transmission and remove the drain plug. Examine the fluid while it drains. If only the filter is being changed, do not drain the fluid.

NOTE: A lot of fluid will drain when the filter is removed.

4. Using a standard strap-type filter wrench, remove the filter by turning it counterclockwise. See [Fig. 3](#).
5. Remove the magnet from the filter attachment tube or from the top of the filter element.
6. Clean any metal debris from the magnet. Then, install the magnet on the filter attachment tube.

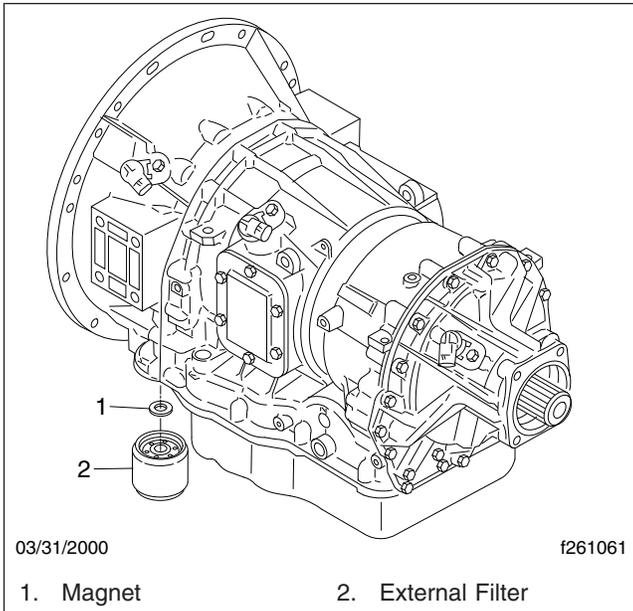


Fig. 3, 2100/2200/2500 Series Transmission External Filter

7. Using transmission fluid, lubricate the gasket on the filter.
 8. Using your hand, install the filter by turning it clockwise until the filter gasket contacts the converter housing or cooler manifold. Then, turn the filter one more complete turn.
 9. Install the drain plug and sealing washer. Tighten the plug 22 to 30 lbf·ft (30 to 40 N·m).
 10. Clean the area around the fill tube and remove the dipstick. Using a clean funnel in the fill tube, add transmission fluid. See [Table 3](#) for approved transmission lubricants, and [Table 4](#) for lubricant capacities.
 11. Check and adjust the fluid level using the procedure under "Checking the Fluid Level".
- mission fluid. Do not use fillers or containers that have been used for water or antifreeze. Dirt, water, or antifreeze could damage the transmission.**
1. Park the vehicle on a level surface and apply the parking brakes.
 2. Operate the vehicle until the transmission reaches normal operating temperature: 160 to 200°F (71 to 93°C).
 3. Clean the area around the drain plug and the transmission fluid pan. Place a drain pan under the transmission and remove the drain plug. Examine the fluid as it drains. If only the filter is being changed, do not drain the fluid.
 4. Remove the 12 mounting bolts (6 each) from the 2 filter covers.
- NOTE:** A lot of fluid will drain when the filter covers are removed.
5. Remove the filter covers, O-rings, and two square-cut seals from the transmission. See [Fig. 4](#).
 6. Remove the filters from the bottom of the control module.
 7. Lubricate the new O-rings with transmission fluid, and install them on the cover assemblies.
 8. Install a new square-cut seal on each cover assembly, and install the fluid filter elements on the cover assemblies.
 9. Install the filter and cover assemblies into the filter compartment.
 10. Align each cover assembly with the holes in the channel plate sump, and push the cover assemblies in by hand to seat the seals.

3000 Series

CAUTION

To prevent dirt from entering the transmission, use only clean containers and fillers for the trans-

CAUTION

Do not use the bolts to draw the filter covers to the sump. This can damage the covers, seals, or sump.

11. Install six bolts in each cover, and tighten the bolts 38 to 44 lbf·ft (51 to 61 N·m).

Approved Allison Transmission Lubricants*		
TES-295 Approval Number	Company	Product Brand Name
AN-051005	ExxonMobil Lubricants and Petroleum Specialties Company	Mobil Delvac Synthetic ATF
AN-011001	Castrol Heavy Duty Lubricants	TranSynd
AN-031002	BP	Autran Syn 295
AN-031003	Cognis Corporation	Emgard 2805
AN-031004	International Truck & Engine Company	Fleetrite Synthetic ATF
AN-071006	John Deere & Company	HD SynTran

* To check the latest Allison approved fluids, go to www.allisontransmission.com. Lubricants listed in order of preference. Do not mix types of oil.

Table 3, Approved Allison Transmission Lubricants

Allison Transmission Lubricant Capacities	
Transmission Model	Fill Capacity:* qt (L)
2100/2200/2500 Series (standard sump)	15 (14)
2100/2200/2500 Series (shallow sump)	13 (12)
3000 Series (4 inch sump)	29 (27)
3000 Series (2 inch sump)	26 (25)

* Quantities listed are approximate. Add the recommended amount of fluid as listed under fill capacity. Do not overfill.

Table 4, Allison Transmission Lubricant Capacities

12. Install a new drain plug O-ring, and install the drain plug. Tighten the drain plug 18 to 24 lbf-ft (25 to 32 N·m).
13. Fill the transmission with fresh transmission fluid and check the fluid level. See **Table 3**. See **Table 4** for lubricant capacities.
14. Check and adjust the fluid level using the procedures under "Checking the Fluid Level".

Checking the Fluid Level



Operating a transmission with the fluid level higher or lower than recommended can result in transmission damage. Do not overfill the transmission. Overfilling will force fluid out of the case through the main shaft openings.

Do not mix types and brands of fluid, because of possible incompatibility. Do not use fluid addi-

tives, friction modifiers, extreme-pressure gear fluids, or multiviscosity lubricants.

Cold Check

Clean all dirt away from around the end of the fluid fill tube before removing the dipstick.



Do not allow foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of transmission parts, make valves stick, and clog passages.

After replacing the transmission fluid or changing the filter(s), it is important to check the fluid level cold to determine if the transmission has a sufficient amount of fluid to be safely operated until a hot check can be performed.

1. Park the vehicle on a flat, level surface.
2. Apply the parking brake and chock the rear tires.
3. Run the engine for at least one minute.
4. Shift from DRIVE to NEUTRAL, and then shift to REVERSE to fill the hydraulic system.
5. Shift to NEUTRAL and allow the engine to idle at 500 to 800 rpm.
6. With the engine running at idle, remove the dipstick from the tube, then wipe the dipstick clean.
7. Insert the dipstick into the tube and remove the dipstick.
8. Check the fluid level reading and repeat the check procedure to verify the reading.

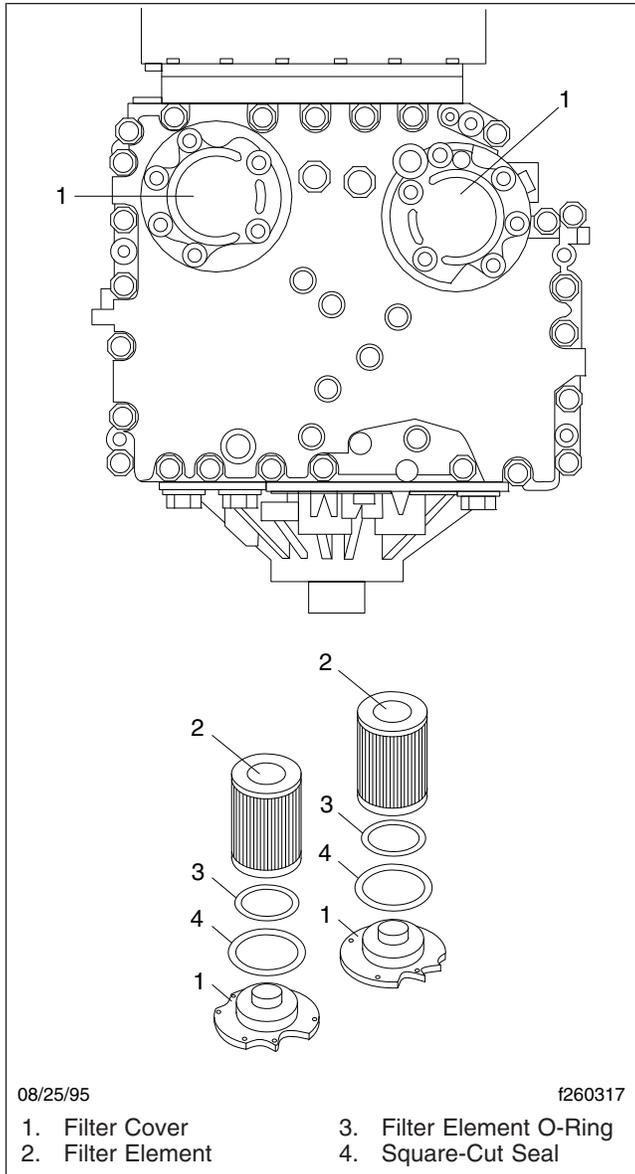


Fig. 4, Allison 3000 Series Transmission Filter Location and Components

If the fluid level is within the COLD RUN band, the transmission may be operated until the fluid is hot enough to perform a HOT RUN check.

If the fluid level is not within the COLD RUN band, add or drain fluid as needed to adjust the fluid level to the middle of the COLD RUN band. See Fig. 5.

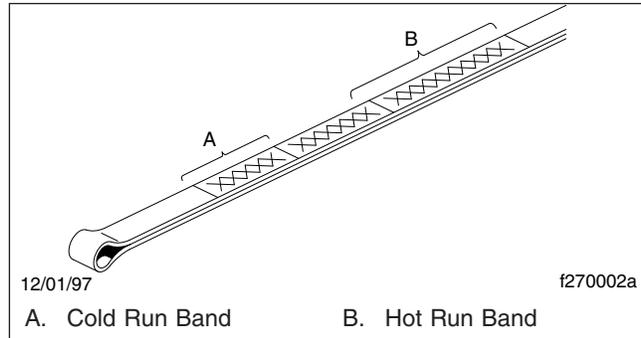


Fig. 5, Dipstick Markings

CAUTION

Do not fill above the COLD RUN band if the transmission fluid is below normal operating temperature. As fluid temperature increases, so does the fluid level. Filling above the COLD RUN band when the transmission is below normal operating temperature may result in an overfilled transmission, which causes fluid foaming and aeration. Fluid foaming and aeration cause transmission overheating and erratic shifting.

NOTE: Perform a hot check at the first opportunity after the normal operating temperature, 160 to 200°F (71 to 93°C) has been reached.

Hot Check

Recommended Method

With the vehicle on a level surface and the transmission in neutral at operating temperature, perform the steps below.

1. On the transmission shift selector, press the up and down arrow keys simultaneously. See Fig. 6.
2. Release the arrow keys and wait for a two-minute countdown.
3. The transmission shift selector display screen will display one of the following messages.
 - OL - OK indicates an acceptable oil level.
 - OL - HI followed by a number indicates the amount that is over-filled.
 - OL - LO followed by a number indicates the amount that is under-filled.
 - OL - 70 indicates that the transmission is not up to operating temperature.

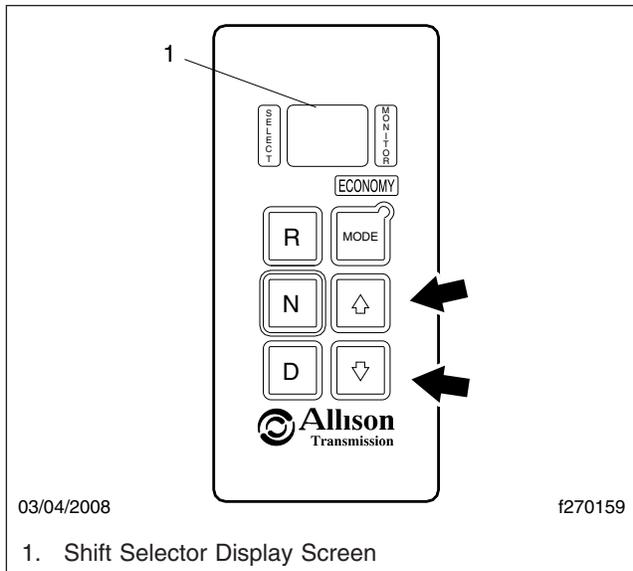


Fig. 6, Transmission Shift Selector

Alternate Method

1. Park the vehicle on a flat, level surface. Apply the parking brake and chock the rear tires.
2. Shift the transmission to Neutral (N).
3. Operate the engine at idle (500 to 800 rpm) until normal operating temperature is reached. Check that the sump temperature is 160 to 200°F (71 to 93°C).
4. With the engine idling, remove the dipstick from the tube and wipe it clean.
5. Insert the dipstick into the tube and remove it.
6. Check the fluid level reading and repeat the check procedure to verify the reading. Safe operating level is within the HOT RUN band on the dipstick. The HOT RUN band is between the HOT FULL and HOT ADD marks.

If the fluid level is not within the HOT RUN band, add or drain fluid as needed to bring the fluid level within the HOT RUN band. See [Fig. 5](#).

26–05 Eaton Fuller Hybrid Transmission Fluid Changing

Draining Transmission Fluid

IMPORTANT: For the most up-to-date Eaton approved lubricants, go to www.roadranger.com.

1. Park the vehicle on a level surface, shut down the engine, and apply the parking brake. Chock the tires.
2. Place a drain pan under the drain plug.
3. Remove the drain plug and let the transmission fluid drain completely.
4. Once the fluid has drained, clean and install the drain plug. Tighten the plug 45 to 55 lbf-ft (61 to 75 N·m).

Filling Transmission Fluid

1. Remove the transmission fill plug.
2. Add transmission fluid until the fluid starts flowing out of the fill hole. See [Fig. 7](#).
3. Clean the fill plug, then install it in the transmission. Tighten the fill plug 60 to 70 lbf-ft (81 to 95 N·m).

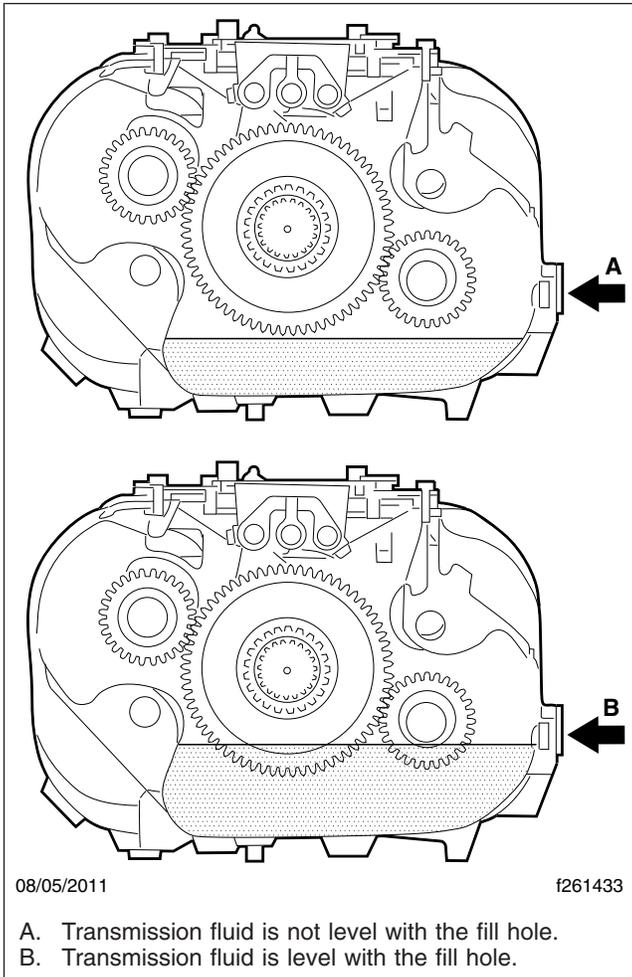


Fig. 7, Transmission Fluid Levels

Title of Maintenance Operation (MOP)	MOP Number
Automatic Tire Chain System Checking	31-02
Frame Fastener Torque Check	31-01
Off-Season Chain Wheel Removal	31-03
Safety Precautions	31-00

31–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

31–01 Frame Fastener Torque Check

Frame brackets and components secured with Huck-bolt® fasteners do not require a torque check, however, they should be inspected for damage. Frame brackets and components secured with conventional bolts and nuts are to be checked at initial maintenance (IM).

Check the torque of frame fasteners to offset the effects of bedding in or seating. When possible, always check the torque of the nut, not the bolt head. This will give a true torque reading by eliminating bolt body friction.

When checking the torque of frame fasteners, inspect the frame for cracks and other damage. Set a click-type torque wrench to the maximum torque of the fastener you are checking. Apply pressure until the torque wrench clicks. Do not loosen the bolt to check the torque. For torque values, see the applicable torque table in **Group 00** of the vehicle *Maintenance Manual*.

NOTICE

Make sure frame fasteners are properly tightened. Continued vehicle operation with loose fasteners could result in bracket or frame damage.

NOTE: Engine supports on vehicles built from January 2007 require the same maintenance as shown below.

Inspect the fasteners at the following locations:

- axle stops

- engine trunnion supports
- exhaust brackets
- frame crossmembers and gussets
- front frame brackets
- front suspension spring brackets
- fuel tank brackets
- radius rods
- rear engine supports
- rear suspension spring brackets
- shock absorbers
- all other frame fasteners

Any component that shows signs of cracking or damage must be repaired or replaced. See the applicable group in the vehicle *Workshop Manual* for repair or replacement information.

31–02 Automatic Tire Chain System Checking

IMPORTANT: The system check should be completed every 500 hours of truck operation.

1. Check all nuts and bolts and make sure they are tight.
2. Grease the chain wheel bearings and arm bearings to prolong their life.
3. Check the chain wheel bearings and arm bearings for play.
4. Inspect the chain links for wear. Make sure there are at least nine links for 190 mm wheels and seven links for 170 mm wheels.
5. Engage the tire chain system and check for air leaks.
6. Check the chain wheel pressure against the tire. It should be at least 20 lbs (9 kg).
7. Drain any water out of the air tank to keep the air lines free of dirt and water. Excess dirt and water may damage the solenoid valve or cause premature wear.
8. Actuate the solenoid valve to keep it clean and functioning correctly.

⚠ WARNING

Due to the high spring tension of the return spring, disassembly of the air cylinder should only be done by qualified personnel. It is recommended that the air cylinder be sent to the chain manufacturer for any repair work. Failure to do so could result in serious personal injury, death, or property damage.

31–03 Off-Season Chain Wheel Removal

1. Remove the chain wheels during the spring and summer months to prolong the life of the arm bearings and components. When the chain wheels are removed, mark how the spacers are placed between the arm and the wheel. When the chain wheels are once again installed for the winter months, put the spacers back between the arm and the wheel as they were before.
2. Although not required, the chain units may also be removed. If this is done, put the vehicle unit number on the chain wheels and chain units. Leave the mounting brackets in place and plug the air lines.
3. Disconnect the dashboard switch or remove the fuse. This will keep the system from being unknowingly activated during the off season.
4. Inspect the chain wheels, arm bearings, and angle joints for wear to ensure the system is ready for the next season.

Title of Maintenance Operation (MOP)	MOP Number
Safety Precautions	32-00
Suspension Inspecting	32-01
Suspension Lubricating	32-02
Suspension U-Bolt Torque Checking	32-03

32–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

32–01 Suspension Inspecting

Freightliner Spring Front and Rear Suspension Spring Assemblies Inspection

Inspect the front and rear suspension spring assemblies for pitted, cracked, broken, or abnormally bent leaves and extreme rust. If any of these conditions exist, replace the spring assembly. See **Group 32** of the *Saf-T-Liner C2 School Bus Workshop Manual* for instructions.

WARNING

Do not replace individual leaves of a damaged leaf spring assembly; replace the complete spring assembly. Visible damage (cracks or breaks) to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. On front spring assemblies, if cracks or breaks exist in the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in property damage, serious personal injury, or death.

IMPORTANT: On multi-leaf suspensions, closely inspect each component of the leaf spring assemblies, including the brackets, U-bolts, and related parts.

Freightliner Spring Shock Absorber Check

NOTE: Shock absorbers are optional on spring suspensions.

Make sure that the shock absorber brackets are tight and that the shock absorber is not striking or rubbing on the frame or some other part of the chassis. Check the rubber mounting bushings and replace them if worn. Inspect the shock absorber for oil leakage, which is defined as being drips of oil on the sides of the shock absorber.

If the shock absorber is worn or damaged, replace it with a new one.

Freightliner AirLiner Torque Arm Bushing Check

1. Without detaching the torque arms, use your hand to attempt to move each of the torque arm ends up, down, in, and out. If there is any movement, replace the torque arm.
2. Inspect the weld seams between the torque arm tube and the shorter bushing tubes. If there are cracks, replace the torque arm. Do not weld the torque arm for any reason.
3. Inspect the rubber bushing ends. See **Fig. 1**. Replace the torque arm for any of the following reasons.
 - There are gaps between the rubber bushing and the pin or the outer steel sleeve.
 - Either bushing end contacts a torque arm pin mounting bolt.
 - There are cracks in the bushing.
 - Part of the rubber bushing extends beyond the outside diameter of the outer bushing sleeve.

