



SHUTTLE BUS CHASSIS MAINTENANCE MANUAL

**Models: FB65
MB45
MB55
XB**

Foreword

Scheduled maintenance provides a key element for safe operation of your vehicle. A proper maintenance program also helps to minimize downtime and to safeguard warranties. This maintenance manual provides information necessary for years of safe, reliable, and cost-efficient vehicle operation.

Perform daily pre-trip inspection and maintenance as outlined in the vehicle operator's manual. Perform the operations in this maintenance manual at scheduled intervals based upon distance traveled or months of operation. Your authorized servicing dealer has the qualified technicians and equipment to perform this maintenance for you. Your dealership can also set up a scheduled maintenance program tailored specifically to your needs. Optionally, your dealership can assist you in learning how to perform the maintenance procedures in this manual.

IMPORTANT: Descriptions and specifications in this manual were in effect at the time of printing. Freightliner Custom Chassis Corporation (FCCC) 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.

For additional information, please contact Freightliner LLC, Service Systems and Documentation, P.O. Box 3849, Portland, OR 97208-3849, U.S.A., or refer to <http://www.Freightliner.com> and <http://www.FreightlinerChassis.com>.

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

Freightliner LLC distributes the following major service publications.

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, specifications, and troubleshooting.
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, procedures for adjustments and for checking the tightness of fasteners. Maintenance manuals do not contain detailed repair or service information.
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 pretrip inspection and daily maintenance of vehicle components. Driver's/operator's manuals do not contain detailed repair or service information.
Parts Technical Manual	Freightliner LLC publishes this manual to aid in the identification of serviceable replacement vehicle parts. This manual is used in conjunction with the parts book and the service parts catalog microfiche.
Service Bulletins	<p>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.</p> <p>IMPORTANT: Before using a particular service bulletin, check the current service bulletin validity list to be sure the bulletin is valid.</p>
Recall Bulletins	These bulletins pertain to special situations that involve service work or replacement of parts in connection with a recall notice. Recall bulletins pertain to matters of vehicle safety. All bulletins are distributed to dealers; customers receive notices that apply to their vehicles.
Field Service Modifications	This publication is concerned with non-safety-related service work or replacement of parts. All field service modifications are distributed to dealers; customers receive notices that apply to their vehicles.

For a page example of the printed manual, see Fig. 1.

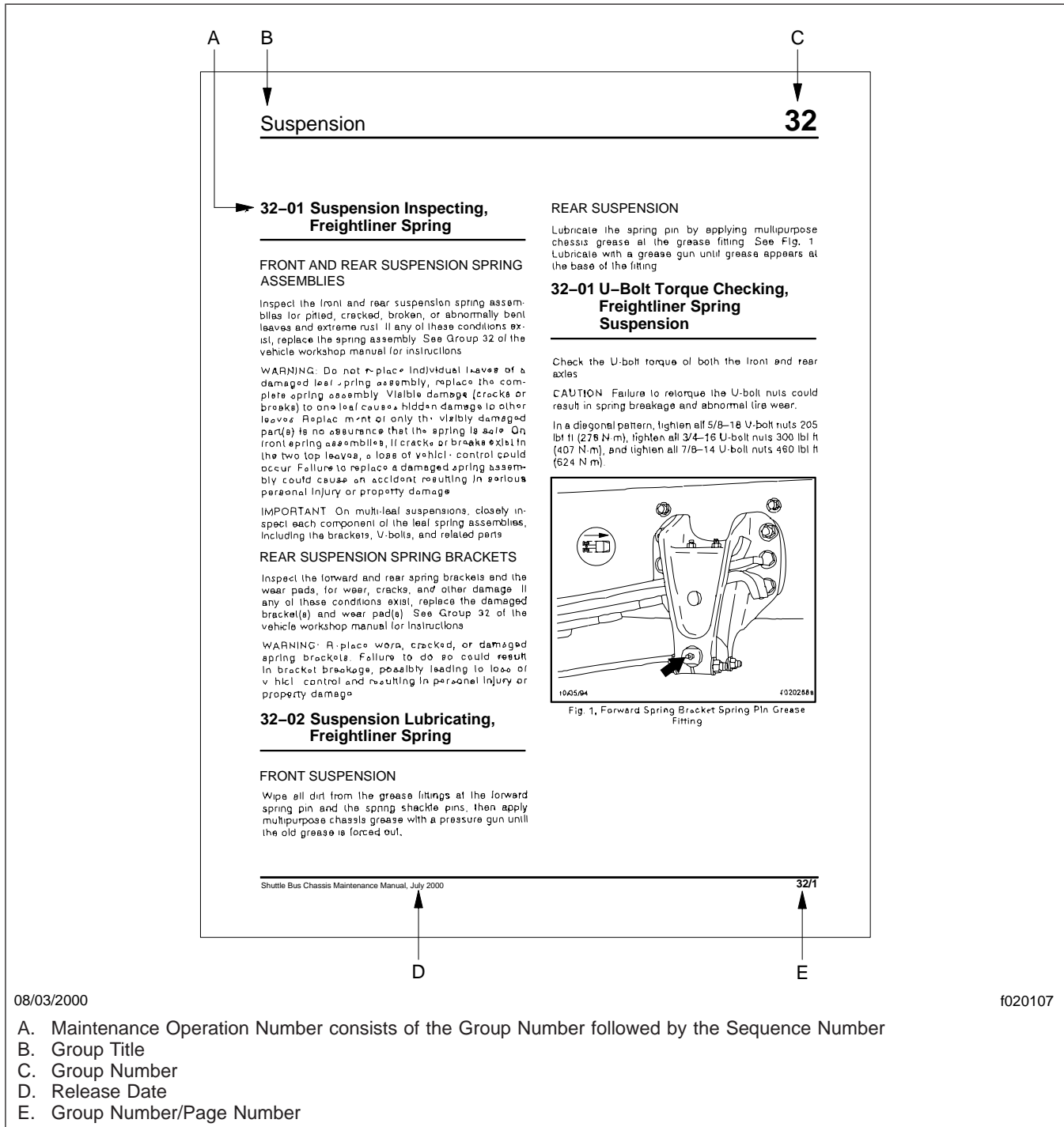


Fig. 1, Page Example of the Printed Manual

Maintenance Manual Contents

Group No.	Group Title
00	General Information
01	Engine
09	Air Intake
13	Air Compressor
15	Alternators and Starters
20	Engine Cooling/Radiator
26	Transmission
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32	Suspension
33	Front Axle
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40	Wheels and Tires
41	Driveline
42	Brakes
46	Steering
47	Fuel
49	Exhaust
54	Electrical, Instruments, and Controls
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Title of Maintenance Operation (MOP)	MOP Number
Determining Scheduled Maintenance Intervals.	00-01
Initial Maintenance IM Operations.	00-06
Lubrication and Fluid Level Check	00-04
M1 Maintenance Interval Operations.	00-07
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Determining Scheduled Maintenance Intervals: 00–01

Description

Category I (urban transport) applies to vehicles that annually travel *up to* 20,000 miles (32 000 kilometers).

Category II (rural transport) applies to vehicles that annually travel *over* 20,000 miles (32 000 kilometers).

The table under *Vehicle Maintenance Schedule Table* shows the two categories of vehicle usage. For each category, the appropriate distance and time intervals are given for performing initial maintenance and for repeating each maintenance operation set (M1 through M3).

The table under *Maintenance Interval Table* shows which maintenance operation set must be performed at the actual distances (miles and kilometers) or actual months of operation for each maintenance category. The schedule of actual distances (and months) is based on the intervals given in the *Vehicle Maintenance Schedule Table*.

The table under *Maintenance Operation Sets* lists, in numerical order, the text reference numbers and descriptions of *all* maintenance operations, and indicates all maintenance operation sets at which each operation must be performed.

Each *Maintenance Interval Operations* table (IM through M3) lists the appropriate text reference numbers and descriptions of only those maintenance operations that must be performed at that maintenance operation set. Each maintenance operation set is listed in a separate *Maintenance Interval Operations* table.

Use

Before placing your new vehicle in service, determine the maintenance category (Category I or II) that applies to your intended use of the vehicle. See the *Vehicle Maintenance Schedule Table* to determine the distance (or time) interval at which each maintenance operation set must be performed for your category of vehicle.

When the vehicle reaches the actual distance (or months) given for an interval, see the *Maintenance Interval Table* to find the maintenance operation set that applies to that interval. Then perform the maintenance operations listed in the applicable *Maintenance Interval Operations* table. Use the mainte-

nance operation reference numbers to find instructions in the manual for completion of each operation.

Complete each maintenance operation set at the required interval. Then, when you have completed maintenance operation set M3 under the 12th Maintenance Number listed in the *Maintenance Interval Table*, repeat the pattern. The 13th Maintenance Number will begin at maintenance operation set M1, under the 1st Maintenance Number listed in the *Maintenance Interval Table*.

NOTE: When performing operations for the 13th Maintenance Number, complete the M1 operations only, not the Initial Maintenance operations.

To determine the distance/months for the 13th Maintenance Number, add your category's distance/months for the 1st Maintenance Number to the distance/months for the 12th Maintenance Number, then perform the operations listed in the applicable table in the *Maintenance Interval Operations* tables. For the 14th Maintenance Number, add the distance/months for the 2nd to the distance/months for the 12th; continue this pattern for each successive Maintenance Number.

Vehicle Maintenance Schedule Table: 00–02
Vehicle Maintenance Schedule Table

Vehicle Maintenance Schedule Table					
Description	Maintenance Operation Set	Maintenance Intervals			
		Frequency	Miles	km	Months
CATEGORY I (Urban Transport) vehicles that annually travel up to 20,000 miles (32 000 km)	Initial Maintenance (IM)	first	2500	4000	3
	Maintenance 1 (M1)	every	2500	4000	3
	Maintenance 2 (M2)	every	10,000	16 000	12
	Maintenance 3 (M3)	every	30,000	48 000	36
CATEGORY II (Rural Transport) vehicles that annually travel over 20,000 miles (32 000 km)	Initial Maintenance (IM)	first	5000	8000	3
	Maintenance 1 (M1)	every	5000	8000	3
	Maintenance 2 (M2)	every	20,000	32 000	12
	Maintenance 3 (M3)	every	60,000	96 500	36

Maintenance Interval Table: 00-03

Maintenance Interval Table

Maintenance Interval Table							
Maint. No.	Maint. Oper. Set	Category I			Category II		
		miles x 100	km x 100	months	miles x 100	km x 100	months
1st	IM + M1	25	40	3	50	80	3
2nd	M1	50	80	6	100	160	6
3rd	M1	75	120	9	150	240	9
4th	M2	100	160	12	200	320	12
5th	M1	125	200	15	250	400	15
6th	M1	150	240	18	300	480	18
7th	M1	175	280	21	350	560	21
8th	M2	200	320	24	400	640	24
9th	M1	225	360	27	450	720	27
10th	M1	250	400	30	500	800	30
11th	M1	275	440	33	550	885	33
12th	M3	300	480	36	600	965	36

Lubrication and Fluid Level Check: 00–04

Lubrication and Fluid Level Check	
Maintenance Operation Reference Number	Maintenance Operation Description
26–02	Transmission Fluid and Filter Changing
26–03	Transmission Fluid Level Checking
32–02	Suspension Lubricating, Freightliner Spring
33–01	Knuckle Pin Lubricating
33–02	Tie-Rod End Lubricating
33–05	Oil-Filled Hubs Oil Level Checking
33–06	Oil-Filled Hubs Oil Changing
33–07	Wheel Bearing Removing, Cleaning, Checking, Repacking, and Adjusting
35–01	Axle Lubricant Level Checking
35–02	Axle Lubricant Changing and Magnetic Plug Cleaning
41–01	Driveline Inspecting and Lubricating
42–04	Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2
42–05	Automatic Slack Adjuster Lubricating and Checking, Meritor
42–09	Camshaft Bracket Bushing Lubricating
42–10	Foot Brake valve Actuator Lubricating, Bendix E–6
42–12	Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes*
42–13	Brake Caliper Slide Pin Lubricating, Bosch Hydraulic Brakes
42–15	Drum Brake Shoe Roller Lubricating
46–01	Steering Driveline Lubricating
46–02	Drag Link Lubricating
46–03	Power Steering Reservoir Fluid Level Checking
46–04	Power Steering Reservoir Fluid and Filter Changing
46–05	Steering Gear Lubricating
54–03	Ground Cables Checking and Cleaning

* IMPORTANT: Lubricate every 6 months "or" every 18,000 miles (28 800 km), whichever comes first.

Table 1, Lubrication and Fluid Level Check

Maintenance Operation Sets: 00–05

NOTE: Maintenance operations appearing in italics in this table are for noise emission control components. Numbers in this table are maintenance operation ref-

erence numbers matching those in the text of this manual.

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
00–04	Lubrication and Fluid Level Check	•	•	•	•
01–01	<i>Engine-Support Fasteners Checking</i>				•
01–02	Engine Drive Belt Inspecting	•	•	•	•
01–03	Pacbrake Inspecting and Maintenance*				
09–01	Air Cleaner Element Inspecting and Replacing			•	•
09–02	Air Intake System Inspecting	•	•	•	•
13–01	Air Compressor Inspecting	•	•	•	•
15–01	Alternator, Battery, and Starter Checking			•	•
20–01	Radiator Cap Checking			•	•
20–02	Radiator Pressure Flushing and Coolant Changing				•
20–03	<i>Eaton Viscous Fan Drive Checking</i>			•	•
26–01	Transmission Breather Checking			•	•
26–02	Transmission Fluid and Filter Changing†				•
26–03	Transmission Fluid Level Checking	•	•	•	•
31–01	Frame Fastener Torque Checking	•			•
32–01	Suspension Inspecting, Freightliner Spring	•	•	•	•
32–02	Suspension Lubricating, Freightliner Spring	•	•	•	•
32–03	U-Bolt Torque Checking, Freightliner Spring	•			•
32–04	Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)	•			•
32–05	Fastener Torque Checking, Freightliner AirLiner	•			•
32–06	Component Clearance Checking, Freightliner AirLiner	•			•
32–07	Component Inspecting and Operation Checking, Freightliner AirLiner				•
32–08	U-Bolt Torque Checking, Freightliner AirLiner	•			•
32–09	Shock Absorber Checking, Freightliner Spring				•
32–10	Torque Arm Bushing Checking, Freightliner AirLiner	•	•	•	•
32–11	Suspension Inspecting, Neway	•			•
33–01	Knuckle Pin Lubricating	•	•	•	•
33–02	Tie-Rod End Lubricating	•	•	•	•
33–03	Tie-Rod End Inspecting	•	•	•	•
33–04	Wheel Alignment Checking, Front Axle	•			
33–05	Oil-Filled Hubs Oil Level Checking	•	•	•	•
33–06	Oil-Filled Hubs Oil Changing				•
33–07	Wheel Bearing Removing, Cleaning, Checking, Repacking, and Adjusting				•

Maintenance Operation Sets: 00–05

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
35–01	Axle Lubricant Level Checking	•	•	•	•
35–02	Axle Lubricant Changing and Magnetic Plug Cleaning	•			•
35–03	Axle Breather Checking	•	•	•	•
40–01	Wheel Nut and Rim Nut Checking	•	•	•	•
41–01	Driveline Inspecting and Lubricating	•	•	•	•
42–01	Air Dryer Checking, Bendix AD–9†			•	•
42–02	Air Dryer Desiccant Replacing, Bendix AD–9				•
42–03	Air Dryer Inspecting, Bendix AD–9†	•		•	•
42–04	Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2			•	•
42–05	Automatic Slack Adjuster Lubricating and Checking, Meritor	•	•	•	•
42–06	Bendix Hydro-Max Power Booster Checking	•	•	•	•
42–07	Brake Lines Checking, Hydraulic Disc Brakes	•	•	•	•
42–08	Brake Lining Wear Checking, Hydraulic Disc Brakes	•	•	•	•
42–09	Camshaft Bracket Bushing Lubricating			•	•
42–10	Foot Brake Valve Actuator Lubricating, Bendix E–6	•		•	•
42–11	Relay Valve Checking, Midland	•	•	•	•
42–12	Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes§	•	•	•	•
42–13	Brake Caliper Slide Pin Lubricating, Bosch Hydraulic Brakes¶				
42–14	ABS Tone Rings Cleaning**	•	•	•	•
42–15	Drum Brake Shoe Roller Lubricating			•	•
42–16	Air Dryer Inspecting, Midland	•		•	•
42–17	Air Dryer Desiccant and Coalescent Filter Replacing, Midland††				
46–01	Steering Driveline Lubricating	•	•	•	•
46–02	Drag Link Lubricating	•	•	•	•
46–03	Power Steering Reservoir Fluid Level Checking	•	•	•	•
46–04	Power Steering Reservoir Fluid and Filter Changing				•
46–05	Steering Gear Lubricating	•	•	•	•
47–01	Diesel Fuel Tank Draining and Vent Checking	•	•	•	•
47–02	CNG Low-Pressure Fuel Filter Draining	•	•	•	•
47–03	CNG High-Pressure Fuel Filter Draining	•	•	•	•
47–04	Fuel/Water Separator Element Replacing			•	•
47–05	CNG Fuel Block Housing Draining	•	•	•	•
47–06	CNG Fuel Leak Testing	•	•	•	•
47–07	CNG Fuel Tank Visual Inspecting‡‡	•	•	•	•
47–08	CNG High-Pressure Fuel Filter Replacing	•	•	•	•

REQUIRED MAINTENANCE OPERATION SET		IM	M1	M2	M3
Maintenance Operation Reference Number and Maintenance Operation					
47–09	CNG Low-Pressure Fuel Filter Replacing	•	•	•	•
47–10	Inline Fuel Strainer Replacing, Cummins ISB02 Engine			•	•
49–01	<i>Exhaust System Inspecting</i>			•	•
54–01	Coolant Level Sensor Cleaning				•
54–02	Electrical System Checking			•	•
54–03	Ground Cables Checking and Cleaning			•	•
83–01	Air Conditioning Checking, R-134a Refrigerant System	•	•	•	•

* With frequent use, the Pacbrake Exhaust Brake will operate free of maintenance. However, if the vehicle is used inconsistently, seasonally, or is exposed to excess moisture, it will be necessary to perform preventative maintenance as instructed in [Maintenance Operation 01–03](#).

† For series 1000/2000/2400 transmissions with non-TranSynd ATF, change oil and filters at 50,000 miles (80 000 km) or 24 months, whichever comes first.

‡ Perform annually during the fall.

§ IMPORTANT: Lubricate every 6 months "or" every 18,000 miles (28 800 km), whichever comes first.

¶ See the "Bosch Pin Slide Disc Brakes Service Manual" for more information.

** This operation applies specifically to vehicles used during winter months in areas where corrosive materials are used on the highways.

†† Replace the desiccant and coalescent filter every 18,000 miles (30 000 km) or every 18 months.

‡‡ Visually inspect the fuel tank every 25,000 miles (40 000 km) OR every 6 months, whichever comes first. The fuel tank must be replaced every 15 years.

Initial Maintenance IM Operations: 00–06

This Initial Maintenance IM Operations table lists all maintenance operations that are to be performed at initial maintenance (IM). Numbers in this table are maintenance operation reference numbers matching those in the text of this manual, that can be used to

find detailed instructions for the operations to be performed. All operations listed in the table, along with the operations listed in the M1 Maintenance Interval Operations table, must be performed to complete the initial maintenance (IM).

Initial Maintenance (IM) Operations

Maint. Oper. No.	Initial Maintenance (IM) Operations
00–07	Perform all M1 Operations
31–01	Frame Fastener Torque Checking
32–03	U-Bolt Torque Checking, Freightliner Spring
32–04	Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)
32–05	Fastener Torque Checking, Freightliner AirLiner
32–06	Component Clearance Checking, Freightliner AirLiner
32–08	U-Bolt Torque Checking, Freightliner AirLiner
32–11	Suspension Inspecting, Neway
33–04	Wheel Alignment Checking, Front Axle
35–02	Axle Lubricant Checking and Magnetic Plug Cleaning
42–03	Air Dryer Inspecting, Bendix AD–9
42–10	Foot Brake Valve Actuator Lubricating, Bendix E–6
42–12	Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes
42–16	Air Dryer Inspecting, Midland

M1 Maintenance Interval Operations: 00–07

This M1 Maintenance Interval Operations table lists all maintenance operations that are to be performed at the M1 maintenance interval. Numbers in this table are maintenance operation reference numbers

matching those in the text of this manual, that can be used to find detailed instructions for the operations to be performed.

M1 Maintenance Interval Operations

Maint. Oper. No.	M1 Maintenance Interval Operations
00–04	Lubrication and Fluid Level Check (includes the following) <ul style="list-style-type: none"> • Transmission Fluid Level Checking • Suspension Lubricating, Freightliner Spring • Knuckle Pin Lubricating • Tie-Rod End Lubricating • Oil-Filled Hubs Oil Level Checking • Axle Lubricant Level Checking • Driveline Inspecting and Lubricating • Automatic Slack Adjuster Lubricating and Checking, Meritor • Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes • Steering Driveline Lubricating • Drag Link Lubricating • Power Steering Reservoir Fluid Level Checking • Steering Gear Lubricating
09–02	Air Intake System Inspecting
26–02	Transmission External Filter Changing (Category II Usage)
32–01	Suspension Inspecting, Freightliner Spring
32–10	Torque Arm Bushing Checking, Freightliner AirLiner
33–03	Tie-Rod End Inspecting
35–03	Axle Breather Checking
40–01	Wheel Nut and Rim Nut Checking
42–06	Bendix Hydro-Max Power Booster Checking
42–07	Brake Lines Checking, Hydraulic Disk Brakes
42–08	Brake Lining Wear Checking, Hydraulic Disk Brakes
42–11	Relay Valve Checking, Midland
42–14	ABS Tone Rings Cleaning*
47–01	Diesel Fuel Tank Draining and Vent Checking
47–02	CNG Low-Pressure Fuel Filter Draining
47–03	CNG High-Pressure Fuel Filter Draining
47–05	CNG Fuel Block Housing Draining
47–06	CNG Fuel Leak Testing
47–07	CNG Fuel Tank Visual Inspecting†

M1 Maintenance Interval Operations: 00–07

Maint. Oper. No.	M1 Maintenance Interval Operations
47–08	CNG High-Pressure Fuel Filter Replacing
47–09	CNG Low-Pressure Fuel Filter Replacing
83–01	Heater and Air Conditioning System Checking

* This operation applies specifically to vehicles used during winter months in areas where corrosive materials are used on the highways.

† Visually inspect the fuel tank every 25,000 miles (40 000 km) OR every 6 months, whichever comes first. The fuel tank must be replaced every 15 years.

M2 Maintenance Interval Operations: 00–08

This M2 Maintenance Interval Operations table lists all maintenance operations that are to be performed at the M2 maintenance interval. Numbers in this table are maintenance operation reference numbers

matching those in the text of this manual, that can be used to find detailed instructions for the operations to be performed. Perform all M1 maintenance interval operations at the M2 maintenance interval.

M2 Maintenance Interval Operations

Maint. Oper. No.	M2 Maintenance Interval Operations
00–07	Perform all M1 Operations
09–01	Air Cleaner Element Inspecting and Replacing
15–01	Alternator, Battery, and Starter Checking
20–01	Radiator Cap Checking
20–03	<i>Eaton Viscous Fan Drive Checking</i>
26–01	Transmission Breather Checking
26–02	Transmission Fluid and Filter Changing (Category II Usage)
42–01	Air Dryer Checking, Bendix AD–9*
42–03	Air Dryer Inspecting, Bendix AD–9 *
42–04	Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV–2
42–09	Camshaft Bracket Bushing Lubricating
42–10	Foot Brake Valve Actuator Lubricating, Bendix E–6
42–15	Drum Brake Shoe Roller Lubricating
42–16	Air Dryer Inspecting, Midland
47–04	Fuel/Water Separator Element Replacing
47–10	Inline Fuel Strainer Replacing, Cummins ISB02 Engine
49–01	<i>Exhaust System Inspecting</i>
54–02	Electrical System Checking
54–03	Ground Cables Checking and Cleaning

* Perform annually during the fall.

M3 Maintenance Interval Operations: 00–09

This M3 Maintenance Interval Operations table lists all maintenance operations that are to be performed at the M3 maintenance interval. Numbers in this table are maintenance operation reference numbers matching those in the text of this manual, that can be

used to find detailed instructions for the operations to be performed. Perform all M1 maintenance interval operations and M2 maintenance interval operations at the M3 maintenance interval.

