Introduction

This manual provides information needed to operate and understand the vehicle and its components. More detailed information is contained in the *Owner's Warranty Information Manual*, the vehicle's workshop manual, and the vehicle's maintenance manual.

Custom-built Thomas Built Buses are equipped with various chassis and body components. Not all of the information contained in this manual applies to every vehicle. For details about components in your vehicle, refer to the chassis specification pages included in all new vehicles and to the vehicle specification decal, located inside the vehicle.

For your reference, keep this manual in the vehicle at all times.

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

Environmental Concerns and Recommendations

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

Event Data Recorder

This vehicle is equipped with one or more devices that record specific vehicle data. The type and amount of data recorded varies depending on how the vehicle is equipped (such as the brand of engine, if an air bag is installed, or if the vehicle features a collision avoidance system, etc.).

Customer Assistance Center

Having trouble finding service? Call the Customer Assistance Center at 1-800-385-4357 or 1-800-FTL-HELP. Call night or day, weekdays or weekends, for dealer referral, vehicle information, breakdown coordination, or Fleetpack assistance. Our people are knowledgeable, professional, and committed to following through to help you keep your vehicle moving.

Reporting Safety Defects

If you believe that your vehicle has a defect which could cause a crash or could cause injury or death, you should immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying Daimler Trucks North America LLC.

If NHTSA receives similar complaints, it may open an investigation, and if it finds that a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you, your dealer, or Daimler Trucks North America LLC.

To contact NHTSA, you may call the Vehicle Safety Hotline toll-free at 1-888-327-4236 (TTY: 1-800-424-9153); go to **www.safercar.gov**; or write to: Administrator, NHTSA, 1200 New Jersey Avenue, SE, Washington, DC 20590. You can also obtain other information about motor vehicle safety from **www.safercar.gov**.

Canadian customers who wish to report a safety-related defect to Transport Canada, Defect Investigations and Recalls, may telephone the toll-free hotline 1-800-333-0510, or contact Transport Canada by mail at: Transport Canada, ASFAD, Place de Ville Tower C, 330 Sparks Street, Ottawa, Ontario, Canada K1A 0N5.

For additional road safety information, please visit the Road Safety website at: **www.tc.gc.ca/roadsafety**.

STI-466-4 (1/11P)
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Printed in U.S.A.

Foreword

Contents

1

Vehicle Identification

Vehicle Certification Plate and Data Plate

The certification plate is attached to the inside roof liner above the driver's window or on the front bulkhead. The certification plate certifies compliance with all Federal Motor Vehicle Safety Standards (FMVSS) in effect at the time of manufacture. Other information included are the date of manufacture, gross axle weight rating (GAWR) front and rear, gross vehicle weight rating (GVWR), vehicle identification number (VIN), vehicle type, and body identification. See **Fig. 1.1**.

The data plate is located on the inside roof liner above the driver's window or on the front bulkhead, and lists manufacturing information. See **Fig. 1.2**.

NOTE: Labels shown in this chapter are examples only. Actual label locations and specifications may vary from vehicle to vehicle.

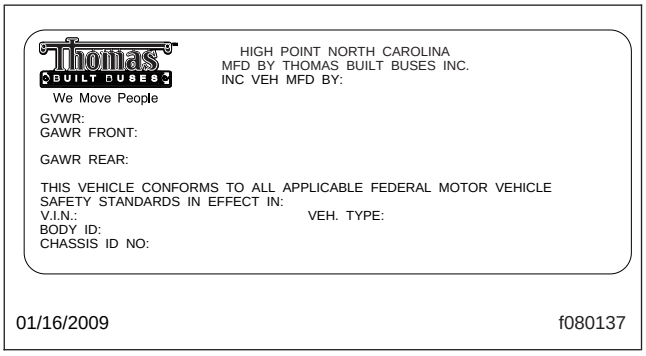


Fig. 1.1, Certification Plate

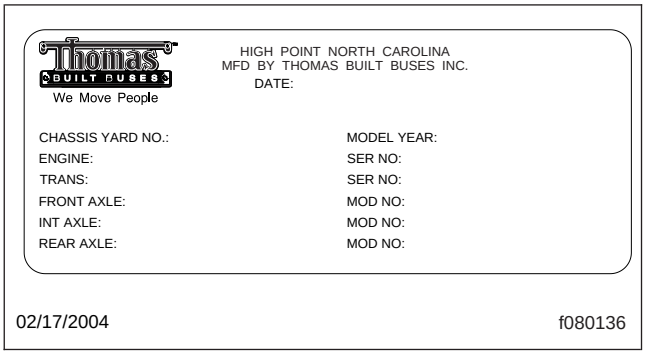


Fig. 1.2, Vehicle Data Plate

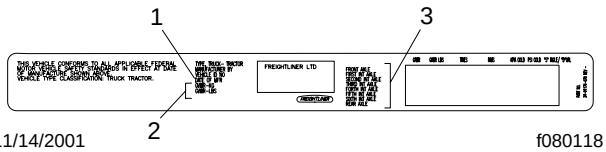
When contact is made with a distributor, authorized service agent, or Thomas Built Buses concerning warranty, parts, or service, the following three sets of numbers must be given to identify the unit:

1. The chassis identification number—identifies the chassis of a Thomas product.
2. The body identification number—includes three numbers, which include the order number, body number, and model number.
3. The VIN—is assigned by the chassis manufacturer and contains information such as the manufacturer, engine type, body style, and order number.

Vehicle Loading

The gross axle weight rating (GAWR) is the maximum weight the axle can carry. GAWR is the combined capacity of the axle, brakes, tires, wheel equipment, and suspension.

The gross vehicle weight rating (GVWR) is the maximum loaded weight of the vehicle. Never load the vehicle over the GVWR. Considerable damage to the drivetrain may result if the vehicle is over the GVWR. Check the GVWR certification statement to find the GVWR. See **Fig. 1.3**.



1. Date of Manufacture: by month and year
2. Gross Vehicle Weight Ratings are developed by taking the sum of all the vehicle's gross axle ratings
3. Gross Axle Weight Ratings are developed by considering each component in an axle system–including suspension, axle, wheels, and tires–using the lowest component capacity as the value for the system

Fig. 1.3, Certification Statement, U.S.

IMPORTANT: Passenger and cargo loads should be distributed proportionately over both the front and rear axles, and sides of the bus.

NOTE: Actual loads on the front and rear axles can only be determined by weighing the vehicle at highway weigh stations or similar facilities. Overloading the vehicle is considered misuse and will void the vehicle warranty.

Federal Motor Vehicle Safety Standard (FMVSS) Labels

NOTE: Due to the variety of FMVSS certification requirements, not all of the labels shown will apply to your vehicle.

Buses purchased in the U.S. are certified by means of a certification statement. See **Fig. 1.3**. The tire and rim information are combined into one label. This label is located in the driver area.

If purchased for service in the U.S., chassis built without a body have an incomplete certification label attached to the driver area. See **Fig. 1.4**. In addition, after completion of the vehicle, a certification label similar to that shown in **Fig. 1.3** must be attached by the final-stage manufacturer. This label will be located in the driver area, and certifies that the vehicle conforms to all applicable FMVSS regulations in effect on the date of completion.

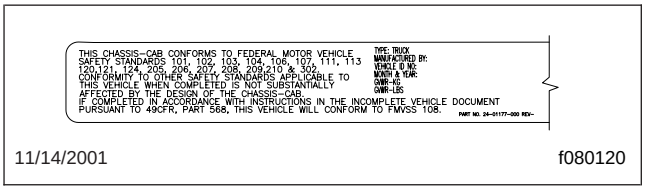


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Fig. 1.4, Incomplete Vehicle Certification Label, U.S.

Canadian Motor Vehicle Safety Standard (CMVSS) Labels

In Canada, buses are certified by means of a "Statement of Compliance" label and the Canadian National Safety Mark, which are located in the driver area. See **Fig. 1.5**. In addition, tire and rim information is also located in the driver area. See **Fig. 1.6**.

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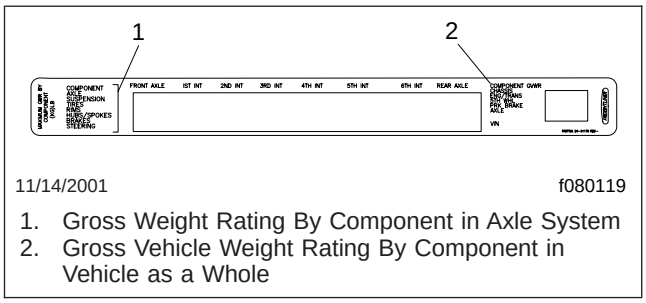
Fig. 1.5, Canadian National Safety Mark



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1. Gross Weight Rating By Component in Axle System
2. Gross Vehicle Weight Rating By Component in Vehicle as a Whole

Fig. 1.6, Tire and Rim Information

If purchased for service in Canada, chassis built without a body are certified by a "Statement of Compliance" label attached to the driver area. See **Fig. 1.3**. This label must be attached by the final-stage manufacturer after completion of the vehicle. The label is located in the driver area, and certifies that the vehicle conforms to all applicable CMVSS regulations in effect on the date of completion.

Tire and Rim Information

Tire and rim labels certify suitable tire and rim combinations that can be installed on the vehicle, for the given gross axle weight rating. Tires and rims installed on the vehicle at the time of manufacture may have a higher load capacity than that certified by the tire and rim label. If the tires and rims currently on the vehicle have a lower load capacity than that shown on the tire and rim label, then the tires and rims determine the load limitations on each of the axles.

See **Fig. 1.6** for U.S. and Canadian tire and rim labels.

EPA Vehicle Noise Emission Control Label

A vehicle noise emission control label is attached either to the left side of the dashboard or in the driver's area. See **Fig. 1.7**.

It is the owner's responsibility to maintain the vehicle so that it conforms to EPA regulations.

IMPORTANT: Certain Daimler Truck incomplete vehicles may be produced with incomplete noise control hardware. Such vehicles will not have a vehicle noise emission control information label.

For such vehicles, it is the final-stage manufacturer's responsibiltiy to complete the vehicle in conformity to U.S. EPA regulations (40 CFR Part 205) and lavel it for compliance.

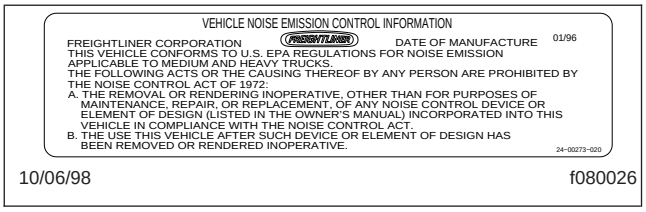


Fig. 1.7, Vehicle Noise Emission Control Label

EPA Exhaust Emissions

To meet EPA07 and EPA10 emissions regulations for vehicles domiciled in the USA or Canada, engines manufactured after December 31, 2006 (EPA07) or December 31, 2009 (EPA10) are equipped with an emission aftertreatment system. Vehicles domiciled outside of the USA and Canada may not have aftertreatment equipment, depending upon local statutory emissions guidelines. There is a warning label (placement will vary by bodybuilder), for important new warning indicators in the driver's message display, that pertain to the aftertreatment system.

It is a violation of US federal law to alter exhaust plumbing or aftertreatment in any way that would bring the engine out of compliance with certification requirements. (Ref: 42 U.S.C. S7522(a) (3).) It is the owner's responsibility to maintain the vehicle so that it conforms to EPA regulations.

2

Vehicle Access

Assist Rails and Access Steps

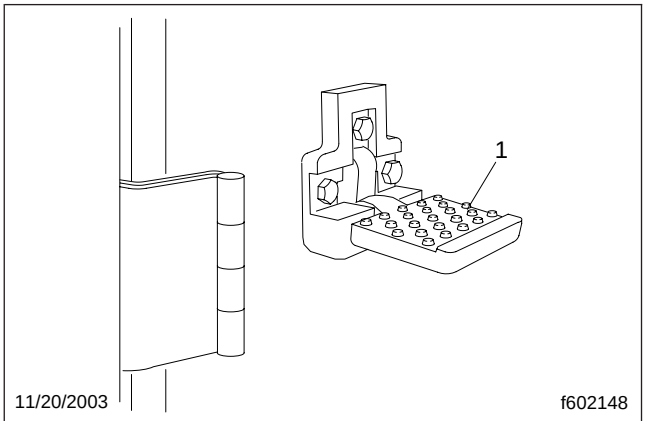
WARNING

Wet or dirty shoe soles greatly increase the chance of slipping or falling. If your soles are wet or dirty, be especially careful when entering or exiting the bus. Always maintain three-point contact with the bus access system while entering and exiting the bus. Three-point contact means both feet and one hand, or both hands and one foot.

For ease of entry and exit, there are two assist rails. There are three or four access steps to provide secure footholds. These assist rails and access steps are all part of the bus access system.

Folding Steps

There are folding steps mounted on both sides of the bus to assist in cleaning the windshield. The steps should be kept clean and the pivot points should be kept lubricated. See **Fig. 2.1**.



1. Folding Step

Fig. 2.1, Folding Step

Entering and Exiting the Bus

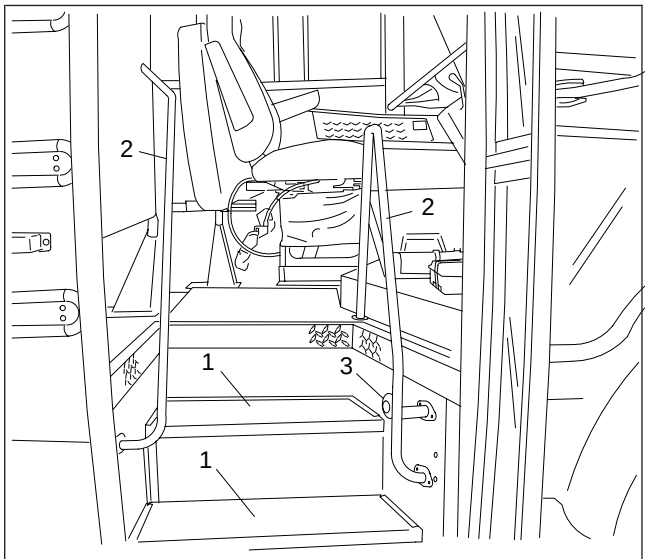
WARNING

Wet or dirty shoe soles greatly increase the chance of slipping or falling. If your soles are wet or dirty, be especially careful when entering or exiting the bus. Always maintain three-point contact with the bus access system while entering and exiting the bus. Three-point contact means both feet and one hand, or both hands and one foot.

Entering the Bus

To enter the bus, do the following. See **Fig. 2.2**.

1. Facing the steps, grasp the assist rail on either side of the steps. Reach up as far as is comfortable.
2. Place your right foot on the bottom step, and pull yourself up.
3. Place your left foot on the next step.
4. Place your right foot on the top step.



1. Steps
2. Assist Rails
3. Stepwell Light

Fig. 2.2, Bus Entry and Exit

Exiting the Bus

To exit the bus, do the following. See **Fig. 2.2**.

1. Facing the steps, grasp the assist rail on either side of the steps.
2. Move your right foot on the first step.
3. Place your left foot on the next step.
4. Step to the ground with your right foot first.

Stepwell Light

A stepwell light is located on the bottom right-hand side of the entry steps. See **Fig. 2.2**.

Front Door Opening and Closing

Buses Equipped with Exterior Door Control

Perform the following steps at the start of each trip.

- Open the front entrance door by turning the exterior key switch to the open position.
- Start the vehicle and allow it to warm up.
- To close the door, move the paddle switch on the driver control panel to the DOOR CLOSED position. See **Fig. 2.3**.

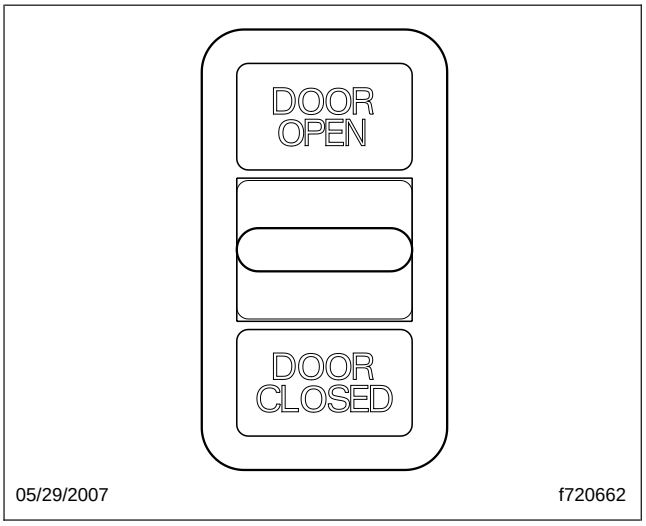


Fig. 2.3, Door Open/Door Closed Paddle Switch

Perform the following steps at the end of each trip.

- Shut down the engine.
- Move the paddle switch on the driver control panel to the DOOR OPEN position.
- Exit the vehicle.
- Turn the exterior key switch to the close position.

Buses without Exterior Door Control

Perform the following steps at the start of each trip.

- Manually open the door.
- After entering the vehicle, activate the emergency air release rocker switch located above the door. See **Fig. 2.4**.
- Start the vehicle and allow it to warm up.
- To close the door, move the paddle switch on the driver control panel to the DOOR CLOSED position. See **Fig. 2.3**.

Perform the following steps at the end of each trip.

- Shut down the engine.
- Activate the emergency air release rocker switch located above the door.
- Manually push the door open and exit the vehicle.
- Close the door manually.

Battery Access

Battery Compartment

The battery compartment is located behind the driver's area, attached to the frame rail. To open the battery access door, insert and turn the key, then pull the access door open. Pull the pull-pin spring latches out to slide the battery tray forward. See **Fig. 2.5**.

With the battery access door open, it is easy to get access to the battery terminals for cleaning, charging, or emergency jump starting.

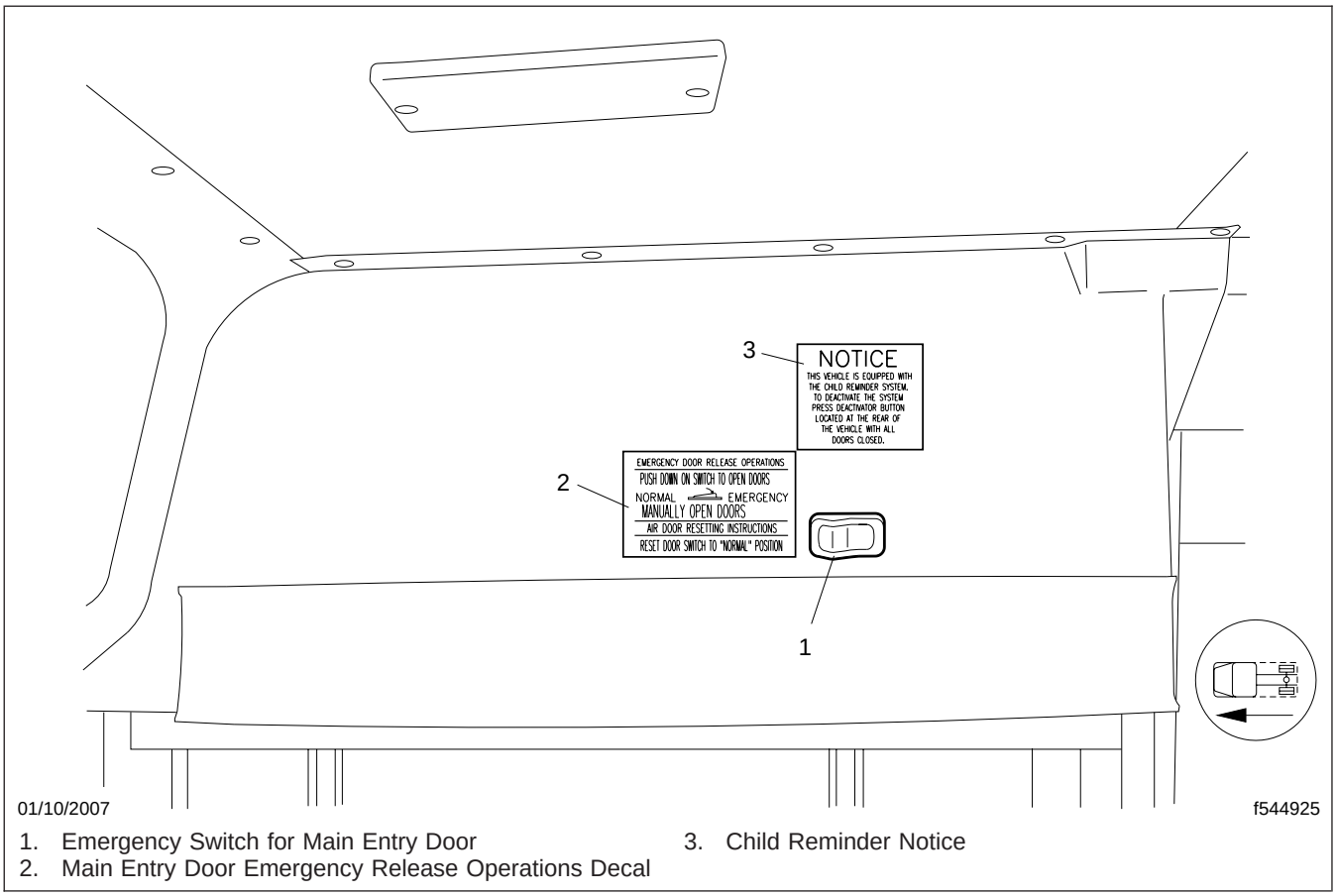
To close the battery access door, swing the door to line up with the hole in the frame, then lock the battery access door with the key.

Battery Disconnect Switch, Optional

NOTICE

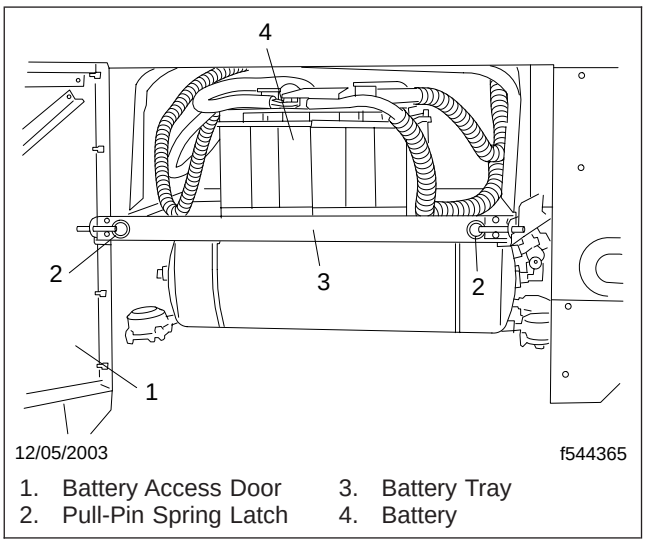
The batteries must be disconnected if the vehicle is not in use for a period exceeding two weeks, or the vehicle may not start, and permanent battery damage could occur.

A battery disconnect switch, if so equipped, cuts off all battery power to the vehicle. It is also used whenever the vehicle is placed out of service for extended



1. Emergency Switch for Main Entry Door
2. Main Entry Door Emergency Release Operations Decal
3. Child Reminder Notice

Fig. 2.4, Emergency Switch for Main Entry Door



1. Battery Access Door
2. Pull-Pin Spring Latch
3. Battery Tray
4. Battery

Fig. 2.5, Battery Access

periods to prevent battery discharge. The battery disconnect switch is located on the side of the battery box. See **Fig. 2.6**.

Hood Opening and Closing

A torsion spring helps to raise the hood, and to lower it to the operating position. Hood restraint cables prevent the hood from overtravel. A hood damper (optional) limits the closing speed. In the operating position, the hood is secured to the half-fenders by a hold-down latch on each side of the hood.

Tilting the Hood

1. Apply the parking brakes.
2. Release both hood hold-down latches by pulling the ends outward. See **Fig. 2.7**.

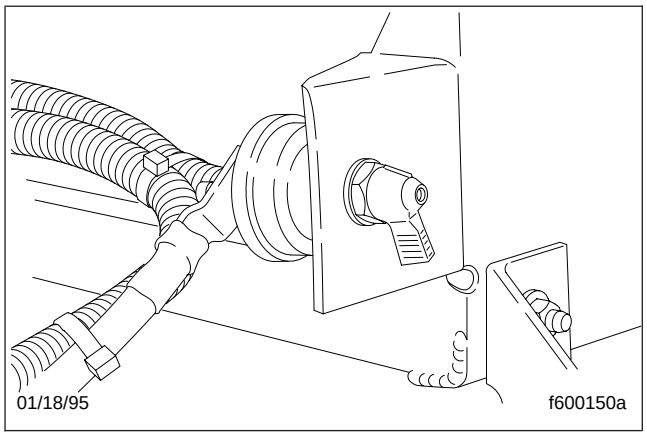
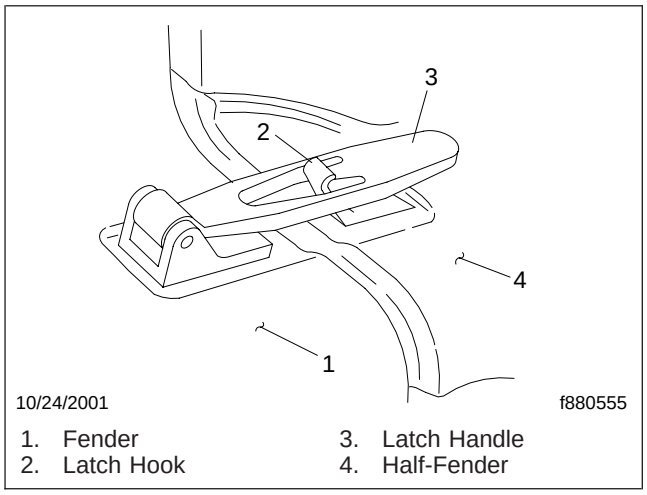


Fig. 2.6, Battery Disconnect Switch



1. Fender
2. Latch Hook
3. Latch Handle
4. Half-Fender

Fig. 2.7, Hood Hold-Down Latch

NOTICE

Do not let the hood free-fall to the full-open position. To do so could cause damage to the hood or hood straps.