52-Inch Multi-Leaf Spring Component Check

No lubrication is required on the 52-inch multi-leaf spring rear suspension.

Inspect the stabilizer bar, if present, for irregular bushing wear or cracks in the brackets. Check the rubber helper spring, if present, for cracks.

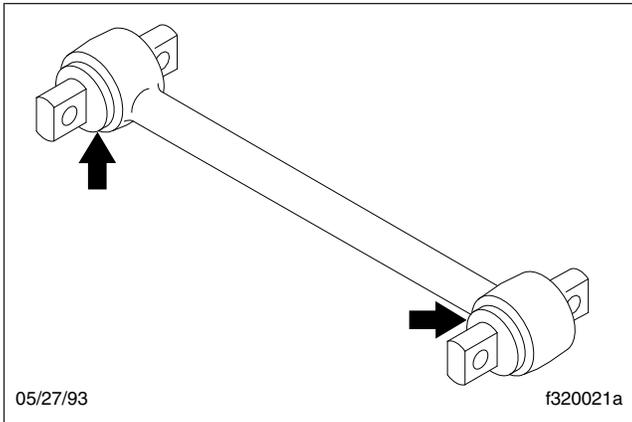


Fig. 1, Torque Arm Bushings

Freightliner AirLiner Component Clearance Check

Check that the air line support brackets are positioned so the air lines do not rub against anything. Reposition any configurations that could contact the air line and result in friction and wear. There must be at least 1 inch (25 mm) clearance around the rubber air spring when inflated. If the clearance is less than 1 inch (25 mm), relocate the obstructing parts.

CAUTION

Failure to relocate obstructing parts could result in damage to the air spring.

Freightliner AirLiner Component Inspection and Operation Check

WARNING

Inspect the components and check their operation as described below. Failure to perform these inspections and checks could result in separation of worn suspension components and loss of vehicle control, possibly causing personal injury or death, or property damage.

1. Check the front tires and apply the parking brake. Raise the rear of the vehicle so the tires just clear the ground and the suspension is fully extended. Place safety stands under the vehicle frame.

2. Squeeze all air springs to check for complete deflation.
3. Inspect each air spring for wear at its connection to its pedestal. Replace any worn air springs.
4. Check the axle connection welds (beam seat to equalizing beam) and axle adapter to axle for cracks. If the welds are cracked, grind them out and reweld the parts.
5. Move the axle up and down while checking for signs of looseness due to worn parts at the front pivot connections. Replace any worn parts.
6. Inspect the shock absorbers for oil leaks and worn rubber bushings. Replace the shock absorbers and/or rubber bushings if wear or damage is noted.
7. Inspect the stabilizer bar, if so equipped, for irregular bushing wear or cracks in the brackets. The stabilizer bar is optional on 10,000- and 15,000-pound AirLiner suspension systems.
8. Remove the safety stands and lower the rear of the vehicle to the ground. Run the engine until air pressure of at least 100 psi (689 kPa) is maintained throughout the system.
9. Check that all air springs are inflated.

Freightliner AirLiner Control Rod Check

1. Without disconnecting the control rods, use your hand to attempt to move each of the control rod ends up, down, in, and out. If there is any movement, examine the control rods for wear or damage. Replace the control rod(s) if necessary.
2. Inspect the rubber bushings for cracks or cuts.
3. Check for any shifting of the barpin.
4. Check for cracks in the metal components and welds.

32-02 Suspension Lubricating

Freightliner Taperleaf Front Suspension

Wipe all dirt from the grease fittings at the forward spring pin and the spring shackle pins. Then apply

multipurpose chassis grease with a pressure gun until the old grease is forced out.

Freightliner AirLiner Rear Suspension

Lubrication is not required on single-axle spring rear suspensions.

Freightliner Leaf Spring Rear Suspension

Wipe all dirt from the grease fittings at the rear leaf spring. Then apply multipurpose chassis grease with a pressure gun until the old grease is forced out. See [Fig. 2](#) for the location of the grease fitting.

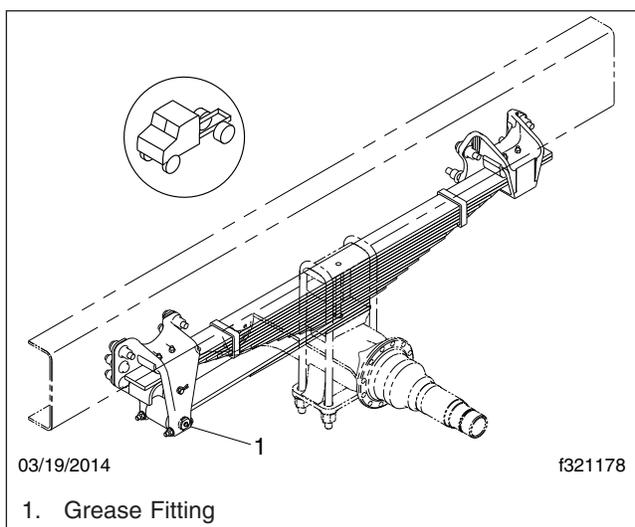


Fig. 2, Grease Fitting, Freightliner Leaf Spring Rear Suspension

32–03 Suspension U-Bolt Torque Checking

Check the U-bolt torque of both the front and rear axles where applicable.

CAUTION

Failure to retorque the U-bolt nuts could result in spring breakage and abnormal tire wear.

1. Park the vehicle on a flat surface and apply the parking brake. Chock the tires.

2. Check the U-bolt torque in a diagonal pattern. See [Table 1](#) for U-bolt torque specifications. Turn the wrench in a clockwise motion (looking up) until the torque wrench clicks.
3. Remove the chocks.

U-Bolt High Nut Torque*	
Size	Torque: lbf-ft (N·m)
5/8–18	Stage 1: Hand tighten Stage 2: 60 (81) Stage 3: 180 to 230 (245 to 313)
3/4–16	Stage 1: Hand tighten Stage 2: 60 (81) Stage 3: 200 (271) Stage 4: 270 to 330 (367 to 449)
7/8–14	Stage 1: Hand tighten Stage 2: 60 (81) Stage 3: 200 (271) Stage 4: 420 to 500 (571 to 680)
1–14	Stage 1: Hand tighten Stage 2: 60 (81) Stage 3: 200 (271) Stage 4: 520 to 600 (707 to 816)

* Tighten in the sequence shown in [Fig. 3](#).

Table 1, U-Bolt High Nut Torque

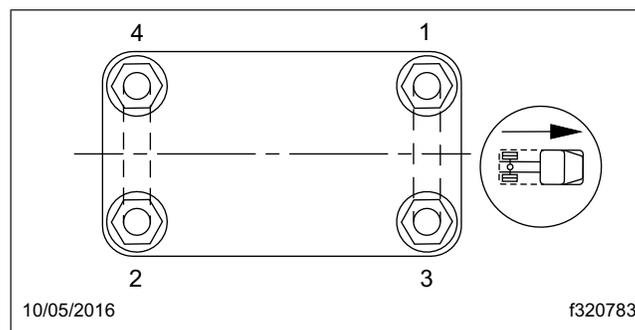


Fig. 3, Tightening Sequence for U-Bolt High Nuts

Title of Maintenance Operation (MOP)	MOP Number
Draw Key Nut Inspecting	33-03
Kingpin Lubricating, Detroit™ Axle	33-01
Safety Precautions	33-00
Tie Rod End Inspecting	33-04
Tie Rod End Lubricating	33-02

33-00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

33-01 Kingpin Lubricating, Detroit™ Axle

NOTICE

Use regulated pressure when lubricating the knuckle assemblies, otherwise damage could result to the knuckle caps.

On the front axle, grease fittings are on the top and bottom caps of each knuckle.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires. When lubricating upper and lower knuckle assemblies, do not raise the front axle.
2. Wipe the grease fittings clean.
3. Apply multipurpose chassis grease, NLGI Grade 1 (6% 12-hydroxy lithium stearate grease) or NLGI Grade 2 (8% 12-hydroxy lithium stearate grease), until new grease is seen at the junctions of the axle beam and knuckles. For locations of grease fittings, see Fig. 1; for grease exit points, see Fig. 2.

33-02 Tie Rod End Lubricating

Procedures for Detroit and Meritor axles are provided below.

Detroit Axle

For any Detroit axle that requires lubrication of the tie-rod ends, wipe the grease fittings clean, then pump multipurpose chassis grease, NLGI Grade 1

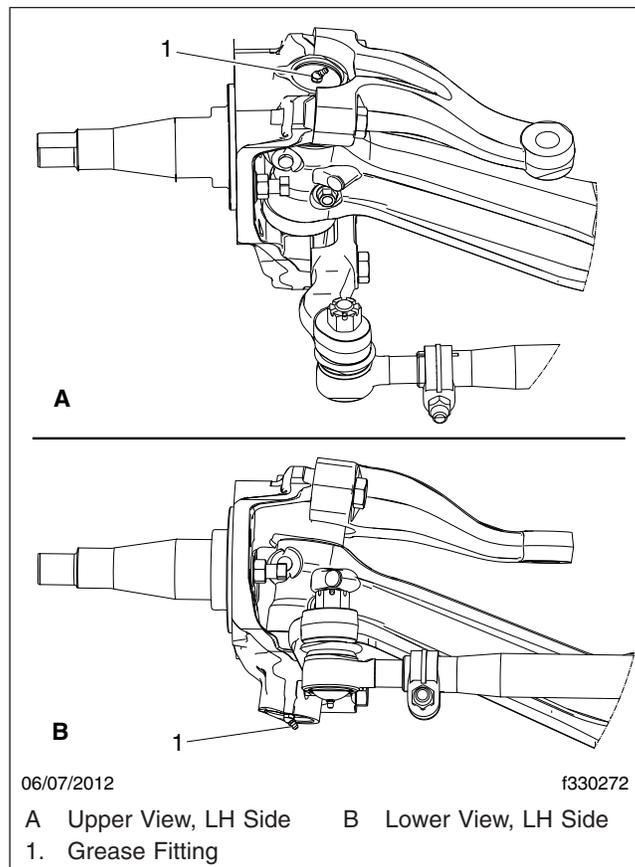


Fig. 1, Grease Fittings, Detroit Axles

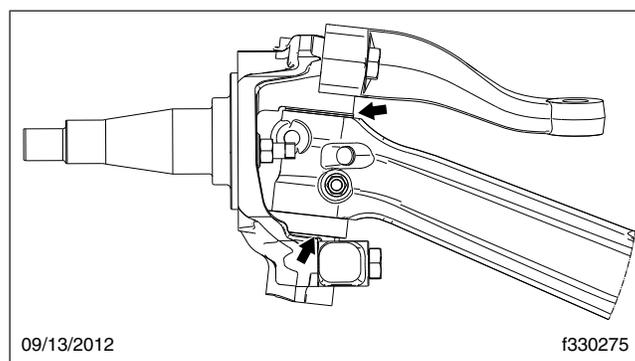


Fig. 2, Kingpin Grease Exit Points, Detroit Axles

(6% 12-hydroxy lithium stearate grease) or NLGI Grade 2 (8% 12-hydroxy lithium stearate grease), into the tie-rod ends until all used grease is forced out and fresh grease is seen at the ball stud neck. See Fig. 3.

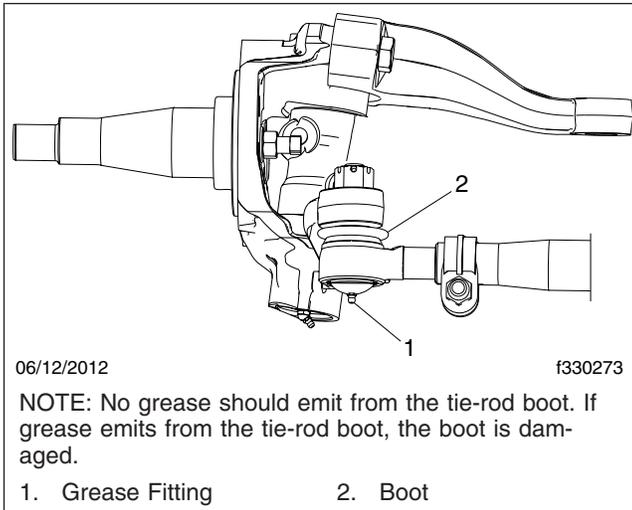


Fig. 3, Grease Fitting and Boot, Detroit Axle

Meritor Axle

The following procedure applies to all tie rod ends on Meritor nondrive steering axles.

1. Park the vehicle with the wheels in the straight-ahead position. Turn off the engine, apply the parking brake and chock the rear tires.
2. Wipe the grease fitting and the seal or boot clean.

NOTE: Synthetic lubricants are not approved for tie rod end lubrication.

3. Using a grease gun, apply a multipurpose grease, NLGI grade 1 or 2, to the grease fitting until all the old grease is purged from the boot. Discolored old grease should come out of the purge holes near the boot crimp or bellows area.

NOTE: If using an air pressure grease gun, do not exceed 150 psi (1035 kPa).

4. If the tie rod end is designed for lube service and it does not accept grease, perform the following substeps.
 - 4.1 Remove the grease fitting.
 - 4.2 Inspect the threaded grease fitting hole in the tie rod end and remove any obstructions.
 - 4.3 Install a new grease fitting.
 - 4.4 Apply lubrication to the new grease fitting.

33–03 Draw Key Nut Inspecting

Axles With Unitized Wheel Ends

Check the torque of the nut that holds the draw key on the side of the knuckle. The torque should be 30 to 45 lbf-ft (41 to 61 N·m). See Fig. 4.

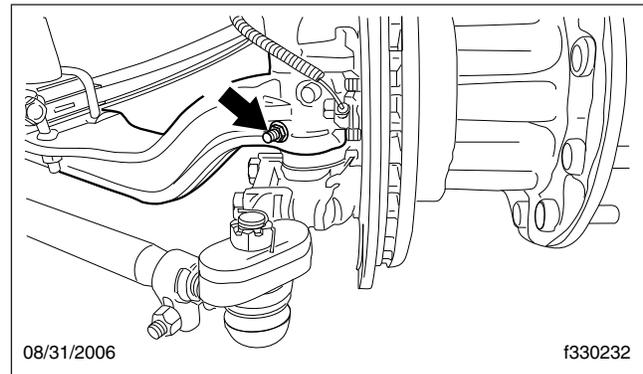


Fig. 4, Draw Key Nut

33–04 Tie Rod End Inspecting

IMPORTANT: If the tie rod end boot is torn or missing, replace the entire tie rod assembly or the tie rod end. Do not replace the boot only.

1. Shut down the engine, apply the parking brake, and chock the rear tires.
2. Check the tie rod boot for cracks, tears, or other damage. If the tie rod boot is damaged, replace the entire tie rod end.
3. Grasp by hand (or use a pipe wrench with jaw protectors to avoid gouging the cross tube) and slightly rotate the cross tube toward the front of the vehicle and then slightly toward the rear. Then center the cross tube between the stop positions. If the cross tube does not rotate in either direction, replace both tie rod ends.
4. Position yourself directly below the ball stud socket. Using both hands, grab the end as close to the socket as possible, no more than 6 inches (15.2 cm) from the end. Firmly apply about 100 pounds of hand pressure in an up and down motion several times. When moving the assembly, check for any movement at both tie rod ends. See Fig. 5.

If any movement is detected at one tie rod end, replace **both** tie rod ends. Always replace tie rod ends in pairs, even if only one tie rod end is damaged.

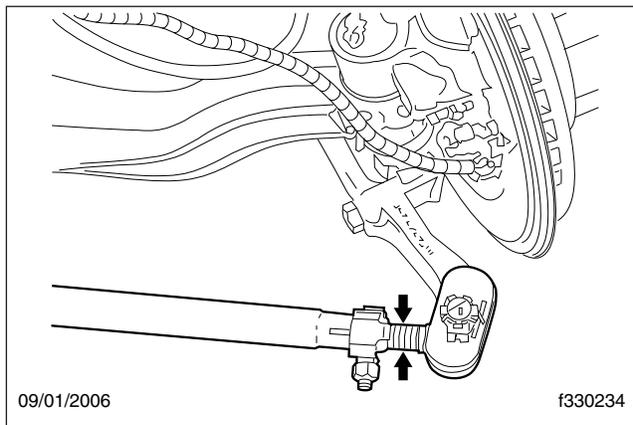


Fig. 5, Checking Tie Rod End Movement

NOTICE

Do not attempt to straighten a bent cross tube. Doing so could result in damage to the axle. Be sure to replace the cross tube with an original equipment cross tube with the same length, diameter, and thread size as the existing cross tube.

5. Check the cross tube for cracks or other damage. If the cross tube is bent or damaged, replace the cross tube.
6. Check the clamps for damage. If a clamp is damaged, replace the clamp. Replace the entire cross tube assembly if either clamp is welded to the cross tube.
7. Check for proper installation of the tie rod end clamp to the cross tube. Make sure that the tie rod ends are threaded in the cross tube past the clamps and the slots at the cross tube ends.
8. Check the grease fittings for damage. If a grease fitting is damaged, replace it.

Some tie rod ends have no grease fittings because they are not greaseable. Do not install a grease fitting on a nongreaseable tie rod end.

9. Check that the cotter pin is in place. If it is not, tighten the tie rod end nut to the applicable value depending on the size of the stud.

- 7/8–14, 160 to 300 lbf-ft (217 to 406 N·m)

- 1–14, 250 to 450 lbf-ft (339 to 610 N·m)
 - 1-1/8–12, 350 to 650 lbf-ft (475 to 881 N·m)
 - 1-1/4–12, 500 to 675 lbf-ft (678 to 915 N·m)
10. Check the steering arm bolts for a minimum torque of 300 lbf-ft (406 N·m). If the steering arm bolt torque has fallen below this specification, remove the bolt, clean all the threads, and apply new Loctite® 680. Tighten the bolt 300 to 450 lbf-ft (406 to 610 N·m).

Title of Maintenance Operation (MOP)	MOP Number
Axle Breather Checking	35-02
Axle Lubricant Changing and Magnetic Plug Cleaning	35-03
Axle Lubricant Level Checking	35-01
Safety Precautions	35-00

35–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

35–01 Axle Lubricant Level Checking

NOTICE

Failure to keep the rear axle filled to the proper level with the recommended lubricant can result in rear axle damage.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. If the vehicle has just been driven, allow a few minutes for the lubricant to settle.
3. Clean the fill plug and the area surrounding the fill plug on the side of the axle carrier. Remove the plug. Check lubricant level when the axle is cold, or near room temperature. See [Fig. 1](#) and [Fig. 2](#).

NOTE: Some Meritor axles have a small tapped and plugged hole located below the housing oil fill hole. This smaller hole is for the lubricant temperature sensor only and must not be used as a fill or level hole.

4. Check that the lubricant is level with the bottom of the fill hole. See [Fig. 3](#). If low, check for oil leaks, and correct as needed. Add oil to the level of the fill plug, using the lubricant in [Table 1](#) for Detroit axles or [Table 2](#) for Meritor axles.

IMPORTANT: A lubricant level close enough to be seen or touched is not sufficient. It must be level with the bottom of the fill hole.

5. Install the oil fill plug and tighten it 30 lbf-ft (41 N·m) for Detroit axles or 35 lbf-ft (47 N·m) for Meritor axles.

IMPORTANT: Always check the axle breather whenever checking the lubricant level. Check the breather more frequently under adverse operating conditions.

6. Check the axle housing breather. Make sure that it is open and unclogged. If the breather is plugged or damaged, clean or replace it as needed.