M3 Maintenance Interval Operations

Maint. Oper. No.	M3 Maintenance Interval Operations
00–07	Perform all M1 Operations
00–08	Perform all M2 Operations
01–01	<i>Engine-Support Fasteners Checking</i>
20–02	Radiator Pressure Flushing and Coolant Changing
26–02	Transmission Fluid and Filter Changing*
31–01	Frame Fastener Torque Checking
32–03	U-Bolt Torque Checking, Freightliner Spring
32–04	Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)
32–05	Fastener Torque Checking, Freightliner AirLiner
32–06	Component Clearance Checking, Freightliner AirLiner
32–07	Component Inspecting and Operation Checking, Freightliner AirLiner
32–08	U-Bolt Torque Checking, Freightliner AirLiner
32–09	Shock Absorber Checking, Freightliner Spring
32–11	Suspension Inspecting, Neway
33–06	Oil-Filled Hubs Oil Changing
33–07	Wheel Bearing Removing, Cleaning, Checking, Repacking, and Adjusting
35–02	Axle Lubricant Changing and Magnetic Plug Cleaning
42–02	Air Dryer Desiccant Replacing, Bendix AD–9
46–04	Power Steering Reservoir Fluid and Filter Changing
54–01	Coolant Level Sensor Cleaning

* For series 1000/2000/2400 transmissions with non-TranSynd ATF, change oil and filters at 50,000 miles (80 000 km) or 24 months, whichever comes first.

General Information

Federal Law, Part 205: Transportation Equipment Noise Emission Controls

Part 205, Transportation Equipment Noise Emission Controls, requires the vehicle manufacturer to furnish, with each new vehicle, such 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 controls maintenance information located in each applicable group of this manual, in conjunction with the vehicle workshop manual, provides these instructions to owners.

Normal Vehicle Use

The maintenance instructions contained in this manual are based on average vehicle use and normal operating conditions. Unusual vehicle operating conditions may require service at more frequent intervals.

Recommendations for Replacement Parts

Replacement parts used for maintenance or repair of noise emission controls should be genuine Alliance parts. If other than genuine Alliance 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 Alliance parts in performance and durability.

Freightliner Noise Emissions Warranty

See the vehicle owner's warranty information book for warranty information concerning noise emission controls.

Tampering With the Noise Controls 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, or (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:

- A. Removal of engine noise-deadening panels.
- B. Removal of, or rendering inoperative, the engine speed governor so as to allow engine speed to exceed manufacturer's specifications.
- C. Removal of, or rendering inoperative, the fan clutch, including by-passing the control on any thermostatic fan drive to cause it to operate continuously.
- D. Removal of the fan shroud.
- E. Removal of, or rendering inoperative, exhaust system components, including exhaust pipe clamping.
- F. Removal of air intake components.
- G. Removal of hood liners (noise-deadening panels).

Maintenance Instructions

Scheduled intervals are in the maintenance table in this Group. A "Verification of Inspections Log" follows, and should be filled in each time the noise emission controls on the vehicle are maintained or repaired.

Metric/U.S. Customary Conversion Table: 00–12

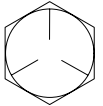
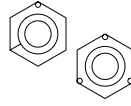
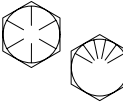
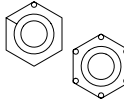
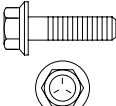
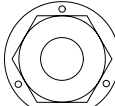
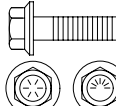
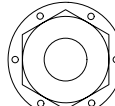
When You Know U.S. Customary	Multiply By	To Get Metric	When You Know Metric	Multiply By	To Get U.S. Customary
Length					
inches (in)	25.4	millimeters (mm)	0.03937		inches (in)
inches (in)	2.54	centimeters (cm)	0.3937		inches (in)
feet (ft)	0.3048	meters (m)	3.281		feet (ft)
yards (yd)	0.9144	meters (m)	1.094		yards (yd)
miles (mi)	1.609	kilometers (km)	0.6215		miles (mi)
Area					
square inches (in ²)	645.16	square millimeters (mm ²)	0.00155		square inches (in ²)
square inches (in ²)	6.452	square centimeters (cm ²)	0.155		square inches (in ²)
square feet (ft ²)	0.0929	square meters (m ²)	10.764		square feet (ft ²)
Volume					
cubic inches (in ³)	16387.0	cubic millimeter (mm ³)	0.000061		cubic inches (in ³)
cubic inches (in ³)	16.387	cubic centimeters (cm ³)	0.06102		cubic inches (in ³)
cubic inches (in ³)	0.01639	liters (L)	61.024		cubic inches (in ³)
fluid ounces (fl oz)	29.54	milliliters (mL)	0.03381		fluid ounces (fl oz)
pints (pt)	0.47318	liters (L)	2.1134		pints (pt)
quarts (qt)	0.94635	liters (L)	1.0567		quarts (qt)
gallons (gal)	3.7854	liters (L)	0.2642		gallons (gal)
cubic feet (ft ³)	28.317	liters (L)	0.03531		cubic feet (ft ³)
cubic feet (ft ³)	0.02832	cubic meters (m ³)	35.315		cubic feet (ft ³)
Weight/Force					
ounces (av) (oz)	28.35	grams (g)	0.03527		ounces (av) (oz)
pounds (av) (lb)	0.454	kilograms (kg)	2.205		pounds (av) (lb)
U.S. tons (t)	907.18	kilograms (kg)	0.001102		U.S. tons (t)
U.S. tons (t)	0.90718	metric tons (t)	1.1023		U.S. tons (t)
Torque/Work Force					
inch–pounds (lbf-in)	11.298	Newton–centimeters (N-cm)	0.08851		inch–pounds (lbf-in)
foot–pounds (lbf-ft)	1.3558	Newton–meters (N-m)	0.7376		foot–pounds (lbf-ft)
Pressure/Vacuum					
inches of mercury (inHg)	3.37685	kilo Pascals (kPa)	0.29613		inches of mercury (inHg)
pounds per square inch (psi)	6.895	kilo Pascals (kPa)	0.14503		pounds per square inch (psi)

Table 2, Metric/U.S. Customary Conversion Table

Torque Specifications Tables: 00–13

IMPORTANT: Grade 8 regular hex zinc-yellow plated capscrews and cadmium- and wax-coated prevailing torque locknuts may be tightened to a lower torque value than the grade 8 regular hex fasteners de-

scribed in [Table 3](#). See [Table 4](#) for torque values for grade 8 regular hex zinc-yellow plated capscrews and cadmium- and wax-coated prevailing torque locknuts.

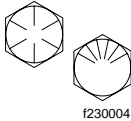
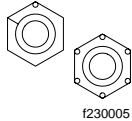
Torque Values for U.S. Customary Thread Fasteners With Lubricated* or Plated Threads†								
Thread Diameter–Pitch	Regular Hex				Flanged			
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 5 Bolt	Grade B Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)	
	 f230002	 f230003	 f230004	 f230005	 f230006	 f230007	 f230008	 f230009
1/4–20	7 (9)		8 (11)		6 (8)		10 (14)	
1/4–28	8 (11)		9 (12)		7 (9)		12 (16)	
5/16–18	15 (20)		16 (22)		13 (18)		21 (28)	
5/16–24	16 (22)		17 (23)		14 (19)		23 (31)	
3/8–16	26 (35)		28 (38)		23 (31)		37 (50)	
3/8–24	30 (41)		32 (43)		25 (34)		42 (57)	
7/16–14	42 (57)		45 (61)		35 (47)		60 (81)	
7/16–20	47 (64)		50 (68)		40 (54)		66 (89)	
1/2–13	64 (87)		68 (92)		55 (75)		91 (123)	
1/2–20	72 (98)		77 (104)		65 (88)		102 (138)	
9/16–12	92 (125)		98 (133)		80 (108)		130 (176)	
9/16–18	103 (140)		110 (149)		90 (122)		146 (198)	
5/8–11	128 (173)		136 (184)		110 (149)		180 (244)	
5/8–18	145 (197)		154 (209)		130 (176)		204 (277)	
3/4–10	226 (306)		241 (327)		200 (271)		320 (434)	
3/4–16	253 (343)		269 (365)		220 (298)		357 (484)	
7/8–9	365 (495)		388 (526)		320 (434)		515 (698)	
7/8–14	402 (545)		427 (579)		350 (475)		568 (770)	
1–8	—		582 (789)		—		—	
1–12	—		637 (863)		—		—	
1–14	—		652 (884)		—		—	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed).

Table 3, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads

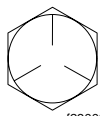
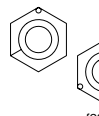
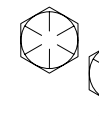

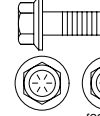
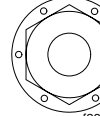
Torque Specifications Tables: 00–13

Torque Values for Grade 8 Regular Hex Zinc-Yellow Plated Capscrews and Cadmium- and Wax-Coated Prevailing Torque Locknuts*		
Thread Diameter-Pitch	Regular Hex	
	Grade 8 or 8.2 Bolt	Grade 8 or C Nut
	Torque: lbf-ft (N-m)	
		
1/4–20	6 (8)	
1/4–28	7 (9)	
5/16–18	13 (18)	
5/16–24	14 (19)	
3/8–16	23 (31)	
3/8–24	26 (35)	
7/16–14	37 (50)	
7/16–20	41 (56)	
1/2–13	56 (76)	
1/2–20	63 (85)	
9/16–12	81 (110)	
9/16–18	90 (122)	
5/8–11	112 (152)	
5/8–18	126 (171)	
3/4–10	198 (268)	
3/4–16	221 (300)	
7/8–9	319 (433)	
7/8–14	352 (477)	
1–8	479 (649)	
1–12	524 (710)	
1–14	537 (728)	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

Table 4, Torque Values for Grade 8 Regular Hex Zinc-Yellow Plated Capscrews and Cadmium- and Wax-Coated Prevailing Torque Locknuts

Torque Specifications Tables: 00–13

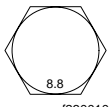
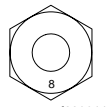
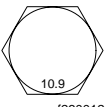
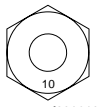
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter–Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)	
	 f230002	 f230003	 f230004	 f230005	 f230008	 f230009
1/4–20	8 (11)		10 (14)		—	
1/4–28	9 (12)		12 (16)		—	
5/16–18	15 (20)		22 (30)		22 (30)	
5/16–24	17 (23)		25 (34)		—	
3/8–16	28 (38)		40 (54)		40 (54)	
3/8–24	31 (42)		45 (61)		—	
7/16–14	45 (61)		65 (88)		65 (88)	
7/16–20	50 (68)		70 (95)		—	
1/2–13	70 (95)		95 (129)		95 (129)	
1/2–20	75 (102)		110 (149)		—	
9/16–12	100 (136)		140 (190)		140 (190)	
9/16–18	110 (149)		155 (210)		—	
5/8–11	135 (183)		190 (258)		190 (258)	
5/8–18	155 (210)		215 (292)		—	
3/4–10	240 (325)		340 (461)		340 (461)	
3/4–16	270 (366)		380 (515)		—	
7/8–9	385 (522)		540 (732)		—	
7/8–14	425 (576)		600 (813)		—	
1–8	580 (786)		820 (1112)		—	
1–12	635 (861)		900 (1220)		—	
1–14	650 (881)		915 (1241)		—	

* Threads may have residual oil, but will be dry to the touch.

† Male and female threads (bolt and nut) must both be unlubricated and unplated; if either is plated or lubricated, use [Table 3](#). Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

Table 5, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads

Torque Specifications Tables: 00–13

Torque Values for Metric Thread Fasteners With Lubricated* or Plated Threads†				
Thread Diameter–Pitch	Class 8.8 Bolt	Class 8 Nut	Class 10.9 Bolt	Class 10 Nut
	Torque: lbf·ft (N·m)		Torque: lbf·ft (N·m)	
	 f230010	 f230011	 f230012	 f230013
M6	5 (7)		7 (9)	
M8	12 (16)		17 (23)	
M8 x 1	13 (18)		18 (24)	
M10	24 (33)		34 (46)	
M10 x 1.25	27 (37)		38 (52)	
M12	42 (57)		60 (81)	
M12 x 1.5	43 (58)		62 (84)	
M14	66 (89)		95 (129)	
M14 x 1.5	72 (98)		103 (140)	
M16	103 (140)		148 (201)	
M16 x 1.5	110 (149)		157 (213)	
M18	147 (199)		203 (275)	
M18 x 1.5	165 (224)		229 (310)	
M20	208 (282)		288 (390)	
M20 x 1.5	213 (313)		320 (434)	
M22	283 (384)		392 (531)	
M22 x 1.5	315 (427)		431 (584)	
M24	360 (488)		498 (675)	
M24 x 2	392 (531)		542 (735)	
M27	527 (715)		729 (988)	
M27 x 2	569 (771)		788 (1068)	
M30	715 (969)		990 (1342)	
M30 x 2	792 (1074)		1096 (1486)	

* Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed).

Table 6, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads

Title of Maintenance Operation (MOP)	MOP Number
Engine Drive Belt Inspecting	01-02
Engine-Support Fasteners Checking (Noise Emission Control).	01-01
Pacbrake Inspecting and Maintenance	01-03

01-01 Engine-Support Fasteners Checking (Noise Emission Control)

Check the front and rear engine-support fasteners for tightness. See **Fig. 1**. See **Section 01.02** of the *Shuttle Bus Chassis Workshop Manual* for procedures.

NOTE: At engine overhaul, and whenever the engine has been removed, inspect the lower and upper isolators and replace them if they are worn. See **Fig. 1**. See **Section 01.02** of the *Shuttle Bus Chassis Workshop Manual* for procedures.

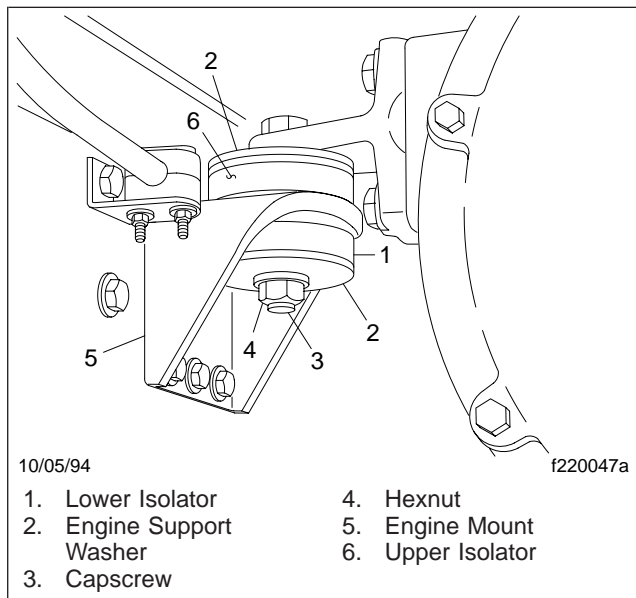


Fig. 1, Rear Engine Mount

01-02 Engine Drive Belt Inspecting

⚠ WARNING

The engine and the belt must be cool before you check the belt. Handling a hot belt can cause personal injury.

Worn or loose drive belts may cause premature bearing failure or engine overheating. Excessive tension, or too little tension on the belt may result in excessive and premature belt wear. Poly-V belts, or serpentine belts, are retained by a belt tensioner that requires no tension adjustment. Replace the engine drive belt if any conditions described in the visual description are found. V-belts are installed as individual belts, and as matched sets. When replacing a matched set of belts, always replace both belts at the same time. Matched belts must be from the same manufacturer. To inspect a belt, gently twist the belt to view the belt sidewalls and bottom. Visually inspect all drive belts for the following conditions, then perform the belt tension inspection.

Visual Inspection

1. Inspect the belt for glazing. See **Fig. 2**, Ref. A. Glazing is indicated by shiny sidewalls, and 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 the belt for ply separation. See **Fig. 2**, Ref. B. 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.
3. Check the belt for a jagged or streaked sidewall. See **Fig. 2**, Ref. C. Jagged or streaked sidewalls are the result of foreign objects, such as sand or gravel in the pulley, or a rough pulley surface.
4. Check for tensile breaks (breaks in the cord body). See **Fig. 2**, Ref. D. Cuts in a belt are usually caused by foreign objects in the pulley, or by prying or forcing the belt during removal or installation.
5. Check for uneven ribs on serpentine (poly-V) belts. See **Fig. 2**, Ref. E. Foreign objects in the pulley will erode the undercord ribs, causing the belt to lose its gripping power.
6. Check the drive belts for cracks. See **Fig. 2**, Ref. F. Small irregular cracks are usually the signs 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

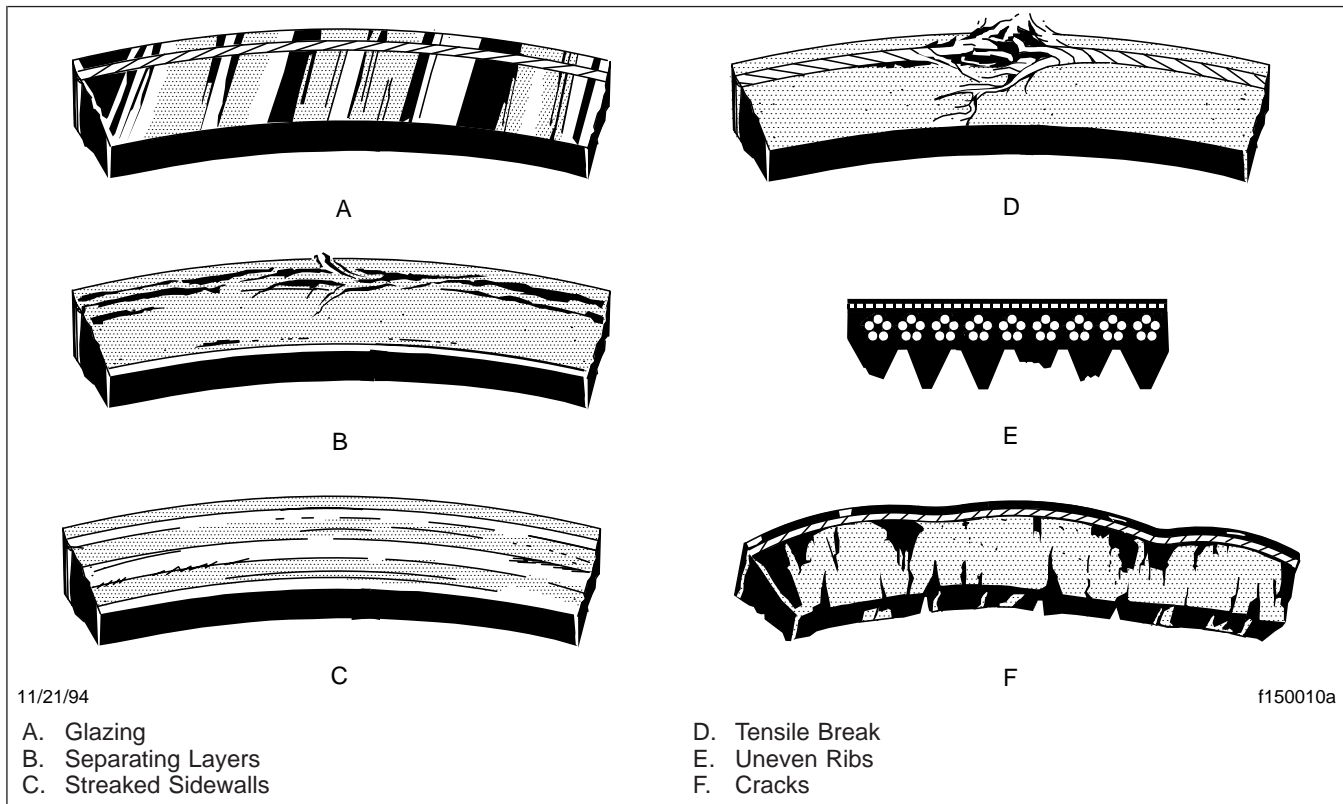


Fig. 2, Drive Belt Replacement Conditions

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.

- Inspect all pulleys for foreign objects, oil, or grease in the grooves.

Belt Tension Inspection

Spring-Tension Type

On belts equipped with a spring tensioner, the belt tension is automatically adjusted. Check that the tensioner is holding tension on the belt by inserting the end of a breaker bar in the 1/2-inch square hole on the forward face of the tensioner, and rotating the tensioner down, away from the belt. When the breaker bar is slowly released, the tensioner should

return to its original position. If not, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual* for replacement instructions.

01–03 Pacbrake Inspecting and Maintenance

With frequent use, the Pacbrake Exhaust Brake will operate free of maintenance. However, if the vehicle is used inconsistently, seasonally, or is exposed to excess moisture, it will be necessary to perform preventative maintenance using the following steps:

- With the engine turned off, use Pacbrake Synthetic Lube or Synco Super Lube and spray or coat a sufficient amount on the restrictor air cylinder valve shaft and the attaching locations at each end of the actuation cylinder. See **Fig. 3** for the exhaust brake lubrication points.
- Using your hands or a pair of pliers, slide the valve several times to distribute the lubricant down the shaft and the attaching locations.

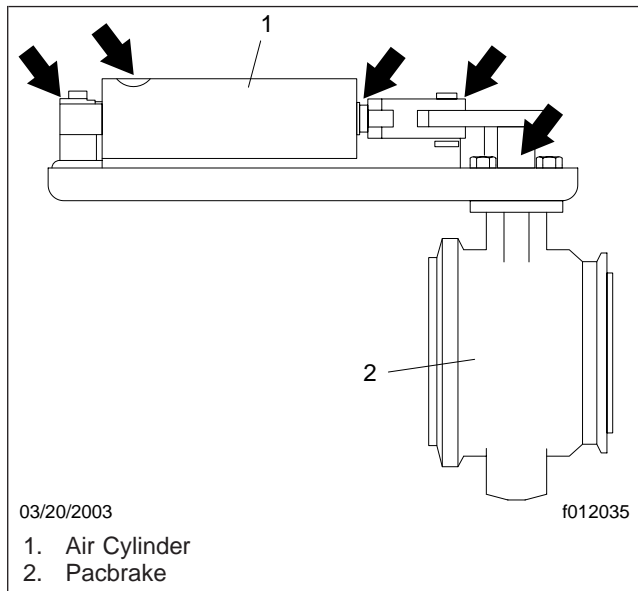


Fig. 3, Pacbrake Exhaust Brake Lube Point Locations

NOTE: Operation of the Pacbrake could be affected by starting the engine and idling for short periods of time. During a cold engine start-up, moisture occurs in the engine and the exhaust system that creates a corrosion hazard. The brake housing may trap water in the valve shaft bore causing corrosion, resulting in an improper or non-functioning brake. If it is necessary to periodically start the engine, reach normal operating temperatures before shutting down the engine.

Title of Maintenance Operation (MOP)	MOP Number
Air Cleaner Element Inspecting and Replacing	09-01
Air Intake System Inspecting.	09-02

09–01 Air Cleaner Element Inspecting and Replacing

Inspect the the air cleaner element for holes or tears at the recommended interval. If the air cleaner element is damaged, replace it. See **Group 09** of the *Shuttle Bus Chassis Workshop Manual* for removal and installation instructions.

Replace the air cleaner element at the recommended interval or when filter restriction reaches 20 to 25 inH₂O (if equipped with an air restriction gauge). See **Group 09** of the *Shuttle Bus Chassis Workshop Manual* for air cleaner element removal and installation instructions.

09–02 Air Intake System Inspecting

Check the air intake system for damaged or cracked hoses and for loose clamps. Make repairs as necessary.

Title of Maintenance Operation (MOP)	MOP Number
Air Compressor Inspecting	13-01

13–01 Air Compressor Inspecting

Inspect the air intake line, oil supply and return lines, and coolant supply and return hoses for tight connections and general condition. Tighten the connections, and replace the lines and hoses, as needed. If the compressor air-intake adapter is loose, remove the adapter, replace its gaskets, and securely install it.

Check the cooling fins on the compressor crankcase. Clean the fins if they are clogged with debris.

Title of Maintenance Operation (MOP)	MOP Number
Alternator, Battery, and Starter Checking.....	15-01

15–01 Alternator, Battery, and Starter Checking

1. 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 *Shuttle Bus Chassis Workshop Manual*.
2. Check that all electrical connections at the alternator and starter are clean. Clean and tighten all charging system electrical connections as needed.
3. Check the alternator wiring for missing insulation, kinks, and heat damage. Replace or repair as needed.



Batteries release a gas mixture that is explosive. 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 has been 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.

4. Inspect the battery cables for wear, and replace as needed. Clean the cable connector terminals with a wire brush. See **Group 54** of the *Shuttle Bus Chassis Workshop Manual* for troubleshooting instructions, and for adjustment, repair, or replacement instructions.
 - 4.1 Clean and tighten the battery ground cable, terminal, and clamps.
 - 4.2 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, and dry. Paint the retainer assembly, if needed, to prevent rusting.
 - 4.3 Check that foreign objects, such as stones, bolts, and nuts are removed from the battery box.