3. Standing in front of the hood, tilt the rear of the hood upward until it reaches the over-center position (45-degrees from vertical). Then slowly bring it to a stop.

Closing the Hood

1. Push the hood over center.
2. As the hood goes over center, the damper (if equipped) automatically slows its rate of descent. If needed, you can also slow its rate of descent with your hand.
3. Make sure the hood is flush with the cowl, then secure the hood by engaging both hood hold-down latches.

IMPORTANT: Make sure that both hold-down latches are fully engaged before operating the vehicle.

Emergency Roof Escape Hatch (optional)

NOTE: A warning buzzer should sound when any exit is open.

The bus may contain emergency roof escape hatches located near the front and rear of the bus, in accordance with Federal or State regulations. On buses equipped with an emergency roof escape hatch, the opening instructions are clearly displayed on the hatch cover. See **Fig. 2.8**.

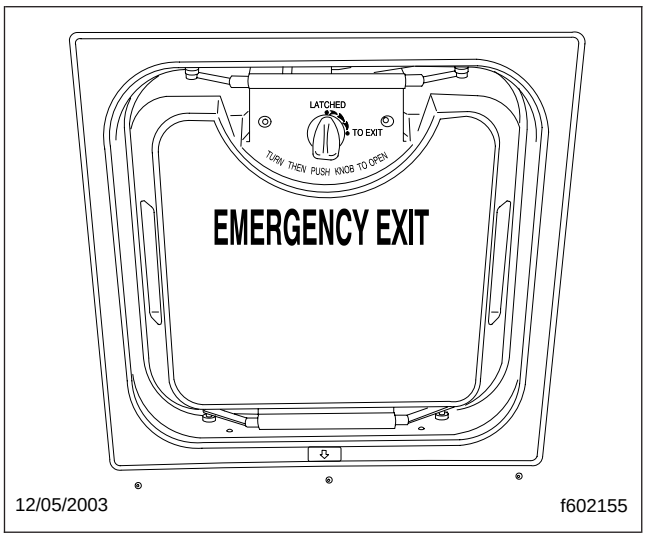


Fig. 2.8, Emergency Roof Escape Hatch

Emergency Door

Rear Emergency Door

The emergency door is located at the back of the bus. To open the door, lift the release handle and push the door out. Once the door is completely open, it will be locked in the open position, allowing passengers to exit without holding the door open. To

close the door, push it back to release it from the locked position. Close the door and lock it by pushing the release handle down. See **Fig. 2.9**.

Using the Main Entry/Exit Door in an Emergency

In an emergency, it may be necessary to use the red switch above the main door to open the door. Push down on the red switch to open the door, then push the door open. See **Fig. 2.4** and **Fig. 2.10**.

Emergency Window Exits

The bus has windows designated as emergency exits. To open the windows in emergency situations, follow the instructions that are clearly displayed on the window frame.

NOTE: Some states require that the operating instructions be located on the window glass.

Vehicles Built Since January 9, 2008

For vehicles built since January 9, 2008, the passenger emergency window exit is a vertical push-out window. Lift up on the window latch to open, and to sound the window buzzer. See **Fig. 2.11** and **Fig. 2.12**.

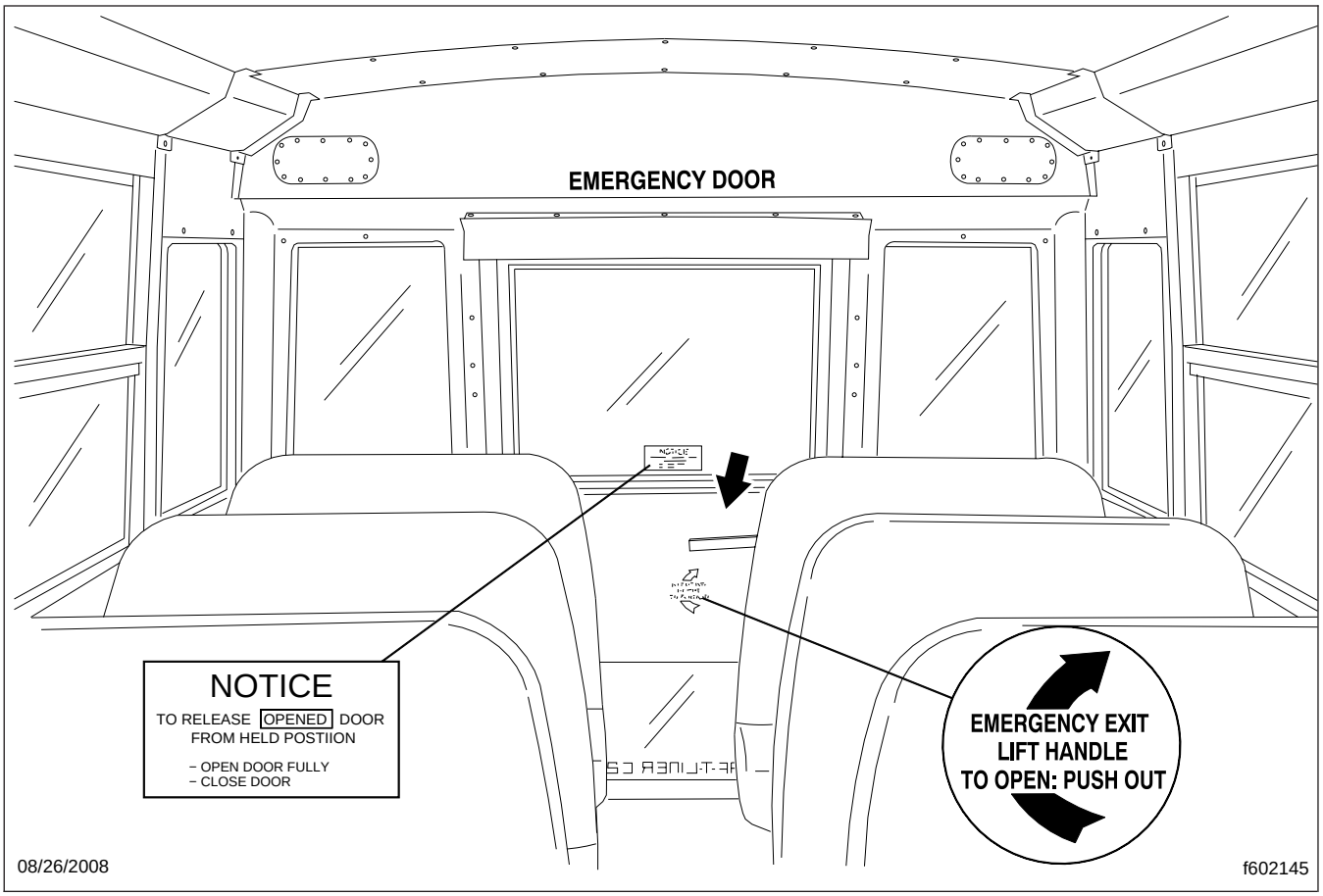


Fig. 2.9, Emergency Door

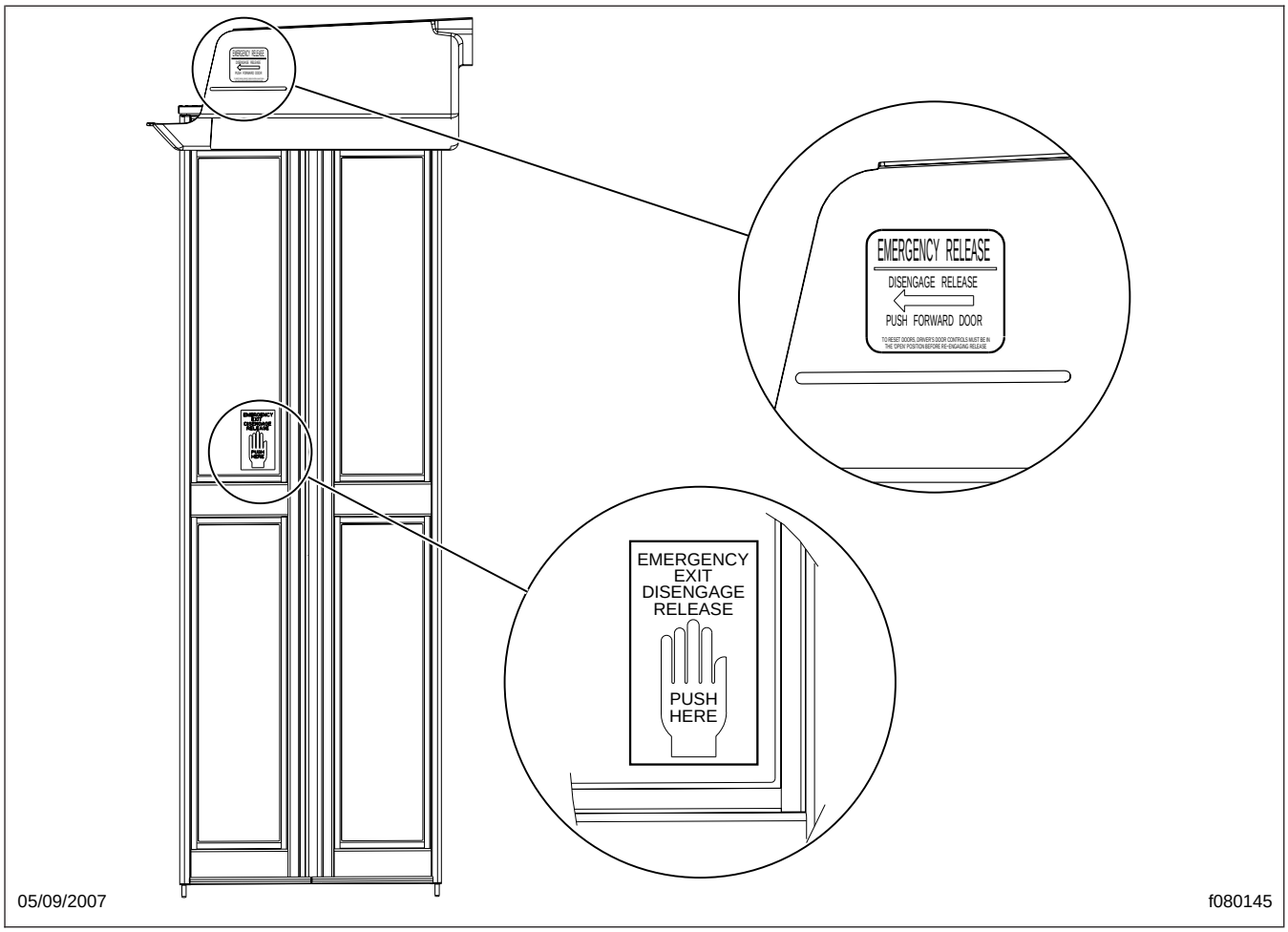
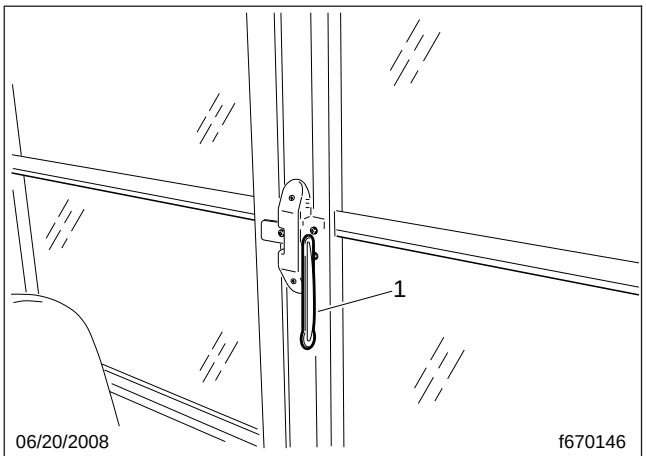
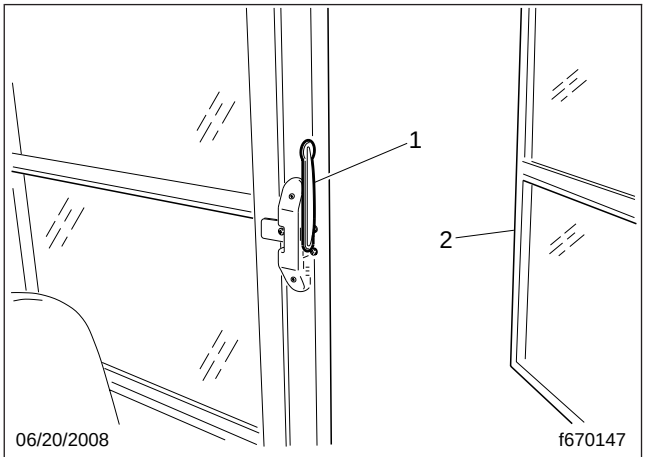


Fig. 2.10, Disengaging the Main Entry Door in an Emergency



1. Window Latch and Buzzer Switch (closed position)

Fig. 2.11, Vertical Push-Out Window (closed position, vehicles built since 1/9/08)



1. Window Latch and Buzzer Switch (open position)
2. Window Frame

Fig. 2.12, Vertical Push-Out Window (open position)

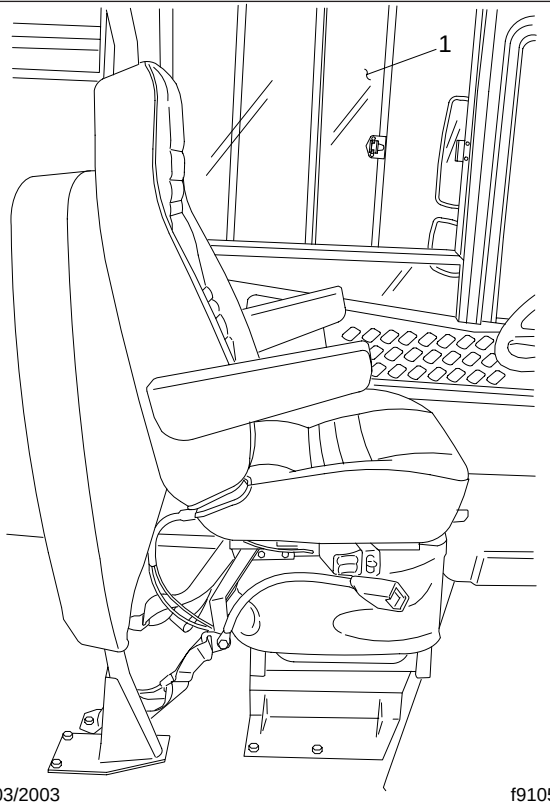
3

Bus Features

Windows

Driver's Window

To open the driver window, press the lock and slide the window rearward. The window will only open half-way. See **Fig. 3.1**.



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1. Driver's Window

Fig. 3.1, Driver's Window

Passenger Windows

Passenger windows on the bus are opened by pressing the locks on the left-hand and right-hand side of the window. There are three settings for the passenger windows. The window can be opened to the one-third, one-half, or full-open positions.

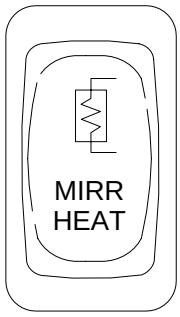
Mirrors

Both driver-side mirrors and crossover mirrors are standard on the bus.

Mirror Heat Switch, Optional

One or both side-view mirrors can be heated to keep them clear of fog, frost, and ice.

To heat the mirrors, press the upper part of the mirror heat switch (MIRR HEAT) on the dash. See **Fig. 3.2**. When the mirror heat switch is on, an amber indicator light illuminates inside the switch.



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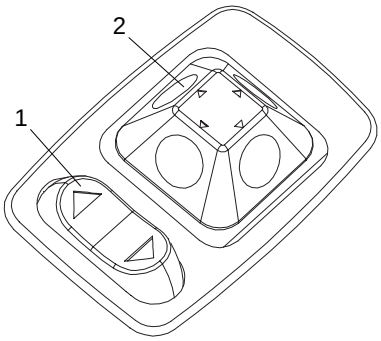
To heat the mirrors, press up; press down to turn off the heat.

Fig. 3.2, Mirror Heat Switch

The mirror heat switch is a smart switch (fully multiplexed).

Power Mirrors, Optional

The main outside mirrors, if heated, can be equipped with an electrical remote control located on the driver's switch panel. See **Fig. 3.3**.



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To adjust the mirror position, press the keypad in the direction you want the mirror to move.

1. Mirror Select Switch 2. Keypad

Fig. 3.3, Power Mirror Switch Pad

To select the mirrors on the left-hand side, press the left side of the mirror select switch. To select the mirrors on the right-hand side, press the right side of the mirror select switch.

The keypad has four arrow keys, pointing up, down, left, and right. To adjust the mirror position, press the keypad in the direction you want the mirror to move.

Seats

General Information

⚠ WARNING

Keep hands, tools, and other objects away from the scissor points under the seats. Failure to do so could cause personal injury.

Unless otherwise noted, all seat adjustments should be made while seated and before the engine is started.

Due to the high degree of adjustability found in high-back air suspension seats, it is possible to set the seat back recline adjustment and the seat slide adjustment in such a combination that the seat back will come into contact with the rear wall of the driver's compartment. It is the responsibility of the driver to adjust the seat to prevent damage to the seat and the driver's compartment.

The following is a description of adjustments that are available on one or more seats. Not all seats have all of the adjustments listed below.

1. Seat Slide (fore-and-aft): When this adjustment is made, the entire seat moves forward or backward on its track. See **Fig. 3.4** for a description of the seat slide and isolator lever.
2. Isolator: This feature (also referred to as backslap isolator or Chugger-Snubber®) reduces the amount of road shock by isolating the occupant from the motion of the vehicle, and allowing the upper seat to move in a simple pendulum motion. Whenever the isolator is not desired, it can be locked out. See **Fig. 3.4**.
3. Lumbar Support: Lumbar support changes the shape of the seat back to give more or less support to the occupant's lumbar (lower back) area. This adjustment is either mechanical or air controlled, depending on make and model of the seat. See **Fig. 3.5**.

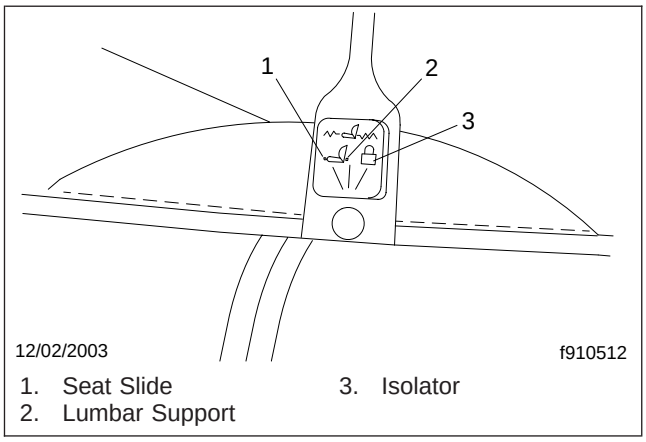


Fig. 3.4, Seat Slide and Isolator Lever

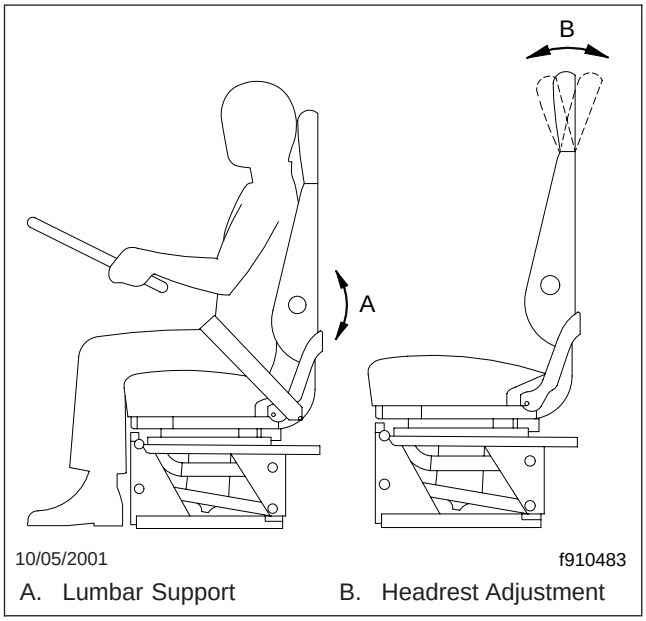


Fig. 3.5, Lumbar Support and Headrest Adjustment

4. Headrest: When this adjustment is made, the upper part of the backrest (back cushion) changes angle to provide head and upper back support. See **Fig. 3.5**.
5. Backrest Tilt: This adjustment pivots the backrest forward or backward. See **Fig. 3.6**.
6. Seat Cushion Tilt: This adjustment raises or lowers the front and/or back of the seat (bottom) cushion. This adjustment is easier to perform when all weight is removed from the seat. See **Fig. 3.6**.

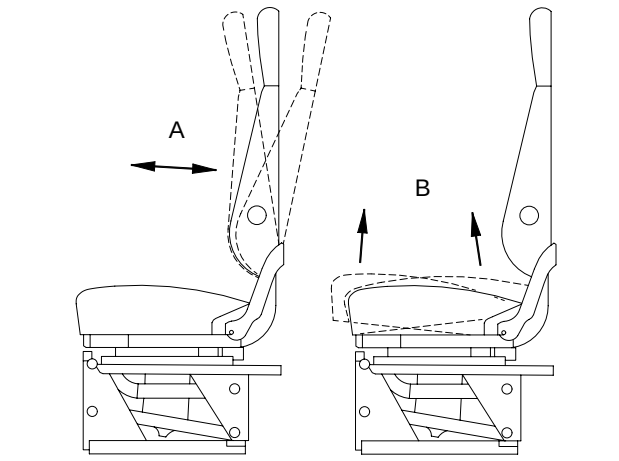


Fig. 3.6, Cushion Tilt Adjustments

7. Seat Tilt: When this adjustment is made, the seat assembly, both backrest and seat cushion, tilts forward or backward. See **Fig. 3.6**.
8. Ride Height Adjustment: The entire seat moves up or down when adjusting the ride height. The adjustment is either manual or air controlled, depending on the make and model of the seat. See **Fig. 3.7**.

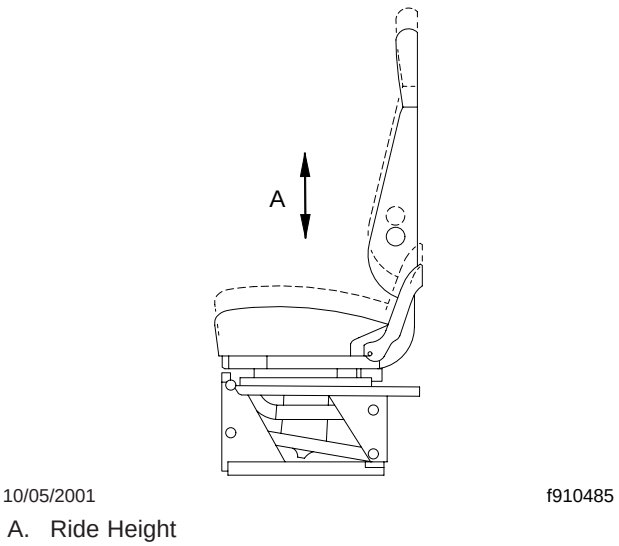


Fig. 3.7, Ride Height Adjustment

9. Damper: When you sit on the seat, a leveling valve places you in the center of the ride zone. When the damper is adjusted properly under normal driving conditions, the seat should not top or bottom against the limits of the vertical travel.
10. Ride Firmness: A firmer ride gives a better feel for the road but less protection against unevenness in the road surface. A softer ride smooths out the bumps.

Bench Seats

Bench seats are standard for passengers on all buses. No adjustments are possible on the two-person bench seat. See **Fig. 3.8**.

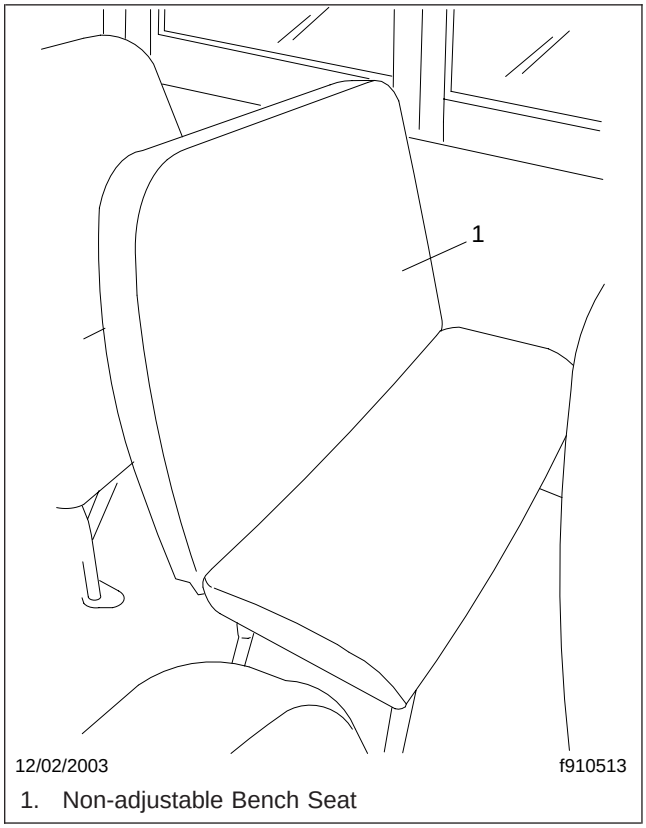
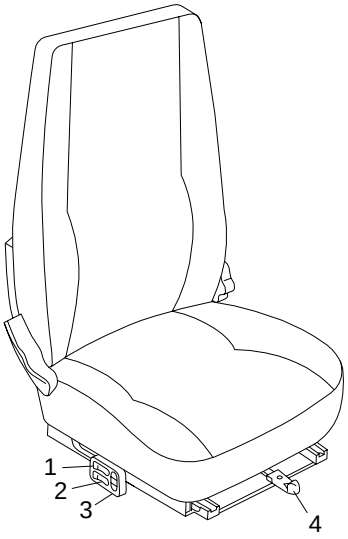


Fig. 3.8, Bench Seat

Bostrom Seat

Seat Slide Adjustment

Move the seat slide and isolator lever to the left and hold it there to slide the seat forward or backward to the desired position. See **Fig. 3.9**.