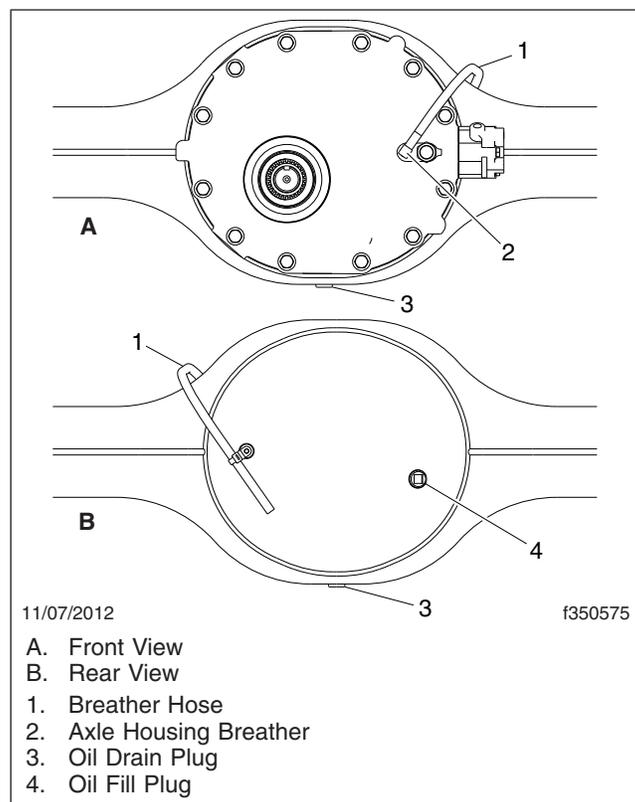


Fig. 1, Component Locations, Detroit Axles

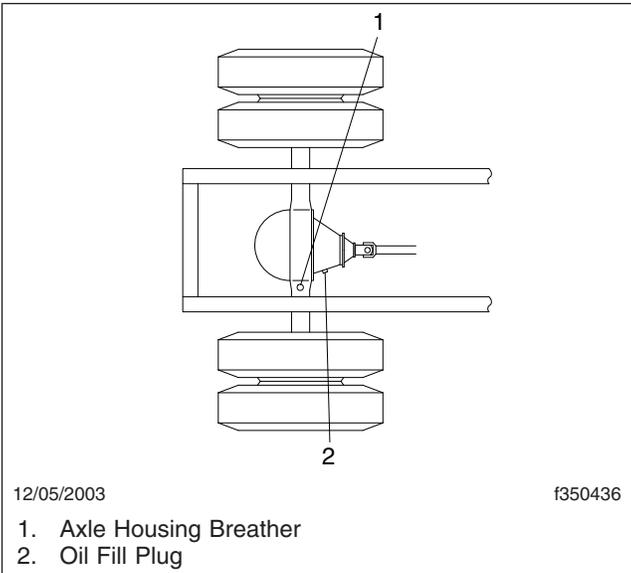


Fig. 2, Component Locations, Meritor Axles

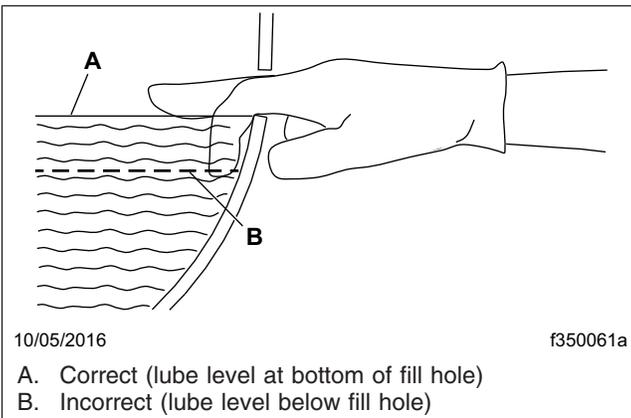


Fig. 3, Axle Lubricant Level Inspection

Detroit Drive Axle Lubricants*		
<p>IMPORTANT: Lubricant used in Detroit rear axles must meet Mercedes-Benz specification 235.20 (mineral) or 235.8 (synthetic). Mobil Delvac™ Gear Oil A 80W-90 and Mobilube™ HD-A Plus 80W-90 meet specification 235.20. Mobil Delvac 1 Gear Oil 75W-90 and Mobilube 1 SHC 75W-90 meet specification 235.8. For more product information, see http://bevo.mercedes-benz.com.</p>		
Type	Ambient Temperature	SAE Viscosity Grade
Mineral Oil	-15°F (-26.1°C) and up†	80W-90

Detroit Drive Axle Lubricants*		
<p>IMPORTANT: Lubricant used in Detroit rear axles must meet Mercedes-Benz specification 235.20 (mineral) or 235.8 (synthetic). Mobil Delvac™ Gear Oil A 80W-90 and Mobilube™ HD-A Plus 80W-90 meet specification 235.20. Mobil Delvac 1 Gear Oil 75W-90 and Mobilube 1 SHC 75W-90 meet specification 235.8. For more product information, see http://bevo.mercedes-benz.com.</p>		
Type	Ambient Temperature	SAE Viscosity Grade
Synthetic Oil	-40°F (-40°C) and up†	75W-90

* Detroit rear axles do not require the use of friction modifiers.

† There is no upper limit on the ambient temperature, but axle sump temperature must never exceed 250°F (121°C).

Table 1, Detroit Drive Axle Lubricants

Recommended Lubricant, Meritor Drive Axles		
Recommended Lubricant Type	Ambient Temperature	Lubricant SAE Viscosity Grade
Hypoid Gear Oil API Service Classification GL-5	10°F (-12.2°C) and up*	85W-140
	-15°F (-26.1°C) and up*	80W-90
	-40°F (-40°C) and up*	75W-90
	-40°F (-40°C) to 35°F (2°C)	75W
Synthetic Gear Oil	-40°F (-40°C) and up*	75W-90
	-40°F (-40°C) and up*	75W-140

* There is no upper limit on the ambient temperature, but axle sump temperature must never exceed 250°F (121°C).

Table 2, Recommended Lubricant, Meritor Drive Axles

35-02 Axle Breather Checking

NOTE: Detroit axles have a breather hose wrapped around the housing breather. The breather hose length should not be lower than approximately 1 inch (25 mm) below the axle housing weld seam.

The axle housing breather must remain clean. See Fig. 1 and Fig. 2. When the axle lubricant level is checked, check that the axle breather is open. Check more often under poor operating conditions. If the breather is plugged, clean it or replace it as needed.

35–03 Axle Lubricant Changing and Magnetic Plug Cleaning

A regular schedule for changing the axle lubricant in a particular vehicle and operation can be accurately determined by analyzing oil samples taken from the axle at specified intervals or mileages. Lubricant suppliers frequently make their laboratory facilities available for determining the useful life of their product under actual service conditions. The final schedule that is recommended may, for economic reasons, be related to lubricant changes that are governed by climatic conditions and magnetic plug maintenance. Change lubricant type and viscosity as climatic temperatures demand, regardless of vehicle mileage or established change schedule.

The normal operating temperature of compounded lubricants during the summer season is about 160 to 220°F (71 to 104°C). The chemicals and additives that give these lubricants increased load carrying capacity oxidize faster at temperatures above 220°F (104°C), contributing to more rapid lubricant deterioration. For this reason, lubricants of this type that operate continuously at high temperatures must be changed more frequently.

NOTICE

Failure to change the axle lubricant at more frequent intervals, when adverse operating conditions require, could result in axle damage.

Axle Draining

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Clean the fill plug and the area around it. Remove the plug from the oil fill hole. See [Fig. 1](#) for a Detroit axle or [Fig. 2](#) for a Meritor axle.



CAUTION

Be careful when draining the axle oil. It may be very hot, and could cause personal injury if it contacts the skin.

3. Remove the plug at the bottom of the housing and drain the lubricant while the unit is warm.

Allow enough time for all the old lubricant to drain completely.

4. Clean the drain plug. For magnetic drain plugs, a piece of key stock or any other convenient steel slug may be used to short the two magnetic poles and divert the magnetic field.

NOTE: Meritor recommends using magnetic plugs with elements having a minimum pickup capacity of two pounds (one kilogram) of low-carbon steel in plate or bar form. Magnets will rapidly lose effectiveness as collected material bridges the gap between the two poles. Clean or change the plugs before this occurs. It may be necessary to clean or change the plugs one or more times between lubrication change intervals.

5. After cleaning the drain plug, install and tighten the plug 30 lbf-ft (41 N·m) for Detroit axles or 35 lbf-ft (47 N·m) for Meritor axles.

Axle Filling

1. With the vehicle on a level surface, fill the axle housings to the bottom of the oil fill hole (in the carrier or housing) with recommended lubricant; see [Table 2](#). Refer to [Table 3](#) for Detroit drive axle lubricant capacities or [Table 4](#) for Meritor drive axle lubricant capacities.

NOTE: Some Meritor axles have a small tapped and plugged hole located below the housing oil fill hole. This smaller hole is for the lubricant temperature sensor only and must not be used as a fill or level hole.

2. Install the fill hole plug and tighten it 30 lbf-ft (41 N·m) for Detroit axles or 35 lbf-ft (47 N·m) for Meritor axles.
3. After filling the carrier and housing assembly with lubricant, drive the vehicle unloaded for one or two miles (two or three kilometers) at speeds not to exceed 25 mph (40 km/h) to thoroughly circulate the lubricant throughout the assembly.

Detroit Drive Axle Lubricant Capacities	
Axle Model*	Capacity†: pints (L)
ARS-13.0-2	15 (7)

Detroit Drive Axle Lubricant Capacities	
Axle Model*	Capacity†: pints (L)
ARS-15.0-2	15 (7)
ARS-17.5-2	15 (7)
ARS-19.0-2	15 (7)
ARS-20.0-2	15 (7)
ARS-21.0-2	15 (7)
ARS-21.0-4	23 (11)
ARS-23.0-4	23 (11)

* Model code may have a "D" in the prefix (for example, DA-RS-13.0-2).

† Quantities listed are approximate and include 1 pint (0.5 liter) for each wheel end and with the drive pinion at 3 degrees.

Table 3, Detroit Drive Axle Lubricant Capacities

Meritor Drive Axle Lubricant Capacities	
Axle Model	Capacity*: pints (L)
MS-10-113D	14 (6.6)
MS-12-113D	15 (7.1)
RS-13-120	18.4 (8.7)
RS-15-120	14.3 (6.8)
RS-17-145	33.6 (15.9)
RS-17-144	32.3 (15.3)
RS-19-144	32.3 (15.3)
RS-19-145	33.2 (15.7)
RS-21-145	32.3 (15.3)
RS-21-160	39.5 (18.7)
RS-21-230	38.9 (18.4)
RS-23-160	39.5 (18.7)
RS-23-161	39.5 (18.7)
RS-23-186	47.3 (22.4)
RS-23-240	37.4 (17.7)
RS-26-185	38.0 (18.0)
RS-30-185	38.0 (18.0)

* Quantities listed are approximate and include 1 pint (0.5 liter) for each wheel end and with the drive pinion at 3 degrees.

Table 4, Meritor Drive Axle Lubricant Capacities

Title of Maintenance Operation (MOP)

MOP Number

Wheel Nut Checking 40-01

40-01 Wheel Nut Checking

IMPORTANT: In addition to the maintenance interval in this manual, check the wheel nut torque the first 50 to 100 miles (80 to 160 km) of operation after a wheel has been removed and installed.

When checking wheel nuts on a stud-piloted dual disc assembly, remove one outer nut at a time, tighten the inner nut, then reinstall the outer nut. Repeat this procedure for all of the inner wheel nuts in the sequence shown in Fig. 1, then tighten all of the outer wheel nuts in the same sequence.

CAUTION

Too little wheel nut torque can cause wheel shimmy, resulting in wheel damage, stud break-

age, and extreme tire tread wear. Too much wheel nut torque can break studs, damage threads, and crack discs in the stud hole area.

See Table 1 for wheel nut torque specifications and see Fig. 1 for the tightening sequence.

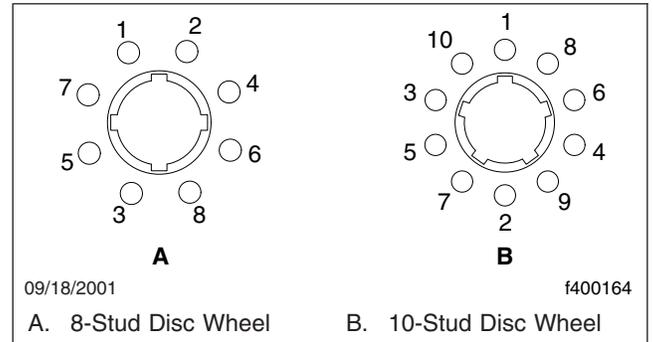


Fig. 1, Wheel Nut Tightening Sequence

Wheel Nut Torque Specifications		
Thread Size	Wheel Manufacturer	Torque (oiled): lbf-ft (N·m)
M20 x 1.5	Accuride Corporation	280 to 330 (380 to 447)
M22 x 1.5	Accuride Corporation	450 to 500 (610 to 678)
1-1/8-16	Accuride Corporation	450 to 500 (610 to 678)
3/4-16	Accuride Corporation	450 to 500 (610 to 678)

Table 1, Wheel Nut Torque Specifications

Title of Maintenance Operation (MOP)	MOP Number
Driveline Inspection	41-01
Driveline Lubrication	41-02
Safety Precautions	41-00

41–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

41–01 Driveline Inspection

WARNING

Do not service or inspect a driveshaft with the engine running. A rotating driveshaft can cause serious personal injury.

Loose end yokes, excessive radial looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke can cause universal joint and bearing defects.

See [Fig. 1](#) for an illustration of half-round end yokes.

1. Check the output and input end yokes on both the transmission and axle for axial looseness. Refer to the axle or transmission manufacturer's service information for the correct specifications.

If loose, disconnect the driveshaft. For instructions, see [Group 41](#) of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer. Tighten the end yoke retaining nut to the proper specification. Refer to the axle or transmission manufacturer's service information for the correct specifications.

2. Inspect for worn universal joints. Apply a vertical force of about 50 pounds to the driveline near the universal joints. If there is any movement, replace the universal joint. For instructions, see [Group 41](#) of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
3. Examine the slip yoke spline for excessive radial movement. See [Fig. 2](#). If excessive radial loose-

ness exists between the slip yoke and the tube shaft, replace the slip yoke and the tube shaft. For instructions, see [Group 41](#) of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

4. Examine the shaft for damaged or bent tubing. Carefully remove any foreign material such as mud or dirt that has built up on the shaft.

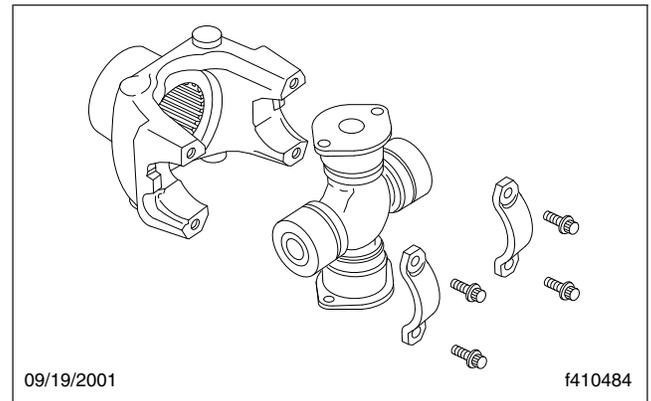


Fig. 1, Half-Round End Yoke

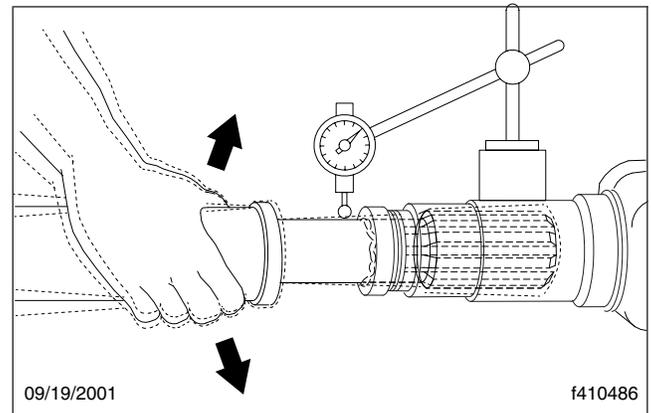


Fig. 2, Checking for Radial Looseness of the Slip Yoke Spline

41–02 Driveline Lubrication

The Easy Service driveline requires periodic lubrication of the universal joints and slip yoke splines. See [Table 1](#) for approved lubricants.

Approved Lubricants	
Lubricant and Specification	Lubricant Brands
Universal joint, slip joint, and spline grease must meet Dana Corporation specifications (NLGI Grade No. 2, with an operating range of 325°F [163°C] to -10°F [-23°C])	Chevron Ultra-Duty EP-2*
	Phillips Petroleum Philube MW-EP2 Grease
	Exxon 5160
	Amalie All Purpose Grease with Moly-L1-2M
	Shell Super Duty Special FF
	Marathon Maralube Molycode 529
	Shell Moly Poly Grease
	Kendall L424 Grease
	Amoco Super Chassis Grease
	Ford Specification M1C-75B or part number PN™C1AZ 19590

* Dana recommended lubricant.

Table 1, Approved Lubricants

Title of Maintenance Operation (MOP)	MOP Number
ABS Tone Rings Cleaning	42-10
Air Brake Inspecting and Leakage Testing	42-09
Air Dryer AD-9, AD-IP Checking	42-06
Bendix Air Dryer AD-9 or AD-IP Desiccant Replacing	42-01
Bendix Hydro-Max® Brake System Inspecting	42-11
Brake Caliper Slide Pin Lubricating, Bosch Hydraulic Brakes	42-12
Brake Inspection	42-15
Brake Lines and Fittings Inspecting, Hydraulic Brakes	42-07
Brake Pedal Linkage and Mounting Plate Inspecting	42-08
Drum Brake Shoe Roller Lubricating	42-13
Foot Brake Valve Actuator Lubricating, Bendix E-6	42-14
Governor D-2A Checking	42-02
Hydraulic Brake Lining Wear Checking	42-03
Meritor Camshaft Bracket Lubricating	42-05
Safety Precautions	42-00
Slack Adjuster Lubricating	42-04
WABCO System Saver Air Dryer Desiccant Cartridge Replacing	42-16

42–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

42–01 Bendix Air Dryer AD–9 or AD–IP Desiccant Replacing

AD–9 Air Dryer

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the tires.
2. Completely drain all air reservoirs. Air pressure gauges should read 0 psi (0 kPa).

IMPORTANT: The compressor discharge line may contain residual air pressure.

3. Identify, tag, and disconnect the three air lines from the end cover.
4. Disconnect the harness connector from the heater and thermostat assembly.
5. Loosen the bolt that secures the upper mounting bracket strap.
6. Remove the two bolts that secure the air dryer to the lower mounting bracket. Mark the position of the mounting bracket to the end cover and mark the bolts to ease installation.
7. Remove the upper mounting bracket strap bolt, and remove the air dryer from the vehicle.
8. Place the air dryer on a bench and remove the remaining 6 bolts, 12 washers, 6 nuts, and the air dryer housing. See [Fig. 1](#). Discard the nuts. Remove the end-cover-to-housing O-ring.
9. Clamp the desiccant cartridge in a vise.

WARNING

Clamping the end cover or housing in a vise could seriously compromise the ability of the air dryer to hold air pressure, which could cause a failure in the brake system, resulting in personal injury or property damage.

10. Twist the end cover counterclockwise to release the cartridge from the end cover. Rotate the end cover until it completely separates from the desiccant cartridge.

NOTE: A substantial torque, up to 50 lbf·ft (68 N·m), may be necessary to remove the desiccant cartridge.

11. Remove and discard desiccant cartridge O-rings.

CAUTION

Dirt or obstructions in the O-ring grooves can cause an O-ring failure that will result in an air leak.

12. Lubricate new O-rings with grease supplied in the kit and install them in the end cover.
13. Install the desiccant cartridge on the end cover. Turn the cartridge clockwise until the desiccant cartridge makes contact with the end cover.
14. Place the desiccant cartridge in a vise, and turn the end cover clockwise an additional 180 to 225 degrees to fully tighten the desiccant cartridge to the end cover.

NOTE: Desiccant cartridge torque should not exceed 50 lbf·ft (68 N·m).

15. Place the housing over the desiccant cartridge and align the mounting holes with the end cover.
16. Install the 6 bolts, 12 washers, and 6 new nuts. Tighten the bolts in a star pattern 270 to 385 lbf·in (3060 to 4340 N·cm). See [Fig. 2](#).
17. Install the air dryer on the lower mounting bracket. Install the two previously marked bolts, four washers, and two new nuts. Tighten the two remaining bolts 270 to 385 lbf·in (3060 to 4340 N·cm). Install the bolt, two washers, and a new nut in the upper mounting bracket strap. Tighten the upper mounting bracket strap nut 80 to 120 lbf·in (904 to 1356 N·cm).