- 4.4 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).
- 4.5 Spray each connection with dielectric red enamel and coat the battery terminals with dielectric grease; see **Table 1**.

Approved Dielectric Protectants	
Protectant Material	Approved Brand
Dielectric Grease	Lubriplate FLP DS-ES
Dielectric Red Enamel Spray	3M 1602 IVI-Spray Sealer
	Spray-On B-6-665

Table 1, Approved Dielectric Protectants

5. Check the terminals on the battery shut-off switch and the magnetic switch. Make sure that the terminal connections are clean and tight. Coat the terminal connections with dielectric red enamel after cleaning; see **Table 1**.

Title of Maintenance Operation (MOP)	MOP Number
Eaton Viscous Fan Drive Checking (Noise Emission Control)	20-03
Radiator Cap Checking	20-01
Radiator Pressure Flushing and Coolant Changing	20-02

20-01 Radiator Cap Checking

WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

The radiator cap is the most often ignored part in the cooling system. If it is suspect, replace it. An inspection means checking the cap with a pressure tester. A radiator cap in good condition will not open below 9 psi (62 kPa). A visual check is also in order: look for signs of deterioration of the inner gasket. Also look for cracks or breaks in the spring retainer in the cap and for corrosion or deposits on the spring itself. If the spring is not in perfect condition, it has probably lost tension; replace it.

20-02 Radiator Pressure Flushing and Coolant Changing

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

WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

1. Drain the radiator.
 - 1.1 Remove the surge tank cap.
 - 1.2 Remove the plug from the bottom of the radiator on the left side of the tank to drain the engine coolant. See [Fig. 1](#).
2. Disconnect the radiator inlet and outlet hose connections.
3. Flush the radiator.
 - 3.1 Attach a flushing gun nozzle to the radiator outlet.
 - 3.2 Run water in until the radiator is full.

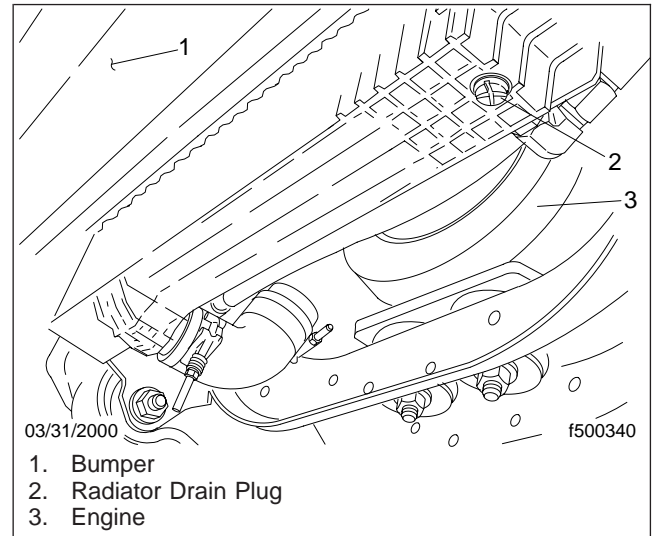


Fig. 1, Radiator Drain Plug

- 3.3 Apply no more than 20 psi (138 kPa) air pressure intermittently to help dislodge sediment buildup in the core.

CAUTION

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

4. Drain the radiator. Then, flush the radiator until clean water flows from the it. Remove the flushing gun.
5. Install the plug in the bottom of the radiator.
6. Connect the hoses. When you install Breeze Constant-Torque hose clamps, the clamps must be tightened to the correct torque. The screw tip of the clamp must extend about 1/4 inch (6 mm) from the clamp housing, and the Belleville washer stacks must be collapsed almost flat. See [Fig. 2](#). You must use a torque wrench to install these hose clamps correctly. The correct installation torque for Breeze Constant-Torque hose clamps is as follows:

For hose clamps with a 5/16-inch tightening screw hex: 40 lbf-in (460 N-cm).

For hose clamps with a 3/8-inch tightening screw hex: 90 lbf-in (1020 N-cm).

NOTE: All hose clamps will lose torque after installation due to "compression set." However, when correctly installed, Breeze Constant-Torque clamps will hold enough torque to automatically adjust and keep consistent sealing pressure. During vehicle operation and shut-down, the screw tip may adjust according to temperature and pressure changes. The torque may need to be adjusted for individual applications.

7. Fill the radiator with coolant.

Use a mixture of 50 percent water and 50 percent corrosion-inhibiting antifreeze to protect the engine to -34°F (-37°C) year round.

See **Table 1** for engine cooling system capacity and **Table 2** for approved antifreezes.

Coolant Capacities	
Engine Make and Model	Radiator Core and System Capacity*: quarts (liters)
Caterpillar CFE Series	28 (26.5)
Cummins B Series and ISB	30.5 (28.9)
Cummins C Series	31.2 (29.5)
Mercedes-Benz 904 Series	29 (27.5)
Mercedes-Benz 906 Series	37.2 (35.2)

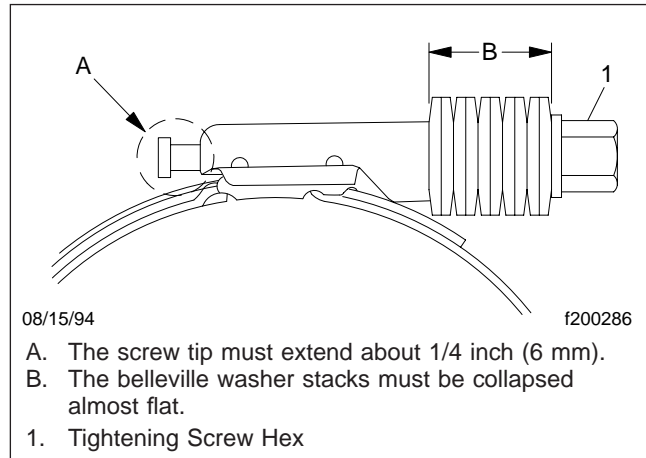
* System capacity includes all hoses, fittings, and the heater core.

Table 1, Coolant Capacities

Approved Coolants	
Coolant Manufacturer	Coolant Designation*
Texaco	JC04 Antifreeze
Van Waters and Rogers Ltd. (Canada)	Diesel Antifreeze No. 6038

* Freightliner-approved antifreeze must meet one of the following conditions: A. Ethylene glycol solution that meets GM 6038-M Engineering Standards. B. Ethylene glycol solution that has less than 0.1% anhydrous sodium metasilicate, and meets either GM 1825-M or GM 1899-M Engineering Standards.

Table 2, Approved Coolants



- A. The screw tip must extend about 1/4 inch (6 mm).
- B. The belleville washer stacks must be collapsed almost flat.
- 1. Tightening Screw Hex

Fig. 2, Breeze Constant-Torque Hose Clamp

20-03 Eaton Viscous Fan Drive Checking (Noise Emission Control)

CAUTION

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 20.02** of the *Shuttle Bus Chassis Workshop Manual* for replacement instructions.

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. At the fan clutch mounting:
 - 3.1 Check for correct drive belt alignment and tension. For specifications, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual*.
 - 3.2 Check for wear of the fan clutch bearings. There should be no side-to-side or in-and-out movement of the fan clutch.

- 3.3 Do all of the checks in **Section 20.00** of the *Shuttle Bus Chassis Workshop Manual*.

Title of Maintenance Operation (MOP)	MOP Number
Transmission Breather Checking	26-01
Transmission Fluid Level Checking	26-03
Transmission Fluid and Filter Changing	26-02

26–01 Transmission Breather Checking

The breather is located at the top left-rear of the transmission main housing. The breather prevents air pressure buildup within the transmission.

Transmission housing breathers must remain unobstructed. A plugged breather could result in pressure build-up, which could cause oil leakage.

If the breather is plugged, clean or replace it. Check more often if the vehicle is operating under very dusty conditions.

CAUTION

When cleaning the transmission, do not spray steam, water, or cleaning solution directly at the breather. Spraying steam, water, or cleaning solution directly at the breather can force the water or cleaning solution into the transmission and contaminate the transmission fluid.

26–02 Transmission Fluid and Filter Changing

IMPORTANT: Extended oil and filter change intervals (as announced by Allison beginning in 2002) do not apply to Allison transmissions in Freightliner-chassis vehicles. Allison transmissions are received partially filled with TranSynd synthetic automatic transmission fluid (ATF). They are then topped-off with a non-TranSynd ATF. For this reason, Allison's extended oil and filter change intervals for TranSynd-only or for a "mixture" of TranSynd and non-TranSynd do not apply. To qualify for the "mixture" intervals, the transmission must be drained as in a standard fluid change and then filled with TranSynd. See the *Allison Owner's Manual* or *Allison Operator's Manual* for more information.

AT Series

1. Park the vehicle on a level surface and apply the parking brakes.
2. Run the engine until the transmission fluid reaches an 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. While the transmission fluid is warm, remove the drain plug and drain the fluid. Disconnect the fill tube from the oil pan.

IMPORTANT: Examine the used transmission fluid for dirt, coolant or water, and metal particles. If any of these contaminants are present, a problem may exist within the transmission system.

4. Support the oil pan, then remove all of the washer-head screws that attach the oil pan to the transmission case. Remove the pan, and discard the pan gasket.
5. Clean the oil pan with mineral spirits.
6. Remove the washer-head screw that attaches the internal fluid filter to the filter spacer, then remove the filter and discard it. See [Fig. 1](#). Remove the fluid intake tube. Then, remove the seal ring from the intake tube and discard it.
7. Remove, clean, and install the governor feed line screen, located in the control valve body. See [Fig. 2](#).
8. Install a new seal ring on the fluid intake tube.

IMPORTANT: Avoid twisting the intake tube when installing the internal fluid filter, intake tube, and seal ring; the seal ring could be pinched, cut, or deformed. An air-tight seal must be maintained.

9. Install the intake tube, with the seal ring installed, in the main housing. Install the internal fluid filter on the intake tube, making sure that the grommet in the filter fits the intake tube snugly.
10. Install the washer-head screw to retain the fluid filter, and tighten it 10 to 15 lbf-ft (14 to 20 N·m).

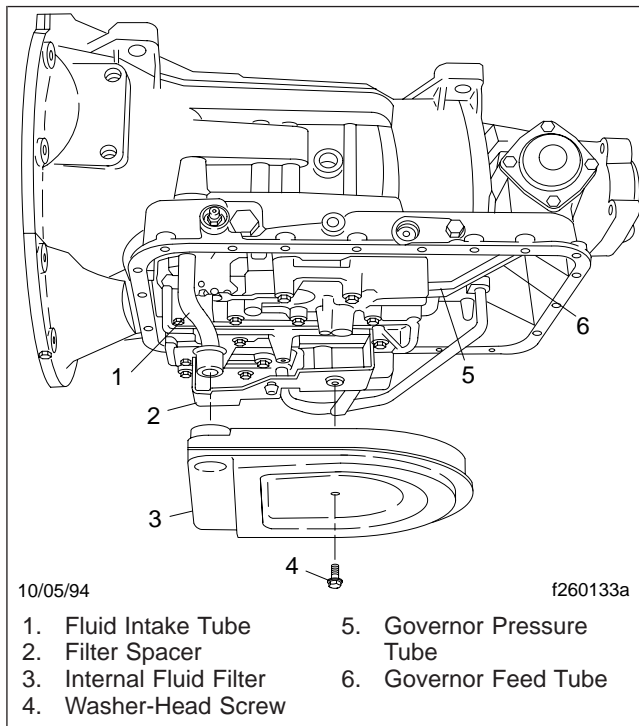


Fig. 1, AT Series Transmission Filter

11. Submerge a new oil pan gasket in transmission fluid for five minutes. Then place the gasket on the pan; do not use any substance as a gasket retainer.

IMPORTANT: Do not use gasket-sealing compounds any place inside of the transmission or where they might be washed into the transmission. Also, nonsoluble vegetable-based cooking compounds or fibrous greases must not be used inside of the transmission.

12. Install the oil pan and gasket.
- 12.1 Guide the pan and gasket carefully into place. Guard against dirt or foreign material entering the pan. Retain the pan with four 5/16–18 washer-head screws, installed by hand in the corners of the pan.
 - 12.2 Install the remaining washer-head screws by hand, carefully threading each through the gasket and into the transmission. Bottom all of the screws before tightening any of them.

12.3 Tighten all of the screws evenly 10 to 15 lbf-ft (14 to 20 N·m). Check the gasket fit while the screws are being tightened.

IMPORTANT: The oil pan bolts must maintain a minimum torque of 60 lbf-in (680 N·cm) after the oil pan gasket has taken a set.

- 13. Install the fill tube at the side of the pan. Tighten the tube fitting 90 to 100 lbf-ft (122 to 136 N·m).
- 14. Install the drain plug and gasket, and tighten the plug 15 to 20 lbf-ft (20 to 27 N·m).
- 15. Replace the external (auxiliary) fluid filter.
- 16. Clean the area around the fill tube and remove the dipstick. Using a clean funnel in the fill tube, add transmission fluid. See **Table 1** for approved transmission lubricants, and **Table 2** for lubricant capacities.

Approved Transmission Lubricants*	
Lubricant Type	Temperature
Dexron III ATF	-25° to +120°F (-32° to +48°C)
TranSynd Synthetic ATF	-25° to +120°F (-32° to +48°C)

* Factory filled with Dexron III. For off-highway operation or where ambient temperature is consistently above +86°F (+30°C) or below -25°F (-32°C), see the manufacturer's fluid recommendations.

Table 1, Approved Transmission Lubricants

Lubricant Capacities, AT/1000/2000/2400/MD Series Transmissions	
Model	Refill Capacity*: quarts (liters)
AT-542	16.0 (15.1)
AT-545	21.0 (19.9)
1000/2000/2400 Standard Sump	10.6 (10)
1000/2000/2400 Shallow Sump	7.4 (7)
MD-3060P	17.5 (16.5)
MD-3060PR	

* Quantities listed are approximate. Add the recommended amount of fluid as listed under refill capacity, then perform a "hot check" and add fluid as needed. Do not overfill.

Table 2, Lubricant Capacities, AT/1000/2000/2400/MD Series Transmissions

17. Check and adjust the fluid level using the procedure under "Transmission Fluid Level Checking."

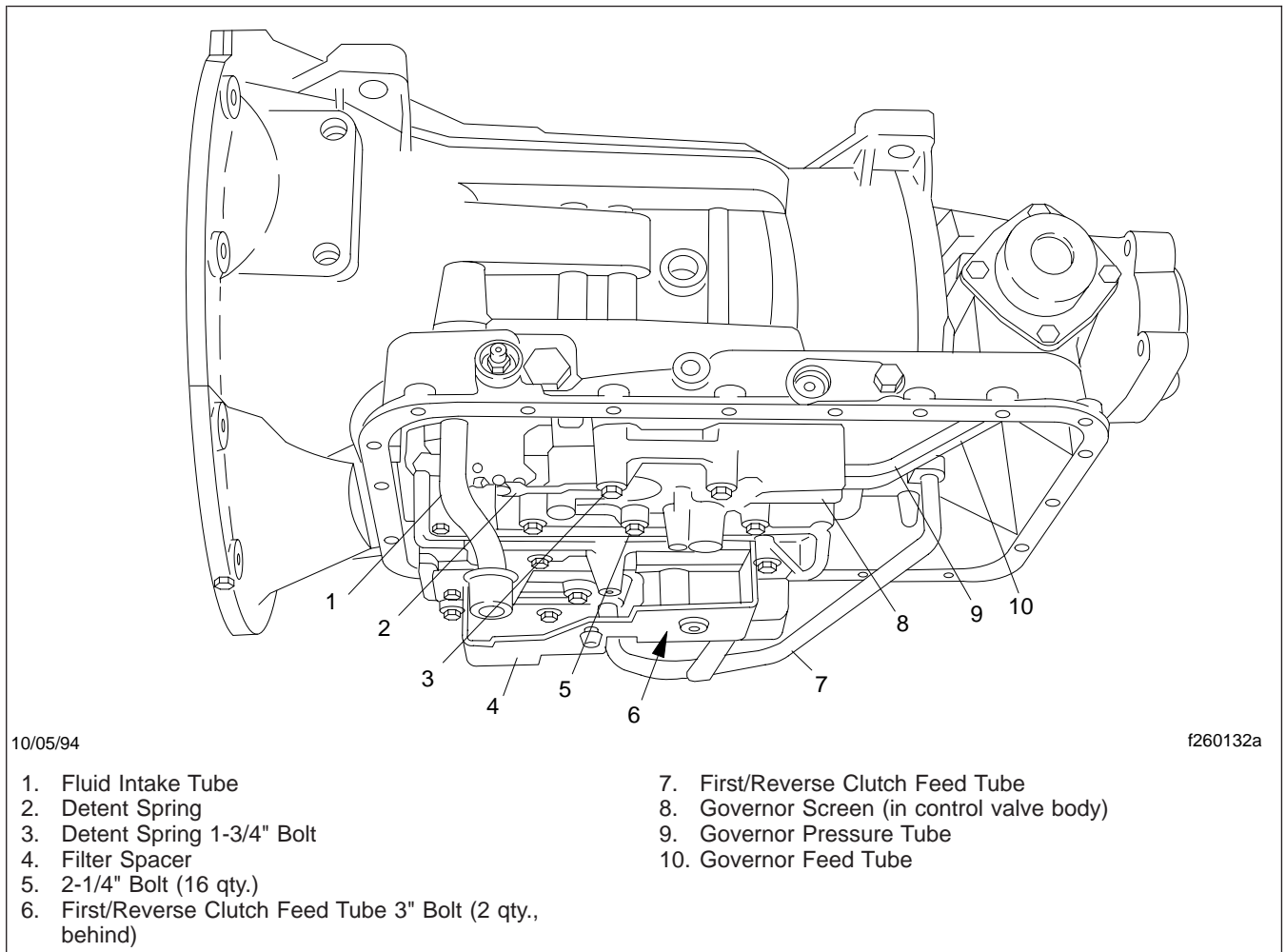


Fig. 2, AT Series Transmission Governor

MD Series

1. See [Fig. 3](#). Park the vehicle on a level surface and set the parking brake.
2. Run the engine until the transmission fluid reaches an 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. While the transmission fluid is warm, remove the drain plug, and drain the fluid.

IMPORTANT: Examine the used transmission fluid for dirt, coolant or water, and metal particles. If any of these contaminants are present, a problem within the transmission system may exist.

4. Remove the bolts from each filter cover at the bottom of the transmission control module. Remove the filter covers, O-rings, seals, and the two cartridge-type filters.

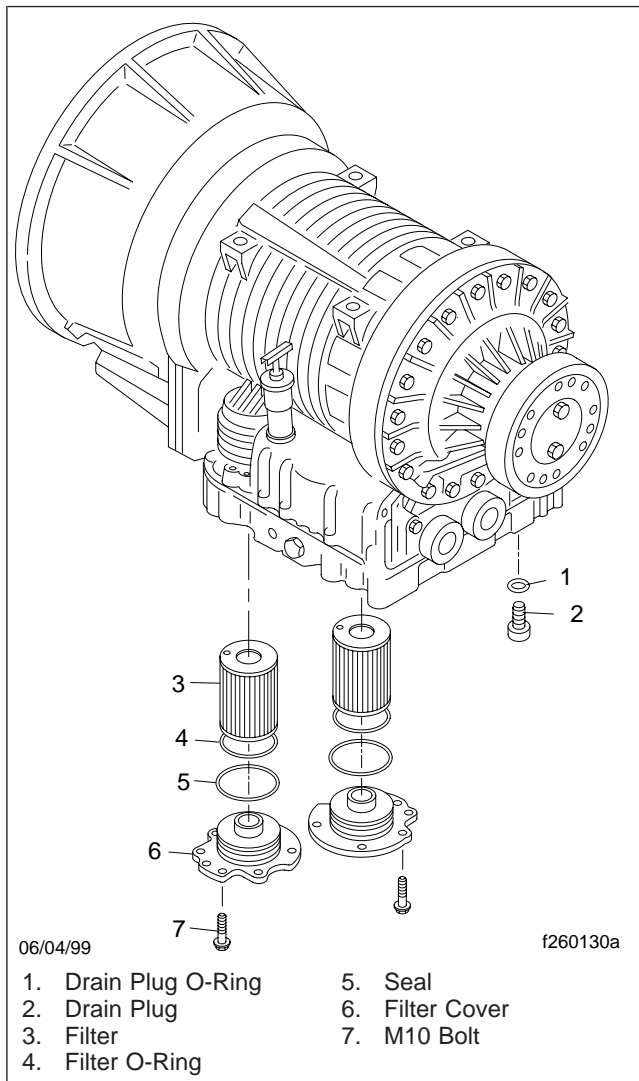


Fig. 3, MD Series Transmission

5. Coat the O-rings lightly with clean transmission fluid. Place the O-rings, seals, and filters on the filter covers. Push each cover assembly into the bottom of the transmission to seat the seals. Install and tighten the bolts 38 to 45 lbf-ft (52 to 61 N-m). Install and tighten the drain plug 18 to 24 lbf-ft (24 to 33 N-m).
6. Clean the area around the fill tube and remove the dipstick. Using a clean funnel in the fill tube, add transmission fluid. See [Table 1](#) for approved transmission lubricants, and see [Table 2](#) for MD series lubricant capacities.

7. Check and adjust the fluid level using the procedures under "Transmission Fluid Level Checking."

1000/2000/2400 Series

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.

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.

1. Park the vehicle on a level surface and set the parking brake.
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.
4. Place a drain pan under the external filter. See [Fig. 4](#). Remove the external filter with a strap type filter wrench by turning it counterclockwise.
5. Remove the magnet from the filter attachment tube or the top of the filter element. Clean any debris from the magnet.

NOTE: Report to your maintenance personal any debris attached to the magnet larger than dust.

6. Reinstall the magnet onto the filter attachment tube.
7. Lubricate the gasket on the filter with clean transmission fluid.

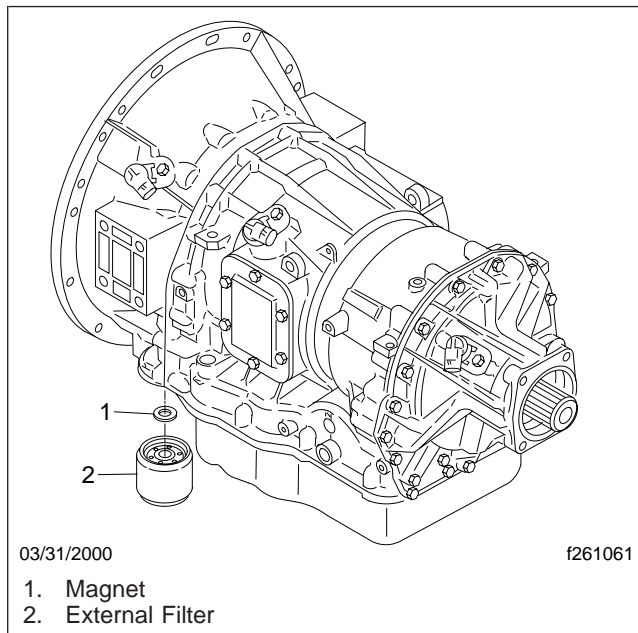


Fig. 4, 1000/2000/2400 Series Transmission External Filter

8. Install, by hand, the filter until the gasket on the filter touches the converter housing or cooler manifold.
9. Turn the filter **ONE FULL TURN ONLY** after the gasket contact.
10. Replace the drain plug O-ring, and install the drain plug. Tighten the drain plug 22 to 30 lbf-ft (30 to 40 N·m).
11. Refill the transmission with fresh transmission fluid. See [Table 1](#) for approved lubricants.
12. Check the fluid level. See [Table 2](#) for lubricant capacities.

Check and adjust the fluid level using the procedures under "Transmission Fluid Level Checking."

26-03 Transmission Fluid Level Checking

⚠ CAUTION

Operating a transmission with the fluid level higher or lower than recommended can result in transmission damage. Do not overfill the transmission.

Do not mix types and brands of fluid, because of possible incompatibility. Do not use fluid additives, friction modifiers, extreme-pressure gear fluids, or multi-viscosity lubricants.

Cold Check

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

⚠ CAUTION

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.

NOTE: 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. A cold check may be made when the sump temperature is 60 to 104°F (15 to 40°C).
2. Run the engine for at least one minute to clear the fluid system of air.
3. With the engine running, wipe the dipstick clean and check the fluid level. Any level within the COLD RUN (lower) band is satisfactory for operating the vehicle. See [Fig. 5](#). If the level is not within the COLD RUN band, add or drain fluid until it reaches the middle of the COLD RUN band.
4. Perform a hot check at the first opportunity after normal operating temperature, 160 to 200°F (71 to 93°C), is reached.