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1. Air Lumbar Support Control Valve (optional)
2. Damper Adjustment Switch
3. Height Adjustment Switch
4. Seat Slide and Isolator Lever

Fig. 3.9, Bostrom Seat

Isolator

To engage the isolator, put the seat slide and isolator lever in the center position. Lock out the isolator by moving the lever to the right.

Lumbar Support

To increase lumbar support, rotate the lumbar support knob forward. To decrease lumbar support, rotate the knob rearward.

On seats equipped with air lumbar support, press the control valve upward to increase lumbar support. Press the control valve downward to decrease lumbar support.

Seat Cushion Tilt

Rotate the seat cushion tilt knob to increase or decrease seat cushion tilt.

Backrest Tilt

To tilt the backrest, lean forward slightly to remove pressure from the cushion and hold the backrest tilt lever rearward. Lean backward slowly to the desired position and release the lever to lock the backrest in place.

Ride Height and Damper Adjustment

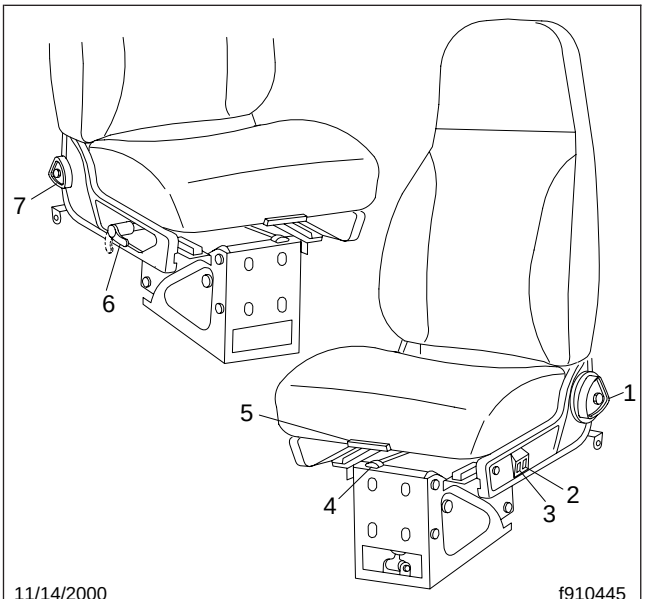
To raise the seat, press the upper portion of the height adjustment switch. To lower the seat, press the lower portion of the switch.

Press the damper adjustment switch to adjust the damper.

National 2000 Series Seat

Seat Slide Adjustment

Move the seat slide lever to the left and hold it there to slide the seat forward or backward to the desired position. Move the lever back to its original position to lock the seat in place. See **Fig. 3.10**.



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1. Backrest Tilt Knob
2. Lumbar Support Switch
3. Height Adjustment Switch
4. Seat Slide Lever
5. Front Cushion Height Adjustment Handle
6. Isolator Handle
7. Rear Cushion Adjustment Knob

Fig. 3.10, National 2000 Series Seat

Isolator

To use the isolator feature, turn the isolator handle to the horizontal position. Turn the isolator handle down to lock out the isolator.

Lumbar Support

To adjust the lumbar support, use the lumbar support switch on the side of the seat to give more or less support to your lower back.

Backrest Tilt

To tilt the backrest, turn the backrest tilt knob until the desired position is reached.

Seat Cushion Adjustment

To adjust the height of the front of the seat cushion, lift the front cushion height adjustment handle, and pull forward or push back to the desired setting.

To adjust the height of the rear of the seat cushion, remove your weight from the seat and turn the rear cushion adjustment knob to one of three positions.

Ride Height Adjustment

To raise or lower the height of the seat, use the height adjustment switch on the side of the seat.

Sears Seat

Seat Slide Adjustment

Push the seat slide (fore-and-aft adjustment) lever all the way to the left and slide the seat forward or backward, as desired. Release the lever to lock the seat in the desired position. See **Fig. 3.11**.

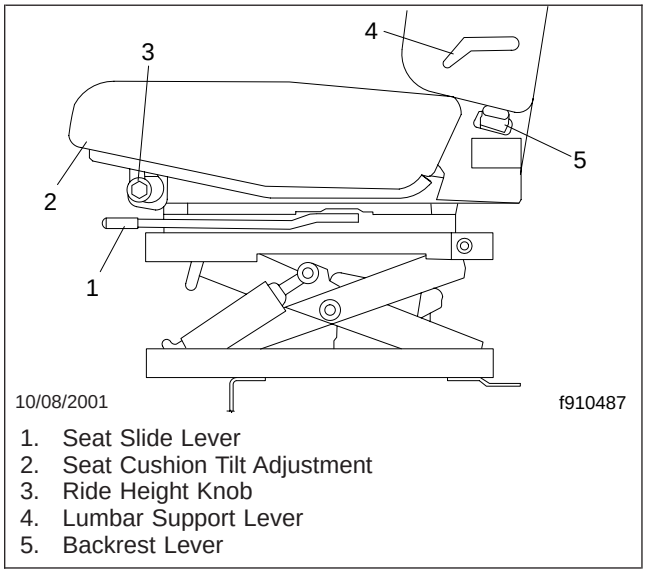
Isolator

To engage the isolator (if installed), move the seat slide and isolator lever all the way to the right. To lock out the isolator, move the isolator lever to the center position. See **Fig. 3.12**.

Lumbar Support

Move the three-position lumbar support lever upward to increase lumbar support (firmer). Move the lever downward to decrease lumbar support (less firm).

NOTE: This three-position lever (see inset) does not rotate a full 360 degrees.



1. Seat Slide Lever
2. Seat Cushion Tilt Adjustment
3. Ride Height Knob
4. Lumbar Support Lever
5. Backrest Lever

Fig. 3.11, Sears Low Profile Seat

For seats with air support, use the aft rocker switch on the control panel on the left-hand side of the seat. Press up to make the seat firmer; press down to make the seat less firm. See **Fig. 3.13**.

Seat Cushion Tilt

To raise the seat cushion, lift upward on the front of the seat cushion, and then push it rearwards. To lower the seat cushion, pull forward on the front of the seat cushion, and then push downwards.

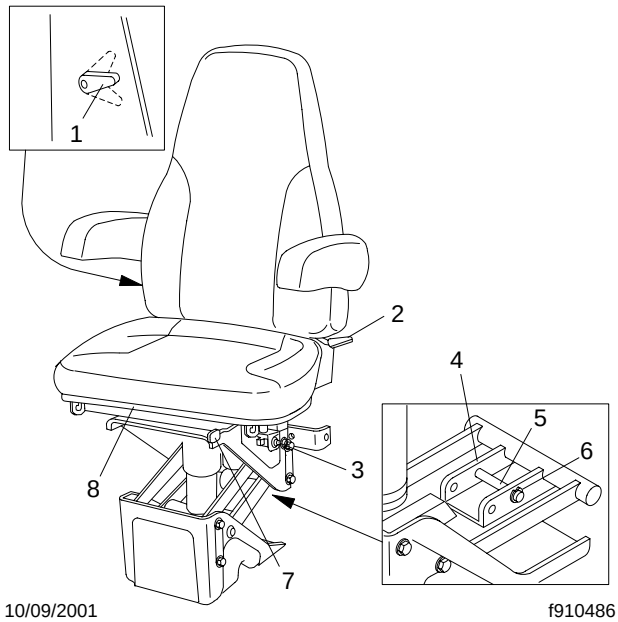
Backrest Adjustment

To adjust the backrest, push downwards on the backrest lever just below the bottom of the backrest cushion. With the lever down, lean forward or backward to the desired position. Release the lever to lock the backrest in place.

Ride Height Adjustment

Push the ride height knob inwards to inflate the air cylinder, raising the height of the seat. Pull the ride height knob outwards to deflate the air cylinder, lowering the height of the seat.

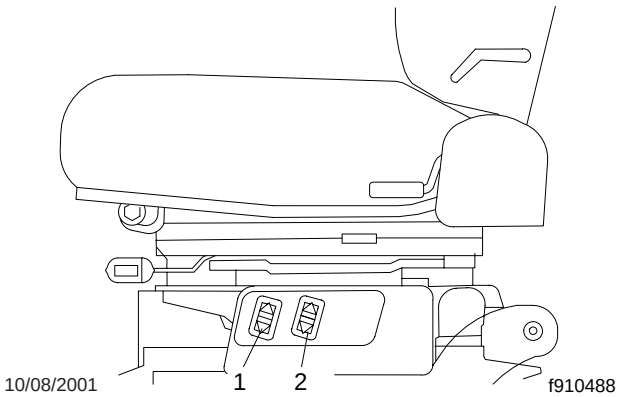
For seats with air support, use the forward rocker switch on the control panel on the left-hand side of the seat. Press up to raise the seat; press down to lower the seat. See **Fig. 3.13**.



NOTE: Armrests are optional.

1. Lumbar Support Lever
2. Backrest Lever
3. Ride Height Knob
4. Shock Absorber Bracket (ride firmness)
5. Pin (ride firmness)
6. Snap Ring (ride firmness)
7. Seat Slide and Isolator Lever
8. Seat Cushion Adjustment

Fig. 3.12, Sears Fleetmaster Seat (with isolator)



1. Ride Height Switch
2. Air Lumbar Support Switch

Fig. 3.13, Air Controls, Sears Seat

Ride Firmness Adjustment

For a softer ride, remove the snap ring and pin from the shock absorber bracket (see inset). Relocate the pin in the other set of holes in the bracket and secure it with the snap ring.

Seat Belts and Tether Belts

General Information

Seat belt assemblies are designed to secure persons in the vehicle to help reduce the chance of injury or the amount of injury resulting from accidents or sudden stops. For this reason, Daimler Trucks North America LLC urges that the driver and *all* passengers, regardless of age or physical condition, use seat belts when riding in the vehicle.

NOTE: Use passenger seat belts, if so equipped, when riding in the bus.

IMPORTANT: Passenger seats may be constructed either as seat belt-ready or without seat belts. Do not add seat belts to seats that are not manufactured for seat belts.

⚠ WARNING

Always use the vehicle's seat belt system when operating the vehicle. Failure to do so can result in severe personal injury or death.

Seat belt assemblies in Daimler Trucks North America (DTNA) vehicles meet Federal Motor Vehicle Safety Standard 209, "Type 1" and "Type 2" requirements.

When transporting a child, always use a child restraint system or the vehicle seat belts as appropriate. To determine whether a child restraint system is required, review and comply with applicable state and local laws. Any child restraint used must comply with Federal Motor Vehicle Safety Standard 213, "Child Restraint Systems." When providing a child restraint system, always carefully read and follow all instructions pertaining to installation and usage for the child. Make certain the child remains in the restraint system at all times when the vehicle is in motion.

In addition to seat belt assemblies, tether belts are installed on suspension-type seats. Tether belts help

secure the seat to the floor and are intended to restrain the seat and seat belt in case of an accident or sudden stop.

IMPORTANT: Seat belts have a finite life which may be much shorter than the life of the vehicle. Regular inspections and replacement as needed are the only assurance of adequate seat belt security over the life of the vehicle.

Seat Belt Inspection

⚠ WARNING

Inspect and maintain seat belts and tethers as instructed below. Seat belts and tethers that were damaged or stressed in an accident must be replaced, and their anchoring points must be checked. When any part of a seat belt system needs replacement, the entire seat belt must be replaced, both the retractor and the buckle side. Do not attempt to modify the seat belt system; doing so could change the effectiveness of the system. Failure to replace damaged or stressed seat belts or any modifications to the system may result in personal injury or death.

Inspect the seat belts and tether belts (if so equipped).

1. Check the web for fraying, cuts, or extreme wear, especially near the buckle latch plate and in the D-loop guide area.
2. Check the web for extreme dirt or dust, and for severe fading from exposure to sunlight.
3. Check the buckle and latch for operation and for wear or damage.
4. Check the Komfort Latch for function and cracks or other damage.
5. Check the web retractor for function and damage.
6. Check the mounting bolts for tightness and tighten any that are loose.

Seat Belt Operation

Three-Point Seat Belt With Komfort Latch

⚠ WARNING

Wear three-point seat belts only as described below. Three-point seat belts are designed to be worn by one person at a time. In case of an accident or sudden stop, personal injury or death could result from misuse.

Fasten the seat belts before driving. Fastening a three-point seat belt while driving creates a hazard.

1. Slowly pull the link end of the three-point seat belt out of the retractor and pull it across your lap (from outboard to inboard) far enough to engage the buckle. If the retractor locks too soon, allow the belt to retract slightly, then slowly pull it out again.
2. Fasten the three-point seat belt by pushing the link into the buckle until it latches. Give the belt a tug at the buckle. If the buckle unlatches, repeat this step. If the problem continues, replace the three-point seat belt. See **Fig. 3.14**.

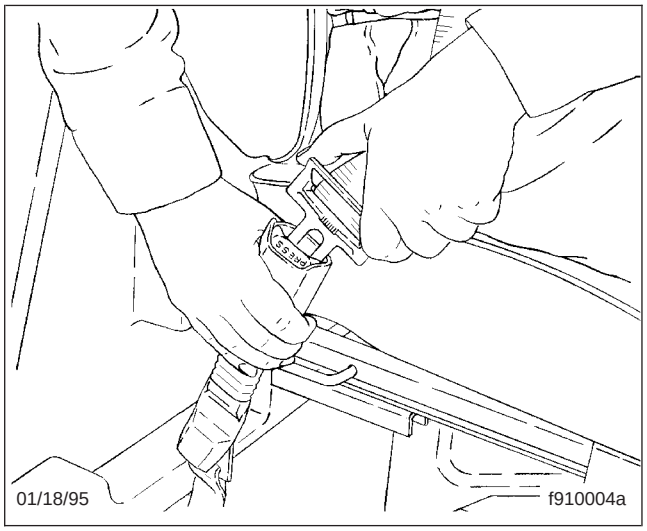
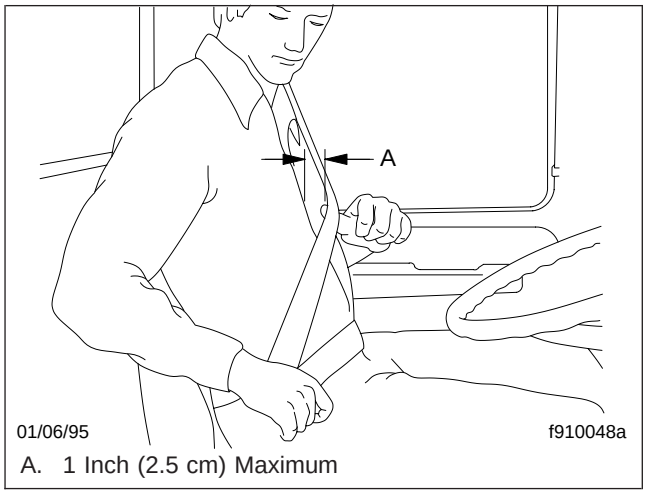


Fig. 3.14, Fastening the Three-Point Belt

3. Position the shoulder strap diagonally across your chest with the adjustable D-loop bracket.

4. If desired, engage the Komfort Latch. See **Fig. 3.15** to adjust the shoulder harness and **Fig. 3.16** to lock the Komfort Latch.



A. 1 Inch (2.5 cm) Maximum

Fig. 3.15, Adjusting Shoulder Harness Clearance

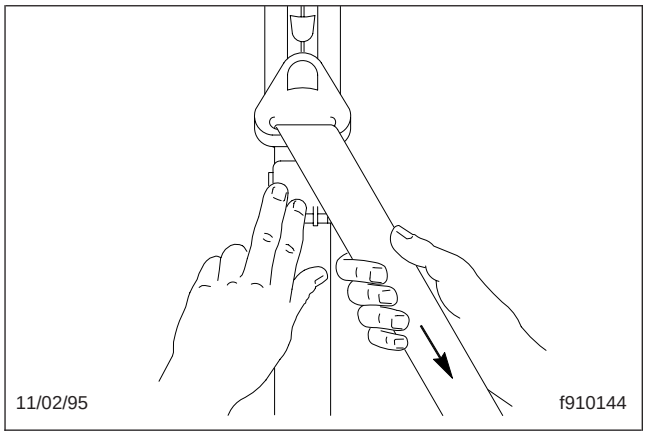


Fig. 3.16, Locking the Komfort Latch

4.1 Pull on the shoulder harness to lessen the pressure of the strap on your shoulder and chest.

4.2 Allow no more than 1-inch (2.5 cm) of slack between your chest and the shoulder harness.

NOTE: More slack can significantly reduce the seat belt's effectiveness in an accident or a sudden stop.

4.3 While holding the belt slack, press the Komfort Latch lever up, clamping the seat belt webbing.

5. To unbuckle the three-point seat belt, push the button on the buckle as shown in **Fig. 3.17**. If the Komfort Latch was locked, release it by giving the shoulder belt a quick tug. If you lean forward against the shoulder belt, the Komfort Latch will automatically release, and will need to be reset.

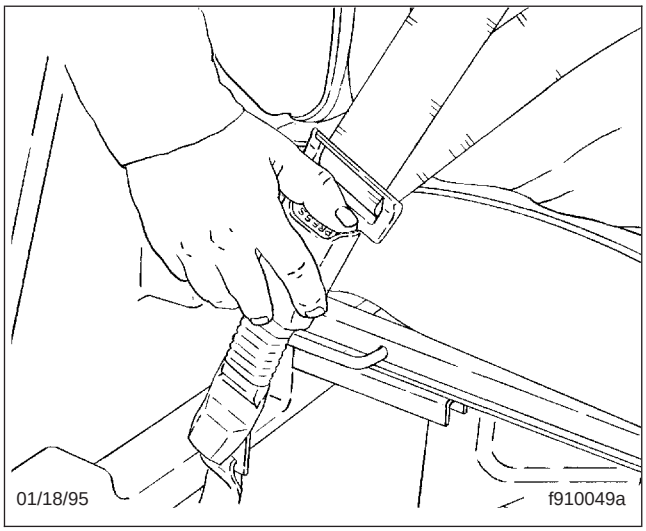


Fig. 3.17, Releasing the Three-Point Seat Belt

NOTE: The Komfort Latch does not have to be released in an emergency situation. The Komfort Latch will release by itself under rough road or other abnormal conditions. Make sure the three-point seat belt is completely retracted when it is not in use.

Bus Amenities

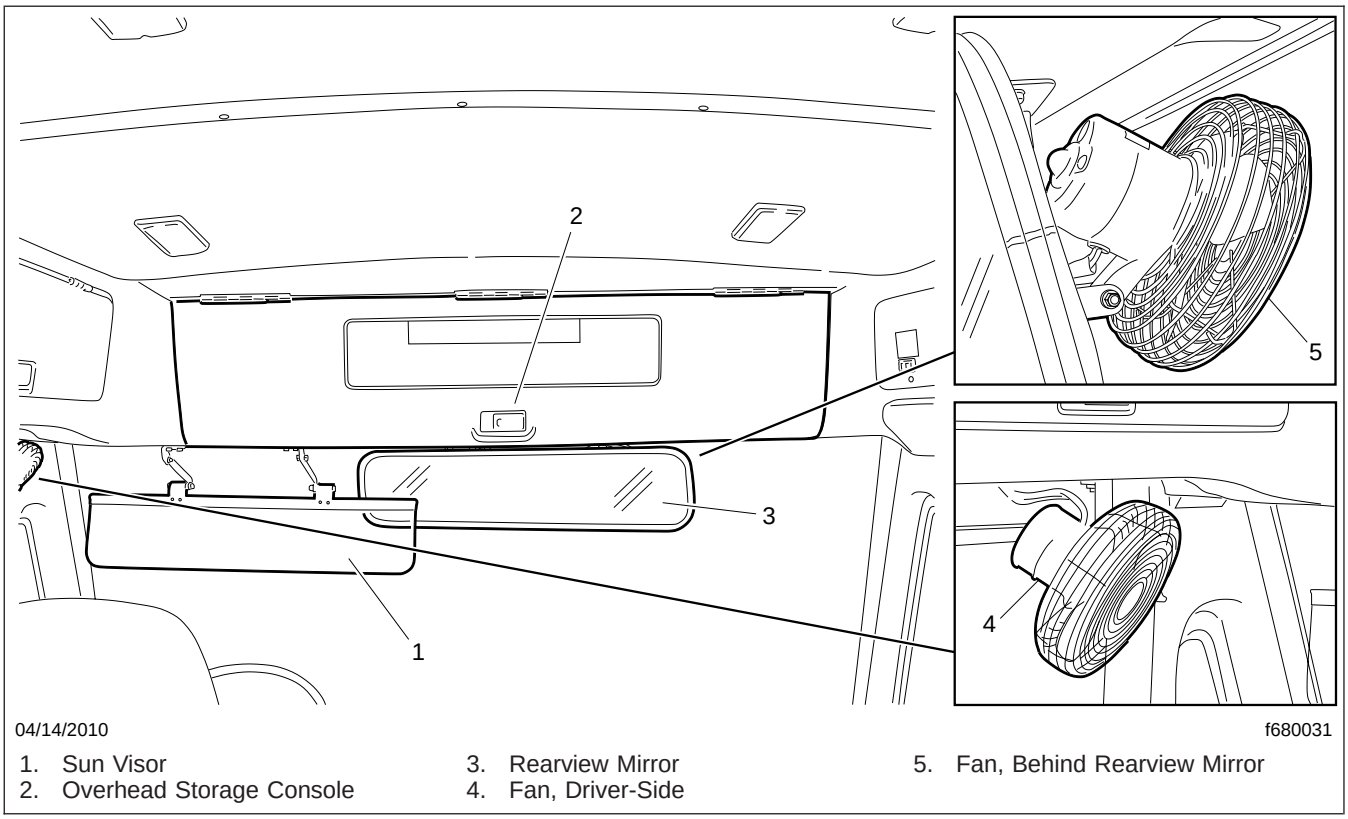
Storage

Overhead Storage

Buses are equipped with an overhead storage console. See **Fig. 3.18**.

Driver-Side Panel Storage

A storage bin is located in the upper switch cabinet of the driver-side panel. See **Fig. 3.19**.



1. Sun Visor
2. Overhead Storage Console
3. Rearview Mirror
4. Fan, Driver-Side
5. Fan, Behind Rearview Mirror

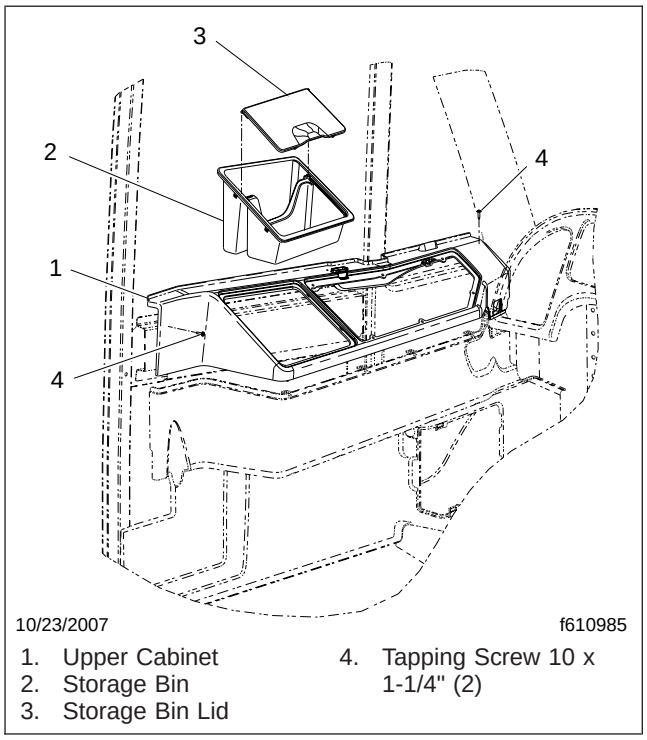
Fig. 3.18, Overhead Storage

Driver-Side Overhead Storage Box

An overhead storage box is located on the driver's side. See **Fig. 3.20**. When the storage box door is fully opened, the prop rod will extend to hold the door in place. To close the storage box door, gently touch the prop rod in the center and close the door.

Windshield Washer Reservoir

The standard location for the windshield washer reservoir is on the right-hand side of the bus, underneath the hood. See **Fig. 3.21**.



1. Upper Cabinet
2. Storage Bin
3. Storage Bin Lid
4. Tapping Screw 10 x 1-1/4" (2)

Fig. 3.19, Storage Bin and Lid

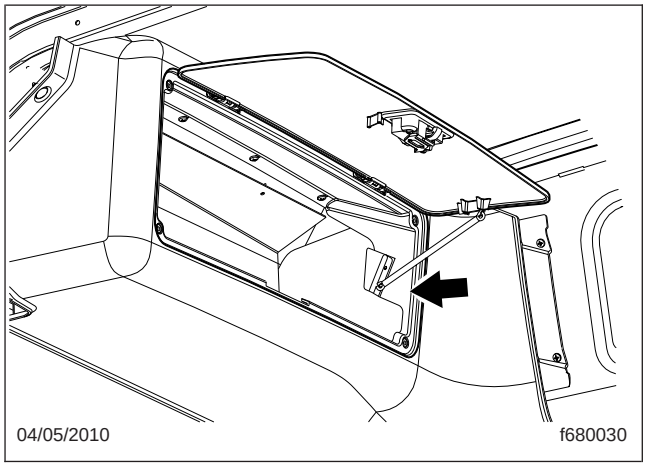
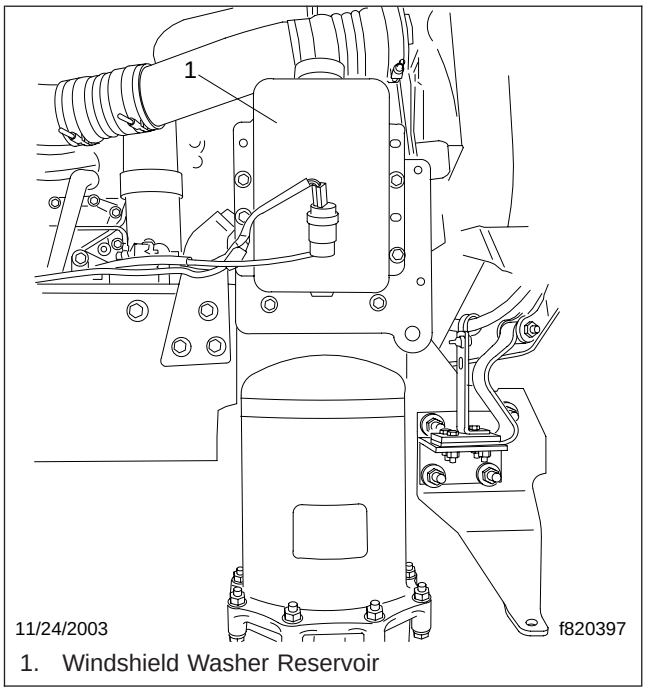


Fig. 3.20, Driver-Side Overhead Storage Box



1. Windshield Washer Reservoir

Fig. 3.21, Windshield Washer Reservoir

4

Instruments

Instrumentation Control Unit

Figure 4.1 and **Fig. 4.2** show a typical set of instruments for vehicles equipped with the Saf-T-Liner C2 School Bus instrument cluster (ICU3-M2).