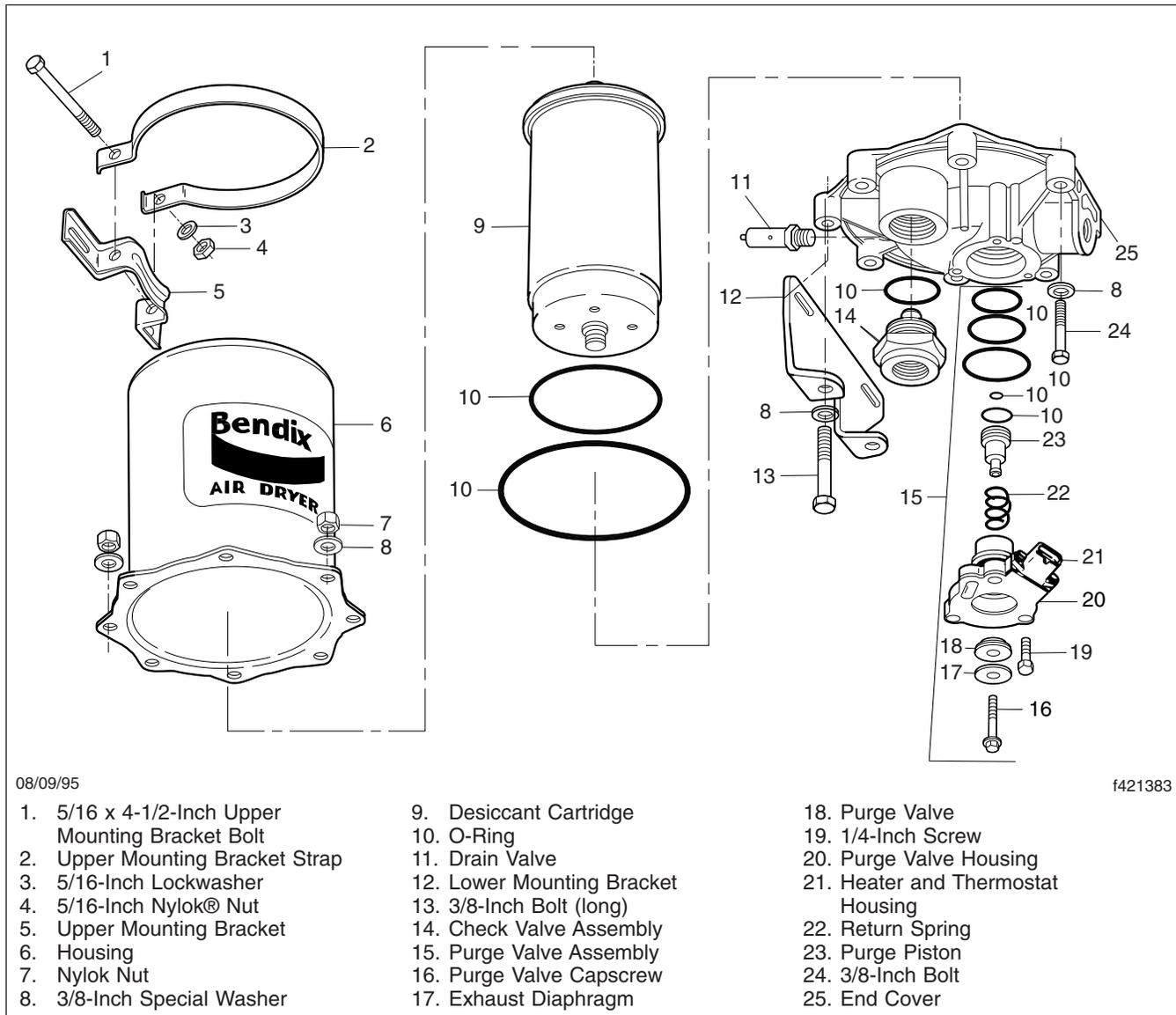


Fig. 1, AD-9 Air Dryer

18. Connect and tighten the three air lines. Connect the harness connector to the heater and thermostat assembly until the lock tab snaps in place.
19. Start the engine, build the air pressure, and check the air brake system for leaks. If any air leaks are present, see **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for diagnosis and repair information.

AD-IP Air Dryer

1. Park the vehicle on a level surface and apply the parking brake. Shut down the engine. Chock the tires.
2. Completely drain all air reservoirs. Air pressure gauges should read 0 psi (0 kPa).

IMPORTANT: The compressor discharge line may contain residual air pressure.

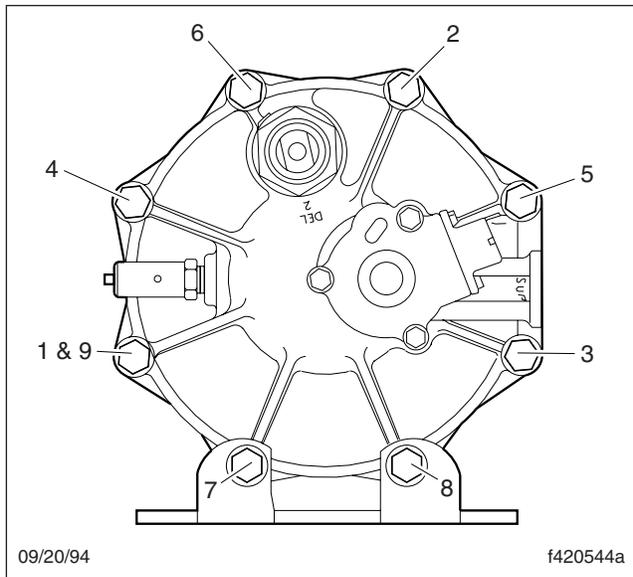


Fig. 2, End Cover to Housing Torque Pattern

3. Using a wrench or a socket, loosen the desiccant cartridge bolt. Then separate the desiccant cartridge from the end cover.
4. Pull the cartridge bolt out of the end of the cover and remove the cartridge.

Do not attempt to disassemble the desiccant cartridge assembly. Parts for the assembly are not available and the cartridge contains a 150 lb spring that cannot be mechanically caged.

5. Remove and discard both O-rings from the desiccant cartridge bolt.
6. Using a clean rag, wipe the inside of the end cover clean. Clean the cartridge bolt bore in the end cover and the sealing surfaces for the large and small diameter desiccant cartridge sealing rings.
7. Inspect the end cover for physical damage, then inspect all air line fittings for corrosion, and replace as necessary.
8. Inspect the bolt, paying attention to the threads and O-ring grooves. Clean the bolt.

IMPORTANT: Use only the grease supplied with Bendix replacement kits.

9. Lubricate the O-rings, bolt O-ring grooves, the sealing rings, and the cartridge grooves. Lubricate the end cover bore for the bolt.

10. Install both O-rings on the cartridge bolt and, using a twisting motion, insert the assembled desiccant cartridge bolt in the end cover.
11. Install the desiccant cartridge on the end cover, making sure that the cartridge is properly seated and flush on the end cover.

NOTE: It may be necessary to rotate the cartridge slightly until the anti-rotation lugs are properly aligned and allow the cartridge to rest flush against the end cover.

12. Using a wrench or socket, tighten the desiccant cartridge bolt to 70 lbf-ft (95 N-m). **Do not** over-torque.
13. Before placing the vehicle into service, perform the testing listed below.
 - 13.1 Close all reservoir drain cocks.
 - 13.2 Build the system pressure to governor cutout and note that the AD-IP air dryer purges with an audible escape of air.
 - 13.3 Fan the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a purge at the AD-IP air dryer exhaust.
 - 13.4 Check for excessive leakage around the head of the desiccant cartridge where it contacts the end cover. With the compressor in loaded mode (compressing air), apply a soapy solution to these areas and observe that any leakage does not exceed a one-inch bubble in one second. If leakage exceeds this measure, remove and re-install the desiccant cartridge.

42-02 Governor D-2A Checking

IMPORTANT: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Every 12 months perform the operational tests as listed below.

Operational Tests

1. Start the engine, build 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. The cutout pressure should be in accordance with the pressure setting of the piece number being used. Common cutout pressures are from 125 to 135 psi (862 to 931 kPa).

With the engine still running, make a series of brake applications to reduce the air pressure and observe at what pressure the governor cuts in the compressor. As in the case of the cutout pressure, the cut-in pressure should be in accordance with the pressure setting of the piece number being used. Cut-in pressure is 105 psi (724 kPa).

NOTE: If the governor cover is marked nonadjustable and the adjusting stem has been sheared off, this is a non-serviceable governor and must be replaced with a new or remanufactured unit.

2. 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. If the pressure settings of the D-2 governor are inaccurate or it is necessary that they be changed, the adjustment procedure follows.
 - 2.1 Remove the top cover from the governor.
 - 2.2 Loosen the adjusting screw locknut.
 - 2.3 To raise the pressure settings, turn the adjusting screw counterclockwise. To lower the pressure settings, turn the adjusting screw clockwise. Be careful not to overadjust. Each 1/4 turn of the adjusting screw raises or lowers the pressure setting approximately 4 psi (28 kPa).
 - 2.4 When proper adjustment is obtained, tighten the adjusting screw locknut and install the cover. The pressure range between cut-in and cut-out is not adjustable.

Cut-In Position

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage is permitted. Excessive

leakage indicates either a faulty inlet valve or lower piston O-ring.

Cutout Position

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage is permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem O-ring, or O-ring at the top of the piston.

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 genuine Bendix parts.

42–03 Hydraulic Brake Lining Wear Checking

WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

1. Chock the tires on the axle that isn't being worked on.
2. Remove the wheel and tire assemblies from the axle that is not chocked.
3. To minimize the possibility of creating airborne brake lining dust, clean the dust from the brake rotor, brake caliper, and brake assembly, using an industrial-type vacuum cleaner equipped with a high-efficiency filter system. Then, using a rag soaked in water and wrung until nearly dry, remove any remaining dust. Do not use compressed air or dry brushing to clean the brake assembly.
4. Measure the thickness of the brake pads at each end of the raised axle. Replace all of the pads at both axle ends if any of the linings is worn to less than 3/16 inch (4.8 mm) at the thinnest point.
5. Make sure that the brake rotor and linings are free of oil and grease.

6. Install the wheel and tire assemblies, then repeat all of the above steps on the other axle.

42-04 Slack Adjuster Lubricating

IMPORTANT: Perform [MOP 42-15](#) before lubricating the slack adjusters.

Automatic slack adjusters that have a grease fitting, must be lubricated periodically to ensure proper brake operation.

WARNING

Failure to lubricate slack adjusters could lead to dragging brakes or a brake failure, resulting in property damage, personal injury, or death.

Haldex

NOTICE

Do not use moly-disulfide-loaded grease or oil. Both the life and reliability of the slack adjuster will be reduced if this type of grease is used.

Lubricate the automatic slack adjuster at the grease fitting. See [Fig. 3](#). Use standard chassis lubricant for Haldex slack adjusters.

Gunite

For operating temperatures of -20°F (-29°C) and higher, use Texaco Multifak EP-2 or Mobil Grease No. 77.

For operating temperatures between -20°F (-29°C) and -40°F (-40°C), use Lubriplate Aero grease.

Gunite automatic slack adjusters are produced without a grease relief. During lubrication with a grease gun, lubricant is forced through the drilled worm wheel onto the camshaft. Lubricate the automatic slack adjuster at the grease fitting until grease appears on the camshaft.

Meritor

NOTE: If equipped with an extended maintenance Q Plus™ brake system, the slack adjuster will not have a grease fitting. These slack ad-

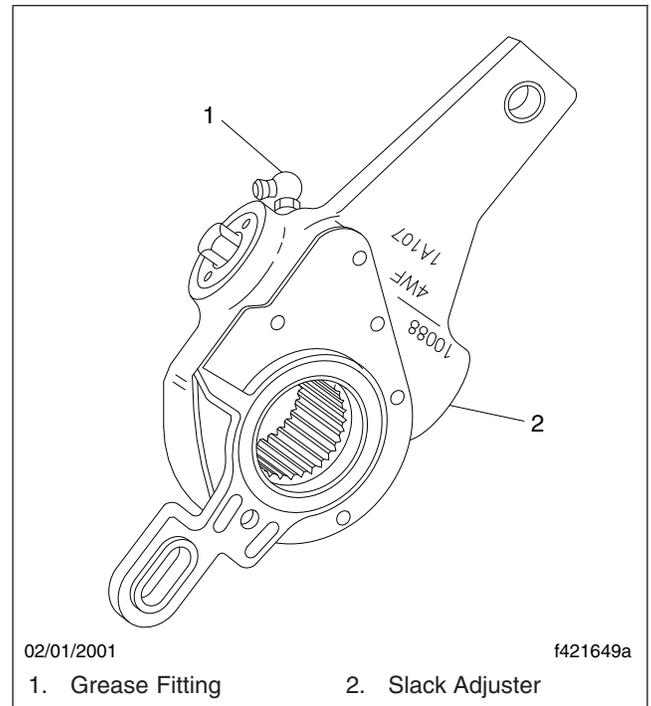


Fig. 3, Haldex Slack Adjuster Grease Fitting

justers use a special NLGI Grade synthetic polyurea grease and do not require lubrication for 3 years or 500,000 miles (800 000 km), whichever comes first. Extended maintenance slack adjusters should be lubricated during brake reline service. For service and lubrication instructions, see **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual*.

For slack adjusters with grease fittings and for operating temperatures above -40°F (-40°C), use an NLGI Grade 1 clay-base grease or an NLGI Grade 1 and 2 lithium-base grease.

For slack adjusters with grease fittings, and for operating temperatures below -40°F (-40°C) and above -65°F (-54°C), use a NLGI Grade 2 synthetic oil or a clay-base grease.

Lubricate the slack adjuster at the grease fitting until grease is forced past the pressure-relief capscrew or past the gear splines around the inboard snap ring. See [Fig. 4](#).

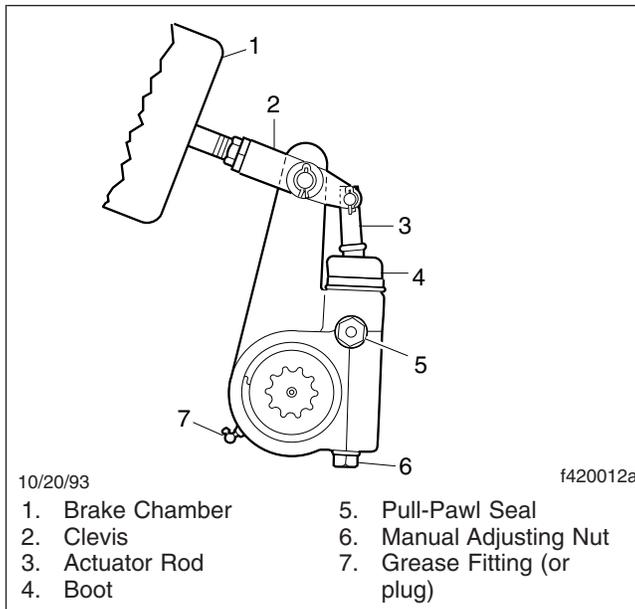


Fig. 4, Meritor Automatic Slack Adjuster

Bendix

Using a quality multipurpose chassis lubricant, NLGI Grade 2, lubricate the automatic slack adjuster through the lube fitting. See Fig. 5. Lubricate the slack adjuster until clean lubricant flows from the grease relief opening in the boot.

42-05 Meritor Camshaft Bracket Lubricating

IMPORTANT: Perform **MOP 42-15** before lubricating the camshaft brackets.

NOTE: If equipped with an extended maintenance Q Plus™ brake system, the camshaft bracket will not have a grease fitting. These camshafts use a special NLGI Grade synthetic polyurea grease and do not require lubrication for 3 years or 500,000 miles (800 000 km), whichever comes first. Extended maintenance camshaft bushings should be lubricated during brake reline service. For service and lubrication instructions, see **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual*.

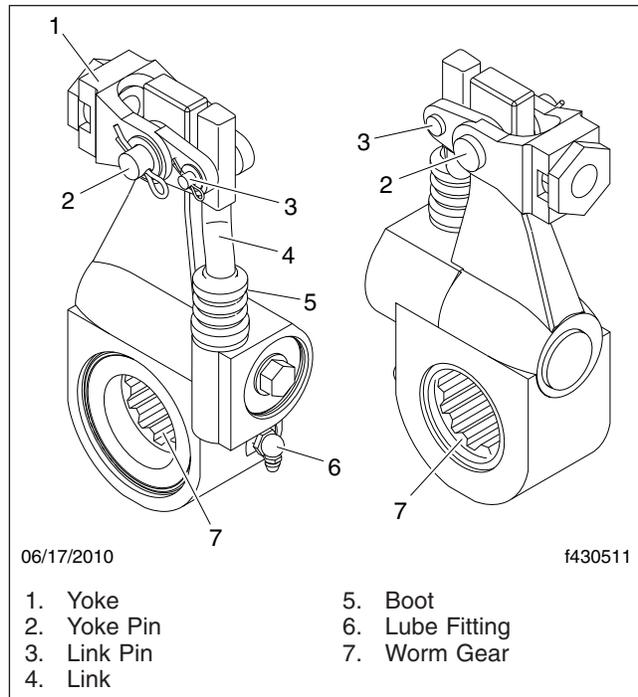


Fig. 5, Bendix Automatic Slack Adjuster

For camshaft brackets with grease fittings, use an NLGI Grade 1 or Grade 2 multipurpose chassis grease.

Lubricate the camshaft bushings through the grease fitting on the camshaft bracket or the spider until new grease flows from the inboard seal. See Fig. 6.

If grease leaks out under the camhead, the camshaft bracket grease seal is worn or damaged. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for grease seal replacement instructions.

⚠ WARNING

If a worn or damaged camshaft bracket grease seal is not replaced, the brake linings could become contaminated with grease. The stopping distance of the vehicle will be increased, which could result in personal injury or property damage.

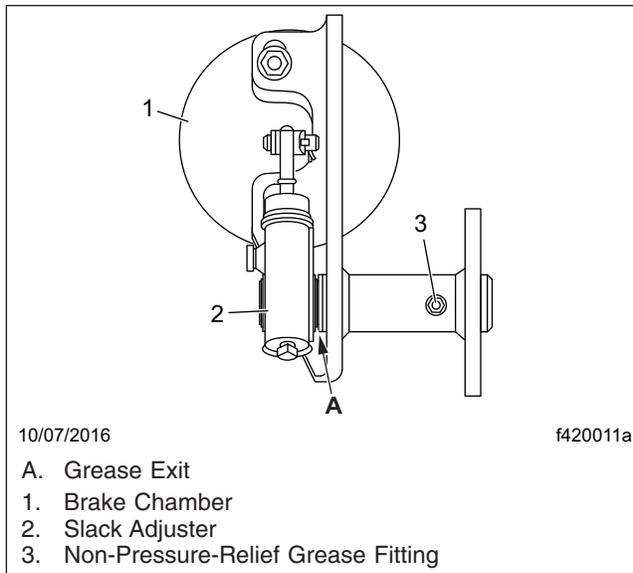


Fig. 6, Camshaft Bracket Lubricating

42-06 Air Dryer AD-9, AD-IP Checking

IMPORTANT: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

Every 3 months:

1. Check for moisture in the air brake system by opening reservoir drain valves and checking for presence of water. If moisture is present, the desiccant cartridge may require replacement; however, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:
 - An outside air source has been used to charge the system. This air did not pass through the drying bed.
 - Air usage is exceptionally high and not normal. This may be due to high air system leakage.

- In areas where more than a 30-degree range of temperature occurs in one day, small amounts of water can temporarily accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal.

NOTE: A small amount of oil in the system is normal and should not be considered as a reason to replace the desiccant cartridge. Some oil at the dryer exhaust is normal.

2. Visually check for physical damage, such as chaffed or broken air and electrical lines and broken or missing parts.
3. Check mounting bolts for tightness. Tighten 30 to 35 lbf·ft (41 to 47 N·m).
4. Perform the operational and leakage tests listed below.

Operational and Leakage Tests

1. Check all lines and fittings leading to and from the air dryer for leakage and integrity. Repair any leaks found.
2. Build system pressure to governor cutout and note that the dryer purges with an audible escape of air. Watch the system pressure and note the pressure fall-off for a 10-minute period. If the pressure drop exceeds 1 psi/minute from either service reservoir, inspect the vehicle air systems for sources of leakage and repair them. Refer to troubleshooting information in Bendix service literature.
3. Check for excessive leakage around the purge valve with the compressor in the loaded mode (compressing air). Apply a soap solution to the purge valve exhaust port and observe that leakage does not exceed a 1-inch (25-mm) bubble in 1 second. If the leakage exceeds the maximum specified, refer to troubleshooting information in the Bendix service literature.
4. Build system pressure to governor cutout and note that the dryer purges with an audible escape of air. Fan the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a dryer purge. If the system does not follow this pattern, refer to troubleshooting information in the Bendix service literature.

5. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

5.1 Electric Power to the Dryer: With the ignition in the ON position, check for voltage to the heater and thermostat assembly using a voltmeter or testlight. Unplug the electrical connector at the air dryer and place the test leads on each of the connections of the female connector on the vehicle power lead. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check to see if a good ground path exists.

5.2 Thermostat and Heater Assembly Operation: These tests are not possible except in cold weather operation. Turn off the ignition switch and cool the thermostat and heater assembly to below 40°F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the air dryer connector half. The resistance should be 1.5 to 3.0 ohms for the 12-volt heater assembly and 6.0 to 9.0 ohms for the 24-volt heater assembly.

NOTE: Some models of the AD-9 may have a resistance reading of 1.0 to 2.5 ohms.

Warm the thermostat and heater assembly to approximately 90°F (32°C) and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values obtained are within the stated limits, the thermostat and heater assembly is operating properly. If the resistance values obtained are outside the stated limits, replace the heater and thermostat assembly.

42-07 Brake Lines and Fittings Inspecting, Hydraulic Brakes

Chock the tires, release the parking brake, and make a full service brake application.

Replace damaged or leaking components, and tighten loose fittings.

42-08 Brake Pedal Linkage and Mounting Plate Inspecting

Inspect the pedal, pedal linkage, and mounting plate assembly for proper operation to ensure that any problems believed to be valve-related are not actually mechanism issues.

42-09 Air Brake Inspecting and Leakage Testing

IMPORTANT: There is no scheduled (Bendix) air valve maintenance that requires disassembly of the valve within the warranty period. If the valve does not function while within the warranty period, do not disassemble the part as this will void the warranty.

If any of the tests in the following procedure fail, refer to **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* to test individual air brake components and valves.

WARNING

Some steps in this operation require the parking brakes to be released. Make sure the vehicle is on a level surface and all tires are chocked. Failure to do so could result in the vehicle rolling, causing personal injury and/or vehicle damage.

1. Park the vehicle on a level surface, shut down the engine, apply the parking brake, and chock all tires.
2. Completely drain all air reservoirs.
3. Install accurate test gauges in the primary and secondary reservoirs.
4. Start the engine and run it at a fast idle.
5. Record reservoir pressures when the low-pressure warning turns off.
6. Record governor cutout pressure and air dryer purge pressure.
7. Reduce service air pressure by applying and releasing the service brakes several times, and record the governor cut-in pressure.