Hot Check

1. Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.

NOTE: The fluid must be warm to ensure an accurate check. The fluid level rises as temperature increases.

2. Park the vehicle. Shift to Neutral (N) and set the parking brake. Let the engine run at idle.
3. Wipe the dipstick clean and check the fluid level. A safe operating level is any level within the HOT RUN (upper) band on the dipstick. See [Fig. 5](#).
4. If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT RUN band.

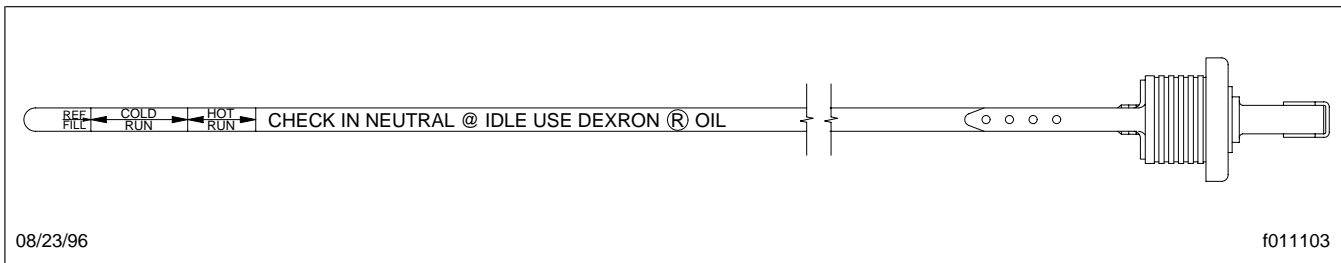


Fig. 5, Dipstick Markings

Title of Maintenance Operation (MOP)

MOP Number

Frame Fastener Torque Checking 31-01

31–01 Frame Fastener Torque Checking

Because of "bedding in" (or seating), the frame fasteners must be torqued at the recommended intervals. These intervals apply to new vehicles, and to frame fasteners that have been removed and installed again.

 **CAUTION**

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

Typical frame fastener applications include suspension and fuel tank brackets, exhaust and engine supports, and frame crossmembers and gussets.

NOTE: This operation is not intended to be a bolt-by-bolt check of the entire chassis. Do a hand check of the typical frame fasteners. If any fasteners are found loose, tighten them to the correct torque value.

See **Group 00** of the *Shuttle Bus Chassis Workshop Manual* for additional information on fasteners and torque values.

Title of Maintenance Operation (MOP)	MOP Number
Component Clearance Checking, Freightliner AirLiner	32-06
Component Inspecting and Operation Checking, Freightliner AirLiner	32-07
Fastener Torque Checking, Freightliner AirLiner	32-05
Shock Absorber Checking, Freightliner Spring	32-09
Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)	32-04
Suspension Inspecting, Freightliner Spring	32-01
Suspension Inspecting, Neway	32-11
Suspension Lubricating, Freightliner Spring	32-02
Torque Arm Bushing Checking, Freightliner AirLiner	32-10
U-Bolt Torque Checking, Freightliner AirLiner	32-08
U-Bolt Torque Checking, Freightliner Spring	32-03

32-01 Suspension Inspecting, Freightliner Spring

Front and Rear Suspension Spring Assemblies

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 *Shuttle Bus Chassis 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.

Rear Suspension Spring Brackets

Inspect the forward and rear spring brackets and the wear pads, for wear, cracks, and other damage. If any of these conditions exist, replace the damaged bracket(s) and wear pad(s). See **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for instructions.

⚠ WARNING

Replace worn, cracked, or damaged spring brackets. Failure to do so could result in bracket breakage, possibly leading to loss of vehicle control and resulting in personal injury or property damage.

32-02 Suspension Lubricating, Freightliner Spring

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.

Rear Suspension

Lubricate the spring pin by applying multipurpose chassis grease at the grease fitting. See **Fig. 1**. Lubricate with a grease gun until grease appears at the base of the fitting.

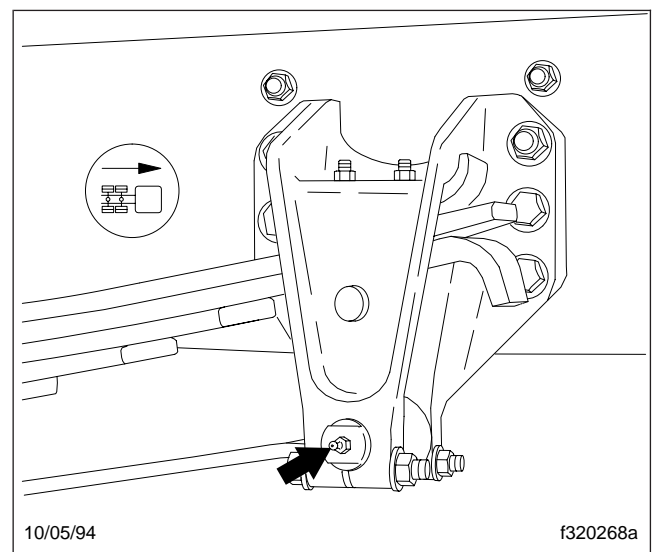


Fig. 1, Forward Spring Bracket Spring Pin Grease Fitting

32-03 U-Bolt Torque Checking, Freightliner Spring

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

⚠ CAUTION

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

In a diagonal pattern, tighten all 5/8–18 U-bolt nuts 205 lbf-ft (278 N·m); tighten all 3/4–16 U-bolt nuts 300 lbf-ft (407 N·m); and tighten all 7/8–14 U-bolt nuts 460 lbf·f (624 N·m).

32–04 Spring Bracket Fastener Torque Checking, Freightliner Spring (Rear)



Continued use with loose fasteners could result in bracket and frame damage.

Torque the fasteners that attach the forward and rear spring brackets and equalizer brackets to the frame rail. Tighten 1/2–13 locknuts with hardened washers 85 lbf-ft (115 N·m). Tighten 5/8–11 locknuts with hardened washers 170 lbf-ft (230 N·m). Tighten 3/4–10 locknuts with hardened washers 305 lbf-ft (415 N·m).

See **Group 00** for other frame fastener torque values.

32–05 Fastener Torque Checking, Freightliner AirLiner

Tighten all suspension fasteners to the torque values in **Table 1**. Also, tighten all suspension air line fittings and air lines.

Torque Values for Freightliner AirLiner Suspensions		
Description	Size	Torque: lbf-ft (N·m)
Leveling Valve Adjustment Nut	1/4–20	5 (7)
Leveling Valve Mounting Bolt Nuts	5/16–18	14 (19)
Air Spring Upper Mounting Locknuts	3/4–16	45 (61)
	1/2–13	23 (31)
Air Spring Lower Mounting Locknuts	1/2–13	55 (75)
Leaf Spring Mounting Eye Bolt Locknuts	3/4–16	270 (365)

Torque Values for Freightliner AirLiner Suspensions		
Description	Size	Torque: lbf-ft (N·m)
Shock Absorber Upper Bracket Mounting Locknuts	5/8–11	125 (170)
Air Spring Upper Mounting Bracket	5/8–11	125 (170)
Spring Hanger Mounting Locknuts	3/4–10	210 (285)
Torque Arm Rod Nut	5/8–11	136 (185)

Table 1, Torque Values for Freightliner AirLiner Suspensions

32–06 Component Clearance Checking, Freightliner AirLiner

Check that the air line support brackets are positioned so that air lines do not rub against anything. Reposition any configurations that could contact 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.



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

32–07 Component Inspecting and Operation Checking, Freightliner AirLiner



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 and property damage.

1. Chock the front tires. Raise the rear of the vehicle so that the tires just clear the ground and so that the suspension is fully extended. Place safety stands under the vehicle frame.

2. Squeeze all air springs to check for complete deflation. If any air springs remain partially or fully inflated, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
3. Inspect each air spring for wear at its connection to the pedestal. Replace any worn air springs; for instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
4. Check the axle connection welds (beam-seat to equalizing-beam) and axle-adapter to axle for cracks. If 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 by following the procedures in **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
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. For instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
7. 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.
8. Check that all air springs are inflated. If the air springs do not inflate, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for possible causes and corrections.

32-08 U-Bolt Torque Checking, Freightliner AirLiner

In a diagonal pattern, tighten all 5/8-18 U-bolt nuts 205 lbf·ft (278 N·m); tighten all 3/4-16 U-bolt nuts 300 lbf·ft (407 N·m); and tighten all 7/8-14 U-bolt nuts 460 lbf·ft (624 N·m).

CAUTION

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

32-09 Shock Absorber Checking, Freightliner Spring

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. See **Fig. 2**. Check the rubber mounting bushings and replace if worn. Inspect the shock absorber for oil leakage.

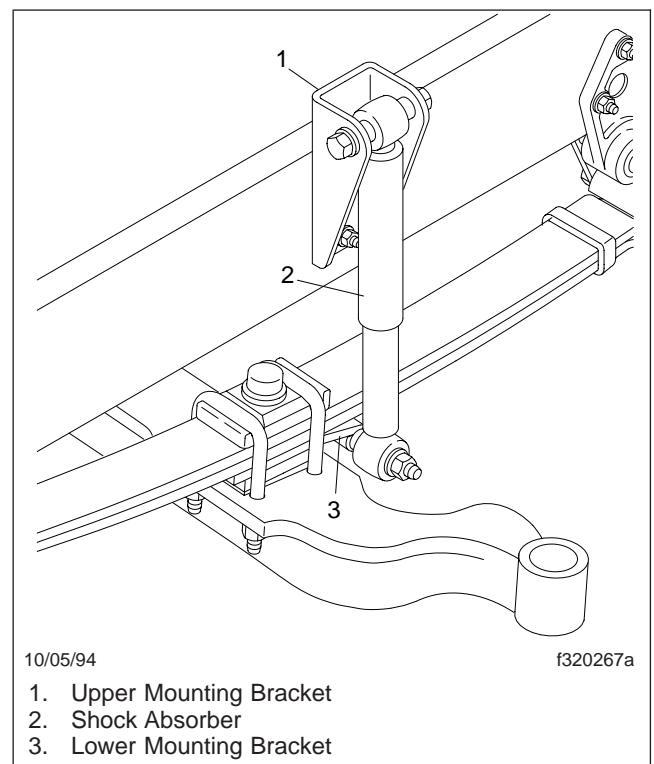


Fig. 2, Shock Absorber Installation (front suspension shown)

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

32-10 Torque Arm Bushing Checking, Freightliner AirLiner

1. Without detaching the torque arms, attempt to move (by hand) each of the rod ends up, down,

in, and out. See **Fig. 3**. If there is any movement, replace the torque arm.

2. Inspect the rubber bushing ends. Replace the torque arm if there are gaps between the rubber bushing and the pin or the outer steel sleeve. If either bushing end contacts a torque arm pin mounting bolt, if there are cracks in the bushing, or if part of the rubber bushing extends beyond the outside circumference of the outer bushing sleeve, replace the torque arm.

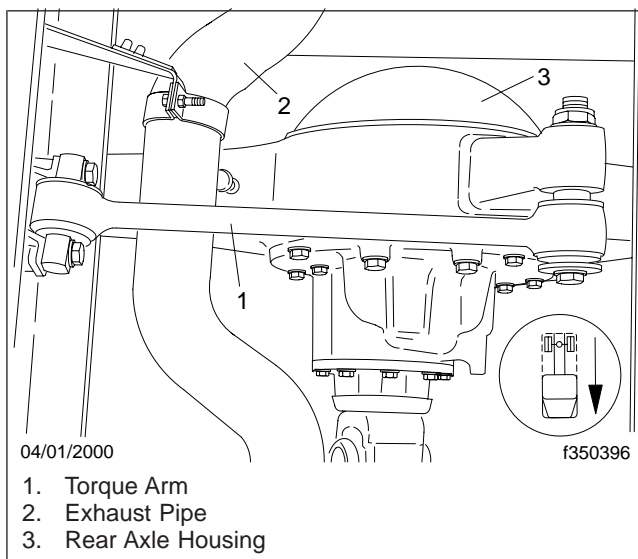


Fig. 3, Torque Arm

IMPORTANT: Be sure to follow the maintenance schedule for checking the torque of the control rod fasteners; see **Table 1** for control rod torque values.

32-11 Suspension Inspecting, Neway

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. Chock the front or the rear tires. Working at the front of the vehicle or at the rear of the vehicle, raise the vehicle so that the tires just clear the ground and the suspension is fully extended. Place safety stands under the vehicle frame. See **Fig. 4**.
2. Squeeze all air springs to check for complete deflation. If any air springs remain partially or fully inflated, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*. Inspect the air springs for cracks, tears, or other damage.
3. Inspect each air spring for wear at the pedestal connection. Inspect for leaks at the upper and lower pedestal connections using a soapy solution. Replace any worn air springs; for instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
4. Inspect the bolts and nuts at the pivot connections, the transverse beam connections, and the axle connections to ensure they are tightened to the correct torque specification.
5. Check all of the other suspension components for any sign of damage, looseness, wear, or cracks. Replace worn or damaged parts. See **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
6. Inspect for cracked welds. If cracks are found, contact Neway immediately for further instructions.
7. Inspect the torque rod and track bar pivot bushings for excessive wear. Replace worn or damaged bushings. See **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
8. 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 by following the procedures in **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.
9. Check for leaks on the height control valves by applying a soapy solution, then watching for bubbles at all air connections and fittings.
10. 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. For instructions, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual*.

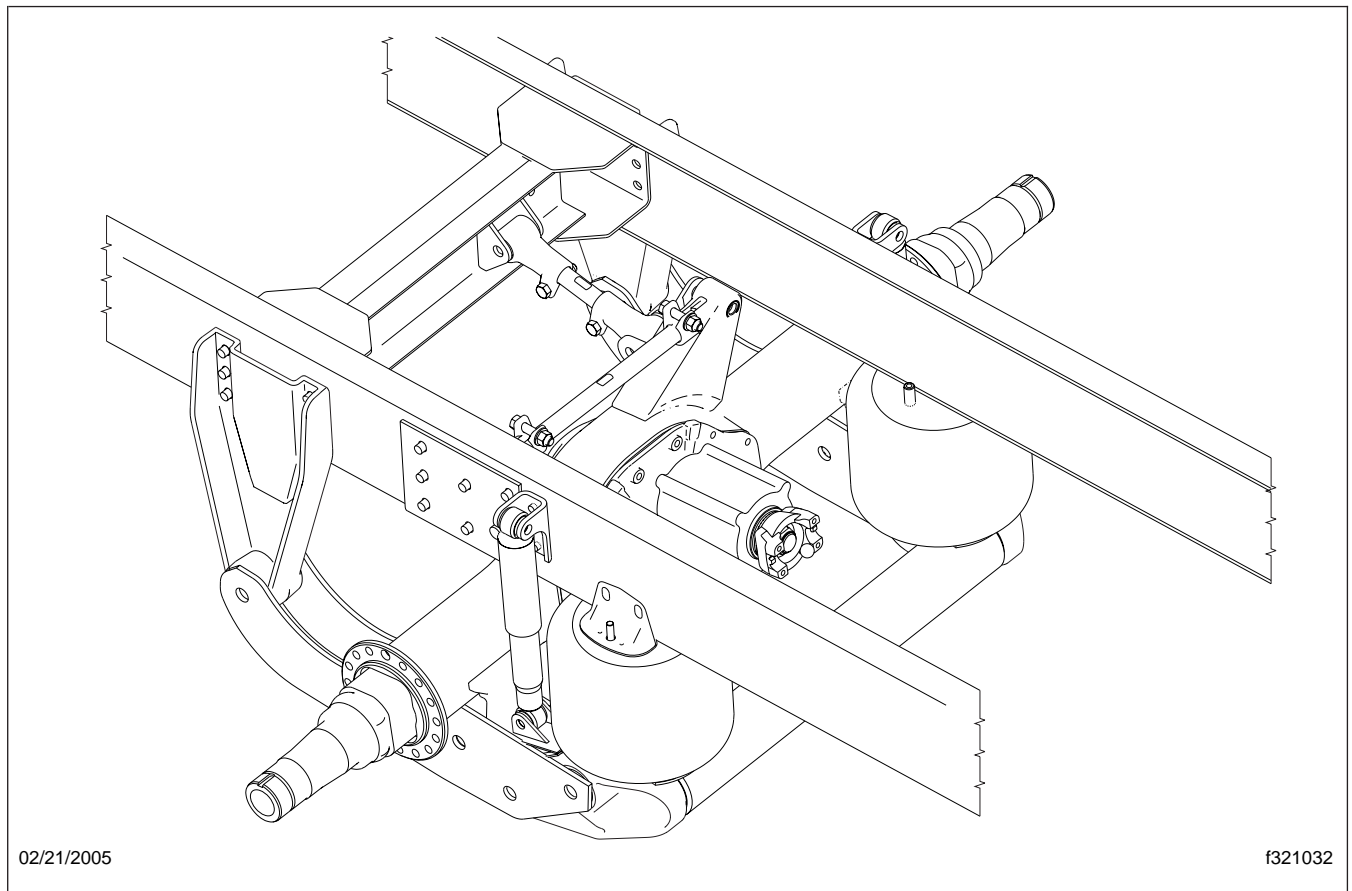


Fig. 4, Holland® Neway® ADL 120/123 Suspension

11. Remove the safety stands and lower the vehicle to the ground. Run the engine until air pressure of at least 100 psi (689 kPa) is maintained throughout the system.

IMPORTANT: Repeat this check at both ends of the vehicle.

12. Check that all air springs are inflated. If the air springs do not inflate, see **Group 32** of the *Shuttle Bus Chassis Workshop Manual* for possible causes and corrections.

Title of Maintenance Operation (MOP)	MOP Number
Knuckle Pin Lubricating	33-01
Oil-Filled Hubs Oil Changing	33-06
Oil-Filled Hubs Oil Level Checking	33-05
Tie-Rod End Inspecting	33-03
Tie-Rod End Lubricating	33-02
Wheel Alignment Checking, Front Axle	33-04
Wheel Bearing Removing, Cleaning, Checking, Repacking, and Adjusting	33-07

33-01 Knuckle Pin Lubricating

Hold a pressure gun on each fitting until fresh grease appears. See **Fig. 1** or **Fig. 2**. This will ensure that all of the old contaminated grease has been forced out. It is not necessary to exceed 4000 psi (27 560 kPa). The best distribution of new lubricant and the best purging of old lubricant occurs when about 4000 psi (27 560 kPa) pressure is applied at the grease gun nozzle. Using a 40 to 1 booster, the air should be limited to 100 psi (689 kPa); using a 50 to 1 booster, the air should be limited to 80 psi (551 kPa). Higher or lower pressures are not recommended.

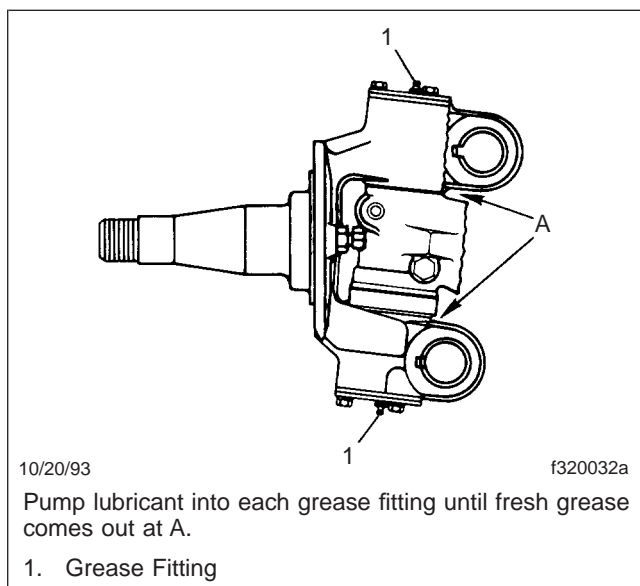


Fig. 1, Meritor Axle Grease Fittings

When lubricating Meritor knuckle pin bushings or Alliance Brand Product (ABP) axle needle bearings for Initial Maintenance, raise the front axle until the front tires are off of the ground. Wipe the lube fittings clean, and slowly feed (for Meritor axles) multipurpose chassis grease (NLGI grade 1 or 2) into each bushing area, or (for ABP axles), lithium 12-hydroxy stearate (with molybdenum disulfide) WL grade 2 grease into each needle bearing area, while turning the wheels from extreme right to left and back again (lock-to-lock). This will eliminate small air pockets and improve grease distribution.

Lower the front axle so that the tires are on the ground, and regrease both top and bottom bushings

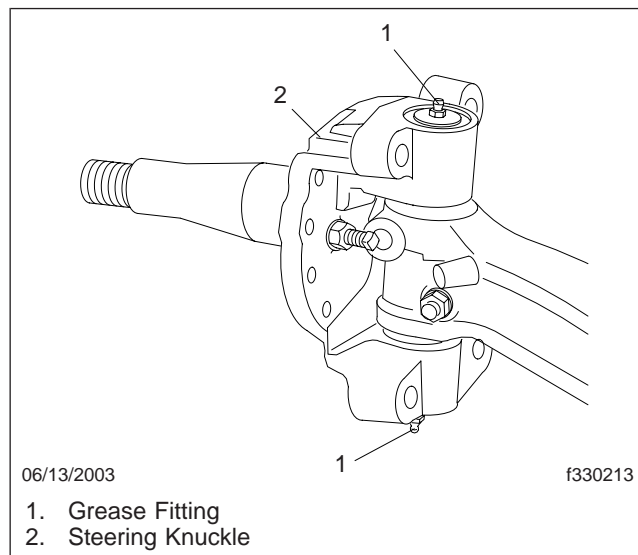


Fig. 2, ABP Axle Grease Fittings

or needle bearings until new grease is seen at the seal on the bushing or needle bearing opposite the fittings.

NOTE: The grease seal will accept the grease pressure without damaging the seal, and is designed to have grease pumped out through it during lubrication. Even if grease leaks out around the top or bottom plate, continue pumping until new grease is seen at the seal on the bushing or needle bearing opposite the grease fitting.

When lubricating knuckle pin bushings or needle bearings at M1 through M3, do not raise the front axle. Wipe the lube fittings clean, and (for Meritor axles) apply multipurpose chassis, or (for ABP axles), lithium 12-hydroxy stearate (with molybdenum disulfide) WL grade 2 grease, until new grease is seen at the grease seal on the bushing or needle bearing opposite the fittings.

33-02 Tie-Rod End Lubricating

Wipe the tie-rod end grease fittings clean, then (for Meritor axles) pump multipurpose chassis grease (NLGI grade 1 or 2), or (for ABP axles), lithium 12-hydroxy stearate (with molybdenum disulfide) WL grade 2 grease, to the tie-rod ends until all used grease is forced out and new grease appears at the ball stud neck.

33-03 Tie-Rod End Inspecting

IMPORTANT: DOT roadside tie-rod assembly replacement criteria specifies that if tie-rod endplay is 1/8 inch (3 mm) or greater, measured on the road, the vehicle must be taken out of service immediately. If less than 1/8 inch (3 mm), the vehicle does not have to be taken out of service but a major out-of-service inspection and maintenance must be scheduled as soon as possible.

1. Check the tie-rod ends for looseness.
 - 1.1 Park the vehicle so that the front wheels are in the "straight ahead" position.
 - 1.2 Chock the front and rear tires.
 - 1.3 Remove dirt and grease from the seals or boots on the tie-rod ends. Visually inspect the tie-rod ends. Replace the tie-rod ends if the seals or boots are cracked, worn, or damaged.

CAUTION

Check the tie-rod endplay by hand. Do not use a pry bar. If a pry bar is used, the dial indicator will not read correctly.

NOTE: for accurate readings, use a dial indicator with a "contour-type" base.

- 1.4 Position the dial indicator so that the base of the indicator is on the bottom of the tie-rod arm. Place the tip of the indicator on the bottom of the tie-rod end at the center of the ball stud on the surface that is most flat, as shown in [Fig. 3](#).
 - 1.5 Set the dial indicator to zero.
 - 1.6 By hand, move the tie-rod end and the cross tube assembly up and down. If the dial indicator reads more than 0.060 inch (1.52 mm), replace the tie-rod end at once.
 - 1.7 Install the dial indicator as described above, and repeat this procedure on the opposite tie-rod end.
2. Inspect the tie-rod ends.