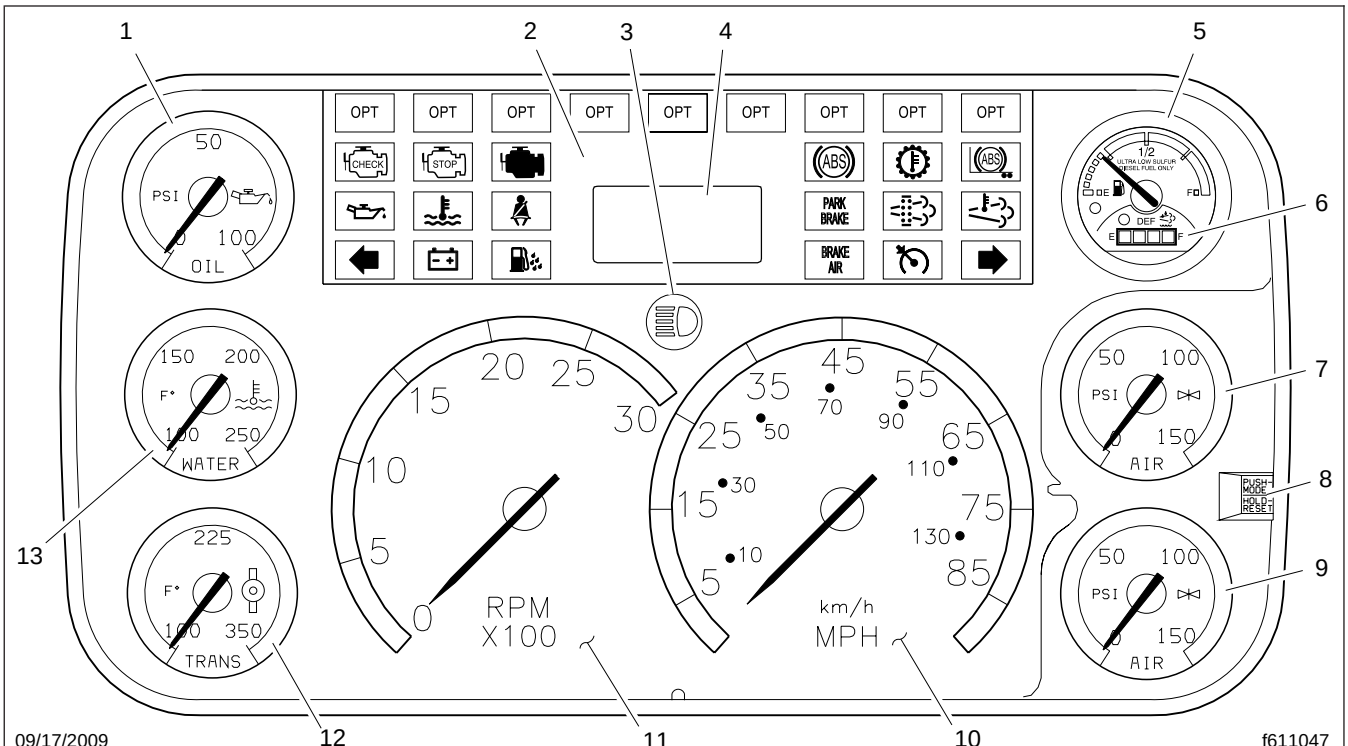
NOTE: This instrument cluster is shown with the U.S. speedometer, which shows miles per hour (mph) more prominently than kilometers per hour (km/h).

Figure 4.3 shows a more basic instrument cluster. The tachometer and the transmission temperature gauge are not shown.

The Saf-T-Liner C2 School Bus instrument cluster (ICU3-M2) is an an updated version of the basic electronic dashboard (ICU3). It can accept information from the datalink and from various sensors installed on the vehicle and deliver that information to electronic gauges.

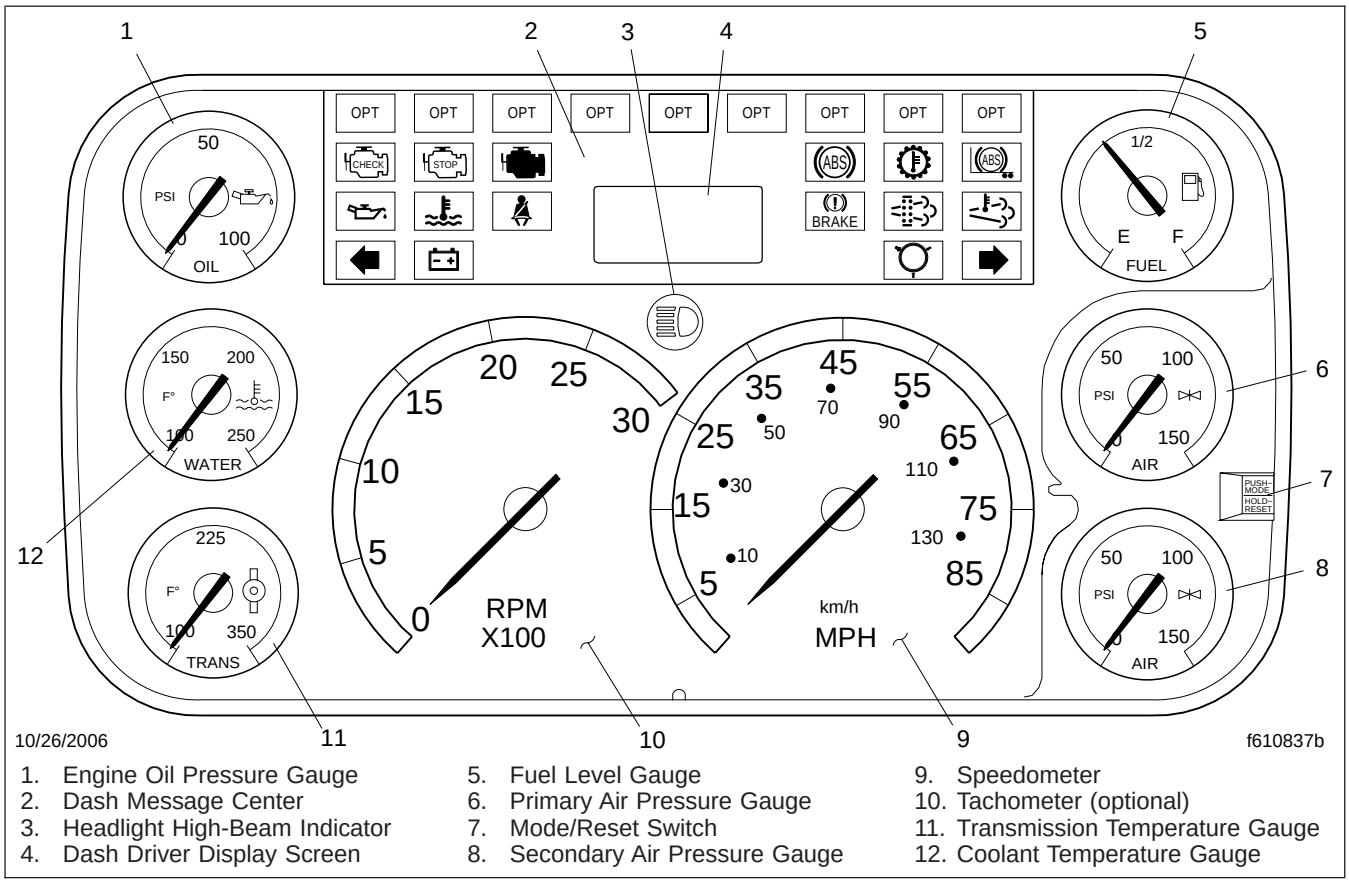
There can be up to eight gauges on the driver's instrument panel (six electronic and two mechanical). Only the air gauges operate mechanically.

The Saf-T-Liner C2 School Bus instrument cluster has the capability to drive independent stand-alone gauges such as those installed on the auxiliary dash panel. **Figure 4.4** shows a typical dash.



1. Engine Oil Pressure Gauge
2. Dash Message Center
3. Headlight High-Beam Indicator
4. Dash Driver Display Screen
5. Fuel Level Gauge
6. Diesel Exhaust Fluid (DEF) Gauge
7. Primary Air Pressure Gauge
8. Mode/Reset Switch
9. Secondary Air Pressure Gauge
10. Speedometer
11. Tachometer (optional)
12. Transmission Temperature Gauge
13. Coolant Temperature Gauge

Fig. 4.1, Gauge Layout (typical, U.S.), EPA10 Compliant



1. Engine Oil Pressure Gauge
2. Dash Message Center
3. Headlight High-Beam Indicator
4. Dash Driver Display Screen
5. Fuel Level Gauge
6. Primary Air Pressure Gauge
7. Mode/Reset Switch
8. Secondary Air Pressure Gauge
9. Speedometer
10. Tachometer (optional)
11. Transmission Temperature Gauge
12. Coolant Temperature Gauge

Fig. 4.2, Gauge Layout (typical, U.S.), EPA07 Compliant

Dash Message Center

The dash message center is the heart of the instrument cluster. It has two parts, a set of 26 warning and indicator lights similar to those found on a conventional lightbar, and a dash driver display screen. The dash light bars have warning and indicator lights that may be lettering or icons. Up until December 31, 2006 the warning and indicator lights are a mixture of ISO icons and lettering. Since January 2007, ISO icons are used for all standard warning and indicator lights. The driver display screen is a one-line by seven-character liquid crystal display (LCD) that normally shows odometer readings. Below this display is a smaller one-line by three-character LCD that shows voltmeter readings.

The dash message center houses all of the standard and optional warning and indicator lights. Warning messages and diagnostic fault codes will appear in the driver display screen. For more information on this system, see under the heading "Ignition Sequence" in this chapter.

Ignition Sequence

The dash message center goes through a prescribed ignition sequence each time the ignition switch is turned on. See **Fig. 4.5** for the ignition sequence.

When the ignition is turned on, all the electronic gauges complete a full sweep of their dials, the warning and indicator lights light up, and the buzzer sounds for 3 seconds.

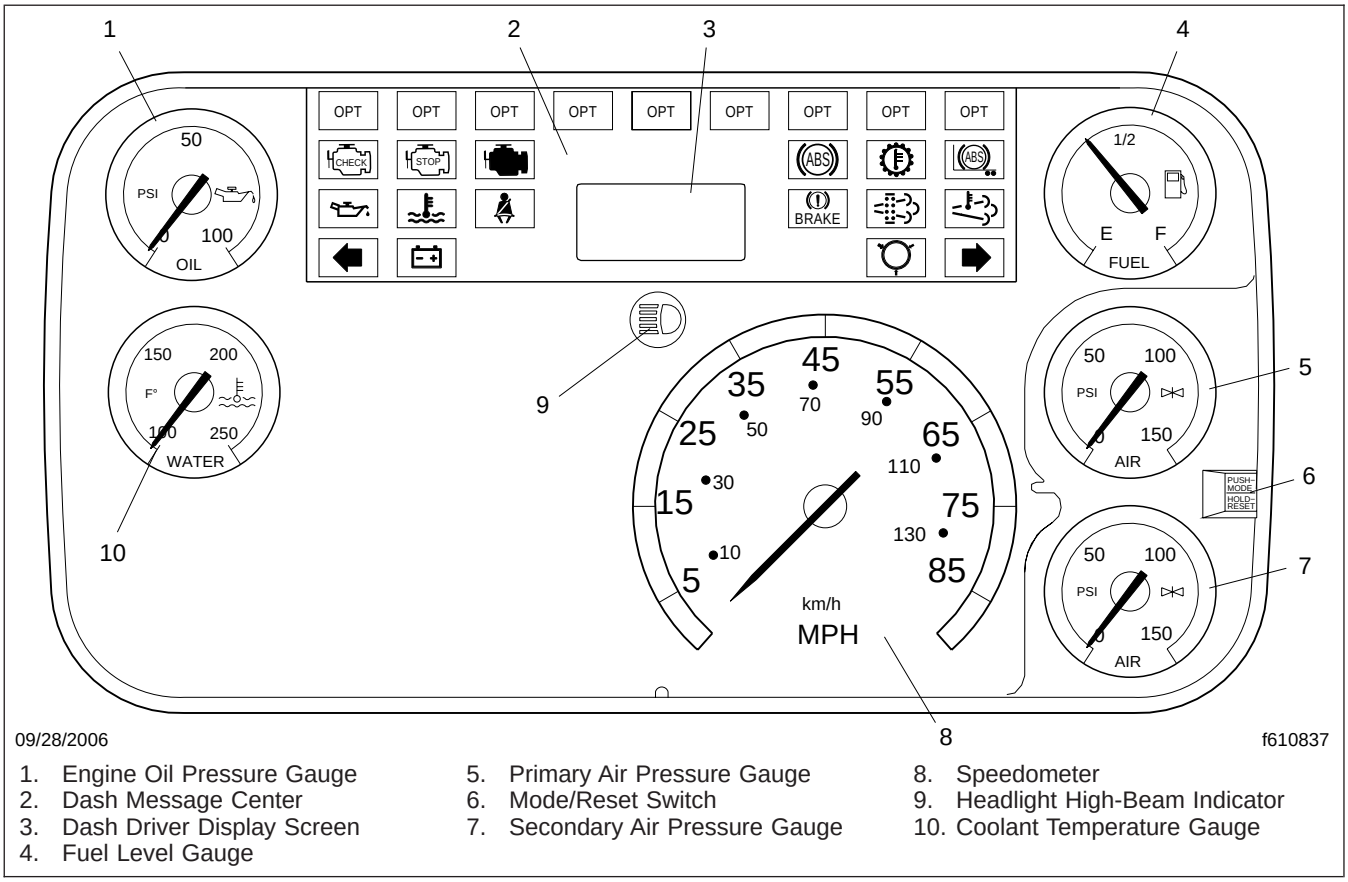
NOTE: The air gauges do not sweep.

IMPORTANT: If any emergency exit is not closed a buzzer will sound continuously.

The following lights illuminate during the ignition sequence:

- Fasten Seat Belt Warning

Instruments



1. Engine Oil Pressure Gauge
2. Dash Message Center
3. Dash Driver Display Screen
4. Fuel Level Gauge
5. Primary Air Pressure Gauge
6. Mode/Reset Switch
7. Secondary Air Pressure Gauge
8. Speedometer
9. Headlight High-Beam Indicator
10. Coolant Temperature Gauge

Fig. 4.3, Gauge Layout (basic), EPA07 Compliant

- Low Battery Voltage Warning
- High Coolant Temperature Warning
- Low Engine Oil Pressure Warning
- Low Air Pressure Warning
- Parking Brake On Indicator
- All engine indicator/warning lights, including Check Engine and Engine Protection
- All ABS indicator/warning lights, including Wheel Spin, and Tractor ABS (if installed)

NOTE: While the engine and ABS warning lights illuminate during the ignition sequence, they are not controlled by the instrument cluster but by their own system ECU (electronic control unit).

When the ignition switch has been turned on, the ICU performs a self-test, looking for active faults.

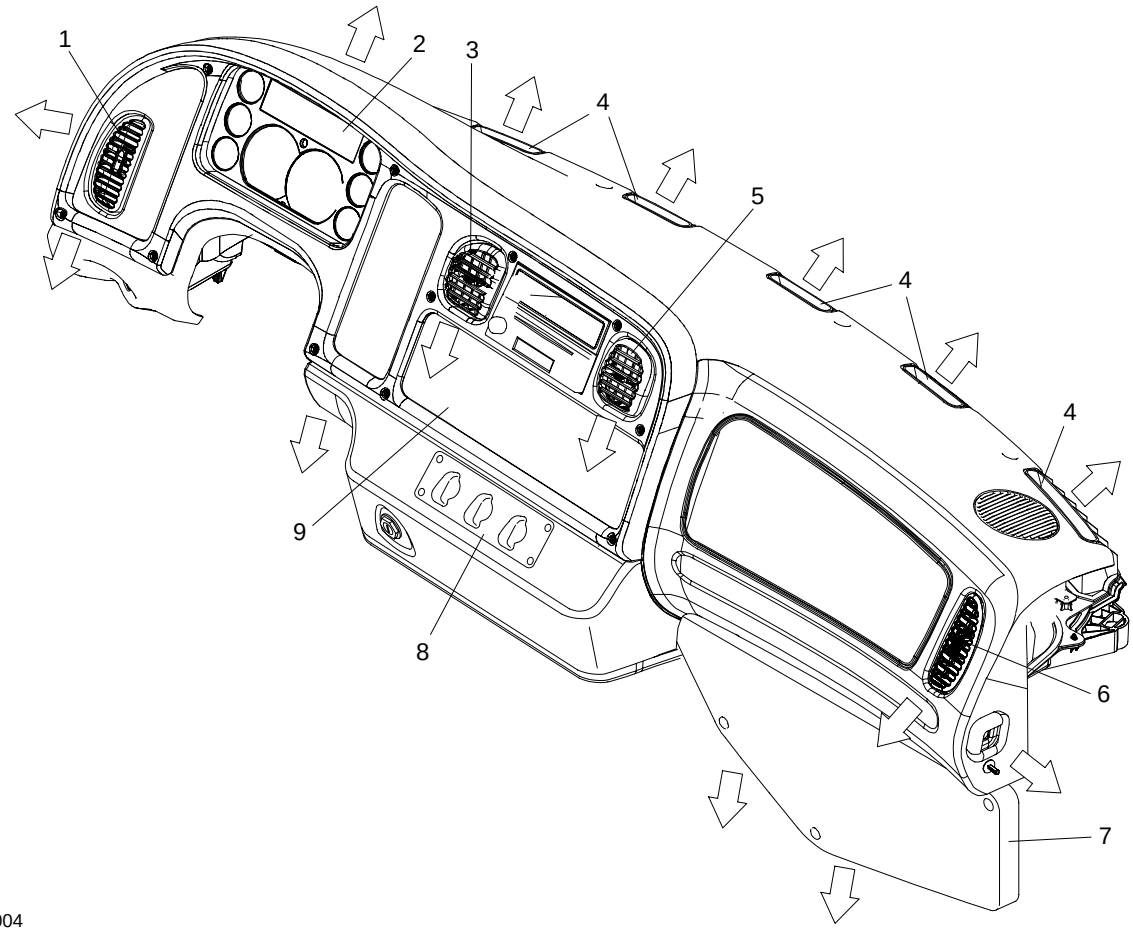
During the first half of the self-test, all segments of the display illuminate as follows:

- First line (odometer): 888888.8
- Second line (units): TRIP MI KM HOURS
- Third line (voltmeter): 38.8 VOLTS SERVICE
- Fourth line: ENGINE

During the second half of the self-test, the software revision level is displayed.

If there are no active faults, the driver display screen displays the odometer.

If, however, the instrument cluster has received active fault codes from other devices, it displays them one after the other until the parking brake is released, or the ignition switch is turned off. Once the parking brake is released, the dash message center displays the odometer again.



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NOTE: Instruments and controls, and their locations, may vary from those shown.

1. Left-Hand Window Outlet
2. Instrumentation Control Unit (ICU3-M2)
3. Left-Hand Dash Outlet
4. Windshield Defrost Outlets
5. Right-Hand Dash Outlets
6. Right-Hand Window Outlet
7. HVAC Cover
8. Climate Control Panel
9. Auxiliary Dash Panel

Fig. 4.4, Dash Panel Layout (typical)

NOTE: If active faults are present, take the vehicle as soon as possible to an authorized Freightliner service facility. See **Chapter 6** for a listing of fault codes.

If the fault is mission critical, that is, if it is a serious problem that requires immediate attention, the engine protection system will activate. In most cases, the check engine light will illuminate also.

Some examples of mission critical faults include:

- high coolant temperature
- low air pressure
- low coolant level
- low engine oil pressure

NOTE: The check engine light does not illuminate for a low air pressure fault.

The legend SERVICE ENGINE can appear on the driver display screen as an active fault code. If this legend appears, it means the trip miles (or hours) have gone beyond the next required service interval, as set by the vehicle operator.

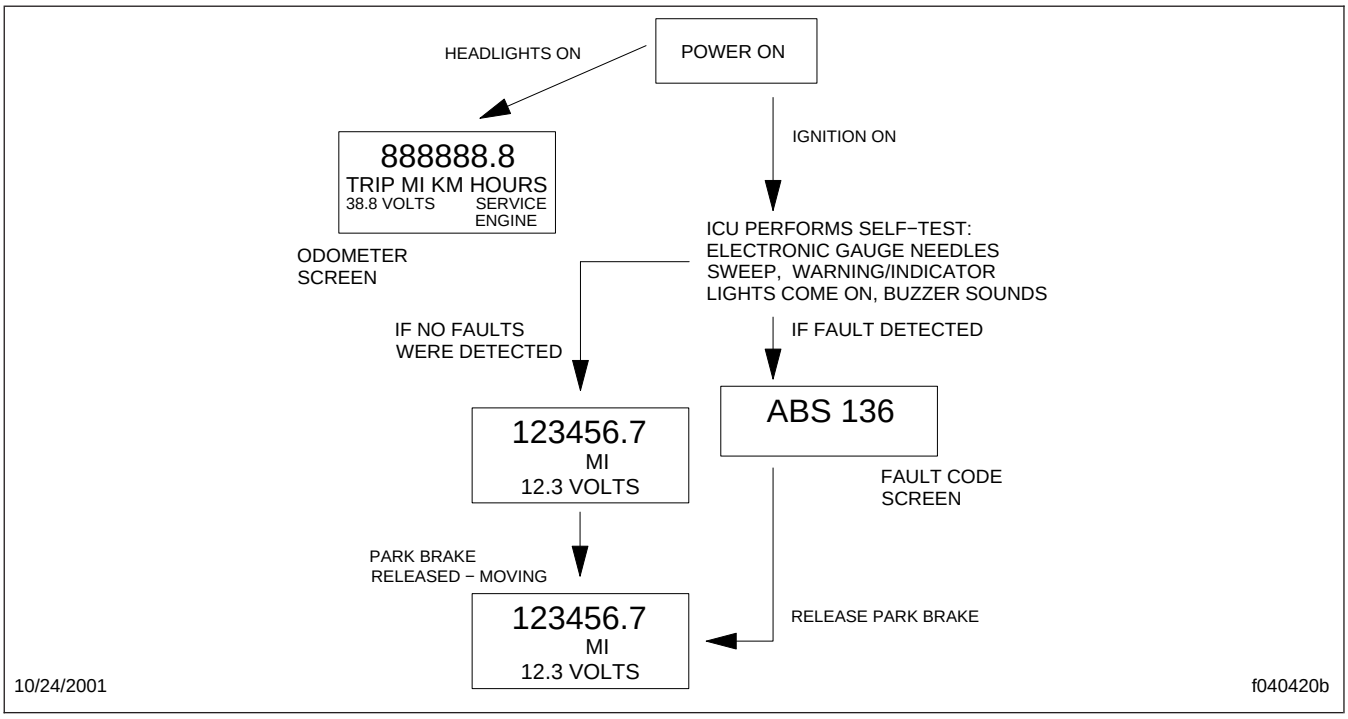


Fig. 4.5, Ignition Sequence

IMPORTANT: If the legend SERVICE ENGINE does appear on the driver display screen while operating the vehicle, bring the vehicle to an authorized Freightliner service facility when convenient.

Odometer

The odometer is set to display in either miles or kilometers, depending on the primary scale of the speedometer. The legend, either MI or KM, illuminates between the odometer and the volts display when the engine is running or the headlights are turned on.

The odometer is a seven-digit display with a decimal point, until the vehicle has traveled 999,999.9 miles or kilometers (km). At one million miles (km), the odometer resets itself to 1000000, without the decimal point, and can continue up to 9,999,999. The odometer only displays significant figures (no leading zeros).

Mode/Reset Switch

The mode/reset switch **Fig. 4.6** is located on the right side of the instrument cluster. The mode/reset switch is used to scroll through the displays on the message display screen, and to reset the trip distance and trip hours values to zero.

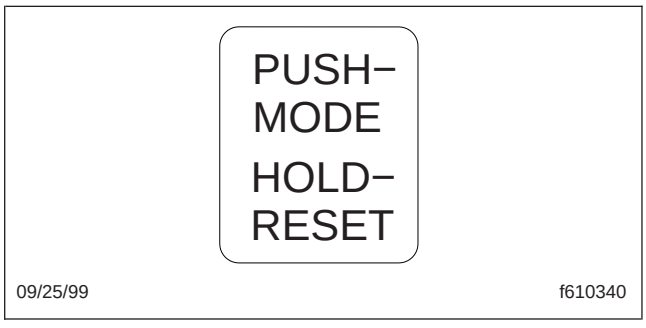


Fig. 4.6, Mode/Reset Switch

When the odometer reading is displayed and the parking brake is applied:

- Press the mode/reset switch once and the trip distance will display.