8. Charge the air system to governor cutout, shut down the engine, and apply the parking brake.
9. Allow pressure to stabilize for one minute.
10. Observe the installed service reservoir gauges. Pressure should not drop more than 10 psi (69 kPa) within five minutes.
11. If necessary, start the engine and charge the air system. Shut down the engine and release the parking brake.
12. Make and hold a full service brake application, allowing the pressure to stabilize for one minute. Observe the installed service reservoir gauges. The pressure should not drop more than 15 psi (103 kPa) in five minutes.
13. With the air system at full pressure and the engine idling, operate the parking brake control valve and note that all spring brake chambers apply and release the parking brake promptly as the control valve knob is pulled out and pushed in.
14. Build air system pressure to cutout, then shut down the engine.
15. Completely drain the secondary (front axle) reservoir. On vehicles equipped with single check valves, where the air dryer is not attached to the reservoir, the primary reservoir should not lose pressure.
16. Make a service brake application. The rear axle brakes should apply and release, and brake lights should illuminate.
17. Close the drain cocks, recharge the system, and completely drain the primary reservoir. On vehicles equipped with single check valves, where the air dryer is not attached to the reservoir, the secondary reservoir should not lose air pressure.
18. Start the engine and charge the air system until the governor cuts out.
19. Shut down the engine and leave the parking brake released.
20. Completely drain the primary reservoir.
21. Make a modulated service brake application. Both front and rear brakes should modulate. At a steady full brake application, pressure should not drop more than 10 psi (69 kPa) within five minutes.

22. Drain all reservoirs, then remove the gauges from the service reservoirs. Close the reservoir drain cocks.
23. Remove the chocks from the tires.

42–10 ABS Tone Rings Cleaning

IMPORTANT: An accumulation of road salt, dirt, and debris on the antilock braking system (ABS) tone rings and sensors can cause the ABS warning light to illuminate.

During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle to ensure proper ABS functioning. Thoroughly clean the wheel/ABS sensor/tone ring areas, removing all corrosive materials.

42–11 Bendix Hydro-Max® Brake System Inspecting

1. Check the fluid level in the hydraulic brake fluid reservoir. If needed, fill the reservoir up to the bottom of the fill-neck. See [Fig. 7](#). Use only heavy-duty brake fluid, DOT 3.
2. Check all hydraulic lines and fittings for damage, leakage, or looseness.
Replace damaged or leaking components, and tighten loose fittings.
3. Check the brake module for leaks. If leaks are found, repair or replace the brake module. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer.
4. Check the electrical connections and harnesses. Make sure the connectors are fully seated and the harnesses are not chafed or cut. Repair or replace any damaged harness. Disconnect any loose connectors and inspect the terminals for corrosion. If corrosion is present, replace the terminals. If corrosion is not present, reconnect the connector.
5. Check the fuse for the hydraulic brake booster pump, as follows.

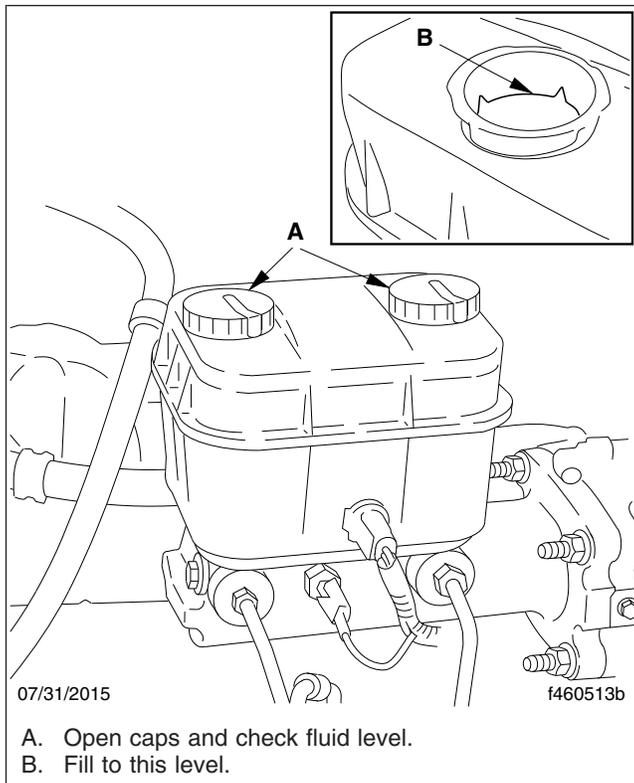


Fig. 7, Hydraulic Brake Fluid Reservoir

- 5.1 Open the cover to the main power distribution module (PDM).
- 5.2 Pull the fuse in position F6 for the Hydro-Max relay.
- 5.3 Inspect the relay to make sure the fuse is not damaged. If the fuse is damaged, install a new fuse. If the fuse is not damaged, install the fuse in position F6.
- 5.4 Close the PDM cover.
6. Check the operation of the Hydro-Max brake booster, as follows.
 - 6.1 With the ignition off, depress the brake pedal and listen for the back-up motor to engage. The operator should also feel the pedal force relieve and the pedal should depress easily.
 - 6.2 With the engine running and the parking brake released, ensure that the BRAKE warning indicator light is **not** on. This is a dual indicator, and indicates that the park-

ing brake is set, and warns if there is a Hydro-Max failure condition other than loss of back-up motor power.

42-12 Brake Caliper Slide Pin Lubricating, Bosch Hydraulic Brakes

WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

NOTE: See the *Bosch Pin Slide Disc Brakes Service Manual* for more information.

Apply 1/8 oz (3.5 g) Aeroshell Grade 5 grease to each of the two slide pin and slide pin bore sets. See the *Bosch Pin Slide Disc Brakes Service Manual* for additional information.

With ZOH-T calipers, install the solid pin (no bushing) only in the anchor plate leading hole position. Install the pin with the rubber bushing and notches only in the anchor plate trailing hole position. Tighten the leading-side pin first, then tighten the trailing-side pin.

Tighten ZOH-T bolts 93 to 107 lbf-ft (126 to 145 N·m). See **Fig. 8**.

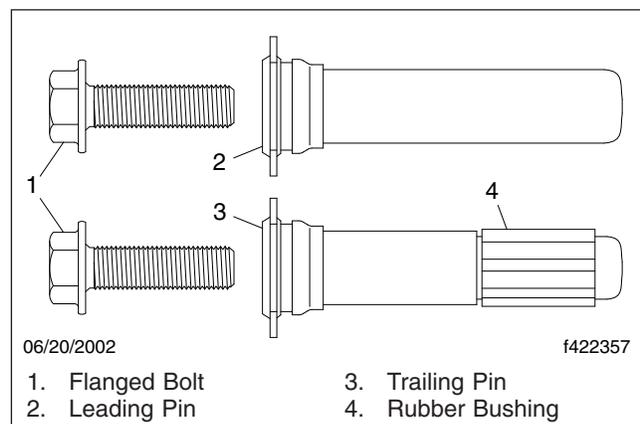


Fig. 8, ZOH-T Slide Pins and Bolts

42–13 Drum Brake Shoe Roller Lubricating

WARNING

Breathing brake lining dust (asbestos or non-asbestos) could cause lung cancer or lung disease. Unless exposure can be reduced below legal limits, wear an air purifying respirator approved by MSHA or NIOSH at all times when servicing the brakes, starting with removal of the wheels and continuing through assembly.

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the tires.
2. Raise the front or the rear axle and then place safety stands under the frame or axle. Be sure that the stands will support the weight of the vehicle.
3. Remove the wheels and the brake drums.

CAUTION

Before you back off automatic slack adjusters, see the slack adjuster manufacturer's service information for instructions. Failure to do so could result in damage to the slack adjusters.

4. Back off the slack adjusters.
5. Push down on the bottom brake shoe and then (by pulling on the roller-retaining clip) remove the bottom cam roller.
6. Lift the top brake shoe and then (by pulling on the roller-retaining clip) remove the top cam roller.
7. Thoroughly clean the rollers, retaining clips, and the roller pin recesses in the brake shoes.

Do not apply grease to the outer diameters of the rollers (where they contact the cam head).

8. Apply a good-quality, multipurpose chassis grease to the retaining clips, brake spider, and the shoe rollers where they contact the brake shoes.
9. One at a time, pull each brake shoe away from the cam and install the top and the bottom shoe rollers.

10. Install the brake drums and the wheels.

DANGER

Do not operate the vehicle until the brakes have been adjusted and checked for proper operation. To do so could result in inadequate or no braking ability, which could cause personal injury, or death, or property damage.

IMPORTANT: See the slack adjuster manufacturer's service information and adjust the brakes at the slack adjusters.

11. Remove the safety stands, lower the vehicle, and remove the chocks from the tires.
12. In a safe area, drive the vehicle and check for proper brake operation.

42–14 Foot Brake Valve Actuator Lubricating, Bendix E–6

1. Remove the brake valve. For instructions, see **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual*.
2. From the outside of the cab, pull the valve away from the frontwall and remove the brake plunger.
3. Wipe off the old grease from the plunger and the adaptor.
4. Inspect the bore of the adaptor and the sliding surface of the plunger. While some discoloration is permissible, there should be no pitting or roughness of the adaptor bore or the sliding surface of the plunger. If pitting or roughness exists, replace damaged parts with new ones.
5. Lubricate the adaptor bore and the sliding surface of the plunger with an approved silicone-based grease, Dow Corning 55 O-Ring Lubricant (formerly Molykote DC–55M), or Loctite® V–755 O-Ring Lubricant.
6. Using a new gasket, install the plunger and brake valve following the instructions in **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual*.

42–15 Brake Inspection

IMPORTANT: This procedure should be performed prior to lubrication of the brake components.

Parking Brake Operational Check



CAUTION

Perform the following check in a clear safe area. If the parking brakes fail to hold the vehicle, personal injury or property damage may result.

1. With the engine running, and air pressure at cut-out pressure, set the parking brake.
2. Put the vehicle in the lowest gear and gently attempt to move it forward. The vehicle should not move. If the vehicle moves, the parking brakes are not operating correctly and must be repaired before the vehicle is returned to service. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for repair procedures.

Brake Component Inspection

1. Park the vehicle on a level surface, set the parking brake, and chock the tires. Once the tires are chocked, release the parking brake.



WARNING

Manually adjusting an automatic slack adjuster to bring the pushrod stroke within legal limits is likely masking a mechanical problem. Adjustment

is not repairing. Before adjusting an automatic slack adjuster, troubleshoot the foundation brake system and inspect it for worn or damaged components. Improperly maintaining the vehicle braking system may lead to brake failure, resulting in property damage, personal injury, or death.

2. With the engine off, and 100 psi (689 kPa) of air tank pressure, have an assistant apply and hold an 80 to 90 psi (550 to 620 kPa) brake application.
3. Check to see if the colored over-stroke band on each brake chamber pushrod is exposed.
If a band shows, the stroke is too long. Check the foundation brake components for wear or damage, and repair as needed. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for inspection, troubleshooting, and repair procedures.
4. Measure the applied chamber stroke. See **Table 1** for the proper stroke for the type of chamber being used. If the stroke is too short, the brakes may drag or will not fully apply. Check for improper operation or adjustment of the automatic slack adjuster. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for inspection and troubleshooting procedures.
5. Start the engine and build air pressure to at least 100 psi (689 kPa). Shut down the engine.
6. Check all of the foundation brake components for damage, wear, and loose or missing parts. Repair as needed. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for repair procedures.

Brake Chamber Stroke Specifications				
Chamber			Max Applied Stroke: inch (mm)	
Manufacturer	Type*	Size†		
Gunit	Standard Stroke	9	1-3/8 (35)	
		12		
		16		
		20	1-3/4 (44)	
		24		
		30		
	Long Stroke	36‡	2-1/4 (57)	
		16	2 (51)	
		20		
		24 (2-1/2 inch rated stroke)		
		24 (3 inch rated stroke)	2-1/2 (64)	
		30		
Haldex	Standard Stroke	12	1-3/8 (35)	
		16	1-3/4 (44)	
		20		
		24		
		2-1/2-Inch Extended Stroke	24	2 (51)
		3-Inch Extended Stroke	24	2-1/2 (64)
		Standard Stroke	30	2 (51)
		Long Stroke	30	2-1/2 (64)
Meritor	Standard Stroke	9	Less than 1-1/2 (38)	
		12		
		16	Less than 1-3/4 (44)	
		20		
		24		
		Long Stroke	24	Less than 1-7/8 (48)
		Standard Stroke	30	Less than 2 (51)

* Long stroke design is indicated by a tag, or embossing, on the brake chamber.

† Specifications are relative to a brake application with 80 to 90 psi (550 to 620 kPa) air pressure in the brake chambers.

‡ If type 36 chamber is used, slack length should be less than 6 inches.

Table 1, Brake Chamber Stroke Specifications

42–16 WABCO System Saver Air Dryer Desiccant Cartridge Replacing

NOTICE

The WABCO System Saver air dryers can use either a standard or oil coalescing desiccant cartridge. When replacing the desiccant cartridge, it is very important to use the same type of cartridge that was originally installed on the dryer. Oil coalescing cartridges can be used in any application, but require more frequent service intervals (every 1 to 2 years instead of every 2 to 3 years for a standard cartridge). Do not replace an oil coalescing cartridge with a standard cartridge, as this may result in contamination and malfunctioning of downstream air system components.

Refer to [Fig. 9](#) for cartridge replacement.

1. Drain the air system.

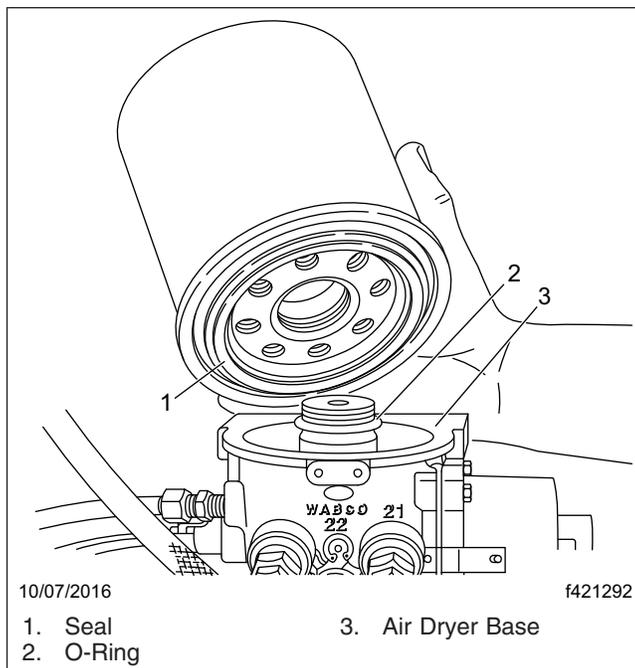


Fig. 9, Desiccant Cartridge Replacement

2. Using a strap wrench, turn the desiccant cartridge counterclockwise and remove it.
3. Remove and discard the O-ring.

4. Clean the top surface of the dryer base with a commercial cleaning solvent.

IMPORTANT: If the air dryer base is damaged, preventing a tight seal, replace the air dryer.

5. Using a multipurpose, high-temperature grease that resists water, steam, and alkali, lightly coat the surfaces of the new O-ring and the dryer base. Install the O-ring.
6. Thread the desiccant cartridge onto the dryer base (turn clockwise). When the seal contacts the base, tighten the cartridge one complete turn more. Do not overtighten.

Title of Maintenance Operation (MOP)	MOP Number
Drag Link Inspecting	46-01
Drag Link Lubricating	46-05
Power Steering Filter Changing	46-06
Power Steering Fluid Level Inspecting	46-03
Power Steering Fluid and Filter Changing	46-02
Power Steering Gear Lubricating	46-04
Safety Precautions	46-00

46–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

46–01 Drag Link Inspecting

WARNING

All steering system components are critical for safe operation of the vehicle. Failure to maintain the steering system as specified may result in loss of steering control, which could lead to personal injury and property damage.

Have someone turn the steering wheel from left to right. Check for movement between the ball stud end at both the pitman arm and the steering arm. Also check if the ball stud nut is loose.

If the ball stud end is loose, replace the drag link. If the ball stud nut is loose, replace the nut and cotter pin. See [Group 00](#) for torque specifications.

Inspect the boot of the drag link at both the pitman arm and the steering arm end for cracks, splits, or other damage. Replace the boot as needed. See [Group 46](#) of the *Saf-T-Liner C2 School Bus Workshop Manual* for drag link removal and installation instructions, or take the vehicle to an authorized Freightliner dealer.

Grasp the drag link near the pitman arm end and move the drag link side to side to check for axial movement in the ball stud end. If it is loose, replace the drag link. See [Group 46](#) of the *Saf-T-Liner C2 School Bus Workshop Manual* for replacement instructions, or take the vehicle to an authorized Freightliner dealer. If there is 1/8-inch (3-mm) movement or more, do not drive the vehicle until the drag link is replaced.

46–02 Power Steering Fluid and Filter Changing

WARNING

Fill only with approved clean fluid. Failure to use the proper fluid could cause seal deterioration and leaks. Fluid leaks could eventually cause loss of power steering assist. This could lead to an accident resulting in personal injury or property damage. Wear eye protection when changing the fluid and filter.

1. Apply the parking brakes and chock the rear tires.
2. Place a drain pan under the power steering reservoir.
3. Remove the retaining ring from the reservoir. See [Fig. 1](#).

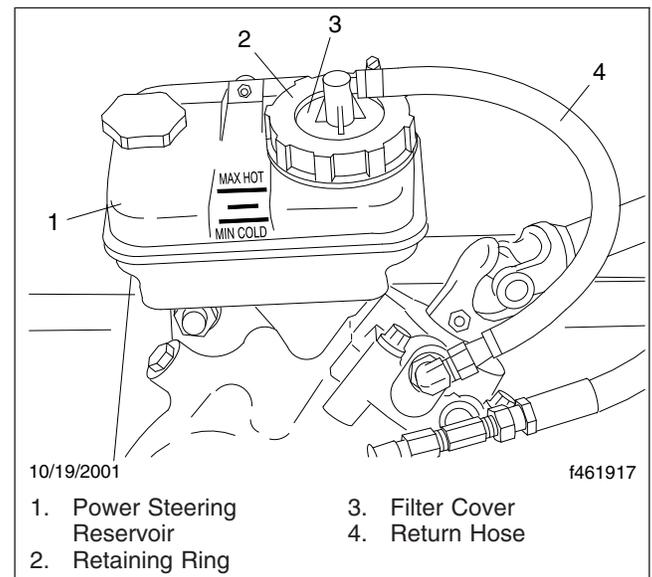


Fig. 1, Power Steering Reservoir

4. Remove the filter and filter cover from the reservoir. Disconnect the filter from the filter cover and discard the filter.
5. Remove the bolts, nuts, and washers that attach the power steering reservoir to the mounting bracket. Drain the fluid from the reservoir, but do not remove the supply line to the reservoir.

- Using bolts, nuts, and washers, attach the reservoir to the mounting bracket.
- Fill the reservoir with an approved power steering fluid to the line between the MIN COLD and MAX HOT lines. See **Fig. 1**. See **Table 1** for approved power steering fluids.

Approved Power Steering Fluids	
Fluid Type*	Approved Fluid*
Automatic Transmission Fluid	Dexron® III
	Dexron® II

* Do not mix fluid types. Refer to the text in this group for a detailed warning statement.

Table 1, Approved Power Steering Fluids

- Raise the front of the vehicle and support it with jack stands.
- Start the engine and operate it at idle. Turn the steering wheel from full left and full right several times until clean fluid starts flowing from the power steering filter cover. Add fluid to the reservoir to maintain the fluid level between the MIN COLD and MAX HOT lines.
- Shut down the engine. Apply a thin film of power steering fluid on the gasket of a new filter. Then attach the filter to the filter cover. Make sure that the gasket under the filter cover is not damaged. If the gasket is damaged, replace it. Install the gasket on the reservoir. Install the filter and filter cover in the reservoir.
- Attach the retaining ring to the reservoir to secure the filter and filter cover.
- Start the engine and check that the power steering fluid level is between the MIN COLD and MAX HOT lines. Add more fluid if needed.
- Raise the vehicle, remove the jack stands, and lower the vehicle.
- Remove the chocks from the tires.

46-03 Power Steering Fluid Level Inspecting

- Apply the parking brake and chock the rear tires.
- With the engine cool, the fluid level should be between the MIN COLD and MAX HOT lines with the engine off.

- Add or remove fluid as necessary to bring the fluid level between the MIN COLD and MAX HOT lines. See **Table 1** for approved power steering fluids.
- With the engine hot, the fluid level should be at the MAX HOT line with the engine off.
- Add or remove fluid as necessary to bring the fluid level to the MAX HOT line. See **Table 1** for approved power steering fluids.
- Remove the chocks from the tires.

46-04 Power Steering Gear Lubricating

TRW THP Series



Apply grease to the sector shaft with only a hand-type grease gun. Use of a high-pressure power grease gun will supply grease too quickly and could affect the high pressure seal, contaminating the hydraulic fluid.

Using a hand-type grease gun, apply NLGI Grade 2 or 3 multipurpose chassis grease until it starts to come out past the sector shaft seal.