- 2.1 The threaded portion of the tie-rod end assembly must be inserted all the way into the cross-tube split, for adequate clamping. See [Fig. 4](#). Replace the parts if this cannot be done. For instructions, see the axle manufacturer's service manual.
- 2.2 Check the tie-rod end nut and clamp nut torques. For Meritor axles, tighten the tie-rod end nut 100 lbf-ft (136 N·m), and tighten the clamp nut 40 to 55 lbf-ft (54 to 75 N·m). For ABP axles, see [Table 1](#) for tie-rod end nut torque specifications and [Table 2](#) for tie-rod end clamp nut torque specifications.

ABP Axle Tie-Rod End Nut	
Thread	Torque: lbf-ft (N·m)
5/8-16	60 to 115 (81 to 156)
5/8-18	60 to 115 (81 to 156)
3/4-16	90 to 170 (122 to 230)
7/14	160 to 300 (217 to 407)

Table 1, ABP Axle Tie-Rod End Nut

ABP Axle Tie-Rod End Clamp Nut	
Thread	Torque: lbf-ft (N·m)
1/2-13	35 to 45 (47 to 61)
5/8-11	40 to 60 (54 to 81)
5/8-18	50 to 64 (73 to 87)
3/4-10	155 to 175 (210 to 237)

Table 2, ABP Axle Tie-Rod End Clamp Nut

33-04 Wheel Alignment Checking, Front Axle

See **Group 33** of the *Shuttle Bus Chassis Workshop Manual* for wheel alignment checking and adjusting procedures.

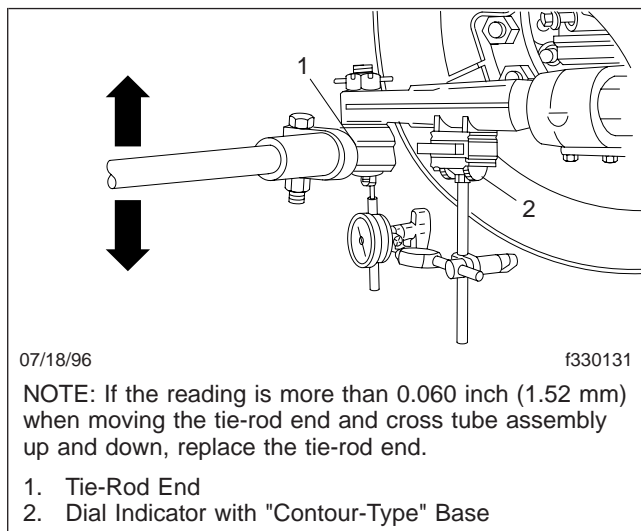


Fig. 3, Measuring Tie-Rod End Looseness

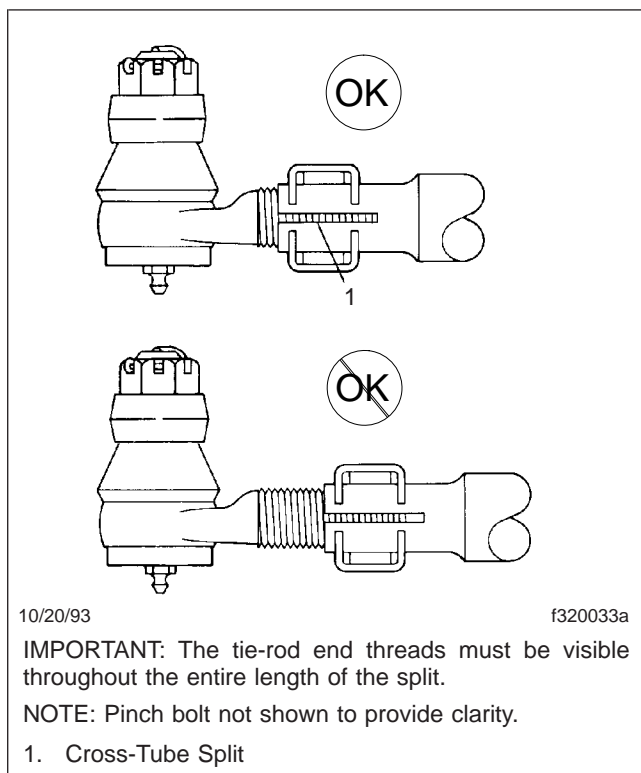


Fig. 4, Tie-Rod End Adjustment

33-05 Oil-Filled Hubs Oil Level Checking

⚠ WARNING

Be careful not to overfill the hubs. Overfilling may cause oil to be forced out of the hubs and to contaminate the brake linings and other brake components. This could result in loss of vehicle control and lead to personal injury and property damage.

1. With the vehicle on a level surface, rotate the front wheels and allow the oil in the hubs to settle.
2. Chock the tires.

IMPORTANT: The oil level should be at, or no more than 1/4 inch (6 mm) above, the level indicators on the hub caps.

3. If necessary, remove the filler caps (in the ends of the hub caps) and add enough oil (80/90 hypoid gear oil) to bring the oil to the proper level.
4. Rotate the wheels, allow the oil to settle, and check the levels again.
5. Install the filler caps securely.
6. Remove the chocks from the tires.

33-06 Oil-Filled Hubs Oil Changing

⚠ WARNING

Be careful not to overfill the hubs. Overfilling may cause oil to be forced out of the hubs and to contaminate the brake linings and other brake components. This could result in loss of vehicle control and lead to personal injury and property damage.

1. With the vehicle on a level surface, rotate the front wheels so that the front hub drain plugs are positioned downward.
2. Chock the tires.
3. Place suitable containers under the hubs, remove the filler caps (in the ends of the hub caps) and the drain plugs, and allow the hubs to drain completely.

4. Install the drain plugs and tighten securely.
5. Add approximately 1 to 1-1/2 pints (0.5 to 0.7 L) of oil (80/90 hypoid gear oil) to each hub.
6. Rotate the wheels, allow the oil to settle, and check the levels.

IMPORTANT: Fill the hubs to the level indicators on the hub caps, or to no more than 1/4 inch (6 mm) above the indicators.

7. Install the filler caps securely.
8. Remove the chocks from the tires.

33-07 Wheel Bearing Removing, Cleaning, Checking, Repacking, and Adjusting

See **Group 33** of the *Shuttle Bus Chassis Workshop Manual* for wheel bearing service procedures.

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

35–01 Axle Lubricant Level Checking

CAUTION

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

NOTE: If the vehicle is exposed to water deep enough to cover the hubs, disassemble and inspect them for water damage and/or contamination. See **Group 35** of the *Shuttle Bus Chassis Workshop Manual* for instructions.

1. Clean the oil fill hole plug, located in the carrier or the side of the axle housing, and the area surrounding it. Remove the plug.

NOTE: Some Meritor axles have a small tapped and plugged hole located near and 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. With the vehicle on level ground, lubricant must be level with the bottom of the oil fill hole.

If low, add lubricant. See **Table 1** for Alliance Brand Product (ABP) axle lubricant capacities. See **Table 2** for Meritor axle lubricant capacities and see **Table 3** for approved Meritor axle lubricants.

3. On ABP axles, install the fill hole plug, and tighten it securely.

4. On Meritor axles, install the fill hole plug, and tighten 35 lbf-ft (47 N·m).

ABP Drive Axle Lubricant Capacities	
Differential/Hubs	Capacity: quarts (liters)
Differential Only	5.8 (5.5)
Differential and Hubs	7.4 (7.0)

Table 1, ABP Drive Axle Lubricant Capacities

Meritor Drive Axle Lubricant Capacities (single axle)*	
Axle Model	Capacity: pints (liters)†
RS–13–120	16 (7.6)
RS–15–120	16 (7.6)
RS–17–145	33.6 (15.9)
RS–19–145	34.4 (16.3)
RS–21–145	32 (15.1)
RS–23–160	42 (19.9)
RS–26–180	46.6 (22)

* Single drive axles equipped with traction equalizers may require a "friction modifier" to correct a slip-stick condition, as described in the vehicle driver's manual. Meritor's experience shows that the following additives perform adequately: Add Elco No. 2 Friction Modifier (1 ounce [30 ml] of additive for each 1 pint [0.5 liter] of lube capacity) or Lubrizol No. 797 or 762 (one ounce [30 mL] of additive for each 1 pint [0.5 liter] of lube capacity).

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

Table 2, Meritor Drive Axle Lubricant Capacities

Recommended Lubricant Type	Ambient Temperature	Lubricant SAE Viscosity Grade	Meritor Specification
Hypoid Gear Oil API Service Classification GL–5	+10°F (–12.2°C) and up*	85W–140	0–76–A
	–15°F (–26.1°C) and up*	80W–140	0–76–B
	–15°F (–26.1°C) and up*	80W–90	0–76–D
	–40°F (–40°C) and up*	75W–90	0–76–E
	–40°F (–40°C) to +35°F (+2°C)	75W	0–76–J
Synthetic Gear Oil	–40°F (–40°C) and up*	75W–140	0–76–L
	–40°F (–40°C) and up*	75W–90	0–76–N
	–40°F (–40°C) and up*	75W–140	0–76–M

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

Table 3, Meritor Drive Axle Approved Lubricants

35–02 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 correlated with 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.

CAUTION

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

Alliance Brand Products (ABP) Axles

1. Remove the filler plug, then the drain plug (in the center bottom of the axle housing), and allow the differential to drain completely.
2. Install the drain plug and tighten it securely.
3. Fill the differential with 80/90 hypoid gear oil through the rear axle fill hole. See [Table 1](#) for axle lubricant capacities.

NOTE: A normal oil change does not include the hubs. Drain the differential and add 5.8 qt (5.5 L) of SAE 80/90 hypoid gear oil through the rear axle fill hole. The lubricant level should be at the bottom of the fill hole.

IMPORTANT: The entire axle capacity (axle completely dry) is 7.4 qt (7 L). Each hub contains 0.80 qt (0.75 L) of lubricant. To protect the outer bearings from oil starvation, jack up (articulate) each side of the axle a minimum of 4 inches (10 cm) to ensure that oil flows to the outer bearings. Articulate the short-side arm for 45 seconds and the long-side arm for 90 seconds. After articulating the axle, add 0.80 qt (0.75 L) of lubricant through the fill hole (in addition to the 5.8 qt [5.5 L] of a normal oil change) for each hub that has been removed. Check the oil level again and ensure that the axle is neither under nor overfilled.

4. Install the fill plug and tighten it securely.

Meritor Axles

Axle Draining and Flushing

1. Remove the plug at the bottom of the housing and drain the lubricant while the unit is warm. Allow enough time for all of the old lubricant to drain completely.
2. Flush the unit with clean flushing oil, then drain it completely.

IMPORTANT: Do not flush axles with solvent, such as kerosene.

3. Clean the drain plugs. 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 2 pounds (1 kg) 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.

4. After cleaning the drain plugs, install and tighten them 35 lbf·ft (47 N·m).

Axle Filling

1. With the vehicle on a level surface, fill the axle housing to the bottom of the oil fill hole (in the carrier or housing) with lubricant. See [Table 2](#) for axle lubricant capacities and see [Table 3](#) for approved axle lubricants.

NOTE: Meritor axles have a small tapped and plugged hole located near and 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 35 lbf-ft (47 N·m).
3. After filling the carrier and housing assembly with lubricant, drive the vehicle, unloaded, for 1 or 2 miles (2 or 3 kilometers) at speeds not to exceed 25 mph (40 km/h), to thoroughly circulate the lubricant throughout the assembly.

35–03 Axle Breather Checking

NOTE: On ABP axles, the axle housing breather is located on the carrier assembly.

The axle housing breather must remain unobstructed. Whenever the axle lubricant level is checked, also check that the axle breather is open. Check more often under poor operating conditions. If the breather is plugged, clean or replace it as needed.

Title of Maintenance Operation (MOP)

MOP Number

Wheel Nut and Rim Nut Checking. 40-01

40-01 Wheel Nut and Rim 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 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 breakage, 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](#), [Table 2](#), [Table 3](#), or [Table 4](#) for wheel nut torque specifications, and see [Fig. 1](#) for the tightening sequence.

Fastener Torque for 10-Hole Disc Wheel With Inner and Outer Locknuts			
Description	Nut Size	Wheel Manufacturer	Torque (dry threads): lbf-ft (N·m)
Front Wheel Nut	3/4-16, 1-1/8-16	Accuride	450-500 (610-680)
Rear Wheel Inner Nut	3/4-16	Accuride	450-500 (610-680)
Rear Wheel Outer Nut	1-1/8-16	Accuride	450-500 (610-680)
Wheel Stud Retainer Nut	3/4-16	Accuride	175-200 (235-270)

Table 1, Fastener Torque for 10-Hole Disc Wheel With Inner and Outer Locknuts

Fastener Torque for 8-Hole Disc Wheel With Cone Locknuts		
Description	Nut Size	Torque (lubricated threads): lbf-ft (N·m)
Front and Rear Wheel Nuts	M20	280-310 (380-420)

Table 2, Fastener Torque for 8-Hole Disc Wheel With Cone Locknuts

Fastener Torque for 10-Stud Hub-Piloted Wheels		
Description	Nut Size	Torque (lubricated threads): lbf-ft (N·m)
Front and Rear Wheel Nuts	M22	390-500 (529-678)

Table 3, Fastener Torque for 10-Stud Hub-Piloted Wheels

Spoke-Type Wheel Fastener Torque			
Description	Size	Wheel Manufacturer	Torque (dry threads): lbf-ft (N·m)
Front Wheel Nut, 5- and 6-Spoke	3/4-10	Gunite	200-225 (270-305)
Rear Wheel Nut, 5- and 6-Spoke With Channel Spacer (Fig. 2)	3/4-10	Gunite	200-225 (270-305)

Spoke-Type Wheel Fastener Torque			
Description	Size	Wheel Manufacturer	Torque (dry threads): lbf·ft (N·m)
Rear Wheel Nut, 5- and 6-Spoke With Corrugated Channel Spacer (Fig. 3)	3/4-10	Gunite	240-260 (325-350)

Table 4, Spoke-Type Wheel Fastener Torque

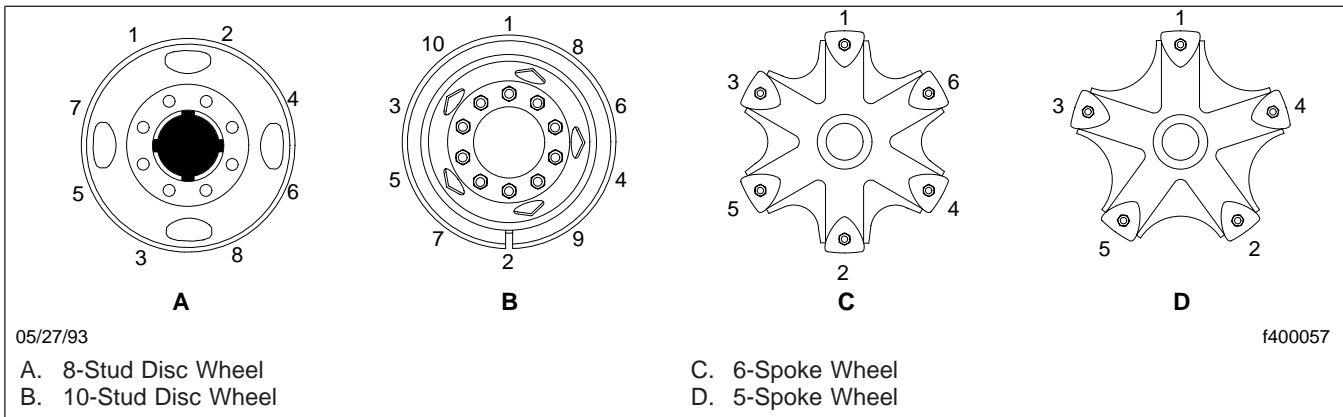


Fig. 1, Wheel Nut and Rim Nut Tightening Sequence

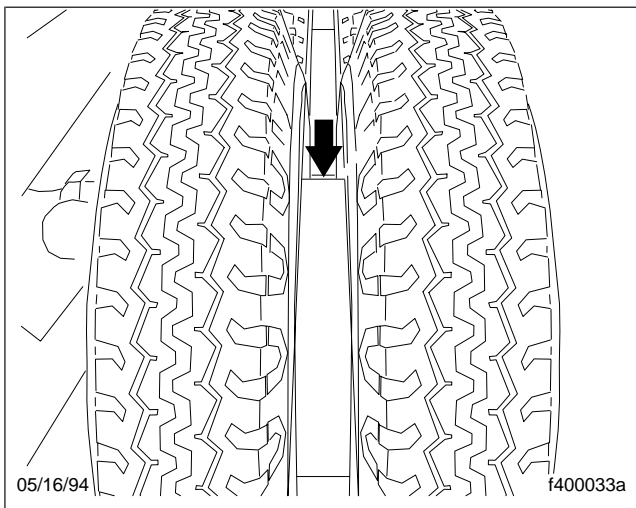


Fig. 2, Non-Corrugated Channel Spacer

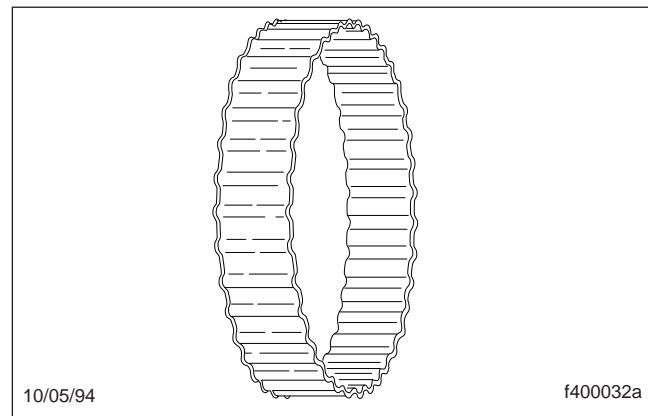


Fig. 3, Corrugated Channel Spacer

Title of Maintenance Operation (MOP)

MOP Number

Driveline Inspecting and Lubricating 41-01

41-01 Driveline Inspecting and Lubricating

Inspecting

Before lubricating the driveline U-joints and slip-joints, make the following checks:

1. Check that the yoke-strap capscrews, see [Fig. 1](#), Ref. 4 are tightened as follows:
 - Spicer SPL90 and 1610: 50 to 60 lbf·ft (68 to 81 N·m)

- Spicer 1710 and 1760: 125 to 135 lbf·ft (170 to 183 N·m)

CAUTION

Do not overtighten the yoke-strap capscrews, due to the extreme load occurring at high-speed rotation. A loose or broken capscrew at any point in the driveline weakens the driveline connection, which could eventually result in serious vehicle damage.

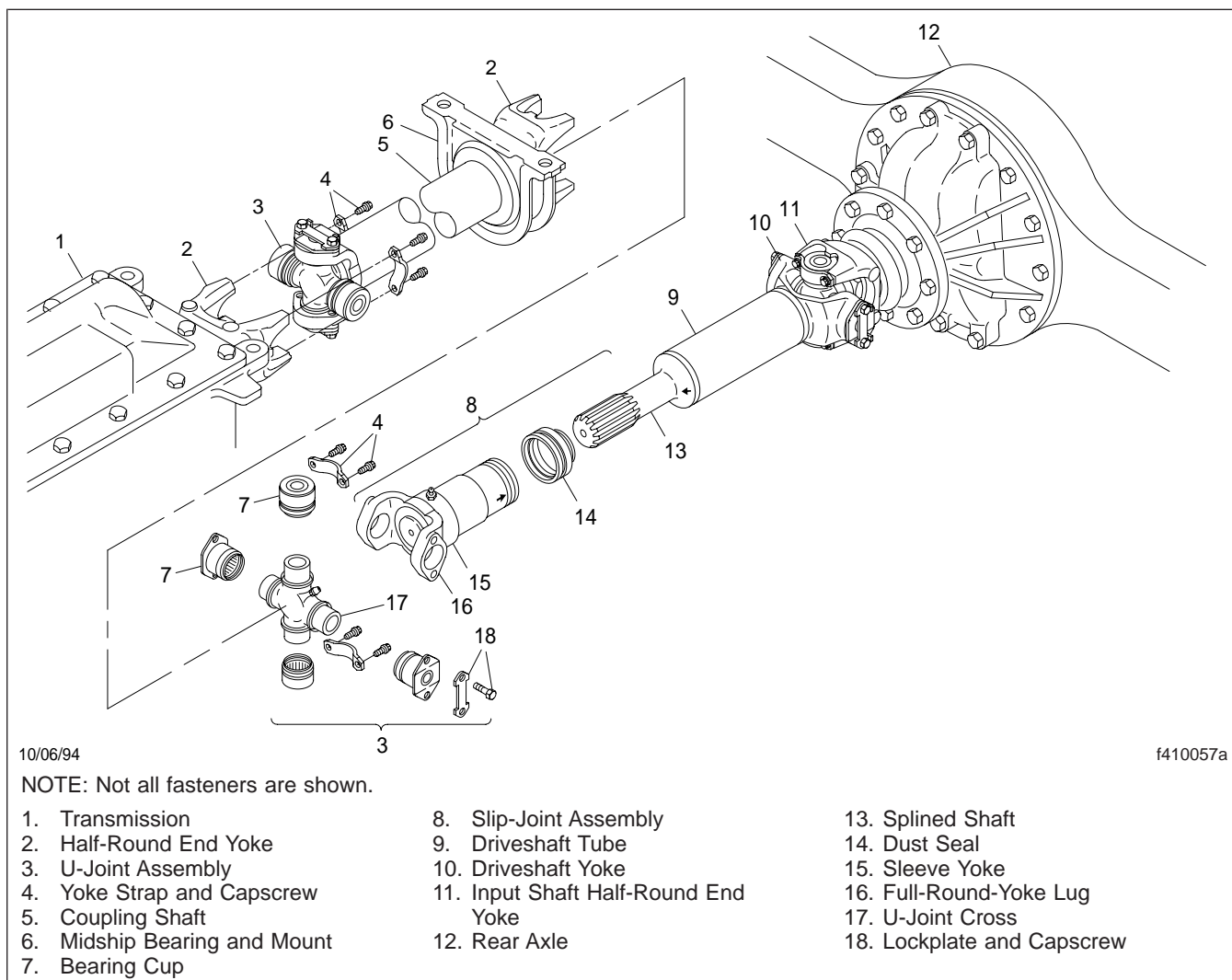


Fig. 1, Driveline Assembly With Midship Bearing

- Check each of the output and input end yokes, see **Fig. 1**, Refs. 2 and 11 for cracks and looseness. Replace cracked yokes. If any end yoke can be moved in or out on its shaft, or can be rocked on its shaft, disconnect the driveshaft and U-joint from the end yoke. Check the drive component's shaft seal for leakage or other visible damage that may have been caused by the loose yoke. Replace the seal if needed. Tighten the end-yoke nut to the value in **Table 1**. If the end yoke is still loose after tightening the yoke nut, install a new yoke and yoke nut.

End-Yoke Nut Torque Specifications		
Description	Thread Size	Torque: lbf-ft (N-m)
<i>Transmissions</i>		
Allison AT Series	1/2-20*	102-121 (138-164)
Allison 2000 and 2400 Series	1/2-20	80-100 (108-136)
<i>Single Axle Input Shaft</i>		
<i>Coupling Shaft (Midship Bearings)</i>		
Spicer SPL90, 1610, 1710	1-1/4-18	475-525 (644-712)

* The Allison AT transmission output shaft end-yoke is retained by a 1/2-20 x 1-1/2-inch bolt and a 1-1/16-inch washer. Both the bolt and the washer must be replaced each time they are removed.

Table 1, End-Yoke Nut Torque Specifications

NOTE: If the end-yoke locknut was removed for any reason, install a new one.

- Check the U-joint assemblies for wear by attempting to move the driveshaft up and down, and from side to side. If movement of the U-joint trunnion in the bearings is greater than 0.006 inch (0.15 mm), replace the U-joint assembly.
- Check the midship bearing and bracket for looseness and deterioration by attempting to move the driveshaft up and down, and from side to side. If the bearing is loose on its shaft, or rattles, replace it. If the bearing bracket is loose on the frame, or the bearing mount is loose on the bracket, tighten the mounting bolt nuts 91 lbf-ft (123 N-m). Replace the midship bearing assembly if the rubber cushion is worn or oil-soaked.
- Check the slip-joints for spline wear by trying to bend the sleeve-yoke and splined shaft back and forth, see **Fig. 2**. If looseness is greater than

0.007 inch (0.18 mm), replace both the sleeve-yoke and the splined shaft.