- Press the mode/reset switch a second time and the trip hours (engine hours) will display.
- Press the mode/reset switch a third time and the SELECT screen and the current units, MI or KM, will display.
- Press the mode/reset switch a fourth time to return to the odometer reading.

To reset trip miles and/or trip hours to zero, press the mode/reset switch for 1 second or longer. To toggle between MI (miles) or KM (kilometers), press the mode/reset switch while in the SELECT screen.

Warning and Indicator Lights

There can be up to 26 warning and indicator lights (telltales) installed in the dash message center. See **Fig. 4.7** and **Fig. 4.8**. There are four rows of lights. Lights installed in the top row are optional and their positions may vary. The lights in the bottom three rows are installed in fixed positions on all vehicles. Most are standard, but a few are optional.

NOTE: In the second, third, and fourth rows, if an optional telltale light is not installed, that position is left blank.

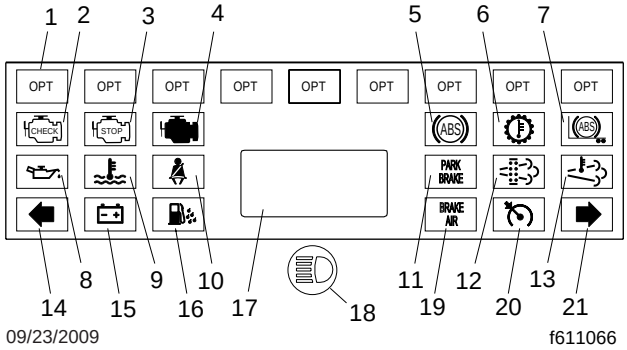
In the following, the standard warning and indicator lights are listed by their position in the dash message center. The lights on the left-hand side of the driver display screen are described first, followed by those on the right-hand side.

The instrument cluster has an emergency buzzer that sounds when mission-critical conditions occur.

Check Engine Indicator

The amber check engine indicator light (CHECK ENGINE legend) illuminates when certain faults are detected. If a critical engine condition exists (for example, low oil pressure or high coolant temperature), the check engine light will illuminate to alert the driver to correct the condition as soon as possible. If the condition gets worse, the engine protection light will illuminate.

NOTE: If the check engine light illuminates during vehicle operation, take the vehicle directly to an authorized Freightliner service facility.



1. Optional Indicator
2. Check Engine Indicator
3. Stop Engine Warning
4. Malfunction Indicator Lamp (MIL)
5. ABS Indicator
6. Check Transmission Indicator
7. Trailer ABS Indicator (not used)
8. Low Oil Pressure Warning
9. High Coolant Temperature Warning
10. Fasten Seat Belt Warning
11. Parking Brake On Indicator
12. Diesel Particulate Filter (DPF) Lamp
13. High Exhaust System Temperature (HEST) Lamp
14. Left-Turn Signal Arrow
15. Low Battery Voltage Warning
16. Low Fuel Warning
17. Dash Driver Display Screen
18. Headlight High-Beam Indicator
19. Low Air Pressure Warning
20. Cruise Control Indicator
21. Right-Turn Signal Arrow

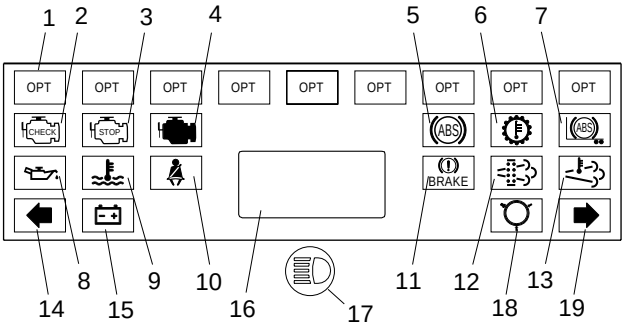
Fig. 4.7, Warning and Indicator Lights, EPA10 Compliant

Engine Protection Warning

WARNING

When the red stop-engine light illuminates, most engines are programmed to shut down automatically within 30 seconds. The driver must immediately move the vehicle to a safe location at the side of the road to prevent causing a hazardous situation that could cause bodily injury, property damage, or severe damage to the engine.

The red engine protection warning light (ENGINE PROTECT legend) illuminates to indicate that the protection system available for the engine has been activated. On some engines, the engine ECU will derate the engine, allowing it to run, but at lower rpm



1. Optional Indicator
2. Check Engine Indicator
3. Stop Engine Warning
4. Malfunction Indicator Lamp (MIL)
5. ABS Indicator
6. Check Transmission Indicator
7. Trailer ABS Indicator (not used)
8. Low Oil Pressure Warning
9. High Coolant Temperature Warning
10. Fasten Seat Belt Warning
11. Brake System Warning/Parking Brake On Indicator
12. Diesel Particulate Filter (DPF) Lamp
13. High Exhaust System Temperature (HEST) Lamp
14. Left-Turn Signal Arrow
15. Low Battery Voltage Warning
16. Dash Driver Display Screen
17. Headlight High-Beam Indicator
18. Low Air Pressure Warning
19. Right-Turn Signal Arrow

Fig. 4.8, Warning and Indicator Lights, EPA07 Compliant

and slower vehicle speed. The vehicle may be driven to a safe location.

The engine ECU will derate the engine. The driver must safely bring the vehicle to a stop on the side of the road.

NOTICE

Because operating the engine when the red engine protection light is illuminated can lead to severe engine damage, the driver must move the vehicle to a safe location as quickly as possible.

To restart the engine turn the ignition switch to OFF, leave it there a few seconds, and turn the switch to START.

IMPORTANT: Do not attempt to restart the engine while the vehicle is moving. Bring the vehicle to a safe stop and restart the engine with the vehicle stopped.

Alternator No Charge Indicator, Optional

The optional amber alternator no charge indicator light (NO CHARGE legend) illuminates when the alternator is not charging properly.

Low Engine Oil Pressure Warning

The red low oil pressure warning light (oil can icon) and emergency buzzer activate whenever the engine oil pressure goes below the preset minimum specified by the engine manufacturer. See **Table 4.1**.

Oil Pressure Specifications*†		
Engine Model	**At Idle Speed: psi (kPa)**	**At Rated RPM: psi (kPa)**
Mercedes-Benz MBE900	50 (345)	50 (345)
Cummins ISB	10 (69)	30 (207)

* Oil pressures are given with the engine at operating temperature. With the engine cold, oil pressure may be higher. Individual engines may vary from the listed pressures; observe and record pressures when the engine is new to create a guide for checking engine condition.

† EPA07 MBE900 engines have an oil pressure switch. When above minimum pressure, the dash gauge will display the values shown in **Table 4.1**. If below minimum oil pressure is reached, the dash gauge will read 0 psi.

Table 4.1, Oil Pressure Specifications

High Coolant Temperature Warning

The red high coolant temperature warning light (thermometer icon) and emergency buzzer activate whenever the coolant temperature goes above a preset maximum specified by the engine manufacturer. See **Table 4.2**.

Maximum Coolant Temperature	
Engine Model	**°F (°C)**
Mercedes-Benz MBE900	221 (105)
Cummins ISB	220 (104)

Table 4.2, Maximum Coolant Temperature

Fasten Seat Belts Warning

The red fasten seat belts warning light (seat belt icon) illuminates for 15 seconds after the ignition switch is turned on.

Left-Turn Signal Arrow

The green left-turn signal arrow flashes on and off whenever the outside left-turn signal lights are flashing.

Both turn signal arrows flash when the hazard warning flasher is turned on.

Low Battery Charge Warning

The red low battery charge warning light (battery icon) illuminates when the battery voltage drops below 12 volts.

Tractor ABS Indicator

The amber tractor ABS indicator light illuminates when there is a malfunction in the vehicle antilock brake system (ABS).

NOTE: For more information about this light and the ABS system, see **Chapter 9**.

Transmission Overheat Indicator

The amber transmission overheat indicator light (TRANS TEMP legend) illuminates when the temperature of the transmission fluid goes above the preset level set by the transmission manufacturer.

For more information, see the transmission manufacturer's manual provided with the vehicle.

Brake System Warning/Parking Brake On Indicator

The red brake system warning/parking brake on indicator light (BRAKE legend) activates whenever the parking brake is engaged.

If the vehicle is moving at a speed of 2 mph (3 km/h) or more, the emergency buzzer will sound until the parking brake is released.

NOTE: The BRAKE legend is required in the U.S. In Canada, the icon is required (exclamation point inside a brake drum with shoes).

Air Filter Indicator

The optional amber air filter indicator light (AIR FILTER legend) illuminates when the air cleaner filter element is clogged, restricting the intake air flow below the level in **Table 4.3**.

If the air filter indicator light is steadily illuminated for any period of time, check the intake-air restriction indicator. If needed, replace the air filter, and reset the intake-air restriction indicator.

Intake-Air Restriction Vacuum Readings		
Engine Type*	**Initial in H_2O**	**Service in H_2O**
Mercedes-Benz	12	20
Cummins ISB	12	25

* Turbocharged engines must be checked at full load and governed engine speed.

Table 4.3, Intake-Air Restriction Vacuum Readings

IMPORTANT: Never attempt to clean the air filter.

Right-Turn Signal Arrow

The green right-turn signal arrow flashes on and off whenever the outside right-turn signal lights are flashing.

Both turn signal arrows flash when the hazard warning flasher is turned on.

Low Air Warning

The red low air pressure warning light (pressure circle icon) and emergency buzzer activate when the engine is turned on if air pressure in the primary or secondary air reservoir is below 65 to 75 psi (448 to 517 kPa), and remain on until air pressure rises above that level in both reservoirs.

The warning light and buzzer also activate during operation whenever air pressure in the primary or secondary air reservoir falls below 65 to 75 psi (448 to 517 kPa).

High Beam Indicator

The blue high-beam indicator light (sideways beam icon) illuminates when the headlight high beams are on.

Emergency Buzzer

The emergency buzzer sounds during the ignition sequence and whenever one of the following conditions exists:

- the engine oil pressure falls below the preset level shown in **Table 4.1**.

- the coolant temperature rises above the preset level shown in **Table 4.2**.
- the air pressure falls below the preset level, which is 65 psi (448 kPa).
- the parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).

Diesel Particulate Filter (DPF) Lamp

Solid illuminated indicates a regeneration is required. Change to a more challenging duty cycle, such as highway driving, to raise exhaust temperatures for at least 20 minutes, or perform a stationary regeneration. See the engine operation manual for details.

Blinking indicates that a stationary regeneration is required immediately. An engine derate and shutdown will occur. See the instructions in the engine manufacturer's operator's manual to perform a stationary regeneration.

High Exhaust System Temperature (HEST) Lamp

A slow (10-second) flash, indicates a regeneration is in progress, and the driver is not controlling the engine idle speed.

A solid illumination indicates potentially hazardous exhaust temperatures at the outlet of the tail pipe if speed is below 5 mph (8 km/h). It does not signify the need for service; it only alerts the vehicle operator of high exhaust temperatures. See the engine operation manual for details.

Malfunction Indicator Lamp (MIL)

Indicates an engine emissions-related fault, including, but not limited to the aftertreatment system. See the engine operation manual for details.

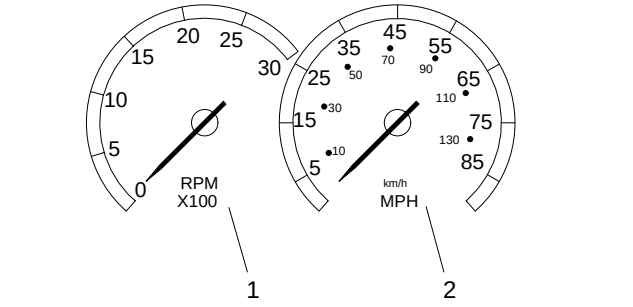
Optional Indicator Lights

The optional indicator lights that are available include: check transmission indicator, intake heater on indicator, low brake fluid warning, low coolant warning, low fuel warning, automatic transmission range inhibit warning, pall filter indicator, water in fuel indicator, differential lock warning, and wheel spin indicator.

Speedometer and Tachometer

Speedometer

Three kinds of speedometer faces are available. The U.S. version of the speedometer registers speed in both miles per hour (mph) and kilometers per hour (km/h), with mph in larger numbers. See **Fig. 4.9**.



1. Tachometer
2. Speedometer

Fig. 4.9, Speedometer and Tachometer

The NAFTA version of the speedometer face reverses this arrangement, with km/h in larger numbers. The metric- only version (not shown) shows km/h exclusively.

Tachometer, Optional

The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range. See **Fig. 4.9**. For low idle and rated rpm, see the engine identification plate.

Standard Instruments

Standard instruments are supplied with the instrument cluster and should be present on every vehicle, with the following exceptions:

- The tachometer is optional on all vehicles.
- The transmission temperature gauge is optional on all vehicles.

Engine Oil Pressure Gauge

NOTICE

A sudden decrease or absence of oil pressure may indicate mechanical failure. Bring the vehicle to a safe stop and investigate the cause to prevent further damage. Do not operate the engine until the cause has been determined and corrected.

The engine oil pressure gauge is mission-critical. See **Fig. 4.10**. If the engine oil pressure falls below the preset levels shown in **Table 4.1**, first, the check engine light will illuminate, and, if the condition does not improve, the engine protection light will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

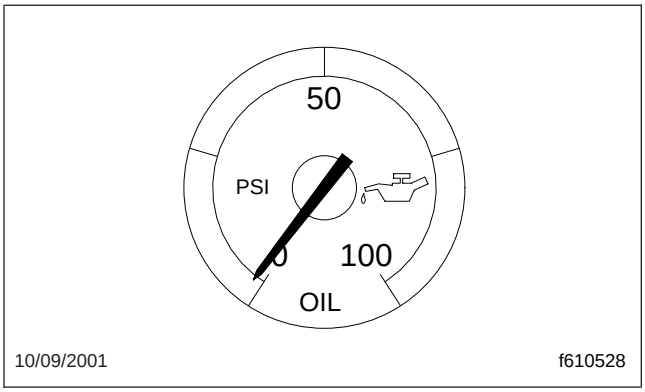


Fig. 4.10, Engine Oil Pressure Gauge

Coolant Temperature Gauge

NOTICE

A sudden increase in coolant temperature may indicate engine or cooling system failure. Bring the vehicle to a safe stop and investigate the cause to prevent further damage. Do not operate the engine until the cause has been determined and corrected.

During normal engine operation, the coolant temperature gauge should read 175 to 195°F (79 to 91°C). See **Fig. 4.11**. If the temperature remains below 160°F (71°C) or exceeds the maximum temperature shown in **Table 4.2**, inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

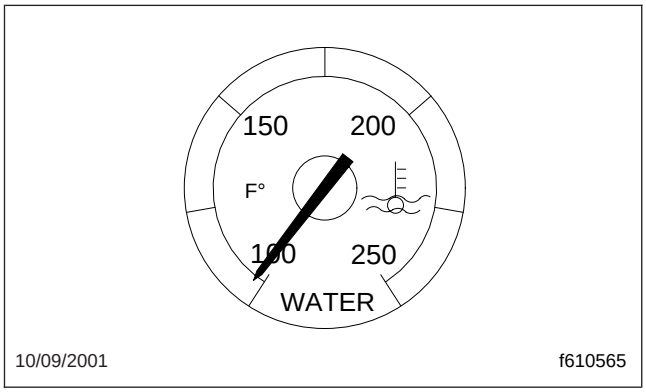


Fig. 4.11, Coolant Temperature Gauge

The coolant temperature gauge is mission-critical. See **Fig. 4.11**. If the coolant temperature rises above the preset levels shown in **Table 4.2**, first, the check engine light will illuminate, and, if the condition does not improve, the engine protection light will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

Transmission Fluid Temperature Gauge, Optional

The transmission fluid temperature gauge is optional.

During normal operation, the transmission fluid temperature gauge reading should not exceed 250°F (121°C) at the sump. See **Fig. 4.12**.

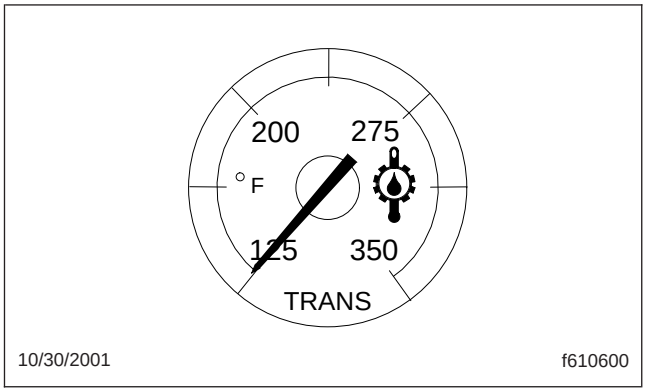


Fig. 4.12, Transmission Fluid Temperature Gauge

NOTICE

A sudden increase in transmission fluid temperature that is not caused by a load increase may indicate mechanical failure. Bring the vehicle to a safe stop and investigate the cause to prevent further damage. Do not operate the vehicle until the cause has been determined and corrected.

NOTE: Under heavy loads, such as when climbing steep grades, temperatures may climb above those given here for limited periods.

Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tank(s). See **Fig. 4.13** and **Fig. 4.14**. One fuel gauge is standard. If equipped with a second (optional) fuel gauge, each fuel tank level is indicated on a separate gauge.

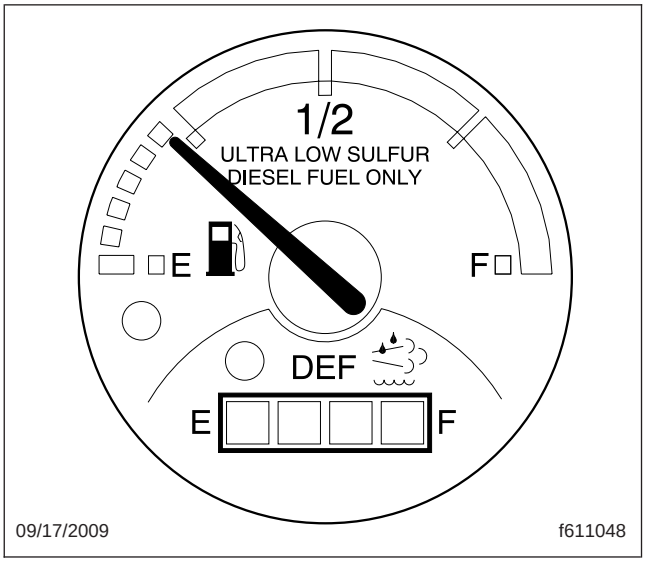


Fig. 4.13, Fuel Level Gauge with Diesel Exhaust Fluid (DEF) Gauge

Primary and Secondary Air Pressure Gauges

WARNING

If air pressure falls below minimum pressure, the braking ability of the vehicle will be limited. Slow the vehicle down and bring it to a gradual stop.

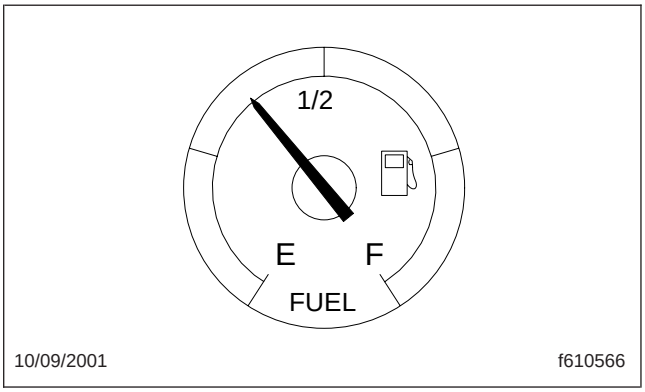
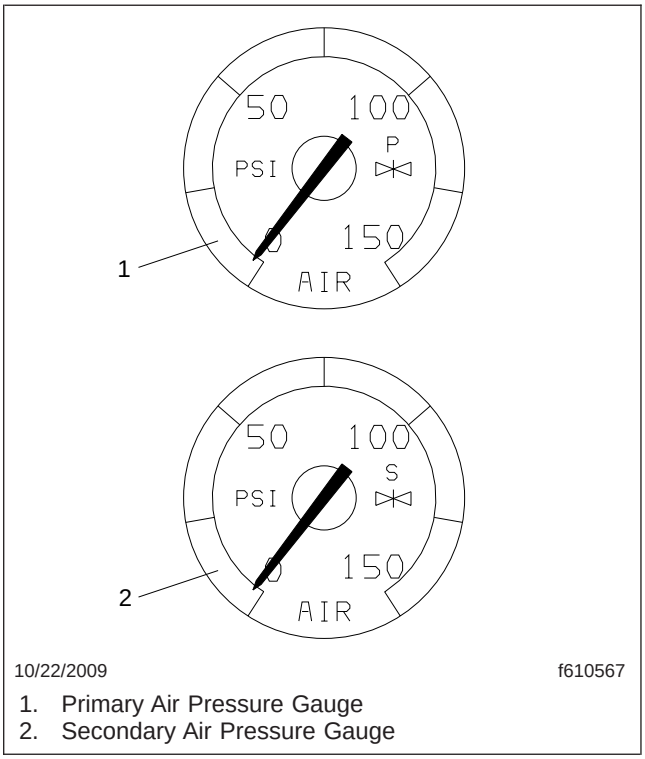


Fig. 4.14, Fuel Level Gauge

Do not attempt to move the vehicle until air pressure has risen above the minimum level. Moving a vehicle without adequate braking power could cause an accident resulting in personal injury or death.

Air pressure gauges register the pressure in the primary and secondary air systems. Normal pressure with the engine running is 100 to 120 psi (690 to 827 kPa) in both systems. See **Fig. 4.15**.



1. Primary Air Pressure Gauge
2. Secondary Air Pressure Gauge

Fig. 4.15, Air Pressure Gauges

Air pressure gauges are required on all vehicles with air brakes. A low-air-pressure warning light and buzzer, connected to both the primary and secondary systems, activate when air pressure in either system drops below a minimum pressure of 65 to 75 psi (448 to 517 kPa).

When the engine is started, the warning light and buzzer remain on until air pressure in both systems exceeds minimum pressure.

Voltmeter

The voltmeter is a digital readout located on the bottom line of the driver display screen whenever the ignition switch is turned on.

It indicates the vehicle charging system voltage when the engine is running and the battery voltage when the engine is stopped. By monitoring the voltmeter, the driver can be aware of potential charging system problems and have them fixed before the batteries discharge enough to create starting difficulties.

The voltmeter will normally show approximately 13.7 to 14.1 volts when the engine is running. The voltage of a fully charged battery is 12.7 to 12.8 volts when the engine is stopped. Battery voltage under 12.0 volts is considered a low battery, and a completely discharged battery will produce only about 11.0 volts. The voltmeter will indicate lower voltage as the vehicle is being started or when electrical devices in the vehicle are being used.

If the voltmeter shows an undercharged or overcharged condition for an extended period, have the charging system and batteries checked at a repair facility.

Optional Instruments

Optional instruments are not found on every vehicle. They are stand-alones, not driven by the instrument cluster, and are usually located on the auxiliary dash panel. They are listed here in alphabetical order, to make the information easier to find.

Ammeter, Optional

An optional ammeter measures current flowing to and from the battery. See **Fig. 4.16**. When the batteries are being charged, the meter needle moves to the plus side of the gauge; when the batteries are being discharged, the needle moves to the minus side. A consistent negative reading when the engine is running indicates a possible problem with the charging system.

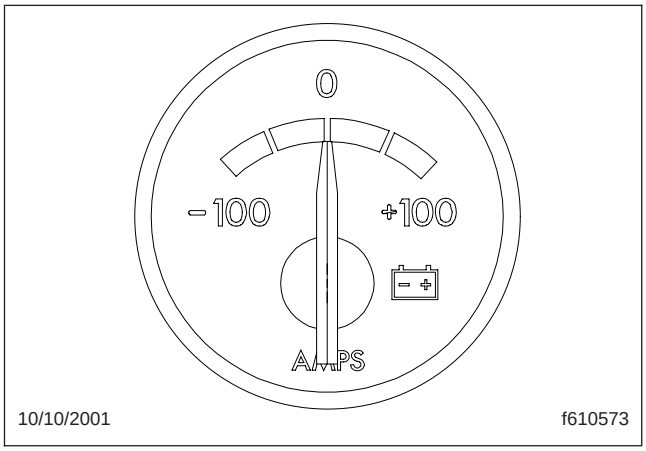


Fig. 4.16, Ammeter

Axle Oil Temperature Gauge, Rear

NOTICE

A sudden increase in oil temperature that is not caused by a load increase may indicate mechanical failure. Bring the vehicle to a safe stop and investigate the cause to prevent further damage. Do not operate the engine until the cause has been determined and corrected.

During normal operation, the optional rear axle oil temperature gauge should read between 160 and 220°F (71 and 104°C) for Meritor™ drive axles. See **Fig. 4.17**.

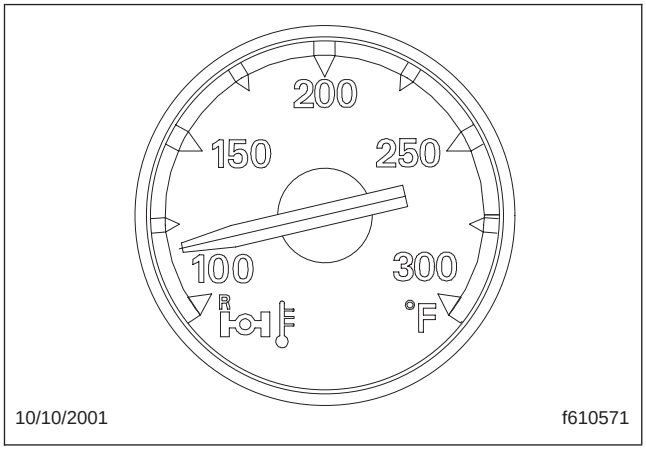


Fig. 4.17, Axle Oil Temperature Gauge

Under heavy loads, such as when climbing steep grades, temperatures up to a maximum of 250°F (121°C) are not unusual.