46-05 Drag Link Lubricating

- Using a clean rag, wipe all dirt from both drag link grease fittings.
- Using a pressure gun, apply grease at the grease fittings until old grease is forced out of the socket. Use multipurpose chassis grease NLGI Grade 2 (8% 12-hydroxy lithium stearate grease) or NLGI Grade 1 (6% 12-hydroxy lithium stearate grease).

NOTE: NLGI Grade 2 is the preferred grade.

46-06 Power Steering Filter Changing

- Apply the parking brake and chock the rear tires.
- Raise the front of the vehicle and support it with jack stands.

3. Remove the retaining ring from the reservoir. See **Fig. 1**.
4. Remove the filter, filter cover, and gasket from the reservoir.
5. Disconnect the filter from the filter cover and discard the filter.
6. Apply a thin film of power steering fluid on the gasket of the new filter. Then attach the filter to the filter cover.
7. Check the gasket that was removed from the reservoir for damage. If the gasket is damaged, replace the gasket. Install the gasket on the reservoir.
8. Install the filter and filter cover in the reservoir. Attach the retaining ring to the reservoir to secure the filter and filter cover.
9. Check the fluid level in the reservoir. If necessary, add fluid to the reservoir to maintain the fluid level between the MIN COLD and MAX HOT lines. See **Table 1** for approved power steering fluids.
10. Raise the vehicle, remove the jack stands, and lower the vehicle.
11. Remove the chocks from the tires.

Title of Maintenance Operation (MOP)	MOP Number
CNG Fuel Cylinder Inspection	47-10
CNG Fuel Filter Replacement	47-09
CNG Fuel System Inspection	47-08
Fuel Filter Replacing, Propane Engine	47-07
Fuel Rail Fitting and Injector Inspecting, Propane Engine	47-06
Fuel Sender Checking	47-04
Fuel Tank Band Nut Tightening	47-01
Fuel Tank and Line Inspecting, Propane Engine	47-05
Fuel/Water Separator Element Replacing	47-02
Inline Fuel Strainer Replacing	47-03
Safety Precautions	47-00

47–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.

DANGER

When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

47–01 Fuel Tank Band Nut Tightening

IMPORTANT: Do not overtighten the nuts.

Hold the retention nut on the fuel tank band with a wrench while backing off the jam nut. Then tighten the retention nut 13 to 17 lbf-ft (18 to 23 N·m). After the retention nut has been tightened, hold the retention nut with a wrench while tightening the jam nut 13 to 17 lbf-ft (18 to 23 N·m).

47–02 Fuel/Water Separator Element Replacing

Alliance Fuel/Water Separator Replacement

The only maintenance necessary on an Alliance fuel/water separator is to replace the filter element.

WARNING

Diesel fuel is flammable and can ignite if exposed to an open flame, intense heat, or other ignition source. Do not drain fuel near, or expose fuel vapor to open flame or intense heat. Exposure to open flame or intense heat could start a fire, possibly resulting in personal injury or property damage. When working on a fuel system, have a fire extinguisher within easy reach.

1. Drain off some fuel by loosening the vent plug and opening the drain valve.

2. Disconnect the water sensor and heater connections if so equipped.
3. Remove the element and bowl together by turning counterclockwise.
4. Remove the bowl from the element and clean the O-ring gland.
5. Apply a coating of clean fuel or motor oil to the new O-ring and element seal.
6. Spin the bowl onto the new element, then spin them both onto the filter head snugly by hand only.

IMPORTANT: Do not use tools to tighten the bowl and element.

7. Connect the water sensor and heater connectors if so equipped.
8. If equipped with a primer pump, loosen the vent plug. Then operate the primer pump until the fuel purges at the vent plug. See [Fig. 1](#).
Close the vent plug.
9. Start the engine and check for fuel leaks.
10. Shut down the engine and correct any fuel leaks.

Davco Fuel Pro® 382 Fuel/Water Separator Filter Replacement

Replace the fuel/water separator element only when the filter element is completely covered.

WARNING

Diesel fuel is flammable and can ignite if exposed to an open flame, intense heat, or other ignition source. Do not drain fuel near, or expose fuel vapor to open flame or intense heat. Exposure to open flame or intense heat could start a fire, possibly resulting in personal injury or property damage. When working on a fuel system, have a fire extinguisher within easy reach.

1. Place a suitable drain pan under the fuel/water separator and open the drain valve. Drain enough fuel to empty the filter, then close the drain valve. See [Fig. 2](#).
2. Using Davco wrench 380134 or 382002, remove the filter collar. Then remove the filter cover.
3. Remove the element and dispose of it properly.

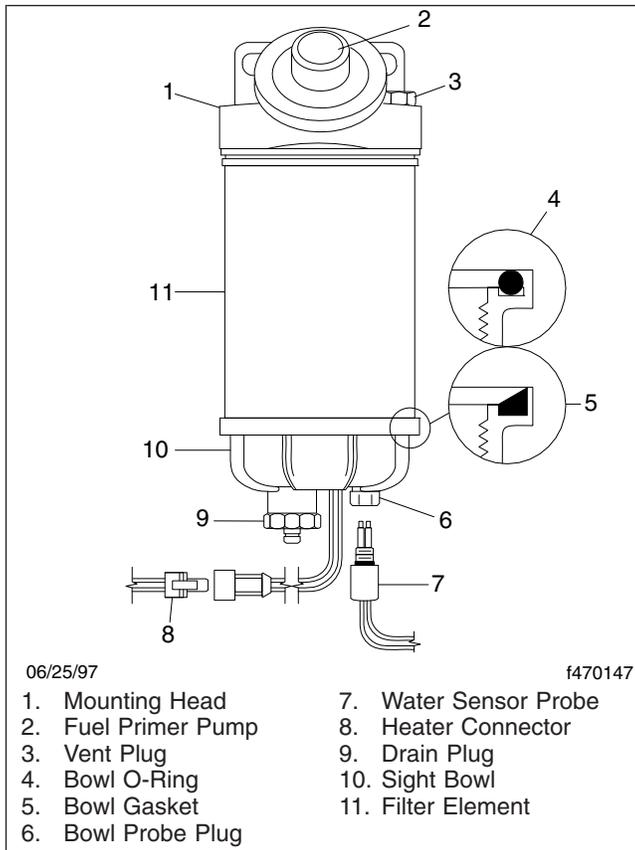


Fig. 1, Alliance Fuel/Water Separator

4. Install a new element. Make sure the grommet is in place on the filter stud.
5. Install a new cover seal on the filter cover.
6. Using the collar, attach the filter cover with the spring to the base.

IMPORTANT: Tighten the collar by hand only.

7. Remove the filter vent. Then fill the fuel/water separator with fuel until the fuel level is 1 inch (2.5 cm) above the collar.
8. Install the filter vent on the fuel/water separator.
9. Start the engine and raise the rpm for 1 minute to purge air.

47-03 Inline Fuel Strainer Replacing

NOTE: Vehicles equipped with a MBE900 engine that are not equipped with a fuel/water separator have an inline fuel strainer. The inline fuel strainer is located on the left-hand frame rail under the cowl area.

1. Remove the tie bands that secure the fuel strainer.

IMPORTANT: The fuel flow arrow on the fuel strainer must be pointed toward the front of the vehicle.

2. Remove the strainer, and install a new one.
3. Secure the fuel strainer with tie bands.

47-04 Fuel Sender Checking

1. Check the fuel sender connections for tightness, and tighten if needed. Apply dielectric grease to the connections if needed.
2. Check the fuel fill hose for tightness, and tighten if needed.

47-05 Fuel Tank and Line Inspecting, Propane Engine

WARNING

Liquid propane can cause serious burns should it contact the skin or eyes. When handling propane, always wear approved protective gloves and eye protection to prevent contact.

Propane is extremely flammable, and can ignite if an ignition source is present, causing burns and other serious injuries. Keep sparks and flames away from propane. Do not smoke near propane or when refueling the vehicle.

See the safety precautions listed in Chapter 17 of the *Saf-T-Liner C2 School Bus Driver's Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the liquid propane, which

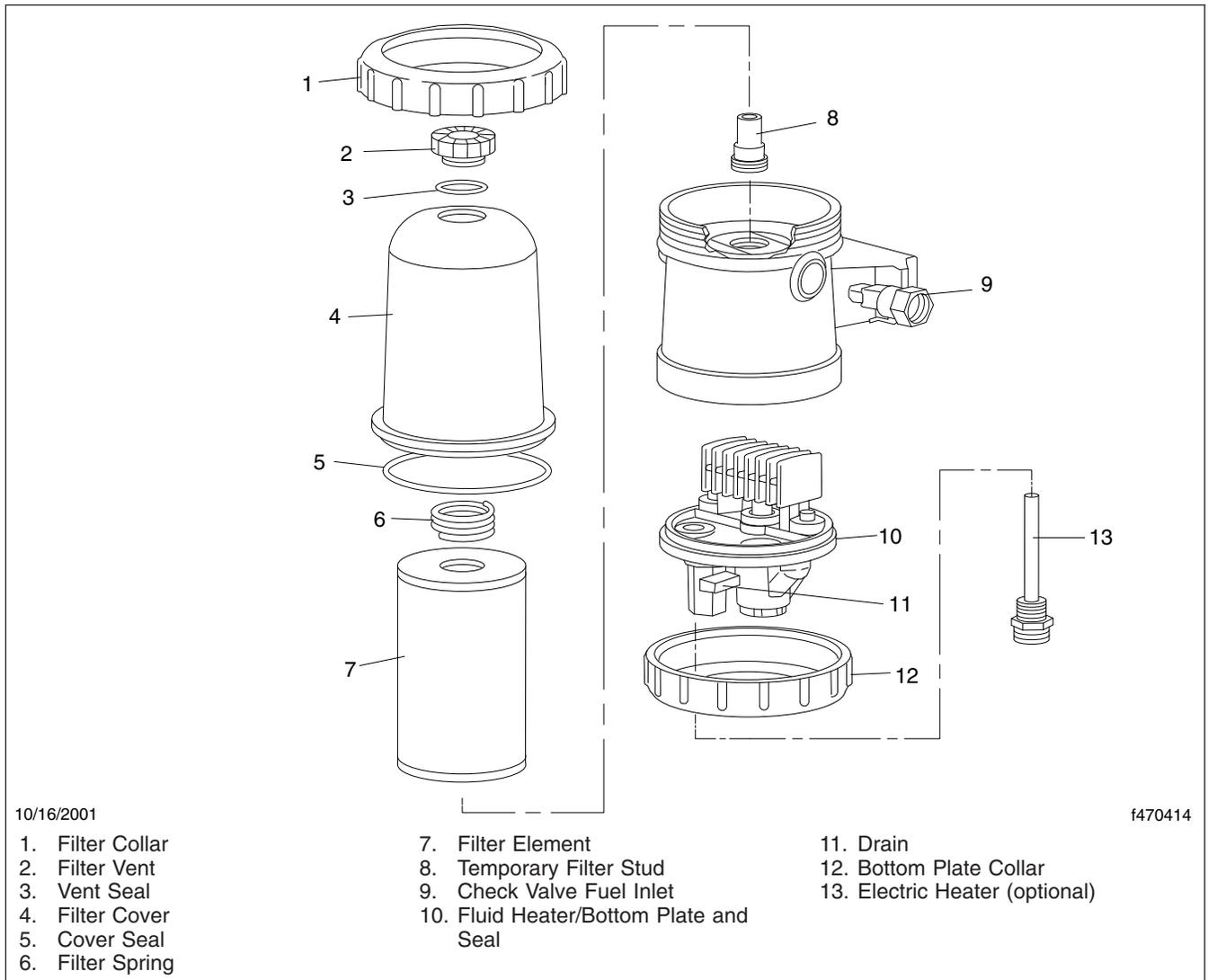


Fig. 2, Davco Fuel Pro 382 (exploded view)

could cause severe bodily harm, or death, or property damage.

1. Inspect the tank and fuel lines for damage.
2. Inspect the brackets and fasteners to make sure the tank is securely fastened.
3. Ensure that all service valves and/or shut-off valves work properly.
4. Make certain the pressure relief valve vent is clear of any obstructions. If equipped with a dust cap, ensure that it is securely in place.
5. Check the tank fittings, connections, and fuel lines for leaks.
6. Check the solenoid wiring and connectors, making certain they are securely attached and locked.

47–06 Fuel Rail Fitting and Injector Inspecting, Propane Engine

WARNING

Liquid propane can cause serious burns should it contact the skin or eyes. When handling propane, always wear approved protective gloves and eye protection to prevent contact.

Propane is extremely flammable, and can ignite if an ignition source is present, causing burns and other serious injuries. Keep sparks and flames away from propane. Do not smoke near propane or when refueling the vehicle.

See the safety precautions listed in Chapter 17 of the *Saf-T-Liner C2 School Bus Driver's Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the liquid propane, which could cause severe bodily harm, or death, or property damage.

NOTE: The fuel rails and injectors do not require any adjustments.

1. Make certain that all electrical connections are connected and locked.
2. Make certain the fuel rail is securely attached to the engine.
3. Use an electronic leak detector or a liquid-leak detection solution to check all injectors, rails, and fittings for fuel leaks.

47–07 Fuel Filter Replacing, Propane Engine

WARNING

Liquid propane can cause serious burns should it contact the skin or eyes. When handling propane, always wear approved protective gloves and eye protection to prevent contact.

Propane is extremely flammable, and can ignite if an ignition source is present, causing burns and other serious injuries. Keep sparks and flames

away from propane. Do not smoke near propane or when refueling the vehicle.

See the safety precautions listed in Chapter 17 of the *Saf-T-Liner C2 School Bus Driver's Manual*, or take the vehicle to an authorized Freightliner dealer. Failure to observe these precautions could lead to the ignition of the liquid propane, which could cause severe bodily harm, or death, or property damage.

The propane system is equipped with two filters—one before the fuel enters the tank, and another before it enters the engine. The replacement procedure that follows applies to both filters. See [Fig. 3](#) and [Fig. 4](#).

IMPORTANT: Venting the fuel supply and return lines must be performed outside. Do not release propane inside a garage or building. Once the fuel lines are vented, the vehicle can be pulled into the garage.

NOTICE

Damage may occur to the valve(s) if they are over-tightened.

1. Turn the fuel supply and return valves clockwise to shut them off at the tanks.

NOTE: Both the fuel supply and return lines must be vented to ensure all pressure is removed from the fuel rails and lines.

2. To vent the system, slowly crack open the fuel supply and return lines that are connected to the supply and return valves until a white mist appears. Continue cracking the lines open until there is absolutely no pressure.
3. Disconnect the fuel supply and return lines from the valves until all service work is finished.
4. Cover the open lines to prevent contaminants from entering the system.
5. Remove and discard the filter.
6. Install the new filter, making certain the arrow on the filter points toward the tank or engine as applicable.
7. Connect both ends of the filter to the fuel line and tighten 28±10 lbf·ft (38±14 N·m).
8. Remove the protective cover from the fuel lines.

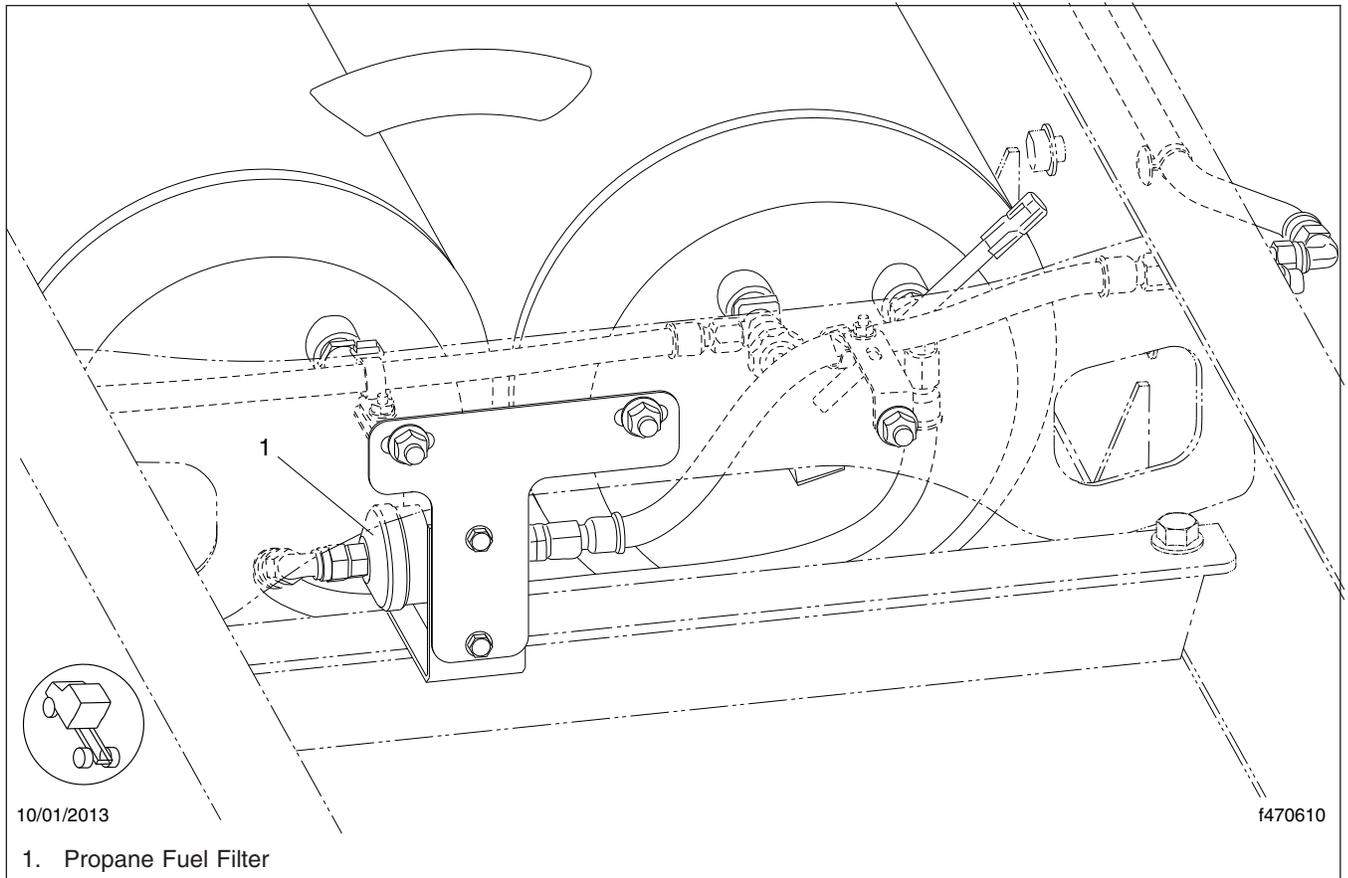


Fig. 3, Fuel Filter Location (fuel going in the tank)

9. Connect the fuel lines to their designated supply and return valve. Tighten the fuel line flare nuts 13 lbf-ft (18 N·m).

NOTICE

Damage may occur to the valve(s) if they are over-tightened.

10. Turn the fuel supply and return valves counter-clockwise, then start the vehicle in order to charge the fuel lines with propane.
11. Check for leaks using an electronic leak detector or a liquid-leak detection solution.

47–08 CNG Fuel System Inspection

WARNING

Natural gas is highly flammable. See the safety precautions listed in Chapter 18 of the *Saf-T-Liner C2 School Bus Driver's Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause serious bodily injury or death.

The following inspections must be performed by a qualified technician, in accordance with the manufacturer's established inspection criteria.