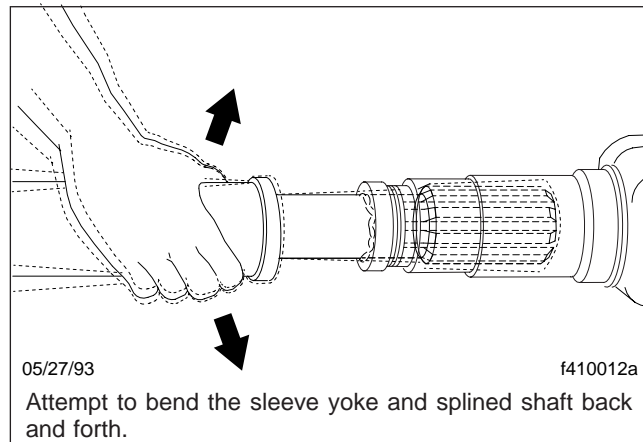


Fig. 2, Slip-Joint Spline Wear Checking

- Check the driveshaft tubes for dents, bends, twists, or other damage. If any tube appears to be damaged, remove the driveshaft and check the runout on the tube. If the tube is not straight (and cannot be straightened) within 0.005 inch (0.127 mm) on the slip-joint seal surface of the splined shaft, 0.010 inch (0.254 mm) on the tube 3 inches (76 mm) from the front and rear welds, and 0.015 inch (0.381 mm) at the center of the tube, replace the tube. See **Fig. 3**.

If the driveshaft tube requires straightening or replacement, balance the repaired driveshaft before installing it. See **Group 41** of the *Shuttle Bus Chassis Workshop Manual*.

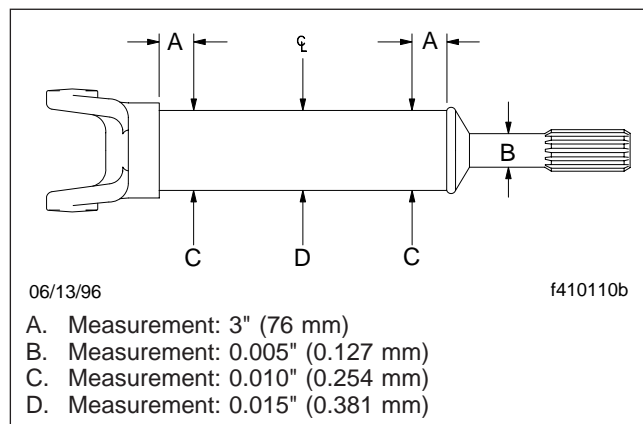


Fig. 3, Driveshaft Runout Specifications

7. Check the driveshaft for missing balance weights, and for debris build-up. Remove any build-up. If any balance weights are missing, remove the driveshaft and have it balanced; see **Group 41** of the *Shuttle Bus Chassis Workshop Manual*.
8. Check the side and bottom clearance between the driveshaft and the 3 driveline guards. See **Fig. 4**. There should be 1-1/2 inches of clearance on each side and 3 inches of clearance between the driveshaft and the bottom of the guard.

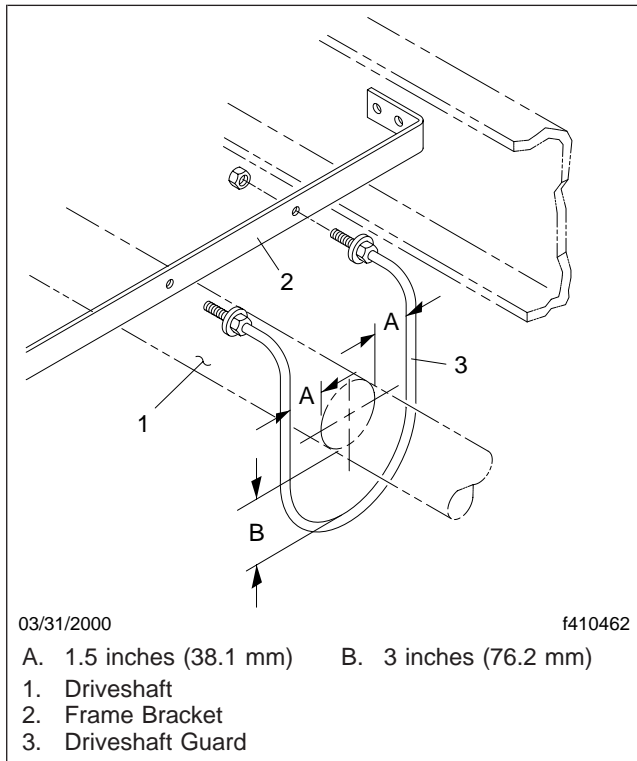


Fig. 4, Driveshaft-to-Driveline Guard Clearance

9. For driveshafts with slip-joints, check that the yoke plug is not loose or missing. See **Fig. 5**, Ref. 2. Replace the yoke plug if needed. If the yoke plug is missing, the splined shaft may be hitting the yoke plug and knocking it out; check the driveshaft for proper length.

U-Joint Lubricating

1. Wipe all old grease and dirt from each U-joint grease fitting. See **Fig. 5**, Ref. 8.

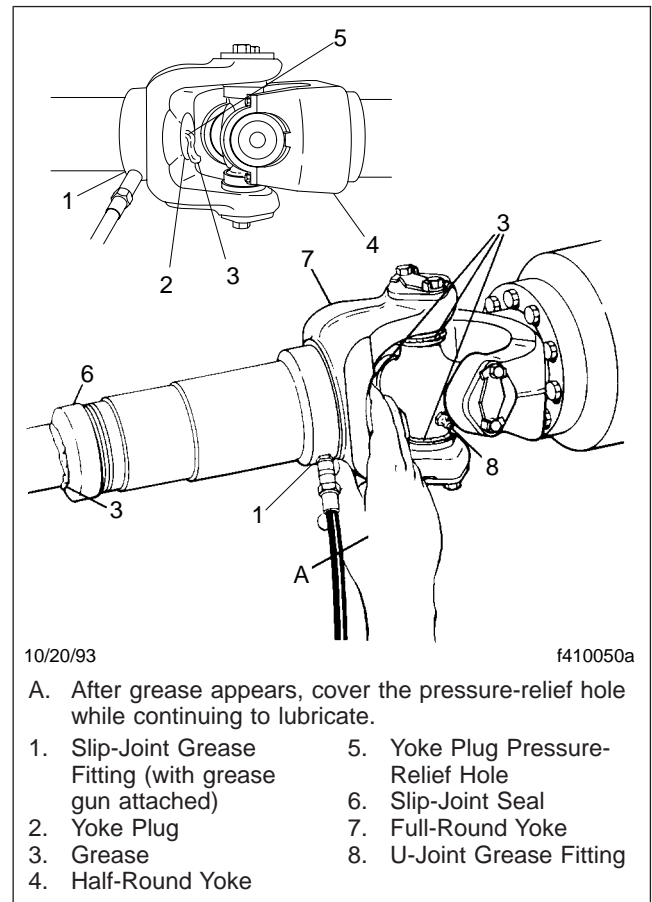


Fig. 5, Slip-Joint and U-Joint Lubricating

2. Use a hand-type grease gun, or a high-pressure gun with a low-pressure adapter, to lubricate the U-joints.

NOTE: If a low-pressure adapter is not used with the high-pressure gun, the U-joints may not receive enough lubricant.

3. Using lithium 12 hydroxy stearate grease (NLGI grade 1 or 2, with EP additives), lubricate until new grease can be seen at all four U-joint seals.

IMPORTANT: Fresh lubricant must be seen escaping from *all four* bearing cup seals of each U-joint.

On full-round yokes, if most of the grease being added to a U-joint can be seen escaping from just one of the U-joint seals, bend the tabs of the lockstrap away from the heads of the bear-

ing cup capscrews, then check the torque on the bearing cup capscrews at that seal. Tighten the bearing cup capscrews as follows:

- 5/16–24 capscrews: 24 lbf·ft (32 N·m)
- 3/8–24 capscrews: 37 lbf·ft (50 N·m)

Bend the lockstrap tabs up, against a flat side of each capscrew. If the capscrews were already tight, or all of the U-joint seals still do not purge, remove the bearing cup at that seal, and examine the seal for damage. If the seal is damaged, replace the complete U-joint assembly.

If grease does not appear at one of the seals, use a screwdriver to pry the U-joint trunnion away from the non-purging seal, or tap the driveshaft or yoke with a plastic or rawhide mallet (on the side opposite the dry seal), while continuing to apply gun pressure. If grease still does not appear, bend the tabs of the lockstrap away from the heads of the bearing cup capscrews, then loosen the bearing cup capscrews (at the bearing with the dry seal) to relieve seal tension. Lubricate the U-joint until the old grease is purged, then tighten the capscrews to the above specifications, and bend the tabs of the lockstrap against a flat side of each capscrew. If the bearing will not take grease, replace the U-joint assembly; see **Group 41** of the *Shuttle Bus Chassis Workshop Manual*.

4. Check the old grease. If it appears rusty, gritty, or burned, replace the U-joint assembly. See **Group 41** of the *Shuttle Bus Chassis Workshop Manual*.
5. Wipe any excess grease from the seals and grease fittings.

Slip-Joint Spline Lubricating

1. Wipe all old grease and dirt from the slip-joint grease fitting. See **Fig. 5**, Ref. 1.
2. Use a hand-type grease gun or a high-pressure gun with a low-pressure adapter, to lubricate the slip-joint. Using lithium 12 hydroxy stearate grease (NLGI grade 1 or 2, with EP additives), lubricate until fresh grease appears at the pressure-relief hole in the yoke plug. Then cover the relief hole with your finger, while continuing to lubricate until fresh grease appears at the slip-

joint seal, see **Fig. 5**, Ref. 6. This ensures complete lubrication of the splines.

3. Wipe any excess grease from the pressure-relief hole, slip-joint seal, and grease fitting.

Title of Maintenance Operation (MOP)	MOP Number
ABS Tone Rings Cleaning	42-14
Air Dryer Checking, Bendix AD-9	42-01
Air Dryer Desiccant Replacing, Bendix AD-9	42-02
Air Dryer Desiccant and Coalescent Filter Replacing, Midland	42-17
Air Dryer Inspecting, Bendix AD-9	42-03
Air Dryer Inspecting, Midland	42-16
Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV-2	42-04
Automatic Slack Adjuster Lubricating and Checking, Meritor	42-05
Bendix Hydro-Max® Power Booster Checking	42-06
Brake Caliper Slide Pin Lubricating, Bosch Brakes	42-13
Brake Caliper Slide Rail Lubricating, Bosch Hydraulic Brakes	42-12
Brake Lines Checking, Hydraulic Disc Brakes	42-07
Brake Lining Wear Checking, Hydraulic Disc Brakes	42-08
Camshaft Bracket Bushing Lubricating	42-09
Drum Brake Shoe Roller Lubricating	42-15
Foot Brake Valve Actuator Lubricating, Bendix E-6	42-10
Relay Valve Checking, Midland	42-11

42-01 Air Dryer Checking, Bendix AD-9

During cold-weather operation, check the operation of the end cover heater and thermostat assembly.

1. With the ignition switch in the ON position, check for voltage to the heater and thermostat assembly. Unplug the electrical connector at the air dryer, and place the test leads of a voltmeter on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check that a good ground path exists.
2. Check the thermostat and heater operation. Turn the ignition switch to the OFF position and cool the end cover assembly to below 40°F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5 to 3.0 ohms for the 12-volt heater assembly.

Warm the end cover assembly to over 90°F (32°C) and again check the resistance. It should exceed 1000 ohms. If it does, the thermostat and heater assembly is operating properly. If it does not, replace the purge-valve housing assembly, which includes the heater and thermostat assembly.

42-02 Air Dryer Desiccant Replacing, Bendix AD-9

The desiccant change interval may vary from vehicle to vehicle. Although typical desiccant cartridge life is three years, many will perform adequately for a longer period of time. To take maximum advantage of desiccant life and ensure that replacement occurs only when necessary, disassemble, clean, and inspect the air dryer. Replace the desiccant cartridge if necessary. For instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

42-03 Air Dryer Inspecting, Bendix AD-9

1. Check the reservoirs for moisture. A small amount (a teaspoon or less) is normal. Larger

amounts may mean that the desiccant needs to be replaced. Check the mounting and connecting lines.

2. Tighten the fasteners attaching the air dryer to the vehicle. Use the following torque values.

28 lbf·ft (38 N·m) for SAE grade 5, 3/8-16 fasteners.

135 lbf·ft (183 N·m) for SAE grade 5, 5/8-11 fasteners.

Check all air lines, fittings, and electrical connections for damage, leakage, or looseness.

3. Replace damaged or leaking parts, and tighten loose fittings or electrical connections.

42-04 Air Reservoir Automatic Drain Valve Disassembling, Cleaning, and Inspecting, Bendix DV-2

Disassemble the drain valve, clean the parts with mineral spirits, and inspect the parts. Replace all rubber parts and any worn or damaged parts; use only genuine Bendix replacement parts or kits. Assemble and install the valve, then check for proper operation and leakage. For instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

42-05 Automatic Slack Adjuster Lubricating and Checking, Meritor

1. Lubricate the slack adjusters using high-temperature, water-proof grease NLGI grade 1, Texaco Thermotex EP 1, Shell Darina No. 1, Marathon 528 heavy-duty, Sunaplex No. 1 EP, Amdex No. 1 EP, or Philube B No. 1. It should be smooth-textured, corrosion-resistant grease, free of fillers and abrasives. See **Fig. 1**.
2. Check the boots for cuts, tears, etc., and replace them if necessary.
3. Check the brake shoe lining wear to determine the proper reline time.

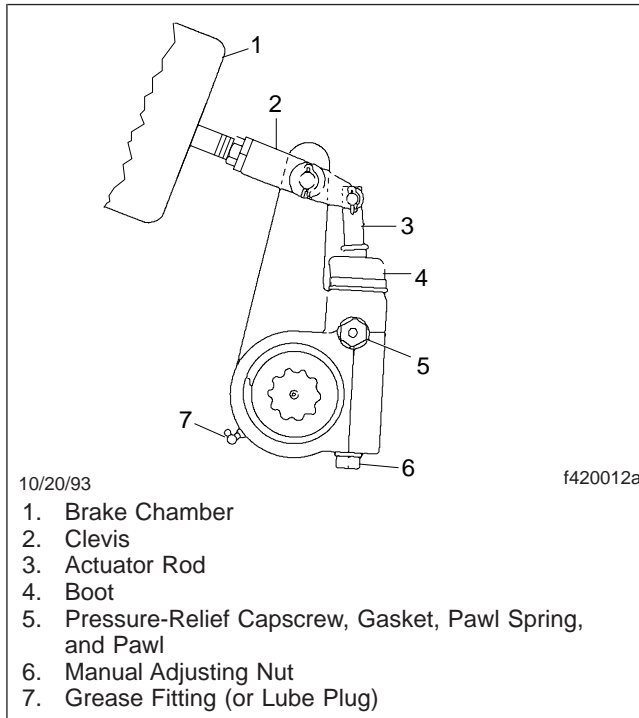


Fig. 1, Meritor Automatic Slack Adjuster

4. Check the free-stroke. If the vehicle has new brakes or brakes with new linings, you must check the free-stroke. If the vehicle is in for routine maintenance and the brakes or linings are not new, go to the next step and check the brake chamber stroke.

IMPORTANT: Do not use installation templates to check the slack adjuster angles. Installation templates are used only when installing a new slack adjuster or reinstalling the existing slack adjuster.

- 4.1 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. See **Fig. 2**, Ref. A.
- 4.2 Use a pry bar to move the slack adjuster, applying the brakes. Again, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. See **Fig. 2**, Ref. B.

The difference between the two measurements is the initial free-stroke, and sets the clearance between the linings and the

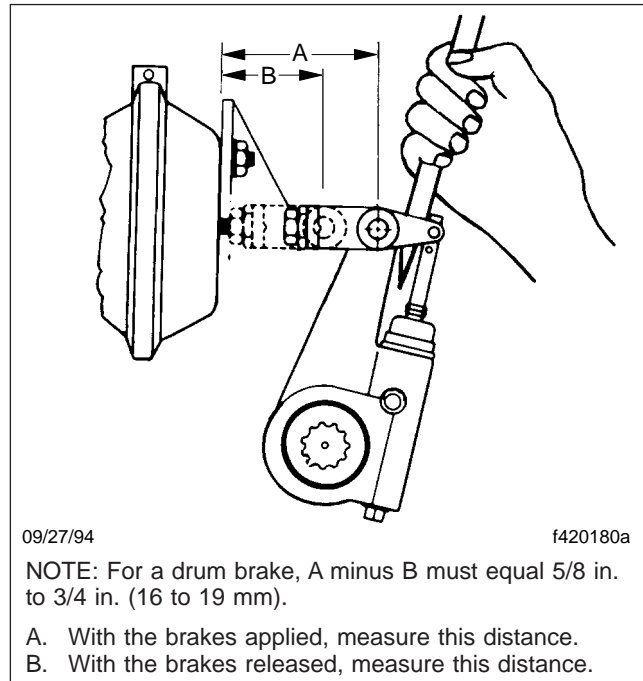


Fig. 2, Measuring Free-Stroke

drum. The free-stroke must be 5/8 to 3/4 inch (16 to 19 mm).

- 4.3 If the free-stroke is incorrect, remove the pressure-relief capscrew, gasket, pawl spring, and pawl from the slack adjuster housing. See **Fig. 1**, Ref. 5. If equipped with a pull-pawl assembly, carefully insert a screwdriver and raise the relief cap about 1/8 inch (3.2 mm). See **Fig. 3**.

CAUTION

Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assembly, raise the relief cap as instructed. Failure to do so could strip the teeth on the pawl.

- 4.4 Turn the adjusting nut 1/8 turn, as shown in **Fig. 4**. Measure the stroke again, and adjust until correct.

CAUTION

Do not make the adjusted chamber stroke too short. The free-stroke must not be less than the

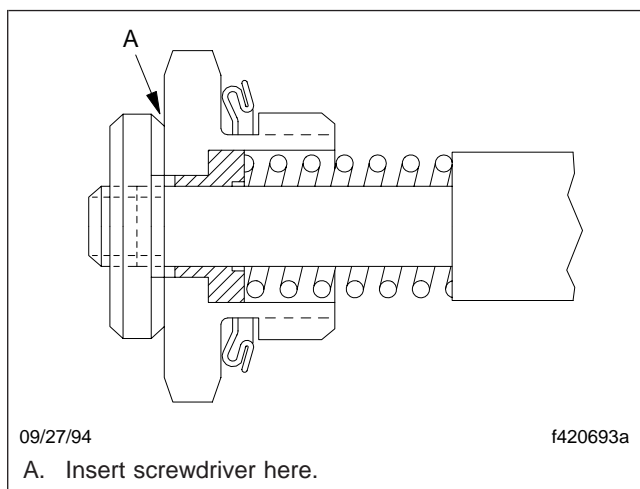


Fig. 3, Pull-Pawl Assembly (sectional view)

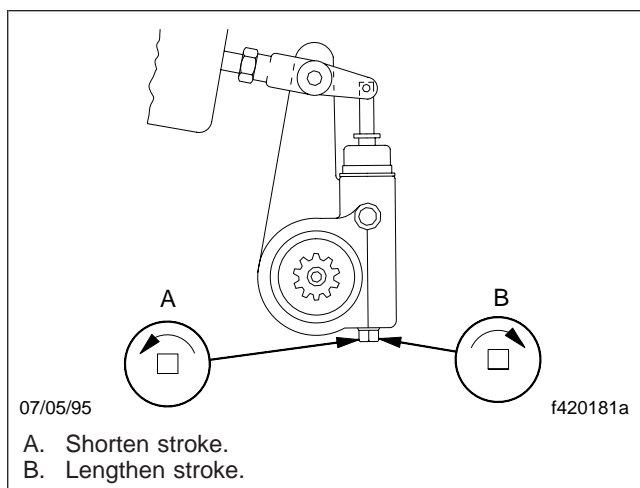


Fig. 4, Brake Stroke Adjusting

measurements given previously. If the chamber stroke is too short, the linings can drag, which could damage the brake.

- 4.5 If removed, install the pawl, pawl spring, gasket, and pressure-relief capscrew. Tighten the capscrew 15 to 20 lbf-ft (20 to 27 N·m). Or, remove the screwdriver from the pull-pawl assembly (if so equipped).
- 5. Check for correct brake chamber stroke.
 - 5.1 With the brakes fully released, measure the distance from the bottom of the brake chamber to the center of the large clevis pin. See Fig. 2, Ref. A.

- 5.2 Build air pressure to 100 psi (690 kPa). Shut down the engine. Fully apply the brakes, then measure the distance from the bottom of the brake chamber to the center of the large clevis pin. See Fig. 2, Ref. B. The difference between the measurements is the brake chamber stroke.
- 5.3 The brake chamber stroke must be less than the measurements shown in Table 1. If the brake chamber stroke is incorrect, remove the pressure-relief capscrew, gasket, pawl spring, and pawl from the slack adjuster housing. See Fig. 1, Ref. 5. If equipped with a pull-pawl assembly, carefully insert a screwdriver and raise the relief cap about 1/8 inch (3.2 mm). See Fig. 3.

Maximum Allowable Brake Chamber Stroke, with Meritor Automatic Slack Adjusters	
Chamber Size Effective Area square inches	Maximum Allowable Stroke* inches (mm) (B minus A)
12	Less than 1-3/8 (35)
16	Less than 1-3/4 (44)
20	Less than 1-3/4 (44)
24	Less than 1-3/4 (44)
24 Long Stroke	Less than 2 (51)
30	Less than 2 (51)

* Adjust the brakes whenever the applied stroke exceeds the maximum.

Table 1, Maximum Allowable Brake Chamber Stroke, with Meritor Automatic Slack Adjusters

CAUTION

Before turning the adjusting nut, remove the pressure relief capscrew, spring, and pawl assembly. If equipped with a pull-pawl assembly, raise the relief cap as instructed. Failure to do so could strip the teeth on the pawl.

- 5.4 Turn the adjusting nut one-eighth turn, as shown in Fig. 4. Measure the stroke again, and adjust until correct.

If the stroke varies or remains greater than the specified range, check the brake components, including the camshafts,

camshaft bushings, anchor pins, rollers, chamber brackets, clevis, and clevis pins. For instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

- 5.5 If removed, install the pawl, pawl spring, gasket, and pressure-relief capscrew. Tighten the capscrew 15 to 20 lbf-ft (20 to 27 N·m). Or, remove the screwdriver from the pull-pawl assembly (if so equipped).

42-06 Bendix Hydro-Max® Power Booster Checking

Check for proper operation; for instructions, see **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

42-07 Brake Lines Checking, Hydraulic Disc Brakes

Check all hydraulic lines and fittings for damage, leakage, or looseness.

Replace damaged or leaking components, and tighten loose fittings.

42-08 Brake Lining Wear Checking, Hydraulic Disc Brakes

Before checking lining wear with the wheel removed, review the following brake lining exposure warnings.

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. To reduce asbestos exposure below legal limits, apply one of the following methods: (1) An enclosed-cylinder vacuum system equipped with a High Efficiency Particulate Air (HEPA) filter; (2) A solvent spray system that keeps the asbestos-contaminated parts wet

until they can be placed in a sealed and labelled plastic bag.

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.

1. Check lining wear.
 - 1.1 Apply the parking brakes. Chock the tires to prevent vehicle movement.
 - 1.2 Remove one or more of the lining inspection plugs, and measure brake lining thickness.
 - 1.3 On front and rear axles, replace linings worn to less than 3/16 inch (4.8 mm).
 - 1.4 Make sure that the brake rotor and linings are free of oil and grease.
 - 1.5 Install the inspection plug(s).
2. If the wheel and hub assembly is removed from the axle, check lining wear. Replace the linings on all brake assemblies if worn to less than 3/16 inch (4.8 mm) at the thinnest point.

NOTE: To replace the brake linings, see the applicable brake section in **Group 42** of the *Shuttle Bus Chassis Workshop Manual*.

42-09 Camshaft Bracket Bushing Lubricating

Pump multipurpose chassis grease (NLGI grade 1 or 2) into the chamber bracket until it appears at the slack adjuster end of the bracket. See **Fig. 5**. Use care that no grease enters the drum cavity. If grease leaks out under the camhead, the camshaft grease seal is worn or damaged, or is installed backwards.

NOTE: The use of meter-type fittings, having a maximum 40 psi (275 kPa) pressure relief at shutoff, is recommended.