Digital Clock, Optional

The optional digital clock has black characters on a constantly backlighted green display, with a brightness that automatically adjusts for day or night. The clock has a 24-hour alarm, with a three-minute snooze feature. See **Fig. 4.18**.

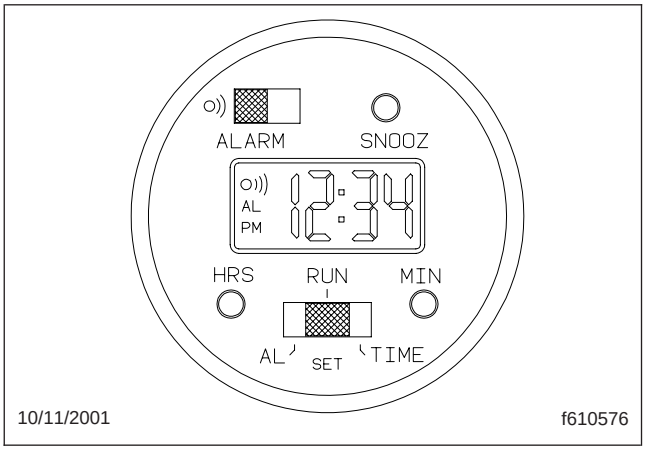


Fig. 4.18, Digital Clock, Optional

1. To set the time of day:
   - 1.1 Push the Run/Set (lower) switch to the right (TIME-SET position).

   NOTE: When the hour setting is for a time between noon and midnight, the small letters PM will appear in the lower left corner of the display; no PM display indicates an AM setting.

   - 1.2 Advance the hour setting to the correct number by pushing and releasing the hour button as many times as needed. Or if the button is pressed and held in for longer than 2 seconds, the numbers will continue to advance until the button is released.
   - 1.3 Advance the minute setting by repeatedly pushing, or pushing and holding the minute button as needed.
   - 1.4 Push the Run/Set switch to the middle (RUN) position.
2. To set the alarm time:
   - 2.1 Push the Run/Set switch to the left (ALARM-SET position).
   - 2.2 Set the alarm time by using the same procedure that you used to set the time of day; remember to set the hour for A.M. (no letters in the corner of the display), or P.M. as desired.
   - 2.3 Return the Run/Set switch to the middle (RUN) position; the readout will return to the time-of-day setting.
3. To operate the alarm:
   - 3.1 With the alarm time set, push the alarm (upper) switch to the left. An alarm "wave" symbol and the letters AL will appear in the upper left corner of the display when the alarm is on.
   - 3.2 When the displayed time of day coincides with the alarm time, the alarm will sound. If the SNOOZ button is not pushed or the alarm switch is not moved, the alarm will automatically stop sounding after 1 minute and will not sound again for 24 hours.
   - 3.3 If desired, press the SNOOZ button while the alarm is sounding to shut the alarm off for 3 minutes. The alarm symbol will flash in the display when the button is pushed and will continue to flash until the alarm switch is moved or the alarm has sounded for one minute. The snooze procedure can be done as many times as desired.
   - 3.4 Move the alarm switch to the right when you wish to shut off or cancel the alarm; the alarm symbol will disappear.

Engine Oil Temperature Gauge

NOTICE

A sudden increase in oil temperature that is not caused by a load increase may indicate mechanical failure. Bring the vehicle to a safe stop and investigate the cause to prevent further damage. Do not operate the engine until the cause has been determined and corrected.

During normal operation, the optional engine oil temperature gauge should read in the following temperature range:

- 177 to 203°F (81 to 95°C) for Mercedes-Benz MBE900 engines.

NOTE: Under heavy loads, such as when climbing steep grades, temperatures that exceed the normal oil temperature range for a short period are not unusual. If the temperature returns to normal when the load decreases, there is no problem. See **Fig. 4.19**.

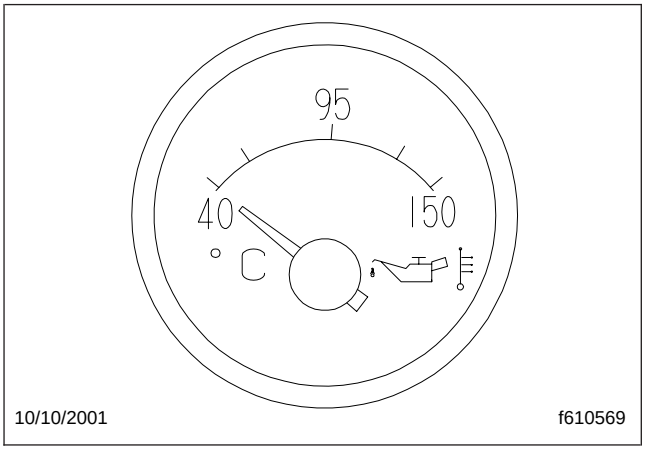


Fig. 4.19, Engine Oil Temperature Gauge

Intake-Air Restriction Indicator

The intake-air restriction indicator measures the vacuum on the engine side of the air cleaner at the air cleaner outlet. See **Fig. 4.20**. On standard installations, it is mounted on the intake air piping in the engine compartment.

As an option for easier viewing, the intake-air restriction indicator can be mounted on the dash, usually on the right-hand control panel.

Intake-air restriction vacuum is measured in inches of water (inH_2O).

If the yellow signal stays locked in the red zone, at or above the values shown in **Table 4.3** after the engine is shut down, the air cleaner needs to be serviced. The indicator then needs to be reset by pressing the black button on the bottom of the indicator.

NOTE: Rain or snow can wet the filter and cause a temporarily higher than normal reading.

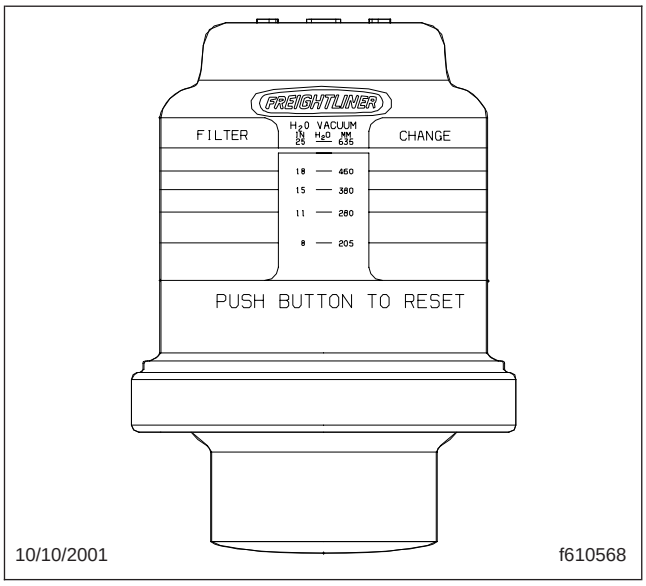


Fig. 4.20, Intake-Air Restriction Indicator

Pyrometer

An optional pyrometer can be installed on the exhaust pipe. A pyrometer registers the exhaust temperature near the turbocharger. See **Fig. 4.21**. Maximum exhaust temperatures are listed in **Table 4.4**.

Variations in engine load can cause exhaust temperatures to vary. If the pyrometer reading shows that exhaust temperature exceeds normal, reduce fuel to the engine until the exhaust temperature is reduced. Shift to a lower gear if the engine is overloaded.

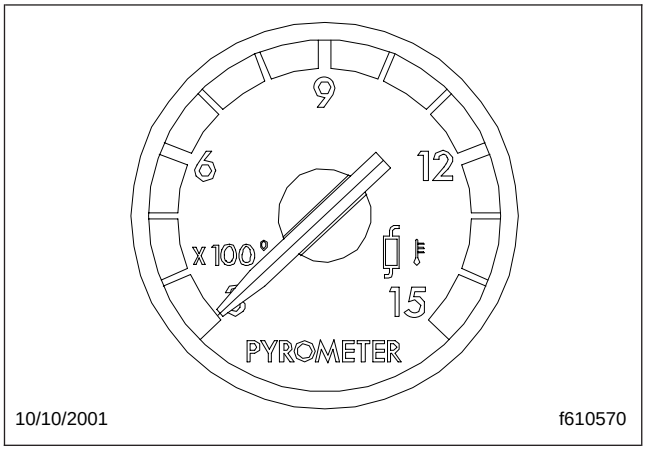


Fig. 4.21, Pyrometer

Maximum Exhaust Temperature	
Engine Model	**°F (°C)**
Mercedes-Benz MBE900	1076 (550)
Cummins ISB	1290 (700)

Table 4.4, Maximum Exhaust Temperature

Turbocharger Boost Pressure Gauge, Optional

A turbocharger boost pressure gauge measures the pressure in the intake manifold, in excess of atmospheric pressure, being created by the turbocharger. See **Fig. 4.22**.

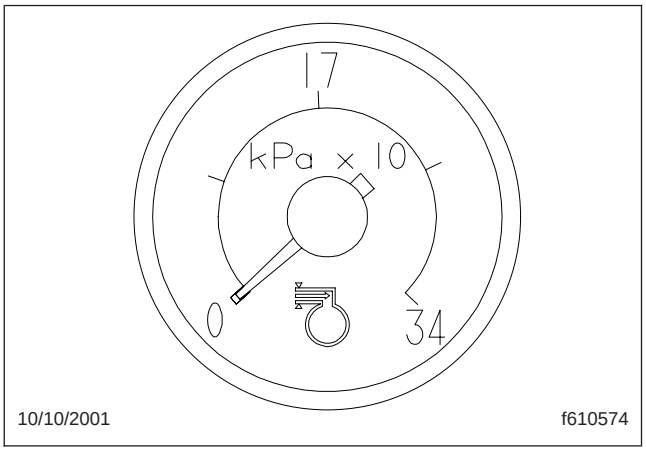


Fig. 4.22, Turbo Boost Pressure Gauge

5

Controls

Ignition Switch and Key

The ignition switch has four positions: ACCESSORY, OFF, ON, and START. See **Fig. 5.1**.

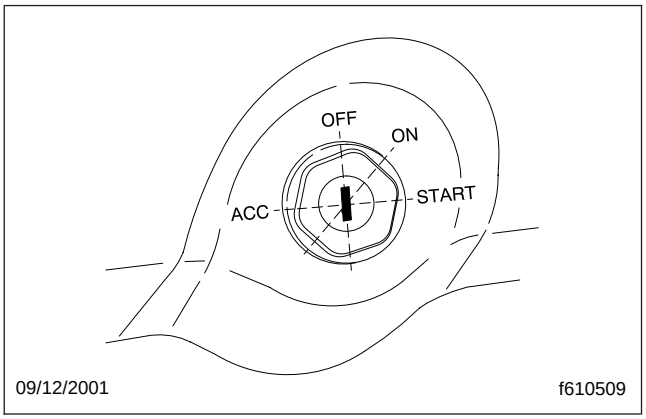


Fig. 5.1, Ignition Switch Positions

In the OFF position, the key slot is vertical; the key can be inserted and removed only in this position. The following can be operated in the off position (regardless of whether the key is inserted): The low beam headlights, taillights, brake lights, road lights, clearance lights, turn signals, hazard warning lights, horn, CB radio, clock, and electric oil pan heater.

In the ACCESSORY position, the key is turned counterclockwise. The radio (if so equipped), mirror heat, air dryer, backup lights, and all of the electrical systems that are operable in the off position are operable in the accessory position.

In the ON position, the key is turned clockwise and all electrical systems are operable. The low air pressure and low oil pressure warning lights (or messages) and buzzer operate until the engine is started and pressure is built up.

In the START position, the key is used only for starting the engine, as soon as the engine starts, the key should be released, and the key should go to the ON position.

Electrical System

The Saf-T-Liner C2 School Bus features a new type of electrical system, different from any previous vehicle. Multiple electrical signals are carried along a simplified set of wires, reducing the size of wiring bundles. There are significantly fewer wires overall, meaning less chance of damage, shorts, and other problems.

⚠ WARNING

Do not attempt to modify, add, splice, or remove electrical wiring on this vehicle without authorization from either Freightliner Custom Chassis or Thomas Built Buses Engineering. Doing so could damage the electrical system and result in a fire that could cause serious personal injury or property damage.

There are three electrical modules, a main module located under the hood on the driver's side above the fender, a chassis module located between the frame rails, and a cab module located to the left of the driver under the switch panel.

This new wiring system features intelligent controls that blink to show switch activity and error conditions. These controls cannot be distinguished by their appearance, only by their function.

For more information about these controls, see the heading "Axle Switches".

Lighting Controls

The lighting controls mentioned under the above heading generally operate through switches located on the dash.

Two types of dash switches are used:

- Paddle switches with a single paddle located in the center of the switch. The paddle can be raised or lowered to perform a function.
- Rocker switches that can be pressed at either the upper or lower end to perform a function. Certain rocker switches are guarded to prevent them from being switched on or off accidentally.

When the panel lights are on, most switch legends are backlit with a colored light, usually green. This allows the driver to find the switch more easily in the dark. When the switch is on, the switch icon is normally backlit with a colored light, usually amber. Some switch icons are dead-fronted (not visible until the switch is turned on). When turned on, some switches are illuminated from within by a red or amber LED (light-emitting diode).

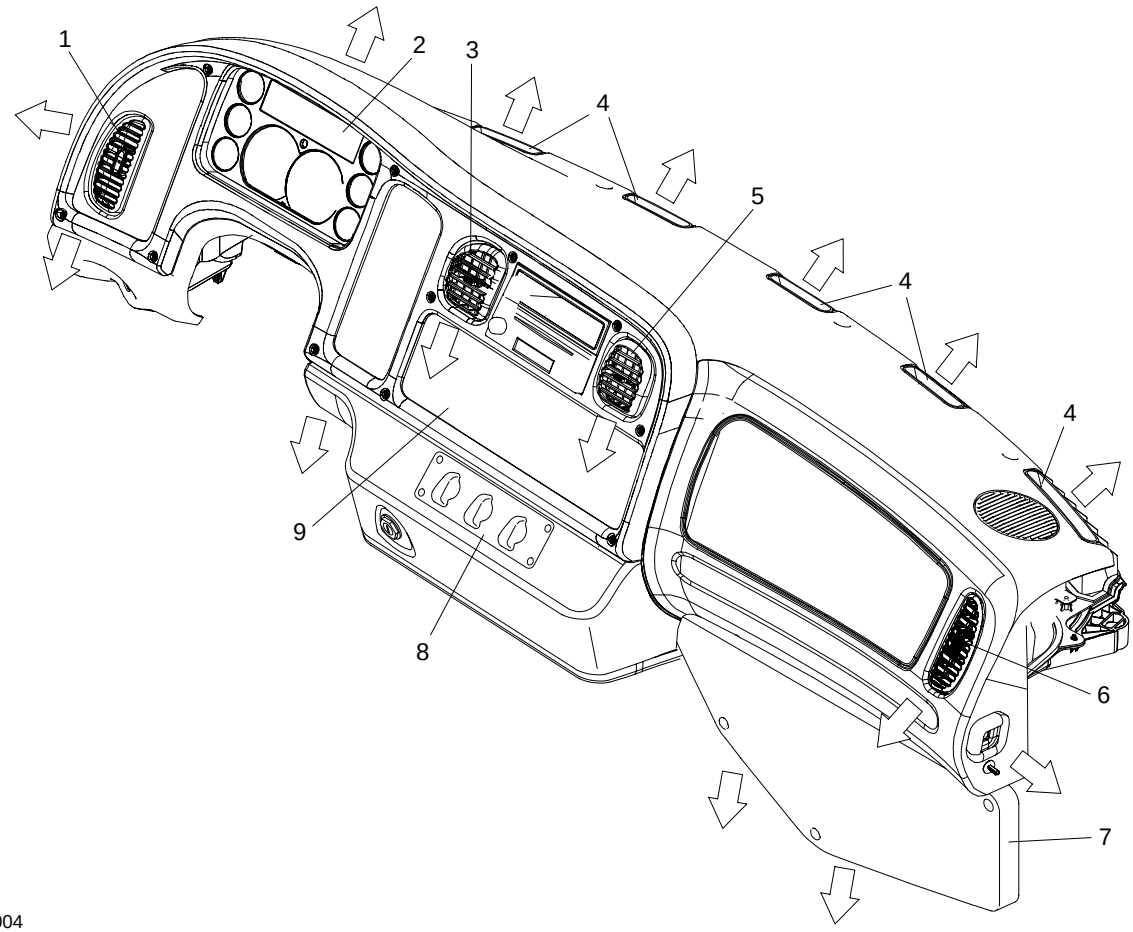
Control Panels

The left-hand control panel contains a louvered window outlet for the face vents of the heating, ventilation, and air conditioning system (HVAC), and four switches arranged in a vertical line, usually the headlight, panel light increase/decrease, and the cruise/RPM control On/Off and Set/Resume switches. See **Fig. 5.2**.

The instrument cluster (ICU3-M2) is located right behind the steering wheel. No controls are installed on the standard instrument cluster.

The right-hand control panel usually contains the transmission push-button shift selector (on vehicles with an automatic or automated transmission). See **Fig. 5.2**. On vehicles with a manual transmission, a variety of switches are installed here. If there is a dash-mounted air-restriction indicator, it is often mounted here.

The radio panel contains two louvered dash outlets for the face vents of the HVAC, one on either side of the radio (if installed). See **Fig. 5.3**.



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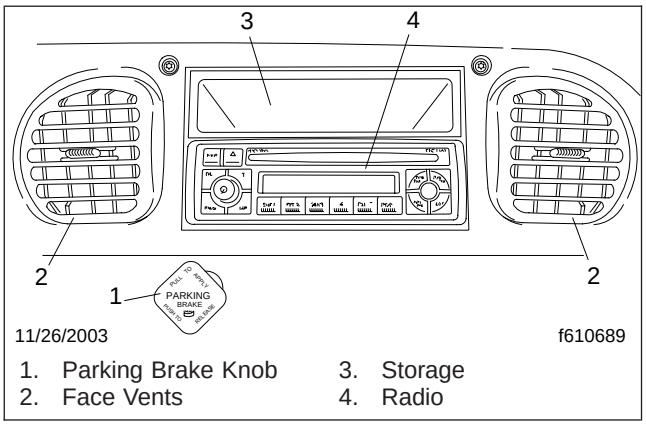
1. Left-Hand Window Outlet
2. Instrumentation Control Unit (ICU3-M2)
3. Left-Hand Dash Outlet
4. Windshield Defrost Outlets
5. Right-Hand Dash Outlets
6. Right-Hand Window Outlet
7. HVAC Cover
8. Climate Control Panel
9. Auxiliary Dash Panel

Fig. 5.2, Dash Panel Layout (typical)



1. Parking Brake Knob
2. Face Vents
3. Storage
4. Radio

Fig. 5.3, Radio Panel

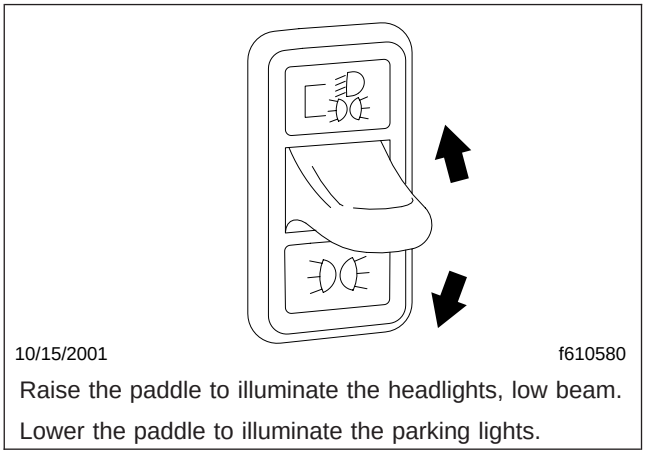
The auxiliary dash panel below the radio panel contains the marker interrupt switch, the air brake valve knobs, and a variety of switch options.

The HVAC climate control panel is on a separate panel below the auxiliary dash panel.

Exterior Light Controls

Headlight/Parking Light Switch

The headlight/parking light switch is a paddle switch located on the left-hand control panel above the cruise/RPM control switches. See **Fig. 5.4**. When the paddle is lowered, the parking lights illuminate (the front turn signals, the marker and identification lights, and the taillights). When the paddle is raised, the low-beam headlights illuminate, along with all the parking lights. To turn off all lights, return the paddle to the center position.



Raise the paddle to illuminate the headlights, low beam.

Lower the paddle to illuminate the parking lights.

Fig. 5.4, Headlight/Parking Light Switch

NOTE: The front turn signal is the amber lens in each headlight unit. The low-beam headlight is the top clear lens in each headlight unit.

When the headlights or parking lights are on, the panel lights also illuminate. An amber light in the switch backlights either the top icon (for headlights and parking lights) or the bottom icon (for parking lights only).

Panel Light Increase/Decrease Switch

When the panel lights are on, they can be either brightened or dimmed by using the Incr/Decr rocker switch just below the headlight switch. See **Fig. 5.5**. To brighten the panel lights, press on the upper part of the rocker (at the "INCR+" legend). To dim the panel lights, press on the lower part of the rocker (at the "DECR–" legend).

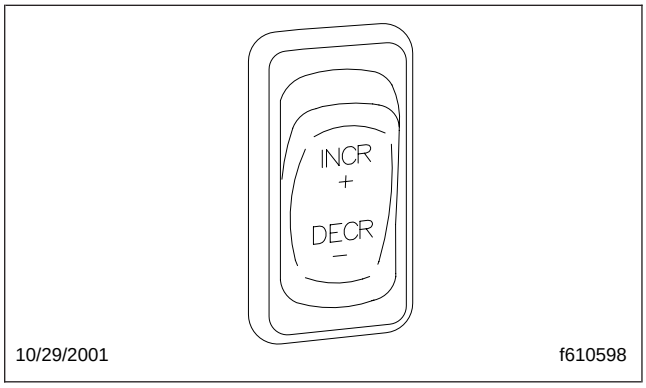


Fig. 5.5, Panel Light Increase/Decrease Switch

When the panel lights are on, both legends are backlit in green.

Daytime Running Lights

Switching on the ignition and releasing the parking brakes automatically activates the daytime running lights, if so equipped. The daytime running lights will operate until the parking brakes are applied or the headlights are turned on.

NOTE: Daytime running lights are standard on all Canadian vehicles.

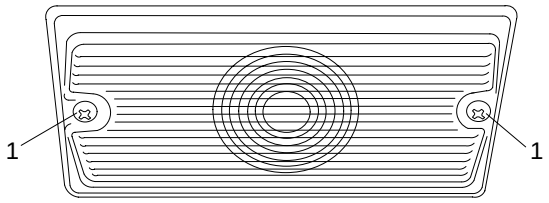
The daytime running lights illuminate at about two-thirds of normal power.

Interior Lights and Light Controls

The interior lights include dome lights, red map lights, and clear reading lights.

Bus Interior Lights

Diffuse dome lights are installed on all buses. The standard dome light has a clear lens and is installed on the roof of the bus. See **Fig. 5.6** for the rear dome light.



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1. Phillips Screws

Fig. 5.6, Dome Light

Footwell Light

A footwell light is located near the steps of the bus to provide light in the step area.

Light Replacement

Interior Lights

To replace the interior light(s) do the following. See **Fig. 5.6**.

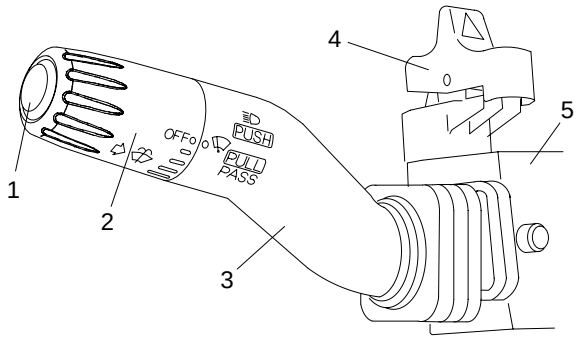
1. Remove the two Phillips screws that attach the lens.
2. Replace the bullet-type bulb and install the lens on the lamp base using the removed screws.

Multifunction Turn Signal Switch

The multifunction turn signal switch is attached to the steering column, just below the steering wheel, on the left-hand side. This switch has the following functions:

- turn signals
- windshield wipers and washers
- headlight high beams
- hazard warning flasher

See **Fig. 5.7** for the multifunction switch and its component parts.



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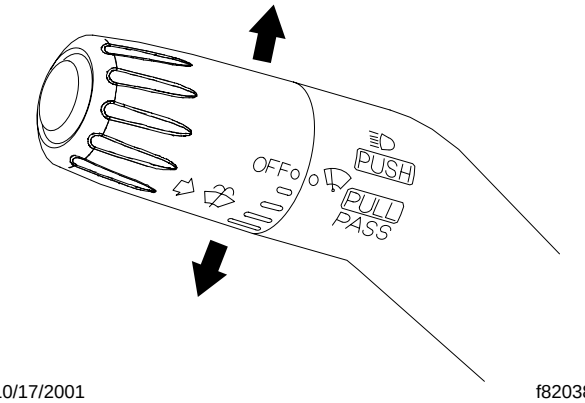
Press down on the upper part of the rocker to activate the flashers.

1. Washer Button
2. Wiper Control Dial
3. Turn Signal Lever
4. Hazard Flasher (red)
5. Multifunction Switch Module

Fig. 5.7, Multifunction Turn Signal Switch

Turn Signal Lever

The turn signal lever is mounted on the steering column. See **Fig. 5.8**. Moving the lever down turns on the left turn signal lights; moving it up turns on the right turn signal lights.



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Move the lever down to turn on the left turn signals.

Move the lever up to turn on the right turn signals.

Fig. 5.8, Turn Signal Controls

When one of the turn signal lights is on, a green indicator arrow flashes at the far left or far right of the warning and indicator light panel.

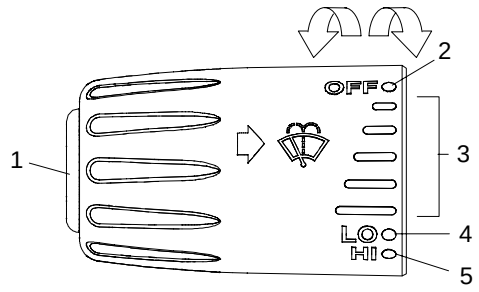
The lever automatically returns to the neutral position (self-cancels the switch) when the steering wheel returns to the straight ahead position after a turn. To cancel the signal manually, move the lever to the neutral position.