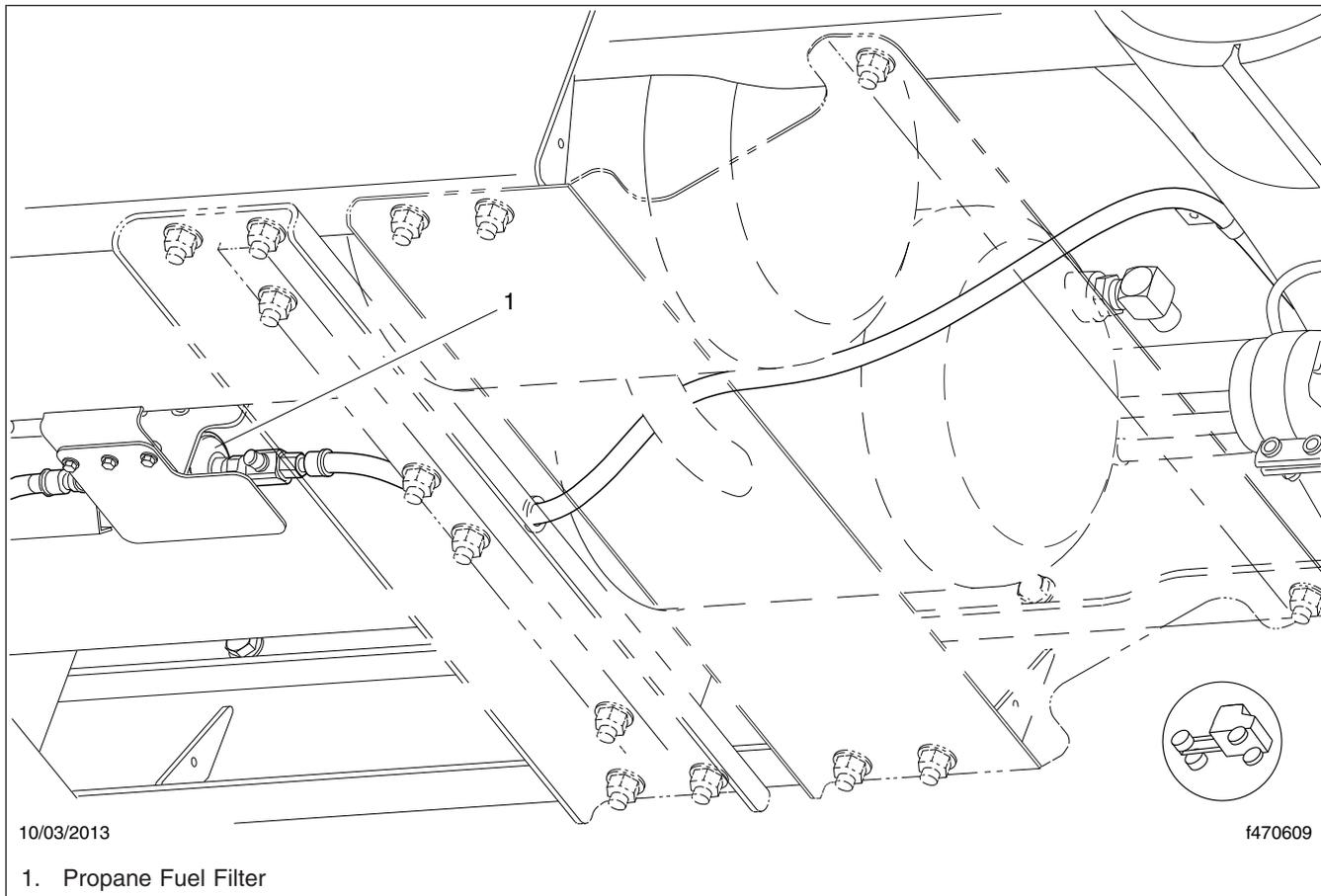


Fig. 4, Fuel Filter Location, (fuel going in the engine)

NOTICE

Do not use a high-pressure washer or steam cleaner on natural gas fuel system plumbing components, as this can introduce moisture and contaminants into the threads of the fittings and damage the sealants.

Use a bubble solution to check for leaks while performing the following inspection.

1. Inspect the fuel cylinders for dents or other signs of damage.
Replace any leaking fuel cylinders.
2. Ensure that the fuel cylinders are secured within the fuel tank cage, if so equipped.
3. Ensure that the fuel panel is secured to the frame. Inspect for any signs of looseness. If

needed, tighten the fuel panel mounting bolts. See [Fig. 5](#).

4. Inspect the fuel fill port for signs of damage or leaks. Ensure the port dust cover and the O-ring inside the port are both present and in good condition. See [Fig. 6](#).
5. Inspect the pressure gauge on the fuel panel for cracks. Ensure the indicator needle is present and in working condition. Inspect the gauge face for accuracy and legibility.
6. Check the following components for signs of damage or leaks.
 - Manual fuel shutoff valve
 - Fuel cylinder shutoff valves (on the fuel tanks)
 - Coolant hoses and fittings

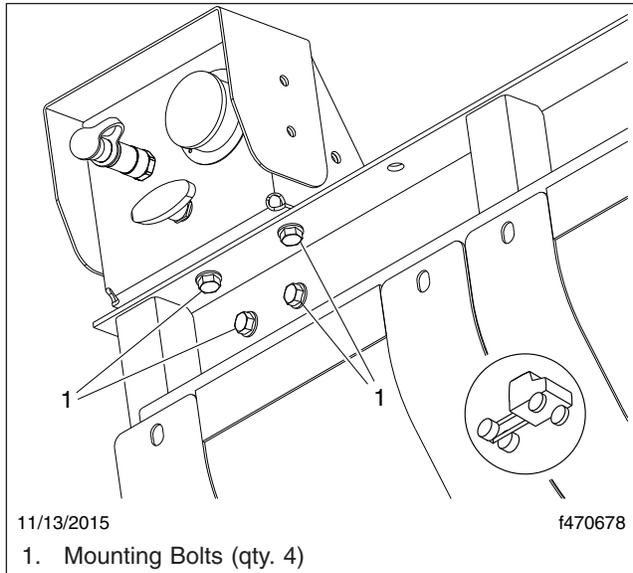


Fig. 5, Fuel Panel Mounting Bolts

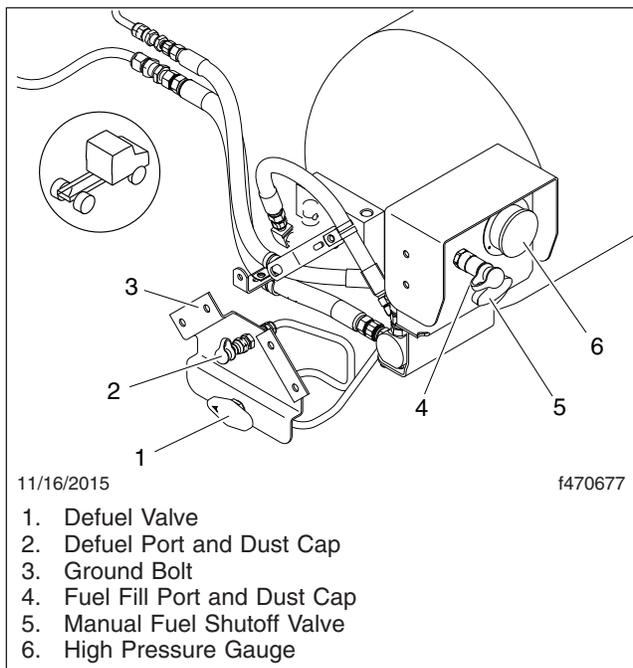


Fig. 6, CNG Fuel Panel

- Fuel lines and fittings
 - All fittings, connections, and joints
7. Replace leaking or damaged fuel lines. Repair or replace leaking or damaged fittings.

47-09 CNG Fuel Filter Replacement

CNG filter element replacement cycles are an important factor in maintaining the CNG fuel system integrity and ensuring maximum operating performance. Actual frequency of the filter element replacement could increase or decrease depending on the cleanliness of the fill station fueling system.

IMPORTANT: The following instructions apply to both the high- and low-pressure fuel filters. The filters screw on and off; there is no need to remove the fuel lines going to and from the filter housing.

1. Shut down the engine and apply the parking brake.
2. Close the CNG fuel cylinder shutoff valves.
3. Start the engine and let it idle until the fuel lines are empty and the engine stops. The gauges on the fuel panel should now read at or near 0 psi.
4. Close the manual fuel shutoff valve on the fuel panel.

IMPORTANT: Some pressure may remain in the fuel system between the solenoid valve and the engine. Use caution, as a small amount of gas may leak out.

5. Put a clean receptacle under the filter assembly. Unscrew the filter from the filter housing. See [Fig. 7](#) and [Fig. 8](#).
6. Remove and discard the filter.
7. Install a new filter in the filter housing.
8. Inspect the O-ring on the filter housing for damage or cracks. If necessary, replace the O-ring.
9. Install the filter on the filter housing. Tighten 90 lbf-ft (122 N·m).
10. Open the manual fuel shutoff valve on the fuel panel.
11. Open the fuel cylinder shutoff valves.
12. Using a methane detector, leak test all fuel system components between the fuel cylinders and the solenoid valve. A bubble solution can be used to pinpoint the exact location of leaks. Repair or replace any leaking components.

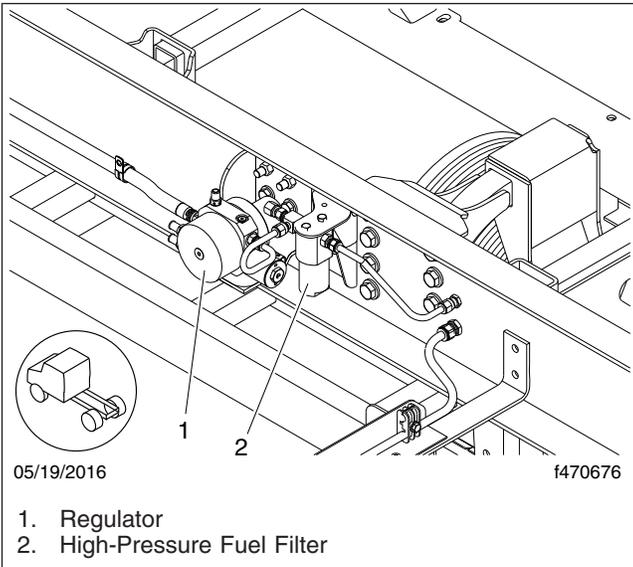


Fig. 7, High-Pressure Fuel Filter

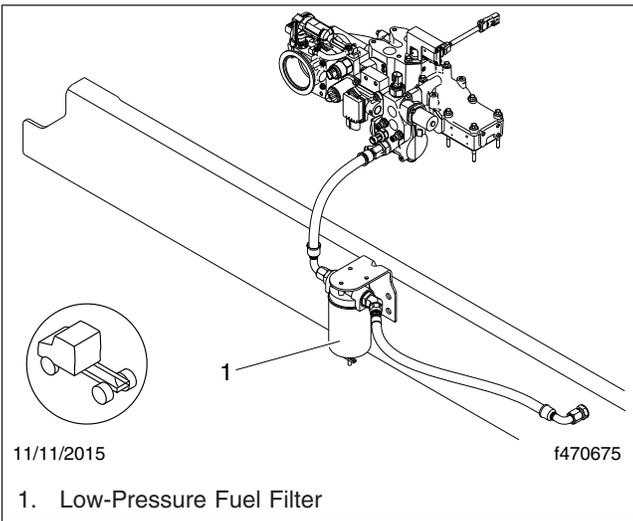


Fig. 8, Low-Pressure Fuel Filter

47-10 CNG Fuel Cylinder Inspection

Have a qualified inspector inspect compressed natural gas (CNG) fuel cylinders for damage or deterioration. Note cuts, cracks, gouges, abrasions, discoloration, broken fibers, loose brackets, damaged gaskets or isolators, heat damage, or other problems.

Refer to Compressed Gas Association (CGA) pamphlet C-6.4, *Methods for External Visual Inspection of Natural Gas Fuel Containers and Their Installations*, for inspection requirements and inspector qualifications.

For more information, go to www.cganet.com.

After inspection, a written report should be provided for each container inspected. Place an inspection label stating the inspection date and inspecting agency identification on each container.

Title of Maintenance Operation (MOP)	MOP Number
Exhaust System Inspecting (Noise Emission Control)	49-01
Safety Precautions	49-00

49–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

49–01 Exhaust System Inspecting (Noise Emission Control)

The exhaust system must be free of leaks, binding, grounding, and excessive vibrations. In addition to inspecting the exhaust system at the scheduled maintenance interval, inspect the exhaust system if the noise level of the vehicle has increased. Replace parts that show leakage, wear, or damage, with genuine Freightliner parts.

These conditions are usually caused by loose, broken, or misaligned clamps, brackets, or pipes. If any of these conditions exist, check the exhaust system components and alignment. Align or replace as necessary. For alignment or adjustment instructions, see **Group 49** of the *Saf-T-Liner C2 School Bus Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

EPA10 and Newer Exhaust System

Definitions of Aftertreatment System (ATS) Terms

Refer to the following list of definitions of ATS terms and components.

- **Aftertreatment System (ATS)**—the entire exhaust system from the turbocharger to the tail pipe, including the Selective Catalytic Reduction (SCR) components.

- **Aftertreatment Device (ATD)**—a device that removes pollutants from exhaust gas after the gas leaves the combustion chamber.
- **BlueTec®**—Daimler’s proprietary SCR technology.
- **Diesel Oxidation Catalyst (DOC)**—a flow-through device that enhances the oxidation of hydrocarbons in the ATD.
- **Diesel Particulate Filter (DPF)**—a component in the ATD that traps particulate matter from the exhaust gas.
- **Diesel Exhaust Fluid (DEF)**—the chemical agent that reacts with the exhaust gases in the SCR to reduce NOx.
- **DEF Pump**—filters and supplies DEF to the DEF metering unit.
- **DEF Tank**—holds DEF and regulates its temperature.
- **DEF Metering Unit**—mixes DEF with compressed air, and meters this mixture into the exhaust flow via an injection nozzle.
- **SCR Catalyst**—the housing containing a treated ceramic flow-through block where the DEF and exhaust gases undergo selective catalytic reduction.
- **Selective Catalytic Reduction (SCR)**—a process used to reduce NOx emissions.

Inspection

IMPORTANT: The Environmental Protection Agency’s 2010 regulations mandate lowered exhaust emissions, thus requiring exhaust system components that reduce emissions. In particular the aftertreatment device (ATD), which is part of the aftertreatment system (ATS), requires special attention during regularly scheduled maintenance inspections. See **Fig. 1** for Cummins ATD sensor locations. If any discrepancies are discovered, refer to the engine manufacturer’s service literature for repair instructions.

1. Check for leakage at the clamp that attaches the exhaust pipe to the turbocharger exhaust outlet. If leakage exists, tighten the nut on the clamp to the required torque. If leakage persists, install a new clamp.

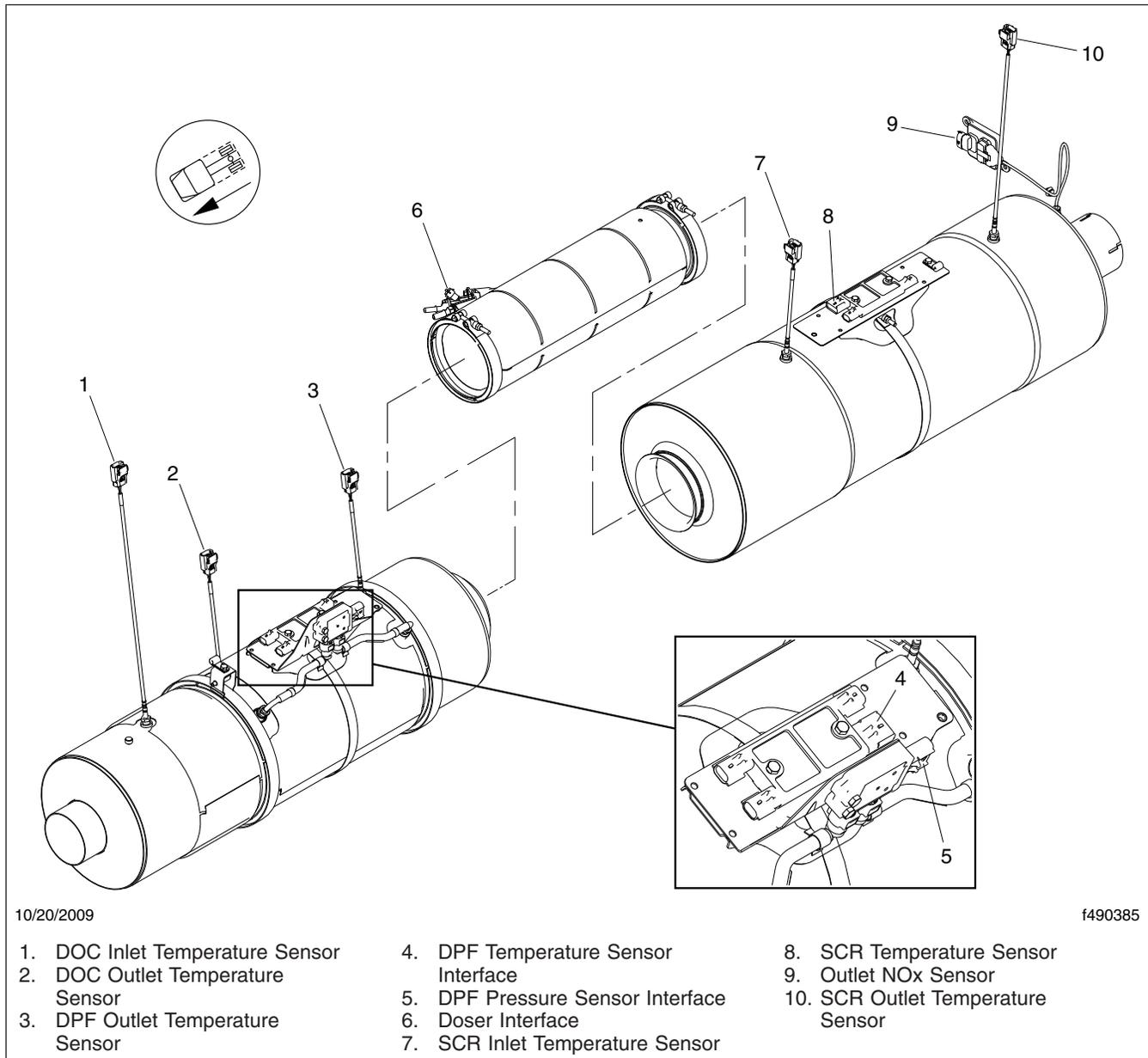


Fig. 1, Cummins ATD Sensor Locations

2. Check the exhaust pipe, bellows, and each exhaust seal clamp for leakage, wear, cracks, or damage. Replace damaged components as needed. If leakage exists at a clamp, tighten the nuts to the required torque. If leakage persists, install a new exhaust seal clamp. Do not reuse seal clamps. Once a seal clamp is loosened or removed, it must be replaced.
3. If present, check the condition of the insulation material around the exhaust pipe between the turbocharger and the ATD.
4. Check the ATD mounting bands for tightness. Tighten to 30 lbf·ft (41 N·m) if needed. Do not overtighten.

5. Check for leaks around the clamps that attach the ATD in the ATS, and around the clamps that retain the DPF in the ATD. No leaks are allowed anywhere in the system.
6. Check all sensors attached to the ATD for leaks or damaged wires. No leaks are allowed.
7. Check the DPF exterior surface for dents or other damage. A dent over 3 inches (76 mm) in diameter and 1/4-inch (6-mm) deep could cause internal damage to the DPF, causing it to malfunction.
8. Check the SCR catalyst for dents and other damage.
9. Check for heat discoloration on the surface of the ATD. Heat discoloration may indicate internal damage; especially around the DPF.

NOTE: Diesel exhaust fluid creeps, causing white crystals to form around the line fittings. The presence of crystals does not mean the system has a leak. Replacing fittings or troubleshooting components is not necessary unless there is a system failure or a fault code.

10. Check the DEF tank, pump, metering unit, and lines for leaks. See **Group 49** of the *Saf-T-Liner C2 School Bus Workshop Manual* for repair procedures.
11. Check any wires, lines, or hoses within 4 inches (10 cm) of the exhaust system for heat damage. Repair or reroute as needed.

Diesel Exhaust Fluid (DEF) Filter Replacement

The Environmental Protection Agency's 2010 regulations require lower nitrogen oxide (NOx) exhaust emissions. Selective catalytic reduction (SCR) uses diesel exhaust fluid (DEF) to lower NOx emissions in the vehicle exhaust. A filter in the DEF pump prevents clogging of the DEF metering unit injection nozzle.

See the engine manufacturer's maintenance manual for DEF filter replacement instructions and maintenance intervals.

EPA07 Exhaust System

Definitions of ATS Components

Refer to the following list of definitions of ATS terms and components.

- Aftertreatment System (ATS)—the entire exhaust system from the turbocharger to the exhaust stack or tail pipe.
- Aftertreatment Device (ATD)—a muffler-like canister that houses a DPF and sensors.
- Diesel Particulate Filter (DPF)—a filter that collects and holds particulate matter (soot and ash).
- Diesel Oxidation Catalyst (DOC)—oxidizes hydrocarbons and reduces NOx.
- Sensors—detect temperatures and pressure within the ATS.

Inspection

IMPORTANT: The Environmental Protection Agency's 2007 regulations require lower exhaust emissions, thus requiring new exhaust system components. See **Fig. 2**. In particular, the aftertreatment device (ATD), which is part of the aftertreatment system (ATS), requires special attention during regularly scheduled maintenance inspections. If any discrepancies are discovered, refer to the engine manufacturer's service literature for repair instructions, or take the vehicle to an authorized Freightliner service facility for repair.

1. Check for leakage at the clamp that attaches the exhaust pipe to the turbocharger exhaust outlet. If leakage exists, tighten the nut on the clamp to the required torque. If leakage persists, install a new clamp.
2. Check the exhaust pipe and each exhaust seal clamp for leakage, wear, cracks, or damage. Replace damaged components as needed. If leakage exists at a clamp, tighten the nuts to the required torque. If leakage persists, install a new exhaust seal clamp. Do not reuse seal clamps. Once a seal clamp is loosened or removed, it must be replaced.