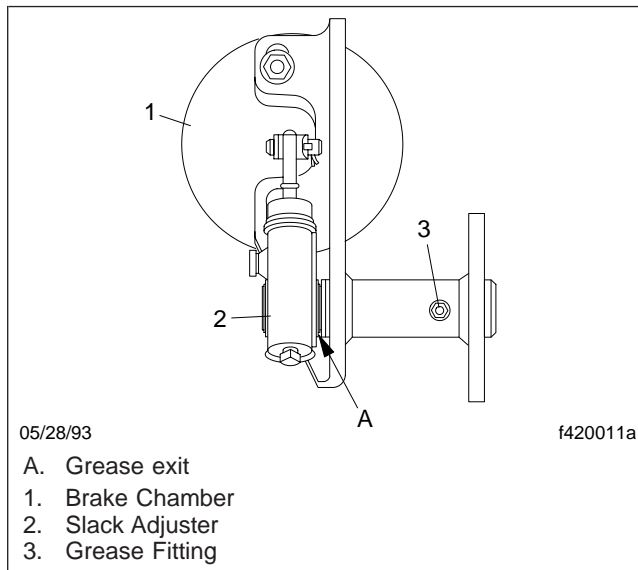


Fig. 5, Camshaft Bracket Bushing Lubrication

42-10 Foot Brake Valve Actuator Lubricating, Bendix E-6

1. Remove the brake valve. For instructions, see **Group 42** of the *Shuttle Bus Chassis 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 *Shuttle Bus Chassis Workshop Manual*.

42-11 Relay Valve Checking, Midland

Chock the tires. Start the engine and run it long enough to pressurize the air system to at least 80 psi (550 kPa), then shut down the engine.

Repeat as necessary, to maintain 80 psi (550 kPa) pressure during this check.

Clean off road grime from the relay valve, and any debris from the valve exhaust port. Listen for air leakage around the fittings or exhaust port. Tighten the fittings as necessary. Use two wrenches to avoid twisting the tubing.

If the valve fails this check, or is damaged, repair or replace it; see the *Midland Service Manual* for instructions. Remove the chocks from the tires.

42-12 Brake Caliper Slide Rail 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. To reduce asbestos exposure below legal limits, apply one of the following methods: (1) An enclosed-cylinder vacuum system equipped with a High Efficiency Particulate Air (HEPA) filter; (2) A solvent spray system that keeps the asbestos-contaminated parts wet until they can be placed in a sealed and labelled plastic bag.

IMPORTANT: Lubricate every 6 months "or" every 18,000 miles (28 800 km), whichever comes first.

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the front or the rear tires, depending on which axle you are working on.
2. Raise the vehicle off of the ground and securely support it with jack stands.

3. Remove the wheel from each wheel end. For instructions, see **Group 40** of the *Shuttle Bus Chassis Workshop Manual*.
4. Place a stool near the axle to rest the caliper upon after it is removed.
5. Remove the key-retaining fastener from the anchor plate. See **Fig. 6**.

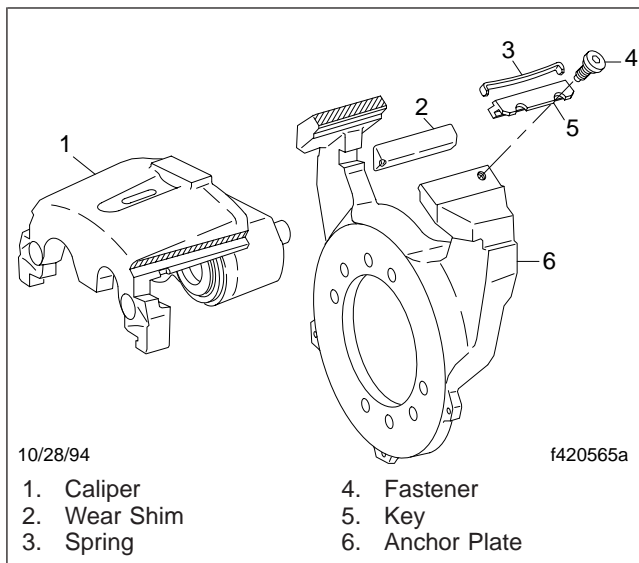


Fig. 6, Anchor Plate and Key Fastener

6. Using a hammer and drift, carefully drive out the key and spring. See **Fig. 7**. Be careful not to nick the anchor plate rail.
7. Insert a large flat-bladed screwdriver through the caliper vent window and into the rotor fins. Pry the caliper outward; this will push the pistons back slightly into the caliper, making removal easier.
8. Grasp the caliper, swing it out and lift it from the anchor plate. Rest the caliper on the stool. For ease of removal, swing the caliper on the forward anchor plate torque rail (the large one opposite the key and spring rail).
9. Carefully remove the brake pads to avoid damaging them or getting grease on the pad faces. Set them aside.
10. Using brake cleaner or alcohol, remove old grease and road accumulation from the caliper V-ways, the anchor plate rails, and the shoe

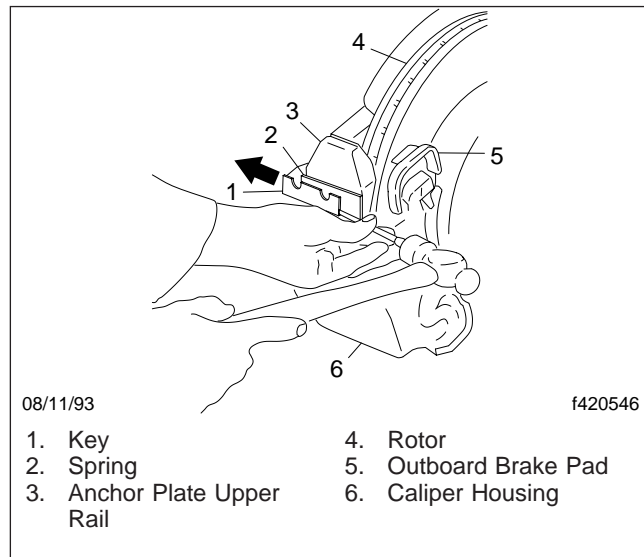


Fig. 7, Drive Out the Key and Spring

slots. Also clean the key and spring. See **Fig. 7** and **Fig. 8**.

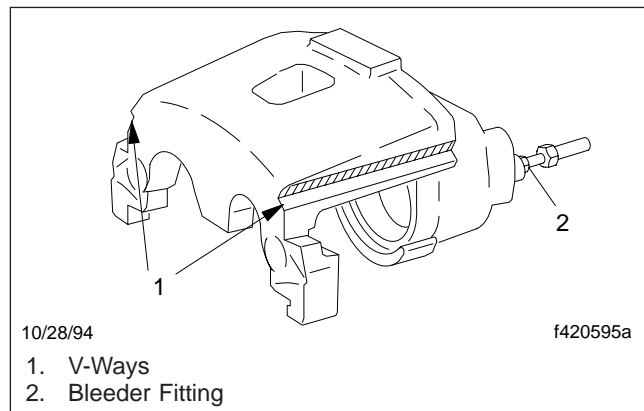


Fig. 8, Caliper V-Ways

11. Using a wire brush or wire wheel, remove any remaining debris from the V-ways, rails, shoe slots, key and spring.
12. Inspect the caliper and ensure that the piston boots are in good condition with no punctures or tears and that they are properly seated in the caliper. Check to see that the heat shields are properly seated. Repair or replace them if necessary.
13. Inspect the brake hoses for twists, cracks, blisters or abrasions, and replace them if necessary.

14. Apply two level teaspoons of Aeroshell Grade 5 (ES-1246) grease on each side of the assembly. Apply it evenly along the full length of the V-way groove and anchor plate rail, and apply one level teaspoon evenly on both sides of the key and spring. After the caliper is installed, pack any accumulation of grease at each end of the rail and along the top of the rail or key at the V-way.
15. Being careful not to get grease or dirt on the pad face, reinstall each brake pad.
16. Grasp the caliper firmly, rest the V-ways on the forward anchor plate torque rail (the large rail) and swing the caliper into place. Make sure that the brake hose is not twisted. Do not get grease on the pad faces or rotor surfaces.
17. With the caliper installed and firmly seated on the forward rail (large rail), position the key and spring between the caliper V-way and the anchor rail from the in-board end of the anchor rail.
18. Carefully drive the key and spring into place. Install the key-retaining fastener and torque it 12 to 18 lbf-ft (16 to 24 N·m).
19. Install the wheels. For instructions, see **Group 40** of the *Shuttle Bus Chassis Workshop Manual*.
20. Before moving the vehicle, press the brake pedal several times to bring the pistons back to the normal position.
21. Raise the vehicle, remove the jack stands, and lower the vehicle to the ground.
22. Remove the chocks from the tires.
23. Test drive the vehicle and ensure that the brakes operate properly.

42-13 Brake Caliper Slide Pin Lubricating, Bosch 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. To reduce asbestos exposure below legal limits, apply one of the following methods: (1) An enclosed-cylinder vacuum system equipped with a High Efficiency Particulate Air (HEPA) filter; (2) A solvent spray system that keeps the asbestos-contaminated parts wet until they can be placed in a sealed and labelled plastic bag.

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 guide pin and guide pin bore sets. See the *Bosch Pin Slide Disc Brakes Service Manual* for additional information.

IMPORTANT: The later ZOH-T caliper has important differences from the early ZOPS caliper. ZOPS calipers (since 1998) and ZOH-T calipers (since 2002) use different slide pins and bolts. See [Fig. 9](#) and [Fig. 10](#). The later trailing pin is identified by notches and has a rubber bushing. Flanged instead of hexbolts are used with the later caliper. The later bolts have a fine thread rather than a coarse thread pitch, are longer, differently colored, and are tightened to a higher torque specification. Use only the ZOH-T bolts to assemble a ZOH-T caliper. The ZOPS caliper bolts have a different thread pitch and will not assemble correctly in a ZOH-T caliper mounting. Also, the ZOH-T bolts will not assemble correctly in a ZOPS caliper. **Do not interchange parts.** It is permissible to use both ZOH-T pins and ZOH-T bolts in a ZOPS anchor plate, but they must be replaced as sets. Both the pins and the bolts must be changed.

DANGER

The correct pins, bolts, and bolt torque must be used. If not, brake function could be impaired and lead to loss of control of the vehicle, which could result in personal injury, death, or property damage.

IMPORTANT: The ZOH-T caliper assembly is similar in appearance to the existing ZOPS caliper. The only obvious difference is that one of the anchor plate slide pins (trailing side) has notches for identification. With ZOH-T calipers,

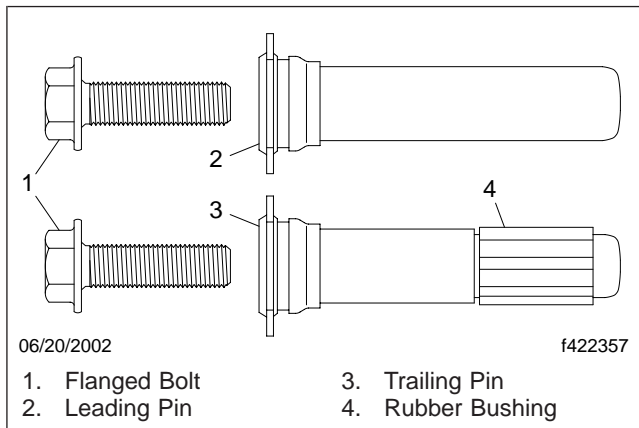


Fig. 9, ZOH-T Slide Pins and Bolts

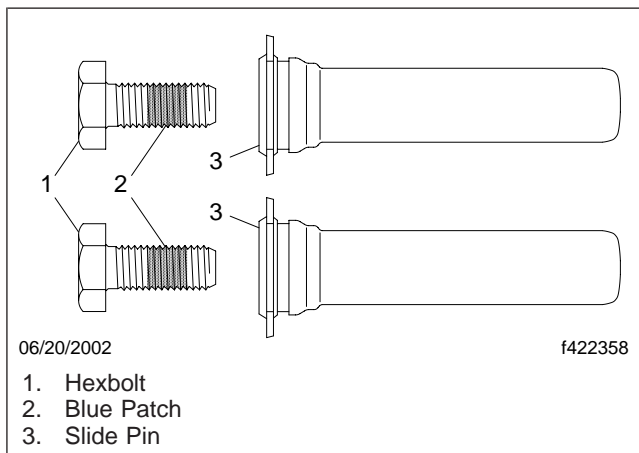


Fig. 10, ZOPS Slide Pins and Bolts

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). Tighten ZOPS bolts 70 to 80 lbf-ft (95 to 108 N-m).

42-14 ABS Tone Rings Cleaning

CAUTION

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.

IMPORTANT: 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.

42-15 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. To reduce asbestos exposure below legal limits, apply one of the following methods: (1) An enclosed-cylinder vacuum system equipped with a High Efficiency Particulate Air (HEPA) filter; (2) A solvent spray system that keeps the asbestos-contaminated parts wet until they can be placed in a sealed and labelled plastic bag.

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. Clean the rollers, retaining clips, and the roller pin recesses in the brake shoes thoroughly.

 **CAUTION**

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

8. Apply a good-quality, multi-purpose 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.

42–16 Air Dryer Inspecting, Midland

1. Check the reservoirs for moisture. A small amount (a teaspoon or less) is normal. Larger amounts may mean that the desiccant needs to be replaced. Check the mounting and connecting lines.
2. Tighten the fasteners attaching the air dryer to the vehicle. Use the following torque values.

28 lbf·ft (38 N·m) for SAE grade 5, 3/8–16 fasteners.

135 lbf·ft (183 N·m) for SAE grade 5, 5/8–11 fasteners.

Check all air lines, fittings, and electrical connections for damage, leakage, or looseness.
3. Replace damaged or leaking parts, and tighten loose fittings or electrical connections.

42–17 Air Dryer Desiccant and Coalescent Filter Replacing, Midland

NOTE: Desiccant change intervals may vary from vehicle to vehicle. Typical desiccant cartridge life is three years. However, if experience has shown that extended or shortened life has resulted on a particular installation, then the interval can be increased or decreased accordingly.

For air dryer desiccant and filter replacement, order either kit DQ6022 or kit DQ6026. The DQ6022 kit contains 1 desiccant cartridge, 1 coalescent filter, and 2 O-rings. The DQ6026 kit contains 1 desiccant cartridge, 1 coalescent filter, and a heater cover. Follow the replacement procedure below.

Replacement

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

3. Loosen the desiccant cartridge with a strap wrench at the base of the cartridge. Spin off the cartridge and discard it.
4. Remove the O-ring from the threaded neck and discard it.
5. Remove the coalescent filter and discard it.

IMPORTANT: Lubricate the new O-rings prior to installation.

6. Install the new small O-ring in the groove on the bottom of the new coalescent filter.
7. Insert the coalescent filter with the O-ring end going into the air dryer opening first. The end of the filter with the "X" will then be facing out.
8. Install the other new O-ring over the threaded neck of the desiccant cartridge.
9. Screw on the desiccant cartridge until resistance is detected. Then, tighten the cartridge 1/4 to 3/4 of a turn by hand.

Operational Check

1. Start the engine and build air pressure to 120 psi (827 kPa).
2. Listen for the purge valve to open and release air. A large volume of air will be expelled, followed by a slow flow of air lasting approximately 30 seconds.
3. Shut down the engine and remove the chocks from the tires.
4. Perform the inspections in **Maintenance Operation 42–16**.

Title of Maintenance Operation (MOP)	MOP Number
Drag Link Lubricating	46-02
Power Steering Reservoir Fluid Level Checking	46-03
Power Steering Reservoir Fluid and Filter Changing	46-04
Steering Driveline Lubricating	46-01
Steering Gear Lubricating	46-05

46-01 Steering Driveline Lubricating

Wipe the grease fittings clean. See **Fig. 1**. Using a pressure gun, apply a lithium-based grease (NLGI grade 2) sparingly to the universal joints and slip-joint splines.

46-02 Drag Link Lubricating

1. Using a clean rag, wipe the dirt from both grease fittings on the drag link. See **Fig. 2**.

2. Using a pressure gun, apply multipurpose chassis grease at the grease fittings until old grease is forced out of the socket.

NOTE: Use multipurpose chassis grease NLGI grade 1 (6% 12-hydroxy lithium stearate grease) or NLGI grade 2 (8% 12-hydroxy lithium stearate grease). The grade 2 chassis grease is preferred.

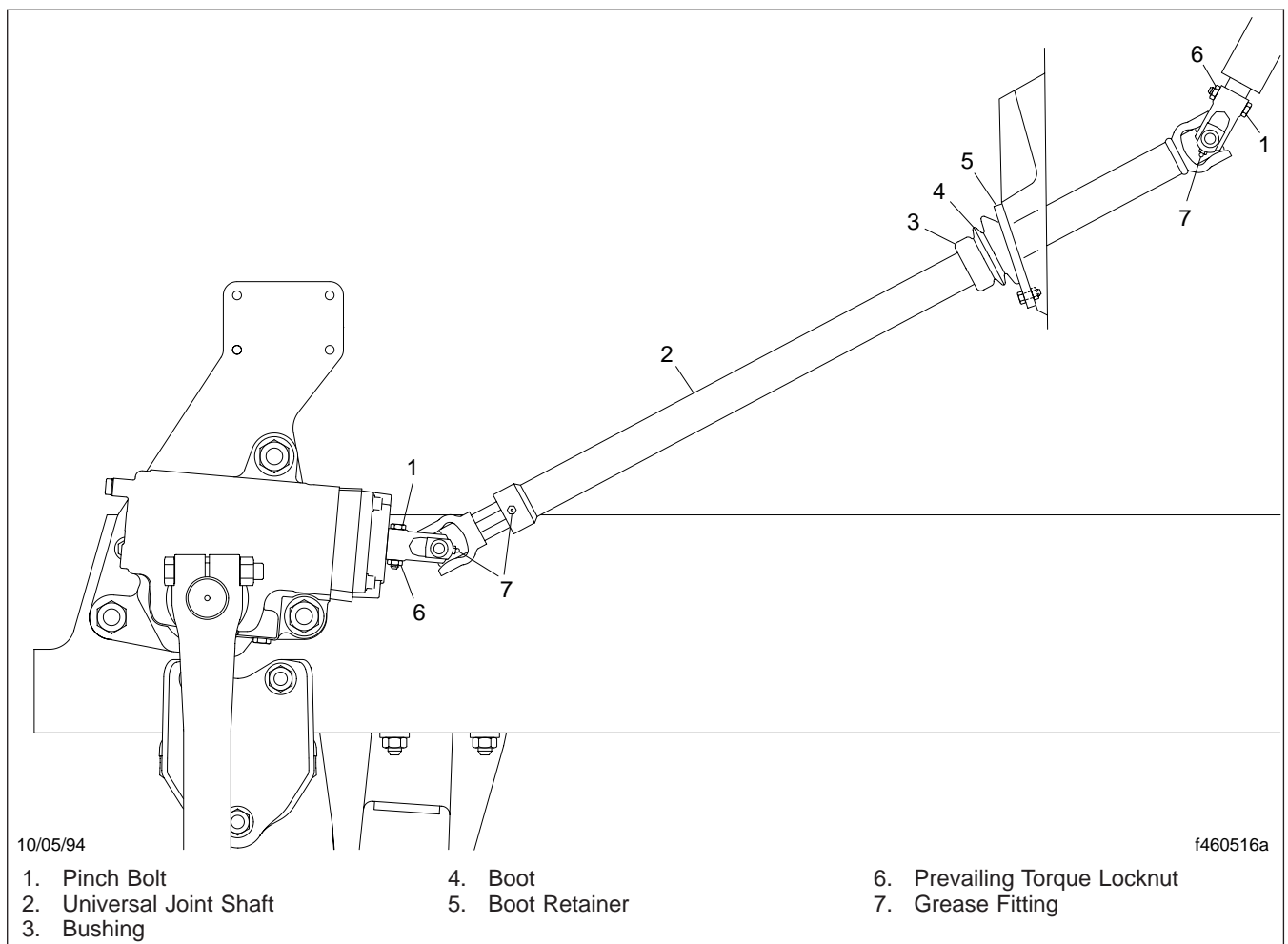


Fig. 1, Steering Driveline

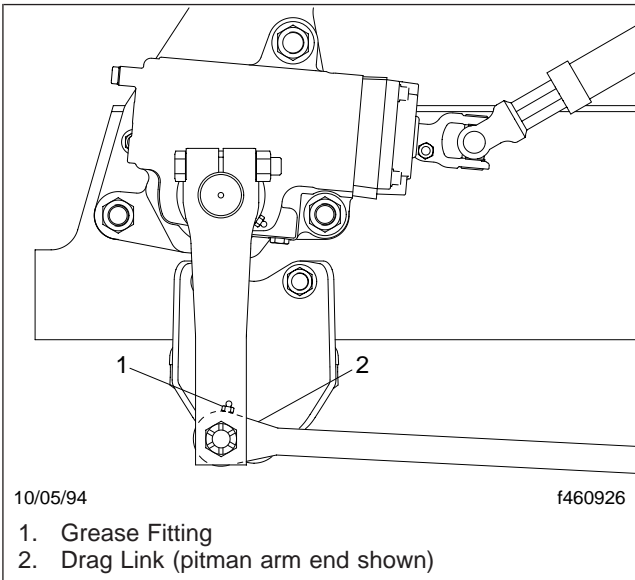


Fig. 2, Steering Drag Link Lubricating

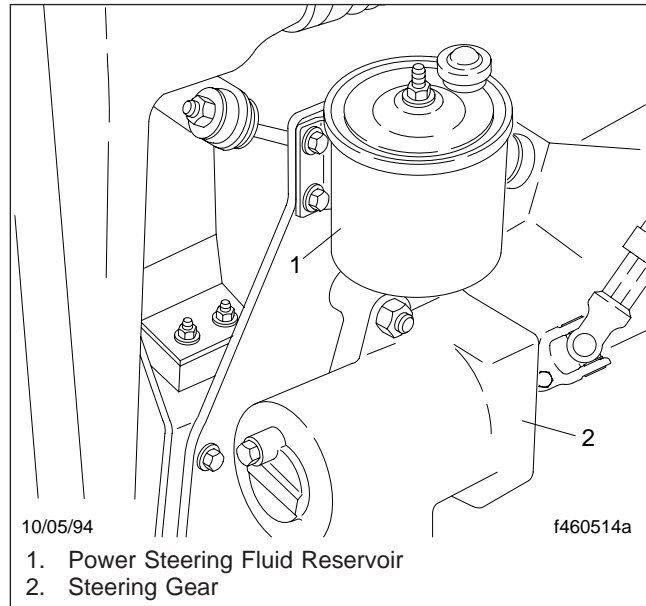


Fig. 3, Power Steering Reservoir

46-03 Power Steering Reservoir Fluid Level Checking

1. Clean around the power steering reservoir dipstick (fill cap) with a clean rag, then remove the dipstick. See Fig. 3.

⚠ WARNING

Fill only with approved clean fluid. Do not mix fluid types. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Fluid leakage could cause loss of power steering assist, possibly resulting in personal injury and property damage.

2. With the power steering fluid at operating temperature, check the fluid level on the dipstick. If below the "add" mark, add enough fluid to bring the level up to the full mark on the dipstick. See Table 1 for approved power steering fluid.

Approved Power Steering Fluid	
Fluid Type	Approved Fluid
Automatic Transmission Fluid	Dexron III*

* Use the same lubricant when assembling parts as is used in the power steering system. See the Warning above.

Table 1, Approved Power Steering Fluid

3. Install the dipstick (fill cap) in the power steering reservoir.

46-04 Power Steering Reservoir Fluid and Filter Changing

1. Remove the dipstick, 3/8-16 hexnut, and cover. See Fig. 3.
2. Drain the power steering reservoir by disconnecting the power steering hydroboost hose from the reservoir. Keep the hose in an upright position to prevent drainage of fluid.
3. Catch the fluid from the reservoir in a drain bucket, then cap the reservoir port.
4. Lift out the spring and filter element.
5. Thoroughly clean the reservoir with a lint-free cloth.

6. Install a new filter element, and position the spring on top of the filter element.
7. Fill the reservoir with approved power steering fluid, see [Table 1](#).

 **WARNING**

Fill only with approved clean fluid. Do not mix fluid types. Any mixture or any unapproved fluid could lead to seal deterioration and leaks. Fluid leakage could cause loss of power steering assist, possibly resulting in personal injury and property damage.

8. Place the disconnected end of the steering hydroboost hose in a drain bucket. *Do not start the engine while draining the system.*
9. Raise the front of the vehicle with a floor jack and support it with jack stands.
10. Have someone turn the steering wheel to full lock left and right, and capture the fluid flowing from the hose in the drain bucket. Add fluid to the reservoir, as needed.
11. Continue turning the steering wheel until clean power steering fluid flows from the hose into the drain bucket.
12. Remove the plug from the reservoir and reconnect the steering gear-to-reservoir hose to the reservoir.
13. Tighten the hose fitting nut finger-tight, then with a wrench, tighten until there is firm resistance. Tighten one-sixth turn more. Do not overtighten.