Windshield Wiper/Washer Controls

NOTICE

Do not move the wiper arms manually. Wiper motor damage will occur if the arms are moved.

The wipers are operated by a rotary switch in the wiper control dial, which is on the end of the turn signal lever. See **Fig. 5.9**. There are five delay settings, marked on the dial by lines of increasing length, and two steady speed settings, LO and HI.



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Rotate the control dial away from you to turn the wipers on, or speed them up.

Rotate the control dial towards you to slow the wipers down, or turn them off.

1. Washer Button
2. OFF Position
3. Delay Positions
4. Wipers On, Low Speed
5. Wipers On, High Speed

Fig. 5.9, Wiper/Washer Controls

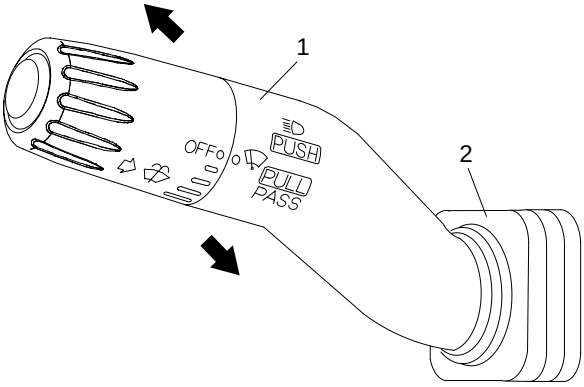
Rotating the control dial forward (in a counterclockwise direction) turns the wipers on. If they are already on, rotating the handle further forward (to a faster speed setting) increases the speed of the wipers through the various delay settings, and to LO and then HI.

Rotating the control dial in the opposite direction (clockwise) causes the wipers to slow down. Rotating the control dial clockwise as far as it will go (to the OFF setting) turns the wipers off.

The washers are operated by a yellow button at the very end of the turn signal lever. To operate the washers, press the button in and hold it in until you want the washers to stop.

Headlight High Beams

Push the turn signal lever forward, towards the windshield, to turn on the high-beam headlights. Pull the turn signal lever back to its original position to turn them off. See **Fig. 5.10**.



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Move the lever away from you to turn on the high beams. Move the lever back to its original position to turn them off.

Move the lever towards you to flash the high beams momentarily.

1. Turn Signal Lever 2. Boot

Fig. 5.10, Headlight High Beams

When the high beam headlights are on, a blue light illuminates on the instrument cluster between the tachometer and speedometer. For vehicles built to operate in the United States, switching on the high beams will switch off the road lights.

NOTE: The ignition switch must be on for the high beams to work.

With the headlight low beams on, pull the lever backward, towards the steering wheel, to flash the high beams (turn them on momentarily).

The headlight low beams remain on continuously during high beam operation. If the low beam headlights are turned off by use of the headlight switch, the high beams turn off also.

Hazard Warning Lights

The hazard warning light flasher is a red rocker switch located on the top of the multifunction switch module. See **Fig. 5.7**. When the flashers are activated, all of the turn signal lights (front, side, and rear) and the two green indicator arrows on the control panel will blink on and off.

To flash the hazard warning lights, press down on the upper part of the rocker (towards the dash). To stop the hazard warning lights, press down on the lower part of the rocker (towards the steering wheel).

Driver Switch Panel

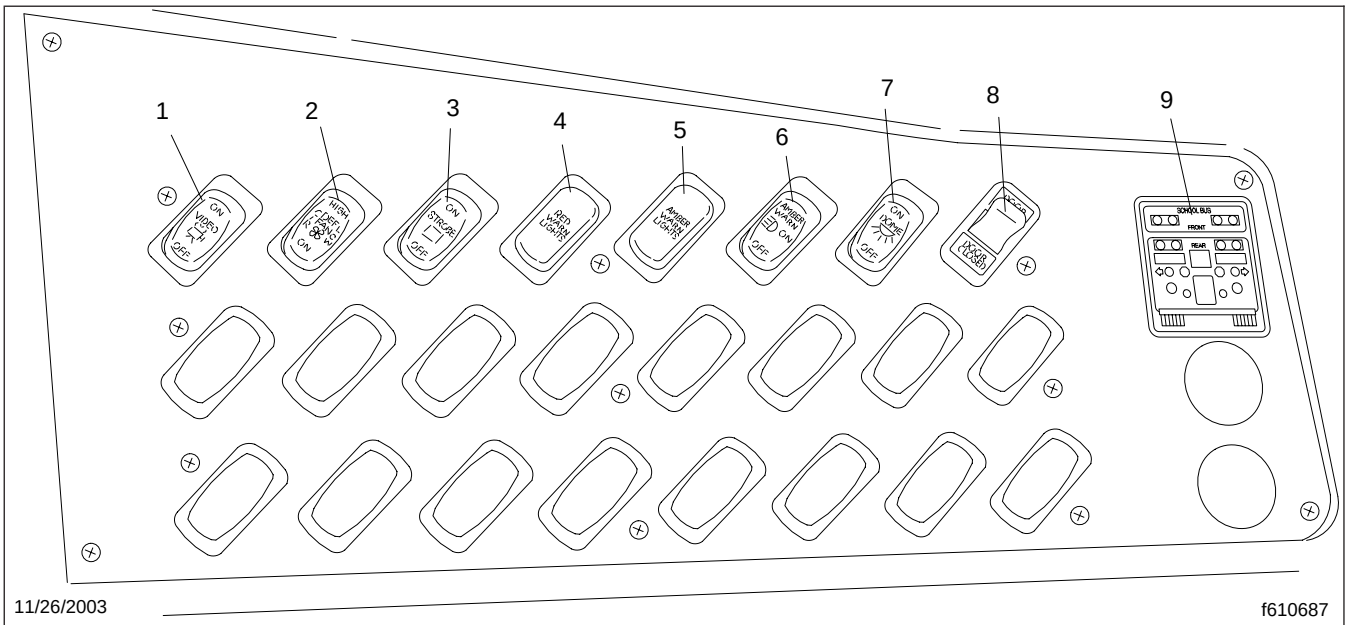
To the left of the driver is a switch panel. The panel has a variety of switches and a light monitor panel. The light monitor panel tells the driver when various lights are operating on the bus. See **Fig. 5.11** and **Fig. 5.12**. The following list describes the function of the various switches on the driver switch panel.

- Video—Operates the video camera, if so equipped.
- Defrost Fan—Operates the defrost fan.
- Strobe Light—Turns the strobe light on and off.
- Red Warning Lights—Operates the flashing lights at the front and back of the bus.
- Amber Warning Lights—Operates the flashing lights at the front and back of the bus.
- Amber Warning On/Off—Operates the amber marker lights.
- Dome Lights—Turns the six inside dome lights on and off.
- Door Open/Door Closed—Opens and closes the main entry door; see **Chapter 2** for operating instructions.
- Light Monitor Panel—Shows the driver what lights are on.

NOTE: Driver panel switches can be arranged in any sequence.

Multiple options are available on the driver switch panel depending on individual school districts. The following is a list of available options.

- Air Conditioner
- Air Conditioner Fan
- Air Horn
- Air Service Door
- Air Service Door (Three-Position Switch)
- Brake Lights
- Crossing Arm Deactivation
- Destination Sign
- Dome Lights Dimmer
- Driver's Dome Light
- Driver's Dome Light Dimmer
- Electric Service Door
- Emergency Door Light
- Emergency Warning (MOM-ON)
- Emergency Warning (OFF-ON)
- Engine Light
- Front Dome Lights
- Front Dome Lights Dimmer
- Fog Lights
- Hatch Vent Fan
- Heated Step Tread
- Heater Pump
- ID Lights
- Left Front Heater (FWD)
- Left Rear Heater (AFT)
- Left Side Defroster Fan
- Luggage Compartment Light
- Master Warning Switch
- Mirror Heater
- Noise Suppression



1. Video
2. Defrost Fan
3. Strobe Light
4. Red Warning Lights
5. Amber Warning Lights
6. Amber Warning On/Off
7. Dome Lights
8. Door Open/Door Closed
9. Light Monitor Panel

Fig. 5.11, Driver Switch Panel (typical)

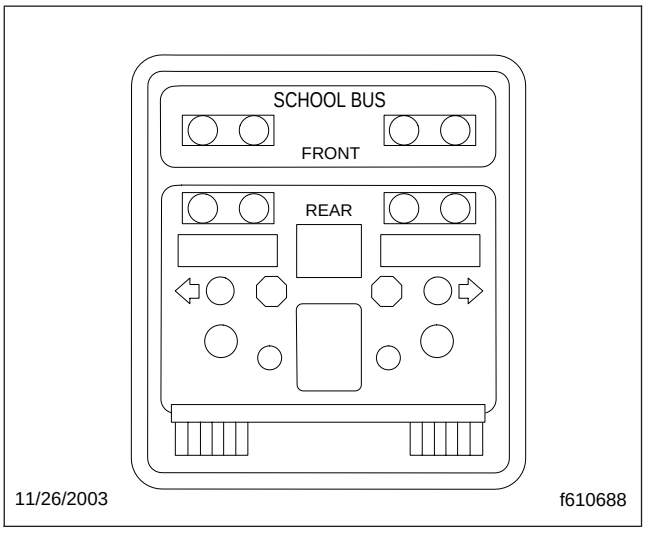


Fig. 5.12, Light Monitor Panel

- Passenger Advisory
- Post-Trip Inspection
- Reading Lights
- Rear Dome Lights
- Rear Dome Lights Dimmer
- Rear Emergency Door
- Right Rear Heater (Rear)
- Sander
- Side Emergency Door
- Step/Door Light
- Stepwell Heater
- Stop Request Pilot Light
- Stop Request Switch
- Switch Backlight Dimmer
- Vandalock Status
- Warning Lights
- Warning Override
- Warning Override Momentary
- Warning System (Master Pilot)
- Wheel Chair Lift Power
- Wheelchair Lift Power Green LED

- Wheelchair Lift Power Red LED

Noise Suppression

When activated, the noise suppression system will simultaneously turn off all noise-producing accessories with one switch. Noise-producing accessories that will be turned off include the heater blowers, air conditioning, defroster fans, auxiliary fans, and the radio, if so equipped.

Passenger Advisory

The passenger advisory activates the emergency exit buzzer when the driver turns the ignition switch off. The driver must walk to the back of the bus and check to make sure all of the seats are empty before pressing the reset switch. Activation produces a pulsed output to the panel buzzer for 60 seconds. If during the 60-second time period, the reset switch at the rear of the bus is pressed, the system is deactivated. If the 60-second time period elapses before the reset switch at the rear of the bus is pressed, the horn will begin to pulse. To deactivate the horn, the ignition must be turned ON and then OFF. At this time, the 60-second timer starts again with the panel buzzer producing an output, allowing 60 seconds to press the reset switch at the rear of the bus.

Horn Controls

Electric Horn

A single electric horn is standard. Dual electric horns are available as an option.

The button for the electric horn is located in the center of the steering wheel. To sound the horn, press down on the button. See **Fig. 5.13**.

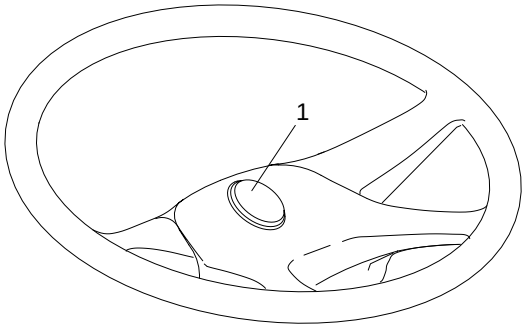
Air Horn

Single and dual air horns are available as options.

Steering Controls

⚠ WARNING

Make sure that the steering column is locked before driving the vehicle. Never tilt or telescope the steering wheel while driving the vehicle. Doing so could cause loss of vehicle control, personal injury, and property damage.



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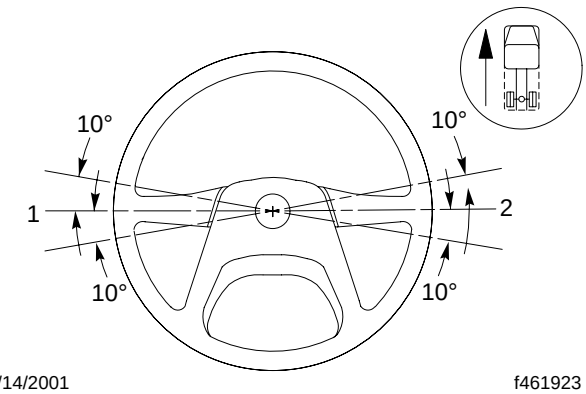
To sound the electric horn, press down on the horn button.

1. Horn Button

Fig. 5.13, Electric Horn Control

When there is no load on the vehicle and the front tires are pointed straight ahead, the steering wheel spokes should be at the 9 o'clock and 3 o'clock positions, or within 10 degrees to either side. See **Fig. 5.14**. See **Group 46** of the *Saf-T-Liner C2 School Bus Workshop Manual* for steering adjustment procedures.



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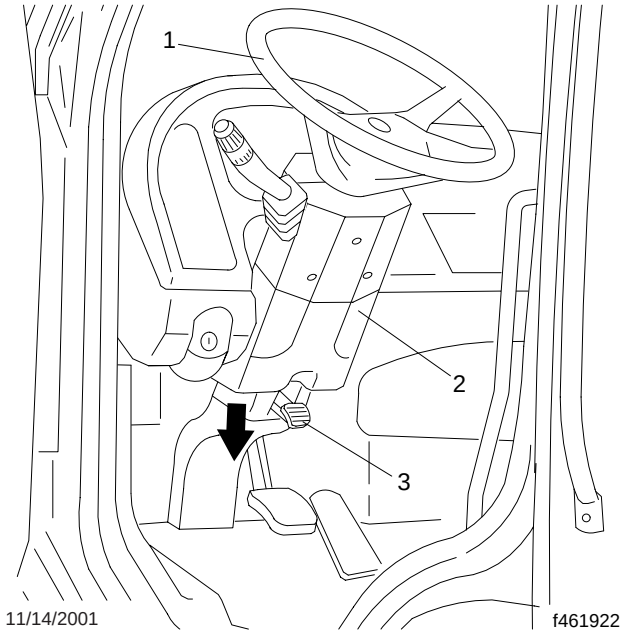
1. 9 o'Clock 2. 3 o'Clock

Fig. 5.14, Steering Wheel Centered

On some vehicles, the steering column may be tilted forward or aft to provide the most comfortable angle for steering the vehicle. The steering column can also be telescoped (raised or lowered) to provide the most comfortable height above the floor.

To tilt the steering column, press down on the foot pedal located below the steering wheel to release the

steering column lock. Adjust the column to the desired position. Release the foot pedal to lock the steering column in place. See **Fig. 5.15**.



Push down on the foot pedal (arrow) to adjust the steering column.

1. Steering Wheel
2. Steering Column
3. Foot Pedal

Fig. 5.15, Adjustable Steering Column

To telescope the steering column, press down on the foot pedal to release the steering column lock. Pull the steering wheel upwards or push the steering wheel downwards until it is at the desired height. Release the foot pedal to lock the steering column in place.

NOTE: For safety, the steering column is locked at all times unless the foot pedal is pressed down.

Power Steering System

The power steering system consists of a steering gear (which includes a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder), hydraulic hoses, power steering pump, power steering reservoir, and other components. Some models are also equipped with a separate hydraulic power cylinder on the right side of the front axle.

The power steering pump, driven by the engine, provides the power assist for the steering system. If the engine is not running, there is no power assist.

If the power assist feature does not work due to hydraulic fluid loss, steering pump damage, or some other cause, bring the vehicle to a safe stop. Do not drive the vehicle until the cause of the problem is corrected.

⚠ WARNING

Driving the vehicle without the power-assist feature of the steering system requires much greater effort, especially in sharp turns or at low speeds, which could result in an accident and possible injury.

Drivers should use the power available with a power steering system carefully. If the front tires become lodged in a deep chuckhole or rut, drive the vehicle out instead of using the steering system to lift the tires from the hole. Also, avoid turning the tires when they are against a curb as this places a heavy load on steering components and could damage them.

Powertrain Controls

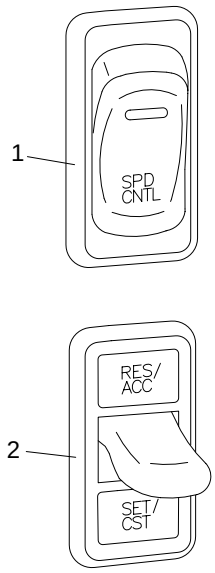
Cruise Control Switch

NOTICE

Do not attempt to shift gears without using the clutch pedal when the cruise control is engaged. Failure to follow this precaution will result in a temporarily uncontrolled increase in engine speed; transmission damage and gear stripping could result.

On standard models, cruise control is activated by two dash switches. See **Fig. 5.16**. On some models, the cruise control can be activated by a button on the transmission shift knob.

- The On/Off Switch—this two-position rocker switch bears the legend SPD CNTL on the lower half of the switch. When the cruise control is on, an amber light illuminates in the top part of the switch.
- The Set/Resume Switch—this three-position paddle switch bears the legend RES/ACC above the paddle and SET/CST below the paddle.



To turn the cruise control on, press the upper half of the On/Off (rocker) switch. To turn cruise control off, press the lower half of the On/Off (rocker) switch.

1. Cruise Control On/Off (rocker) Switch
2. Cruise Control Set/Resume (paddle) Switch

Fig. 5.16, Cruise Control Switches, Dash-Mounted

NOTE: For 2007 Mercedes-Benz engines, if the cruise On/Off switch is in the ON position when the ignition is turned off, the switch will have to be cycled from ON to OFF, and then back ON, in order to operate the cruise control.

1. To cruise at a particular speed, do these steps:
   - 1.1 Press the upper half of the On/Off (rocker) switch on the instrument panel.
   - 1.2 Hold the accelerator pedal down until the speedometer reaches the desired speed.
   - 1.3 Momentarily lower the paddle of the Set/Resume switch to SET/CST.
2. To disengage the cruise control, do these steps:
   - 2.1 Press down the brake pedal (on automatic or manual transmission) *or*

     Press down the clutch pedal (on manual transmission only)
   - 2.2 Press the lower half of the On/Off (rocker) switch on the instrument panel.
3. To resume a preselected cruise speed, do these steps:
   - 3.1 If the On/Off (rocker) switch on the instrument panel is off, turn it on.
   - 3.2 Momentarily raise the paddle of the Set/Resume switch to RES/ACC. Cruise will return to the last speed selected.

NOTE: If the ignition is shut off, the speed memory will be lost.

4. To adjust cruise speed up, raise the paddle of the Set/Resume switch to RES/ACC and hold it there until the vehicle accelerates to the new speed, as desired.
5. To adjust the cruise speed down, lower the paddle of the Set/Resume switch to SET/CST and hold it there until the vehicle decelerates to the new speed, as desired.

NOTE: For more information about cruise control operation, see the engine manufacturer's service manual.

Exhaust Brake Switch

The exhaust brake is controlled by a dash-mounted rocker switch to help slow the vehicle when the accelerator is released. See **Chapter 7** under the heading "Exhaust Braking System" for additional information.

To turn the exhaust brake on, press on the upper part of the rocker (at the light inside the switch). The exhaust brake turns off automatically. See **Fig. 5.17**.

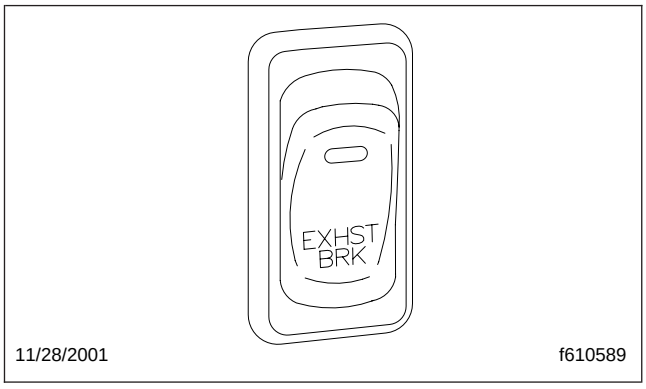


Fig. 5.17, Exhaust Brake Switch

When the exhaust brake switch is on, an amber LED illuminates inside the switch. When the panel lights are on, the EXHST BRK legend is backlit in green.

Engine Fan Switch

The engine cooling fan can be turned on by the engine fan switch (ENG FAN legend). The fan will continue to operate for a set amount of time and then turn off unless the coolant temperature is high enough to continue the fan operation.

To turn the engine fan on, press on the upper part of the rocker (at the fan icon). See **Fig. 5.18**.

When the engine fan is running, the fan blade icon is backlit in amber. When the panel lights are on, the ENG FAN legend is backlit in green.

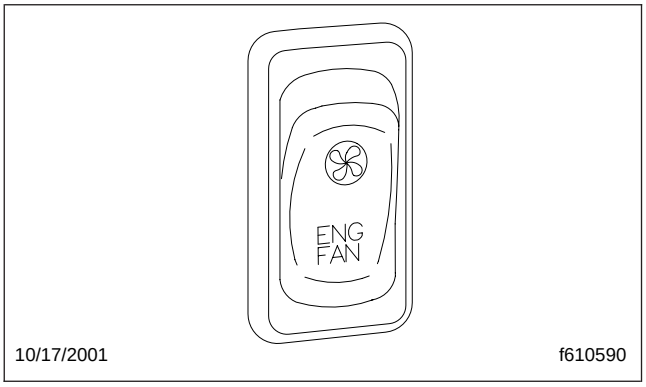


Fig. 5.18, Engine Fan Switch

Transmission Controls

If so equipped, the transmission range control valve and splitter valve are attached to the gearshift knob. Transmission shift pattern labels are located inside the cab. See **Chapter 9** for complete transmission operating instructions.

On vehicles with standard Allison On-Highway Series automatic transmission, there is a T-handle shift selector. See **Fig. 5.19**.

When the transmission is in D (drive), the vehicle will operate in the overdrive (5th) gear. To shift down into the direct drive (4th) gear, use the overdrive lockout switch (O/D legend). See **Fig. 5.20**. The transmission will shift into 4th gear and remain in that gear unless a range inhibitor is active, such as engine overspeed. See **Chapter 9** for more information about range inhibitors.

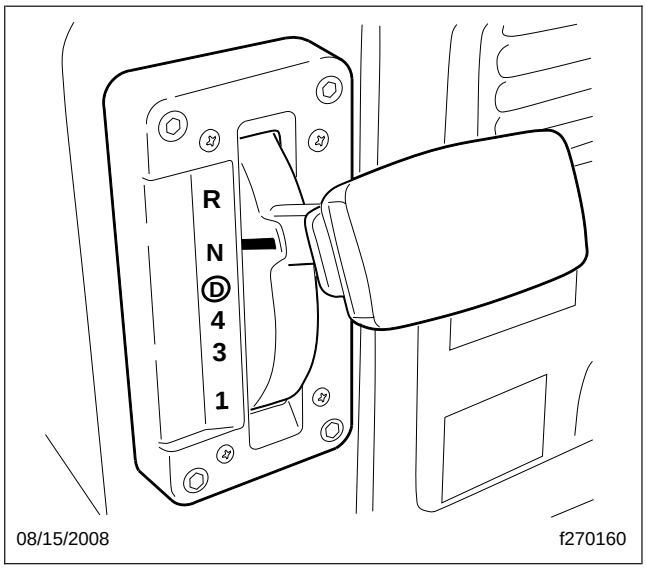


Fig. 5.19, T-Handle Shifter

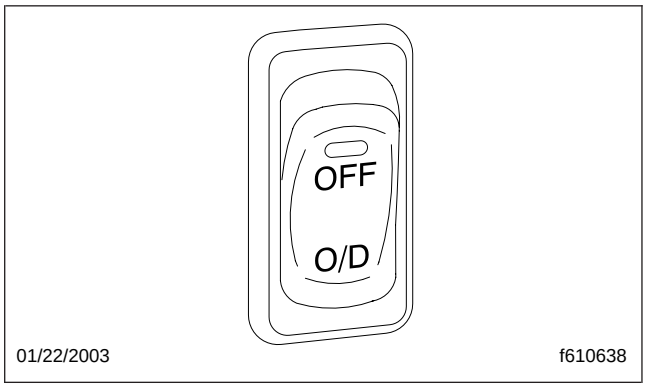


Fig. 5.20, Overdrive Lockout Switch

To shift to fourth gear, press on the upper part of the rocker (at the LED). The LED will come on and stay illuminated until the bottom part of the rocker switch is pressed.

On vehicles with an Allison MD Series automatic transmission or an Eaton Autoshift automated transmission, a push-button shift selector provides four, five, or six forward ranges and one reverse range. See **Chapter 9** for more information about the push-button shift selector.

Axle Switches

All axle switches contain a red LED (light-emitting diode) that illuminates the switch from within when the switch is turned on (the upper part of the rocker

is pressed). The legend under the LED, if any, is not visible until the switch is turned on.

IMPORTANT: A guard is positioned around all axle switches to prevent unintentional activation.

NOTE: For more information on axle switch function, see **Chapter 9**.

Differential Lock Switch

NOTICE

Differential lock should only be engaged when the vehicle is stopped or moving slowly at low throttle. This will prevent internal axle damage.

The differential lock switch is a two-position guarded rocker switch. It causes the wheels on each axle governed by the switch to rotate together. It is also known as side-to-side wheel lock. See **Fig. 5.21**.