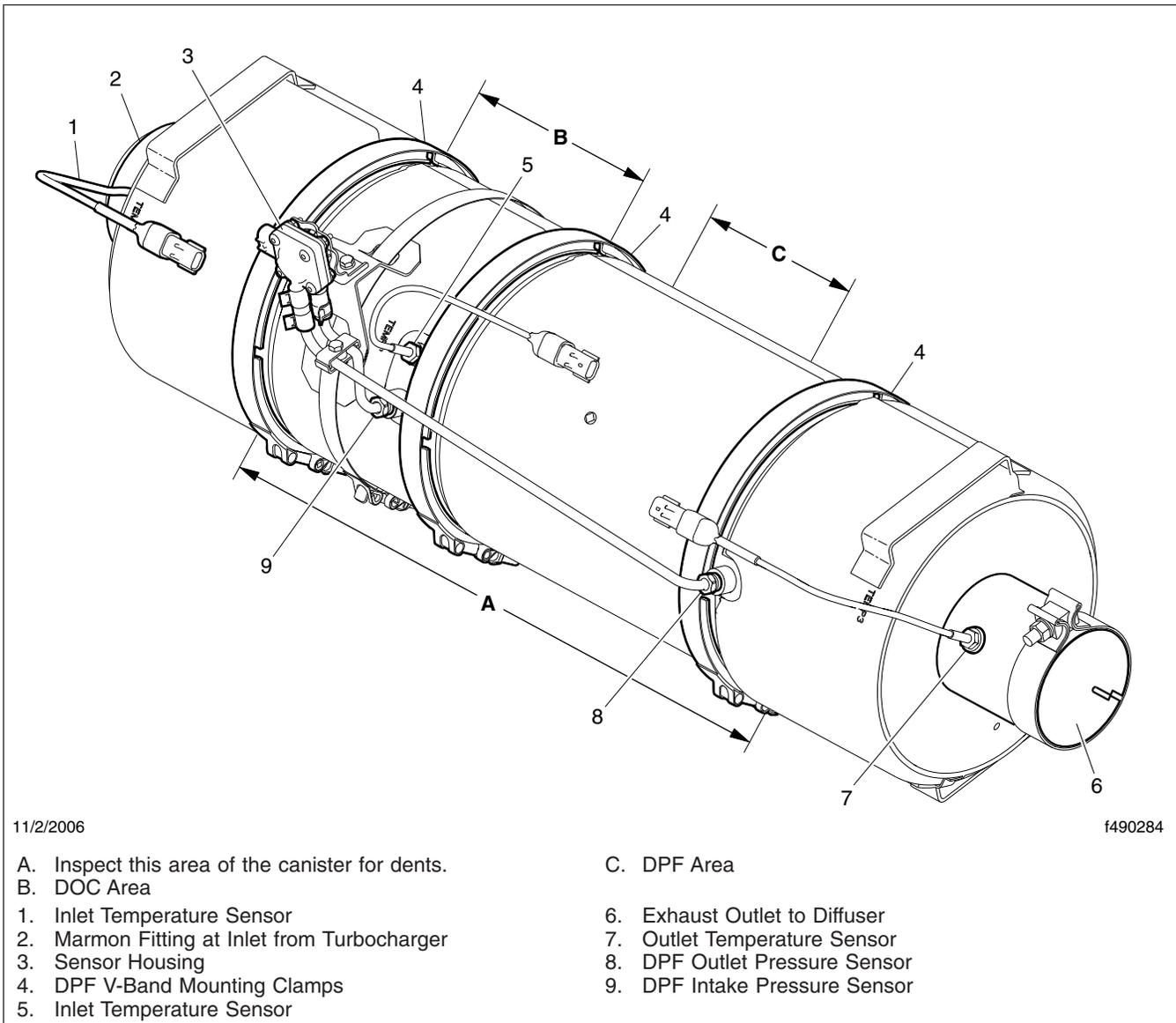


Fig. 2, Aftertreatment Device (typical)

3. If present, check the condition of the insulation material around the exhaust pipe between the turbocharger and the ATD.
4. Check the ATD mounting bands for tightness. Tighten to 30 lbf-ft (41 N-m) if needed. Do not overtighten.
5. Check for leaks around the clamps that attach the ATD in the ATS, and around the clamps that retain the DPF in the ATD. No leaks are allowed anywhere in the system.
6. Check all sensors attached to the ATD for leaks or damaged wires. No leaks are allowed.
7. Check the DPF exterior surface for dents or other damage. See [Fig. 2](#), Reference A. A dent over 3 inches (76 mm) in diameter and 1/4-inch (6-mm) deep could cause internal damage to the DPF, causing it to malfunction.

8. Check for heat discoloration on the surface of the ATD. Heat discoloration may indicate internal damage; especially around the DPF.
9. Check any wires, lines, or hoses within 4 inches (10 cm) of the exhaust system for heat damage. Repair or reroute as needed.

Title of Maintenance Operation (MOP)	MOP Number
Battery Voltage Checking	54-01
Power Electronic Carrier (PEC) Air Filter Inspecting and Replacing	54-02

54-01 Battery Voltage Checking

Check the battery open circuit voltage using an accurate voltmeter. If the voltmeter registers 12.5V or below, fully charge the battery to 12.65V. A fully charged battery will have a voltage of 12.65V with the charger disconnected.

54-02 Power Electronic Carrier (PEC) Air Filter Inspecting and Replacing



Unprotected contact with any live high-voltage components can cause serious injury or death.

1. Perform the high-voltage service shutdown procedure.
 - 1.1 Locate the red PEC service switch on the front of the PEC and push the switch in to the "Off" position. See [Fig. 1](#).

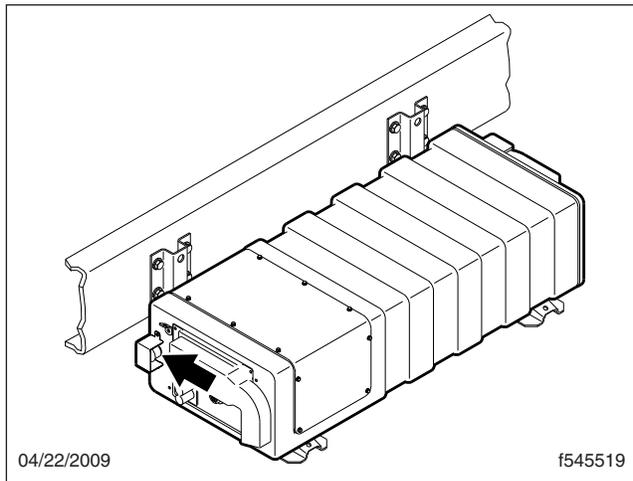


Fig. 1, Service Switch

- 1.2 Remove the service switch cover and install the lockout bracket.
- 1.3 Fasten a tag to the lockout bracket.

- 1.4 Make certain the service switch cannot move from the "Off" position.
- 1.5 Allow the system to set for a minimum of five minutes to discharge high voltage.
- 1.6 Connect ServiceRanger and view the Data Monitor PID 116 called "High-Voltage Battery Potential".
- 1.7 The voltage should be 30 volts or less. If the voltage is above 30 volts, do not work on the vehicle. Contact Eaton® at 1-800-826-HELP (4357).
- 1.8 Turn the ignition off and continue with the air filter inspecting and replacing procedure.

NOTE: The voltage will drop to zero when the key is turned off.

2. Remove the four capscrews holding the PEC air filter cover. See [Fig. 2](#).

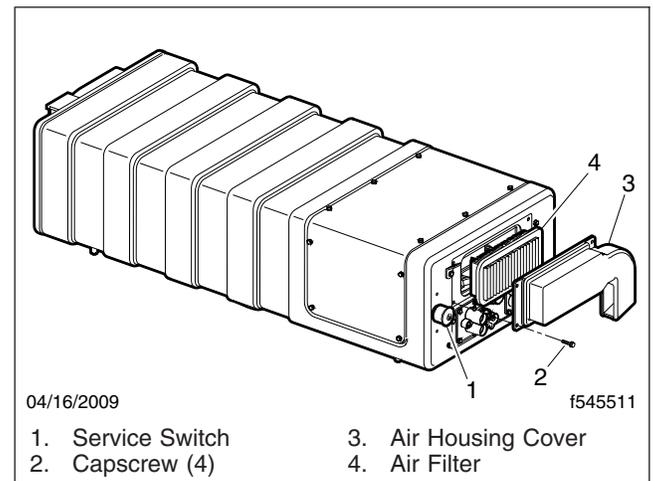


Fig. 2, PEC Components

3. Remove the air filter cover and pull the air filter from the housing.
4. Install the air filter into the PEC housing.

NOTE: The air filter is directional and can only be put in with the short side of the filter element facing out of the PEC.

5. Install the air filter cover with the four capscrews. Tighten the capscrews 14 to 20 lbf-ft (19 to 27 N-m).

6. Perform the high-voltage service power-up procedure.
 - 6.1 Install all high-voltage connectors back into their locked positions.
 - 6.2 Remove the lockout bracket and tag **only if you are the person who is working on the vehicle.**
 - 6.3 Install the protection bracket over the service switch.
 - 6.4 Pull the service switch out and let the vehicle set for two minutes.
 - 6.5 Start the vehicle and ensure it operates correctly.

Title of Maintenance Operation (MOP)	MOP Number
Air Door Inspection.	72-02
Door Seals Lubrication.	72-01

72-01 Door Seals Lubrication

NOTE: The main entry door, rear emergency exit, and emergency hatch seals require lubrication. Do *not* lubricate the door latches or hinges. They come from the manufacturer with lifetime lubrication and do not require maintenance.

Lightly coat the door seals with a lubricant that is safe for rubber (as recommended by the lubricant manufacturer).

2. Tighten the drive linkage locknuts 30 lbf-ft (41 N·m). See [Fig. 2](#), items 1 and 7.
3. If the door requires adjustment, see **Section 72.02, Subject 140** in the *Saf-T-Liner C2 School Bus Workshop Manual* for instructions.

72-02 Air Door Inspection

1. Tighten the flange bolts 12 lbf-ft (16 N·m) on the forward and aft leaf brackets. See [Fig. 1](#).

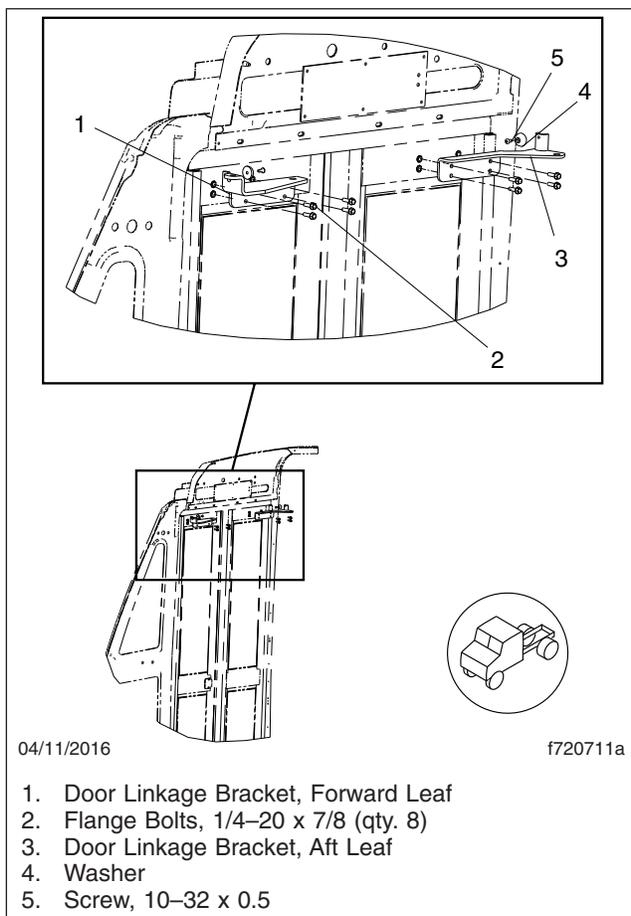


Fig. 1, Tightening the Flange Bolts

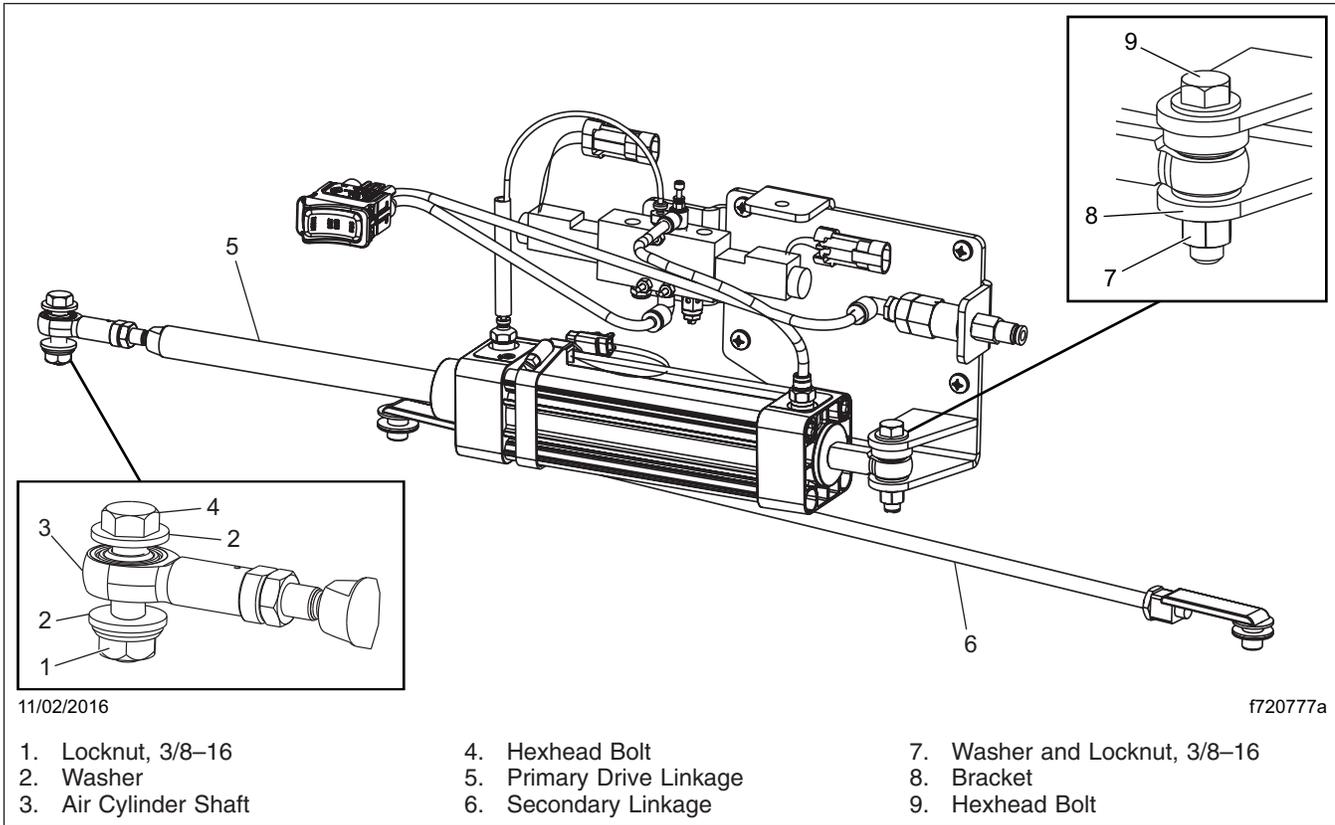


Fig. 2, Air Door Drive Linkage

Title of Maintenance Operation (MOP)	MOP Number
Air Conditioner Inspection.	83-01
HVAC Air Filter Cleaning.	83-02
Safety Precautions.	83-00

83–00 Safety Precautions

Safety Precautions in this section apply to all procedures within this group.



When working on the vehicle, shut down the engine, set the parking brake, and chock the tires. Before working under the vehicle, always place jack stands under the frame rails to ensure the vehicle cannot drop. Failure to follow these steps could result in serious personal injury or death.

83–01 Air Conditioner Inspection

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Operate the heater and, if so equipped, the air conditioner, to check for proper operation in all modes.
3. Open the hood.
4. Check the condition of the refrigerant compressor clutch assembly for visible signs of damage due to excessive heat. If the friction surface of the pulley shows signs of excessive grooving due to belt slippage, replace both the pulley and the drive plate.
5. Inspect the refrigerant compressor drive belt for damage, and replace it if necessary.
6. Check the tightness of the compressor mounting fasteners. The torque value for the mounting fasteners is 15 to 19 lbf-ft (20 to 26 N·m).
7. Inspect the drive plate. If the friction surface of the drive plate shows visible signs of damage due to excessive heat, make sure the refrigerant compressor turns freely. If the compressor does not turn freely, the compressor should be replaced. For instructions, see the applicable section in **Group 83** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.
8. Using a feeler gauge, check that the drive plate clutch clearance is 0.016 to 0.031 inch (0.4 to 0.8 mm). If the gap is not even around the

clutch, gently tap down at the high areas. If the overall gap is out of spec, remove the drive plate assembly and change the shims as necessary. For instructions, see the applicable section in **Group 83** of the vehicle *Workshop Manual*, or take the vehicle to an authorized Freightliner dealer.

9. Check that the wiring harness connector is not damaged or loose. Replace the wiring harness if it is damaged.
10. Check the overall condition of the air conditioning hoses. Look for cracks, cuts, and abrasions on the hoses. Replace damaged hoses.
11. Check for a buildup of road debris on the condenser fins. Using air pressure and a whisk broom or a soapy spray of water, carefully clean the condenser. Be careful not to bend the fins.
12. Close the hood.

83–02 HVAC Air Filter Cleaning

The HVAC air filter must be cleaned every 12 months or 8000 miles (12 872 km), whichever comes first, to permit proper operation of the HVAC system.

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Disconnect the batteries.
3. Remove the three lower HVAC cover Torx screws; two at the bottom of the cover and one on the right. Remove the cover.
4. Disconnect the wiring harness from the evaporator probe, if equipped with air conditioning.
5. Remove the capscrews that attach the evaporator service cover to the HVAC assembly. Remove the evaporator service cover. See **Fig. 1**.
6. Pull the filter out of the HVAC assembly. See **Fig. 2**.
7. Clean the filter with a warm detergent solution. Dry the filter before installing it.
8. Install the filter in the HVAC assembly.
9. Remove the condensate seal from the evaporator service cover and install a new condensate seal on the cover.

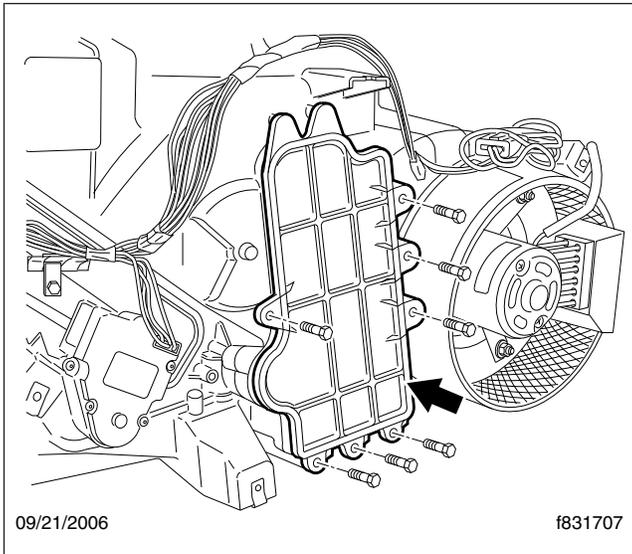


Fig. 1, HVAC Cover Removal

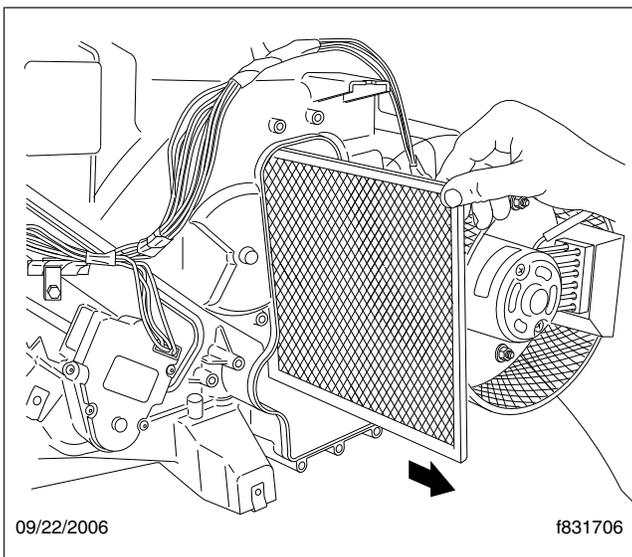


Fig. 2, HVAC Assembly Filter Removal

10. Using capscrews, attach the evaporator service cover to the HVAC assembly.
11. Connect the wiring harness to the evaporator probe.
12. Attach the lower HVAC cover to the dash panel. Install the three Torx screws; two at the bottom of the cover and one on the right.
13. Connect the batteries.

Title of Maintenance Operation (MOP)

MOP Number

Hood Rear Support Lubrication 88-01

88–01 Hood Rear Support Lubrication

1. Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
2. Open the hood.
3. Clean both the hood- and cab-mounted hood rear support components with a soapy water solution.
4. Cover all contact surfaces of the hood rear support brackets and isolators with an approved multi-purpose, lithium-complex, soap-based grease; see [Table 1](#).
5. Close the hood.

Approved Suppliers of Multi-Purpose Lithium Grease	
Supplier	Grease
Chevron	Delo Heavy Duty EP
Exxon	Unirex EP2
Mobil	Mobil Grease XHP 222
Shell	Retinax LC Grease
Texaco	Starplex 2

Table 1, Approved Suppliers of Multi-Purpose Lithium Grease