Remove the jack stands and lower the vehicle.
14. Fill the reservoir with approved fluid, as needed. Start the engine and let it idle. Have someone turn the steering wheel from lock to lock until no bubbles are seen in the reservoir. Turn off the engine.
15. Install a new cover gasket, the cover, and the 3/8-16 hexnut. Tighten the hexnut 28 lbf-ft (38 N-m). Install the dipstick.
16. Start the engine and check the power steering reservoir fluid level. If the fluid level is low, add more of the approved fluid to bring the level up to the full mark on the dipstick.

46-05 Steering Gear Lubricating

1. Wipe off debris from the grease fitting. See [Fig. 4](#).
2. Using a hand-type grease gun, apply multipurpose chassis grease until the grease starts coming out of the sector shaft dirt and water seal.

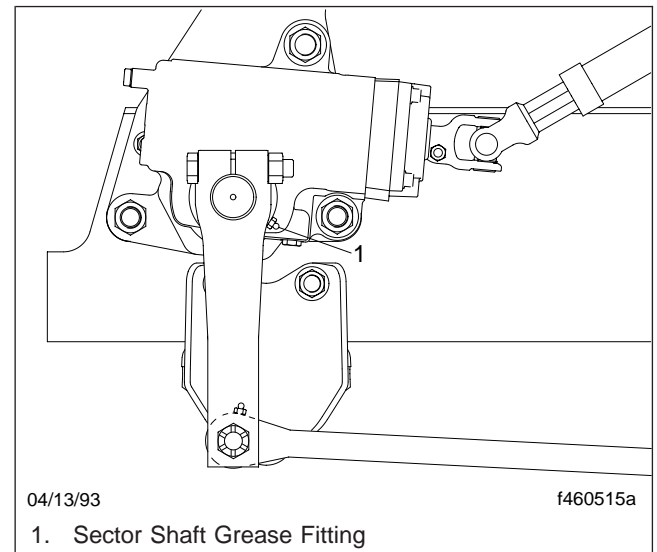


Fig. 4, Sector Shaft Lubricating, TAS Series

Title of Maintenance Operation (MOP)	MOP Number
CNG Fuel Block Housing Draining	47-05
CNG Fuel Leak Testing	47-06
CNG Fuel Tank Visual Inspecting	47-07
CNG High-Pressure Fuel Filter Draining	47-03
CNG High-Pressure Fuel Filter Replacing	47-08
CNG Low-Pressure Fuel Filter Draining	47-02
CNG Low-Pressure Fuel Filter Replacing	47-09
Diesel Fuel Tank Draining and Vent Checking	47-01
Fuel/Water Separator Element Replacing	47-04
Inline Fuel Strainer Replacing, Cummins ISB02 Engine	47-10

47-01 Diesel Fuel Tank Draining and Vent Checking

Remove the plug or open the drain valve at the bottom of the fuel tank, and allow the tank to drain until all traces of water and sediment have disappeared; install the plug or close the drain valve.

On earlier vehicles with a screw-on fuel cap, remove the fuel cap and clean it with solvent. Make sure that the fuel cap vent is open. Install the cap.

On vehicles with a quarter-turn fuel cap, check to be sure that the vent line at the inboard side of the fuel tank is clean and not plugged.

47-02 CNG Low-Pressure Fuel Filter Draining

WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator's Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Shut off the fuel supply at the fuel tanks.

Drain the fuel filters, which are mounted on the left-hand frame near the fuel regulator, by removing the drain nut at the bottom of each filter housing.

47-03 CNG High-Pressure Fuel Filter Draining

WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator's Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Shut off the fuel supply at the fuel tanks.

WARNING

Vent the system in a well-ventilated area and avoid sources of ignition such as sparks or cigarettes. Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator's Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Vent the system.

Drain the fuel filters, which are mounted on the left-hand frame rail near the fuel regulator, by removing the drain nut at the bottom of the filter housing.

47-04 Fuel/Water Separator Element Replacing

1. Park the vehicle on level surface. Shut down the engine, set the parking brake, and chock the tires.
2. Locate the fuel/water separator.
3. Replace the element.
4. Remove the chocks from the tires.

47-05 CNG Fuel Block Housing Draining

WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Shut off the fuel supply at the fuel tanks. Vent the system.

Remove the drain nut at the bottom of the engine internal fuel filter, which is mounted on the left-hand side of the engine.

See the engine manufacturer’s operation and maintenance manual for further information.

47–06 CNG Fuel Leak Testing

 **WARNING**

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator’s Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Inspect and test the fuel tanks and the fuel lines. Use a natural gas detector to check for any leaks.

Replace leaking fuel tanks; repair or replace any lines or connections that are leaking. For procedures and safety precautions, see Group 47 of the *Shuttle Bus Chassis Workshop Manual*.

47–07 CNG Fuel Tank Visual Inspecting

 **WARNING**

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator’s Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*.

Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

Each fuel tank must be visually inspected at specified intervals for external damage and deterioration. The inspection must be performed by a qualified person, in accordance with the manufacturer’s established reinspection criteria and Compressed Gas Association documents.

Perform this maintenance procedure as indicated in the maintenance interval chart in this manual. See Table 1 for the remedies to any damage found on the tank. See Group 47 of the *Shuttle Bus Chassis Workshop Manual* for tank repair procedures.

47–08 CNG High-Pressure Fuel Filter Replacing

 **WARNING**

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator’s Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

The high pressure fuel filter is located inside of the left-hand frame rail, near the rear of the fuel tank.

CNG Tank Visual Inspection		
Damage	Condition	Remedy
Abrasion on the Fiberglass Wrap	Less Than 0.010 Inch (0.4 mm) Deep	No repair needed.
	More Than 0.010 Inch (0.4 mm) But Less Than 0.030 Inch (1.2 mm) Deep	Repair.
	More Than 0.030 Inch (1.2 mm) Deep	Replace tank.
Cuts in the Fiberglass Wrap	Less Than 0.020 Inch (0.8 mm) Deep	No repair needed.
	More Than 0.020 Inch (0.8 mm) But Less Than 0.030 Inch (1.2 mm) Deep	Repair if less than 8 inches (200 mm) long.
	More Than 0.030 Inch (1.2 mm) Deep	Replace tank.
Dents on Metal Ends	Less Than 0.060 Inch (1.6 mm) Deep	No repair needed
	More Than 0.060 Inch (1.6 mm) Deep	Replace tank.
Gouges on Metal Ends	Bare Metal is Exposed	Replace tank.

CNG Tank Visual Inspection		
Damage	Condition	Remedy
Chipped Paint on Tank Ends	No Gray Primer Seen	No repair is needed.
	Gray Primer Seen, But Not Damaged	Repair with two-part epoxy resin.
	Gray Primer Damaged	Repair. Sand and remove rust, clean with pre-paint solvent, apply cold-galvanizing zinc primer and apply two-part epoxy resin.
Stress Cracks from Acid	Cracks in Fiberglass	Remove tank for inspection if exposed to acid. Replace if cracks are seen. Replace strap gaskets if exposed to acid.
Strap Gaskets	Gaskets Damaged or Missing	Approved gaskets must be installed between strap and tank. Replace strap gaskets if exposed to acid.
Tank Shield	Shield is Damaged	Repair or replace shield.
Tank is Old	Tank is 15 Years Old	Replace tank after 15 years from date on label.
Vehicle Was in Accident or Fire	Tank Was Hot or Damaged from Impact	Replace tank or remove tank and test.

Table 1, CNG Tank Visual Inspection

1. Shut off the fuel supply at the tanks.
2. Vent the fuel supply system.
3. After the system has been vented, remove the filter housing. See Fig. 1.
4. Remove and discard the O-ring used to seal the filter housing.
5. Remove and discard the filter element.
6. Install the new element and press it into place.
7. Install the new O-ring.
8. Apply a thread lubricant to the housing threads, and screw the filter housing onto the filter head.

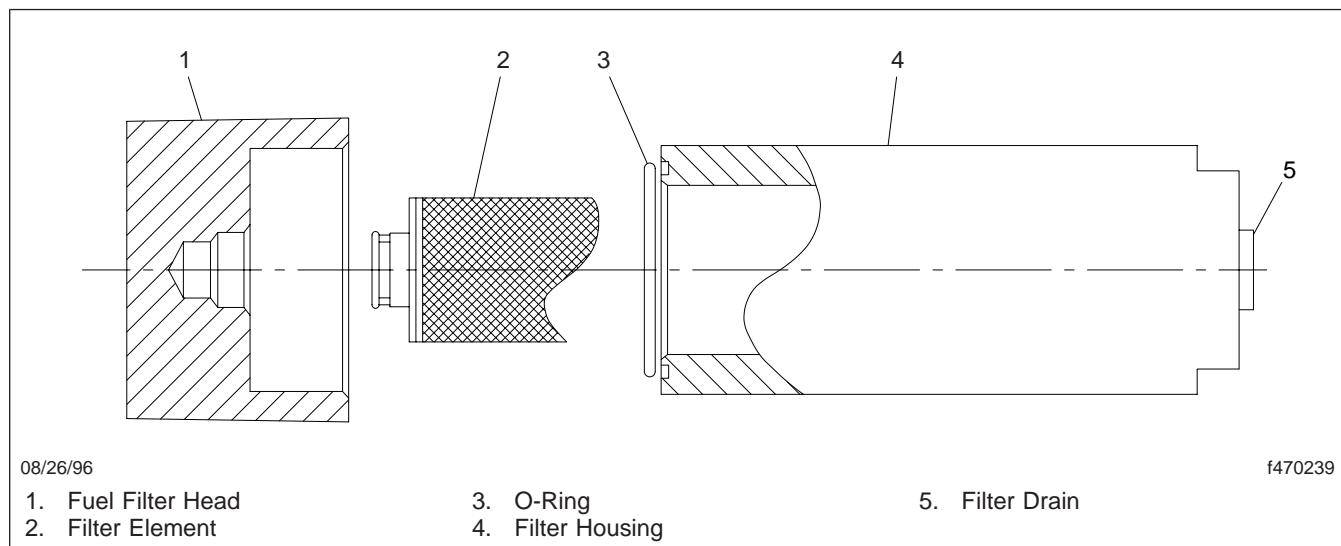


Fig. 1, CNG High-Pressure Fuel Filter Assembly

9. Check for leaks using a natural gas detector.
10. Tighten the filter housing.
11. Turn the fuel supply on at the tanks.

47-09 CNG Low-Pressure Fuel Filter Replacing

WARNING

Compressed natural gas is highly flammable. See the safety precautions listed in Chapter 10 of the *Shuttle Bus Chassis Operator's Manual* or Group 47 of the *Shuttle Bus Chassis Workshop Manual*. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily harm, or death, or property damage.

The low pressure fuel filter is located inside of the left-hand frame rail, near the center of the fuel tank.

Turn the valve counter-clockwise to close the filter drain.

1. Shut off the fuel supply at the tanks.
2. Vent the fuel supply system.
3. After the system has been vented, remove the filter bowl. See [Fig. 2](#). Using a 26-mm wrench, remove the bowl nut. Then remove the bowl, the element retainer, and the filter element.

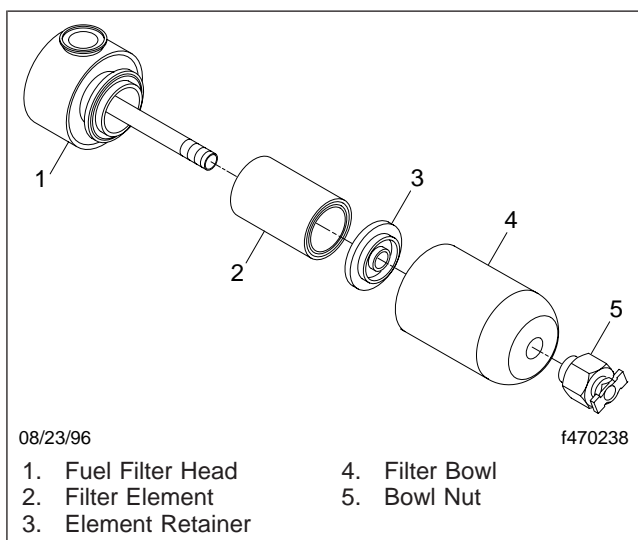


Fig. 2, CNG Low-Pressure Fuel Filter Assembly

NOTE: Be sure that the O-ring is positioned properly inside of the filter head.

4. Install the new element, the element retainer, the bowl, and the bowl nut.
5. Turn the fuel supply on at the tanks.

47-10 Inline Fuel Strainer Replacing, Cummins ISB02 Engine

NOTE: Vehicles with a Cummins ISB02 engine have an inline fuel strainer located on the left-hand side of the engine.

1. Remove the brackets at each end of the fuel strainer.
2. Remove the P-clip.

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

3. Remove the strainer, and replace it with a new one.
4. Install the P-clip.
5. Install the brackets on each end of the fuel strainer.

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

49-01 Exhaust System Inspecting (Noise Emission Control)

NOTE: In addition to the maintenance interval in this manual, inspect the exhaust system if the vehicle has a noticeable increase in noise level at any time. Replace parts that show leakage, wear, or damage.

1. Check the muffler body, muffler outlet stack, muffler shield, and inlet tubes, for leakage, dents, corrosion, or holes in the muffler.
2. Inspect the exhaust pipe for leakage, wear, or damage; replace with new parts, if needed. Do not reuse wide-band clamps. Once a clamp is removed, it must be replaced.

On Caterpillar and Cummins engines, check for leakage at the V-type clamp that attaches the exhaust pipe to the turbocharger exhaust outlet. If leakage exists, tighten the nut on the V-type clamp 50 lbf-in (560 N-cm). Using a plastic hammer, tap around the clamp, then tighten again to 50 lbf-in (560 N-cm). If leakage persists, replace the clamp.

3. Check for leakage at each wide-band exhaust clamp, see [Fig. 1](#). If leakage exists, tighten the nuts on Torca "Torctite" exhaust clamps 40 to 60 lbf-ft (54 to 81 N-m). If leakage persists, install a new wide-band exhaust clamp. See **Section 49.00** of the *Shuttle Bus Chassis Workshop Manual* for procedures.

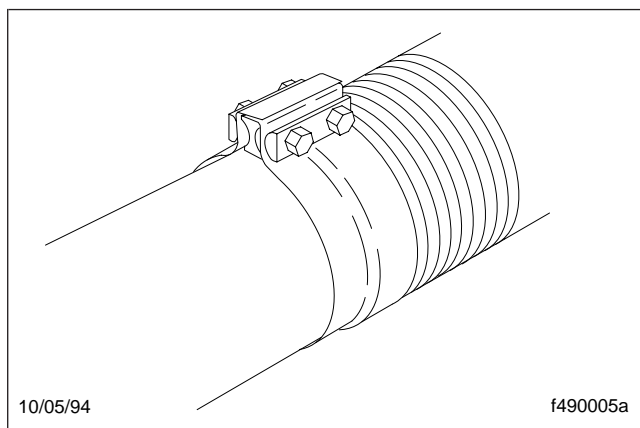


Fig. 1, Wide-Band Exhaust Clamp

Title of Maintenance Operation (MOP)	MOP Number
Coolant Level Sensor Cleaning.	54-01
Electrical System Checking.	54-02
Ground Cables Checking and Cleaning.	54-03

54-01 Coolant Level Sensor Cleaning

1. Drain enough coolant from the radiator to expose the coolant level sensor.
2. Disconnect wire 173 from the sensor in the radiator surge tank. Remove the sensor from the surge tank.
3. Using a fine-grit sandpaper, clean the sensor until the metal is exposed. Clean the tapped hole with a wire brush.
4. Install the sensor (do not seal the sensor threads with tape), and reconnect wire 173. Fill the cooling system to the proper level.
5. Start the engine. The LOW WTR light and warning buzzer should be off. If the light and buzzer are on, replace the sensor.

54-02 Electrical System Checking

Cab

1. Uncover the electrical panel by removing the fasteners. See [Fig. 1](#).

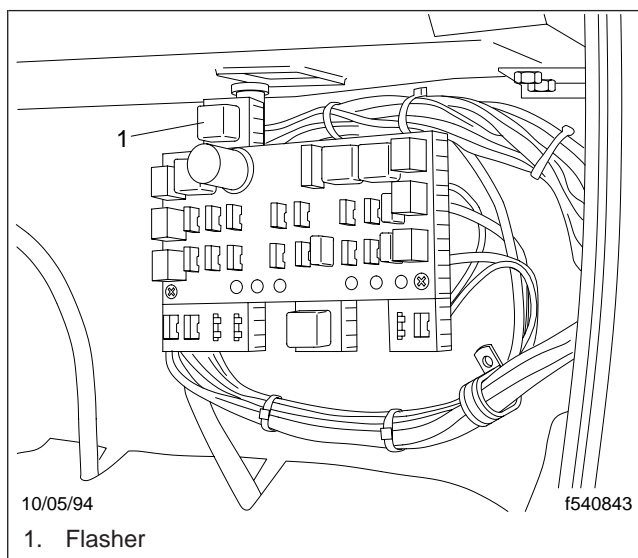


Fig. 1, Under-Dash Electrical Panel

2. Check the wiring harness for movement that could strain the electrical connections. Install more clamps on the harness if needed.
3. Check all of the wiring for chafing, kinks, and discolored insulation. Find the cause of any problems, then repair, replace, or reroute the wires as needed.
4. Check that all of the relays and circuit breakers are firmly seated in their mounting plates.
5. Check the turn-signal flasher (if so equipped). See [Fig. 1](#). Make sure that the two male and female connectors are firmly connected. Check that the flasher fuse is firmly seated in the holder.
6. Check the cigarette lighter. Look inside of the socket for signs of overheating (discoloration or melting) caused by misuse of the lighter socket.
7. Test the electric horn. If it does not work, turn the adjustment screw in or out until the horn works. If the horn still does not work, check the wiring. If the wiring is not damaged, replace the horn.
8. Check connectors on the right side of the front-wall, below the radiator surge tank. See [Fig. 2](#). Check the terminals for tightness, damage, corrosion, or dirt.

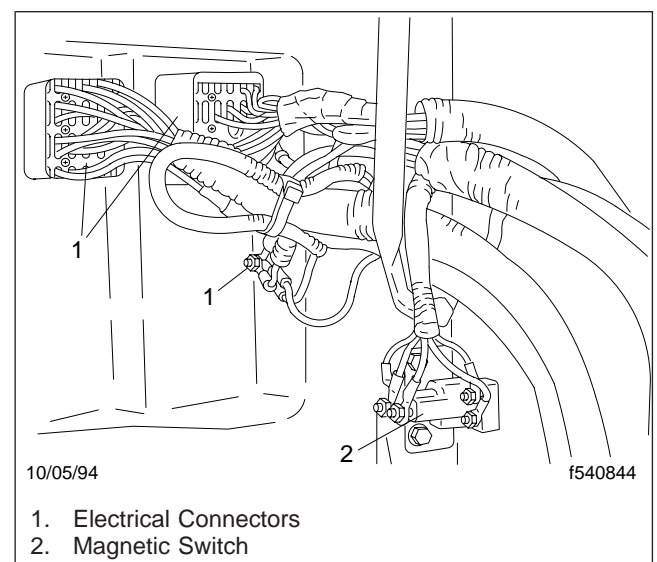


Fig. 2, Right Side of the Frontwall

9. Check the seven-way trailer cable plug at the back of the cab. Make sure that all of the pins are tight and free of dirt and grease.

Chassis

1. Check the main wiring harness. Check the wiring insulation for damage from chafing or heat. Also check for kinks. Reroute, repair, or replace the wires as needed.
2. Check connections at the starter, starter relays, alternator, and chassis grounds.
3. Check all of the tie straps for breakage or damage. Replace any broken or cracked tie straps.



CAUTION

Do not use flat-strip aluminum tie straps for holding electrical wiring. The sharp edges on these tie straps may cause breaks in the wire insulation, allowing the aluminum tie strap to make contact with the wire. This could cause a short circuit and damage to the wiring.

4. Check the temperature sending units on the axles and transmission. Check for damaged wires and loose connectors.

54-03 Ground Cables Checking and Cleaning

Check that the ground cables are clean, undamaged, and tight. If necessary, disconnect them and clean the mating surfaces with a soda solution. Then, connect them securely. Spray the ground cable connections with dielectric red enamel. See [Table 1](#) for approved part numbers.

Approved Dielectric Grease and Red Enamel	
Material	Part Number
Dielectric Grease	48-02349-000
Dielectric Red Enamel Spray	MMM 1602 IVI Spray-Sealer (Spray-On B-6-665)

Table 1, Approved Dielectric Grease and Red Enamel

Title of Maintenance Operation (MOP)	MOP Number
Air Conditioner Checking, R-134a Refrigerant System	83-01

83–01 Air Conditioner Checking, R-134a Refrigerant System

Preliminary Checks

1. Park the vehicle on a level surface. Shut down the engine, set the parking brake, and chock the tires.
2. Make sure that the refrigerant compressor drive belt is not damaged and that it is correctly tensioned. Also check the tightness of the compressor mounting fasteners. For instructions and torque values, see **Group 01** of the *Shuttle Bus Chassis Workshop Manual*.
3. Using a feeler gauge, check for correct clutch clearance. For instructions, see **Group 83** of the *Shuttle Bus Chassis Workshop Manual*.
4. Inspect the compressor clutch coil wire. Check the connector for damage or looseness. Replace the wire if it is damaged.
5. Check for broken, burst, or cut hoses. Also check for loose fittings on all parts.



WARNING

Wear eye protection when using compressed air to clean parts, as permanent harm to eyes could result from flying debris.

6. Check for a build-up of road debris on the condenser fins. Using a whiskbroom and air pressure, or a spray of soapy water, carefully clean off the condenser; be careful not to bend the fins.

Cooling Checking

1. Start the engine and set engine speed at 1500 rpm. Close the doors and windows.

IMPORTANT: When outside temperature and humidity are high it will take longer to cool the interior, especially if fresh-air vents are left open.

2. Turn on the air conditioner; set the controls at maximum cooling and blower speed.
3. Allow the system to run for at least 10 minutes (longer on hot and humid days).

4. Check air flow from the vents. If there is not enough air flow, check the air intake vent for blockage and the blower motor for proper operation.

If the air flow is not cold enough, see **Group 83** of the *Shuttle Bus Chassis Workshop Manual*.

5. Carefully feel the system lines.
 - The compressor discharge line should feel hot.
 - The condenser inlet line should be noticeably warmer than the outlet line.
 - The line from the condenser should feel warm.
 - The inlet and outlet lines of the receiver-drier should be about the same temperature.
 - The line from the receiver-drier to the evaporator should feel warm.
 - The line from the evaporator to the compressor should feel cold.

NOTE: Oily spots on the lines or at the fittings could indicate a system leak.

Refrigerant Checking

If equipped with a moisture indicator sight glass, check the color of the moisture indicator. See **Fig. 1**, Ref. 1.

If the moisture indicator is a deep cobalt blue, the refrigerant charge is dry. If the indicator is *not* blue, the system is contaminated with water; recover the refrigerant, replace the receiver-drier, evacuate the system, and add a full refrigerant charge.

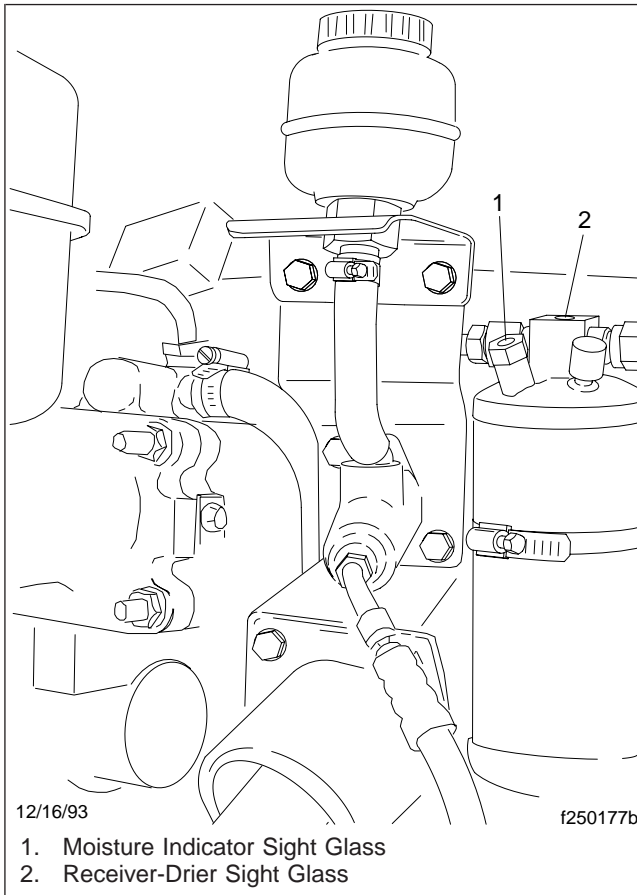


Fig. 1, Receiver-Drier