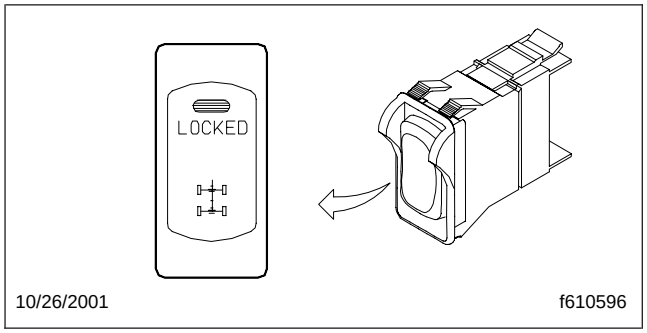


Fig. 5.21, Differential Lock Switch

To lock the wheels together, press the upper half of the rocker momentarily (at the LED). To turn off differential lock, press the upper half of the rocker again.

When the panel lights are on, the double-axle icon is backlit in green.

IMPORTANT: The differential lock switch is guarded to prevent unintentional switch activation. If the LED in the switch begins to blink during normal operation, when the switch has not been activated, this indicates an error condition. Bring the vehicle to an authorized Freightliner service facility as soon as possible.

Interaxle Lock Switch

NOTICE

Do not turn on the interaxle lock switch when the tires are slipping. Do not continuously operate the vehicle with the interaxle lock engaged during good road conditions. To do so could result in damage to the axle gearing and excessive tire wear.

The interaxle lock switch is a two-position guarded rocker switch installed on vehicles with dual drive axles. It causes both axle shafts to rotate together. See **Fig. 5.22**.

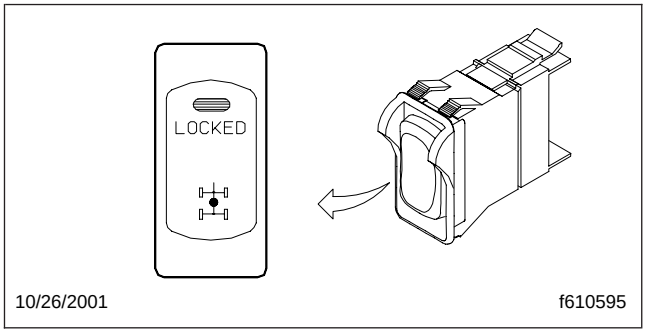


Fig. 5.22, Interaxle Lock Switch

To lock the axles together, press the upper half of the rocker momentarily (at the LED). To turn off interaxle lock, press the upper half of the rocker again.

When the panel lights are on, the double-axle icon is backlit in green.

IMPORTANT: The interaxle lock rocker switch is guarded to prevent unintentional switch activation. This switch does not have a diagnostic blink function when inactive.

Backup Alarm

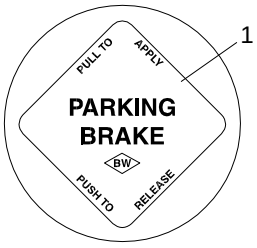
The backup alarm sounds when Reverse (R) gear is engaged. Check the operation of the backup alarm daily (if so equipped).

Braking Controls

Parking Brake Control Valve

The yellow diamond-shaped knob on the auxiliary dash panel operates the parking brake control valve

(park brake switch). See **Fig. 5.23**. Pulling the yellow knob applies the parking brakes (spring brakes). Pushing in the knob releases the parking brakes. Before the parking brakes can be released, the air pressure in either air brake system must be at least 65 psi (448 kPa).



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1. Parking Brake Control Valve

Fig. 5.23, Parking Brake Control Valve

See **Chapter 10** under the heading "Dual Air Brake System" for further information about the parking brake control valve.

Meritor™ WABCO® Antilock Braking System (ABS)

The Meritor WABCO Antilock Braking System (ABS) has an amber indicator light (ABS legend) and, if equipped with automatic traction control (ATC), an amber wheel spin indicator light (WHEEL SPIN legend). See **Fig. 5.24**.

See the brake system operating instructions in **Chapter 10** for more information about ABS.

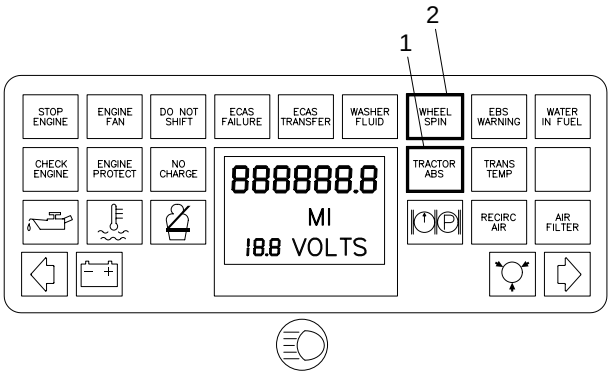
Other Dash-Mounted Controls

Aftertreatment System (ATS) Regen Switch

A regeneration (regen) switch, located on the dash, allows the driver to control three states. See **Fig. 5.25**. These include:

- request regeneration
- default (automatic regeneration)
- inhibit regeneration

See the engine operation manual for details on operation of the regen switch.



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1. Tractor ABS Indicator
2. Wheel Spin Indicator

Fig. 5.24, ABS Indicator Lights

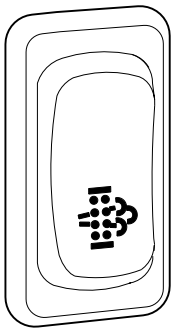

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Fig. 5.25, ATS Regen Switch

CB Radio Connections

An antenna connection and positive (+) and negative (–) power connections are provided for a CB radio.

Heater/Air Conditioner/Defrost Control Panel

Standard controls for the heating, ventilation, defrosting, and air-conditioning system (HVAC) consist of an eight-speed fan switch, an air selection switch, and a temperature control switch. See **Fig. 5.26**. On vehicles with air conditioning, the panel also contains a telltale LED and an air recirculation button.

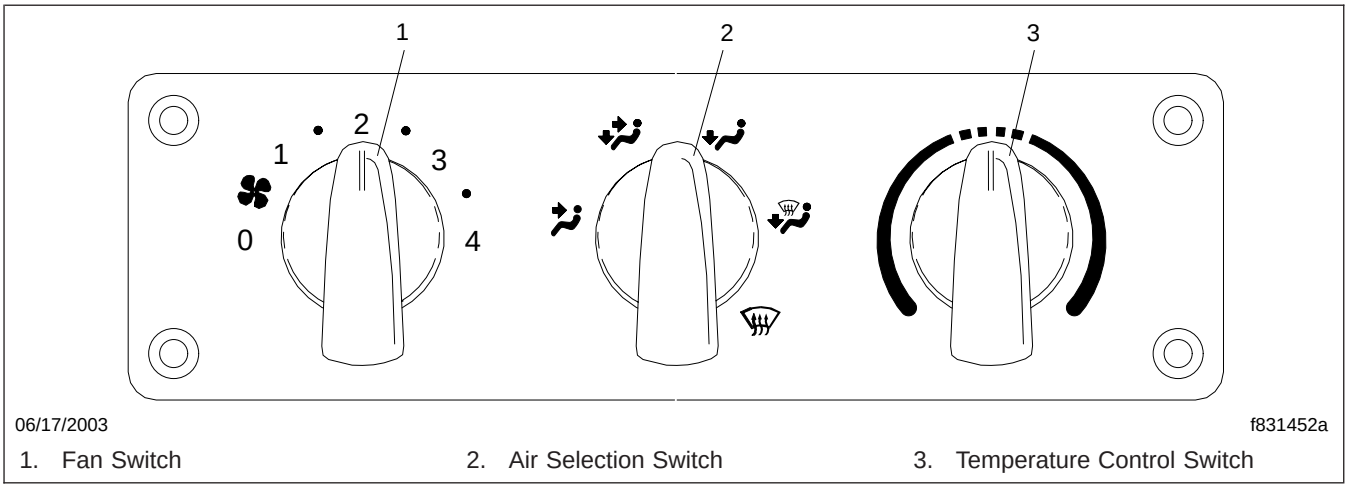


Fig. 5.26, Climate Control Panel Without Air Conditioning

Climate Control Panel

The climate control panel controls the HVAC for the driver. The climate control panel without air conditioning is shown in **Fig. 5.26**. The climate control panel with air conditioning is shown in **Fig. 5.27**.

NOTE: The bus may be equipped with a Webasto heating system. The Webasto heating system warms the engine prior to starting the bus, and also assists in generating additional heat for the passengers during operation. For operating instructions see the Webasto operators manual.

Fan Switch

The fan switch controls the fan speed, and forces fresh or recirculated air through the air outlets. The fan switch has eight fan speeds and an off position.

To increase airflow, turn the fan switch to the right or to a higher number. To decrease the airflow, turn the switch to the left or to a lower number.

Passenger Heater Switch

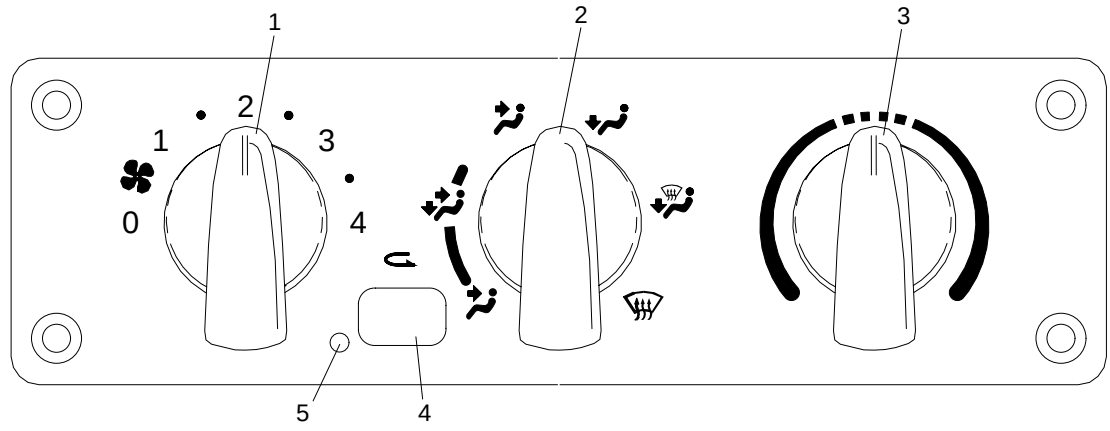
The underseat heater switches allow the driver to control the fan speed of the underseat heaters.

Air Selection Switch

The air selection switch allows you to control the flow of air through the face outlets, the floor outlets, the defrost (windshield) outlets, or a combination of these outlets, to give you nine air selection modes on a system without air conditioning. See **Fig. 5.28**. A system with air conditioning has 11 air selection modes, four of which are air conditioning modes. See **Fig. 5.29**.

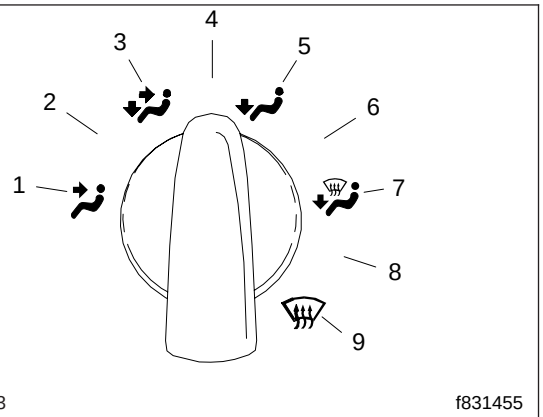
Air Selection Switch Without Air Conditioning

1. **Face Mode:** Directs all airflow through the face or instrument panel outlets.
2. **Selection between Face Mode and Bi-Level Mode:** Directs 75 percent of the airflow through the face outlets and 25 percent through the floor outlets.
3. **Bi-Level Mode:** Directs the airflow equally to the face outlets and the floor outlets.
4. **Selection between Bi-Level Mode and Floor Mode:** Directs 25 percent of the airflow through the face outlets and 75 percent through the floor outlets.
5. **Floor Mode:** Directs all airflow through the floor outlets.
6. **Selection between Floor Mode and Floor/Defrost Mode:** Directs 75 percent of the airflow through the floor outlets and 25 percent through the defrost outlets.
7. **Floor/Defrost Mode:** Directs the airflow equally to the floor outlets and the defrost outlets.



1. Fan Switch
2. Air Selection Switch
3. Temperature Control Switch
4. Recirculation Button
5. Recirculation Indicator

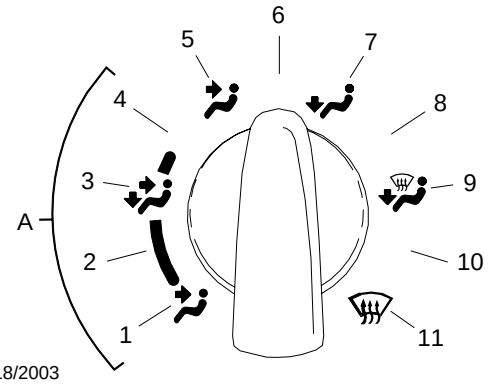
Fig. 5.27, Climate Control Panel With Air Conditioning



1. Face Mode
2. Selection Between Face Mode and Bi-Level Mode
3. Bi-Level Mode
4. Selection Between Bi-Level Mode and Floor Mode
5. Floor Mode
6. Selection Between Floor Mode and Floor/Defrost Mode
7. Floor/Defrost Mode
8. Selection Between Floor/Defrost Mode and Defrost Mode
9. Defrost Mode

Fig. 5.28, Air Selection Switch Without Air Conditioning

8. **Selection between Floor/Defrost Mode and Defrost Mode:** Directs 75 percent of the airflow through the defrost outlets and 25 percent through the floor outlets.



A. Air Conditioning Modes
1. Air Conditioning Face Mode
2. Selection Between Air Conditioning Face Mode and Air Conditioning Bi-Level Mode
3. Air Conditioning Bi-Level Mode
4. Selection Between Air Conditioning Bi-Level Mode and Face Mode
5. Face Mode
6. Selection Between Face Mode and Floor Mode
7. Floor Mode
8. Selection Between Floor Mode and Floor/Defrost Mode
9. Floor/Defrost Mode
10. Selection Between Floor/Defrost Mode and Defrost Mode
11. Defrost Mode

Fig. 5.29, Air Selection Switch With Air Conditioning

9. **Defrost Mode:** Directs all airflow through the defrost outlets.

Air Selection Switch With Air Conditioning

1. **Air Conditioning Face Mode:** Directs all airflow through the face or instrument panel outlets.
2. **Selection between the Air Conditioning Face Mode and the Air Conditioning Bi-Level Mode:** Directs 75 percent of the airflow to the face outlets and 25 percent to the floor outlets.
3. **Air Conditioning Bi-Level Mode:** Directs the airflow equally to the face outlets and the floor outlets.
4. **Selection between the Air Conditioning Bi-Level Mode and the Face Mode:** Directs 25 percent of the airflow to the face outlets and 75 percent to the floor outlets.
5. **Face Mode:** Directs all airflow through the face outlets.
6. **Selection between Face Mode and Floor Mode:** Directs the airflow equally through the face outlets and the floor outlets.
7. **Floor Mode:** Directs all airflow through the floor outlets.
8. **Selection between Floor Mode and Floor/ Defrost Mode:** Directs 75 percent of the airflow through the floor outlets and 25 percent through the defrost outlets.
9. **Floor/Defrost Mode:** Directs the airflow equally to the floor outlets and the defrost outlets. The recirculation button will not work in this mode.
10. **Selection between Floor/Defrost Mode and Defrost Mode:** Directs 75 percent of the airflow through the defrost outlets and 25 percent through the floor outlets. The recirculation button will not work in this mode.
11. **Defrost Mode:** Directs all airflow through the defrost outlets. The recirculation button will not work in this mode.

Temperature Control Switch

The temperature control switch is used to select the desired temperature. Turn the switch to the left (counterclockwise) for cool air, or to the right (clockwise) for hot air. There are 21 positions on the temperature control switch, ranging from full cool air to full hot air.

Fresh Air Mode

Fresh air, or outside air, is circulated through the heating and air conditioning system unless the recirculation mode, if equipped, is turned on.

Recirculation Mode

The recirculation mode is only available on vehicles with air conditioning.

The recirculation mode limits the amount of outside air entering the cab. Press the recirculation button to prevent dusty or smoky air from entering the cab. The recirculation mode can also be used to decrease the time required to cool or heat the cab interior during extreme outside temperature conditions. When the recirculation mode is on, the recirculation indicator will be on. See **Fig. 5.27**.

The recirculation mode is not available when the air selection switch is in one of the following modes:

- floor/defrost mode
- selection between floor/defrost mode and defrost mode
- defrost mode

When the recirculation mode is turned on, it will stay on for 20 minutes, or until the recirculation button is pressed again, or the air selection switch is turned to a defrost mode.

The system enters a partial recirculation mode for five minutes after being in full recirculation mode for 20 minutes. This cycle repeats as long as the system is in recirculation mode.

Defrosting

Before using any of the defrost modes, clear the screen at the base of the windshield if snow or ice is present.

Air Conditioning

There are four air conditioning modes on the air selection switch. The air conditioning settings on the air selection switch are blue, in addition to the selection

between the air conditioning bi-level mode and the face mode.

IMPORTANT: Operate the air conditioner at least five minutes each month, even during cool weather. This helps prevent drying and cracking of the refrigerant compressor seals and reduces the chance of refrigerant leaks in the system.

NOTE: The heating and air conditioning system has a brushless blower motor with a protection or shutdown mode to prevent damage due to overheating and overcurrent conditions. If the brushless blower motor goes into a protection mode, the motor will operate at a slower speed. If the overheating or overcurrent condition continues, the motor will shut down and stop completely.

The motor will resume proper operation after the motor has cooled or the overcurrent condition has been resolved. It will be necessary to cycle the fan switch off, and then on, to reset the motor. If the problem appears repeatedly, take the vehicle to a Freightliner dealer or authorized service outlet for repairs.

Booster Pump

The booster pump switch energizes an auxiliary coolant booster pump to circulate coolant to the heaters when the engine is idling or when stop-and-go driving conditions reduce coolant flow due to low engine rpm.

6

Basic Electrical System Overview

Basic Electrical System Overview

Electrical System General Information

The Saf-T-Liner C2 features a new type of electrical system, different from any previous bus. Multiple electrical signals are carried along a simplified set of wires, reducing the size of wiring bundles. There are significantly fewer wires overall, meaning less chance of damage, shorts, and other problems. The information in this chapter is to help familiarize the driver with the basic electrical system. Servicing the electrical system should be done only by qualified technicians. Special skills and equipment are required. Take your vehicle to an authorized Thomas Built Bus service facility for repairs.

⚠ WARNING

Do not attempt to modify, add, splice, or remove electrical wiring on this vehicle. Doing so could damage the electrical system and result in a fire that could cause serious personal injury or property damage.

Power Distribution Modules

There are two power distribution modules (PDAs).

The main PDM is located under the hood on the driver's side above the fender. See **Fig. 6.1**. The main PDM distributes battery power to the vehicle's control modules, and contains the fuses required to protect the power feed circuits to these modules. While the main PDM provides power to the modules, the modules themselves control power flow and circuit protection to the various components of the vehicle's electrical systems. Because of this, traditional PDM devices such as relays and circuit breakers are no longer necessary on the main PDM.

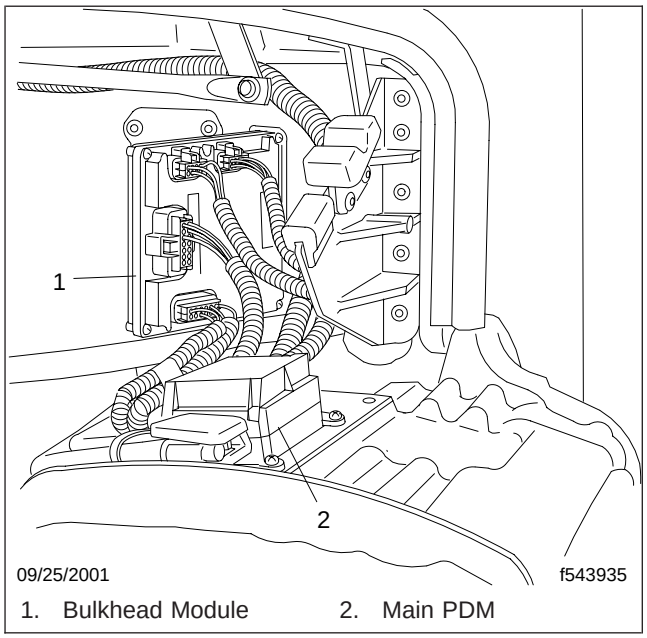
Inside the lid of the fuse box there is a sticker that shows the locations of the fuses and describes the circuit(s) that each fuse protects. Fuse configuration will vary depending on the PDM assembly installed. See **Fig. 6.2**. See **Table 6.1** for descriptions of a typical set of fuses.

The cab PDM is located in the switch panel cavity at the driver's left elbow and handles circuits inside the vehicle, such as heaters, doors, fans, lights, and other interior accessories. See **Fig. 6.3**.

Because the electrical system is multiplexed, no relays are needed. The multiplexing module performs the functions normally provided by relays.

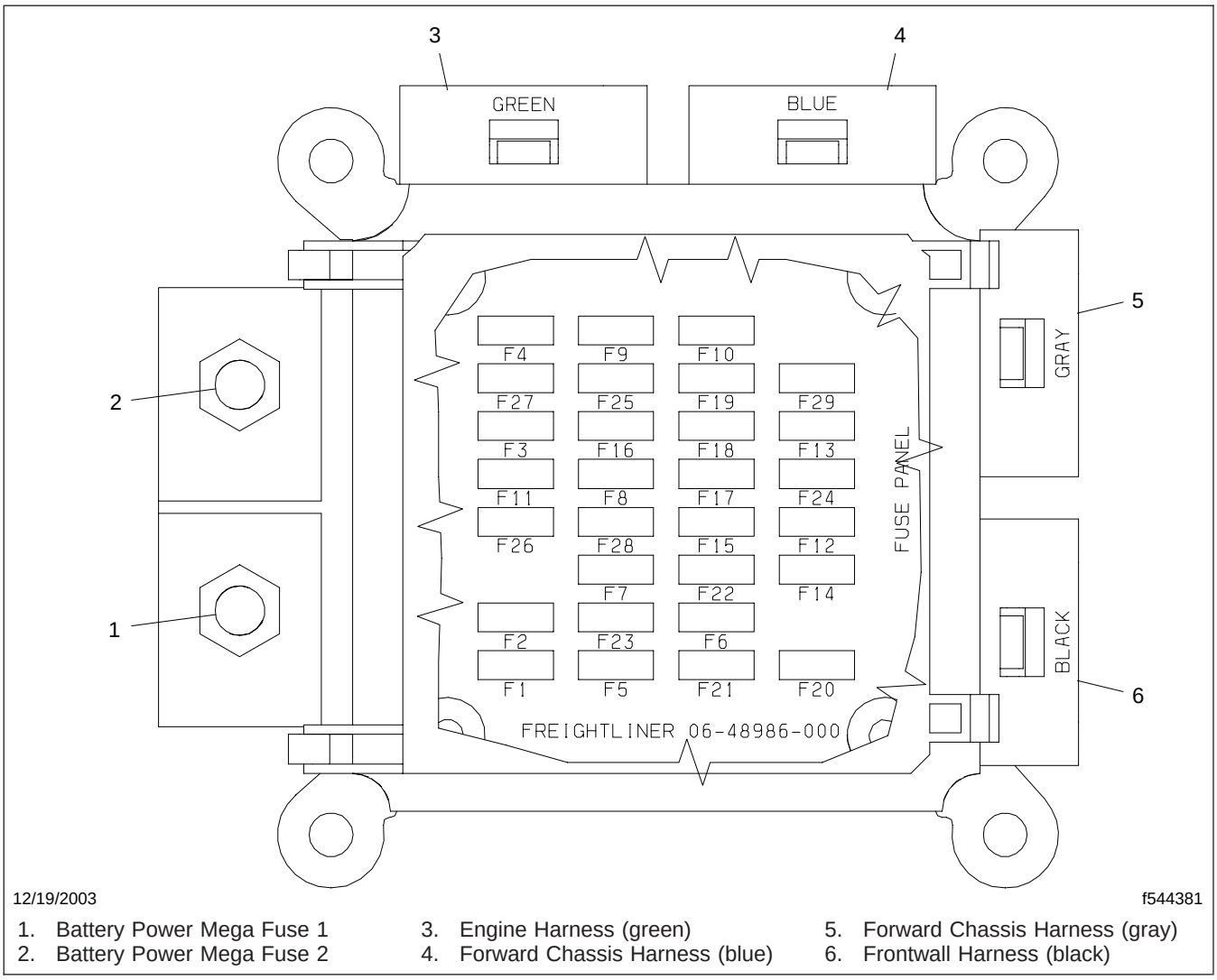
Fuse Identification		
CAV	**Description**	**Fuse**
F1	VCU (Spare)	10A (—)
F2	Blower Motor	30A
F3	Engine ECU	20A
F4	RR Wall HTR RLY LO/HI	30A
F5	Ignition Switch	10A
F6	Hydromax RLY (Spare)	30A (—)
F7	Stepwell HTR RLY LO/HI	30A
F8	ICU3-M2	10A
F9	Transmission ECU	10A
F10	Expansion Module 1	30A
F11	Expansion Module 1	30A
F12	Radio/Diagnostic	20A
F13	Expansion Module 1	30A
F14	Expansion Module 2	30A
F15	Bulkhead Module	30A
F16	ABS ECU	15A
F17	Chassis Module	30A
F18	Bulkhead Module	30A
F19	Chassis Module	30A
F20	Bulkhead Module	30A
F21	Expansion Module 2	30A
F22	Bulkhead Module	30A
F23	Expansion Module 2	30A
F24	Hydraulic Pump and RLY (Spare)	25A (—)
F25	Adjustable Pedals	10A
F26	Chassis Module	30A
F27	Heater Booster Pump	20A
F28	Bulkhead Module	30A
F29	Crossing Arm RLY	10A

Table 6.1, Main PDM Fuse Identification



1. Bulkhead Module 2. Main PDM

Fig. 6.1, Location of the Main PDM



1. Battery Power Mega Fuse 1
2. Battery Power Mega Fuse 2
3. Engine Harness (green)
4. Forward Chassis Harness (blue)
5. Forward Chassis Harness (gray)
6. Frontwall Harness (black)

Fig. 6.2, Main PDM

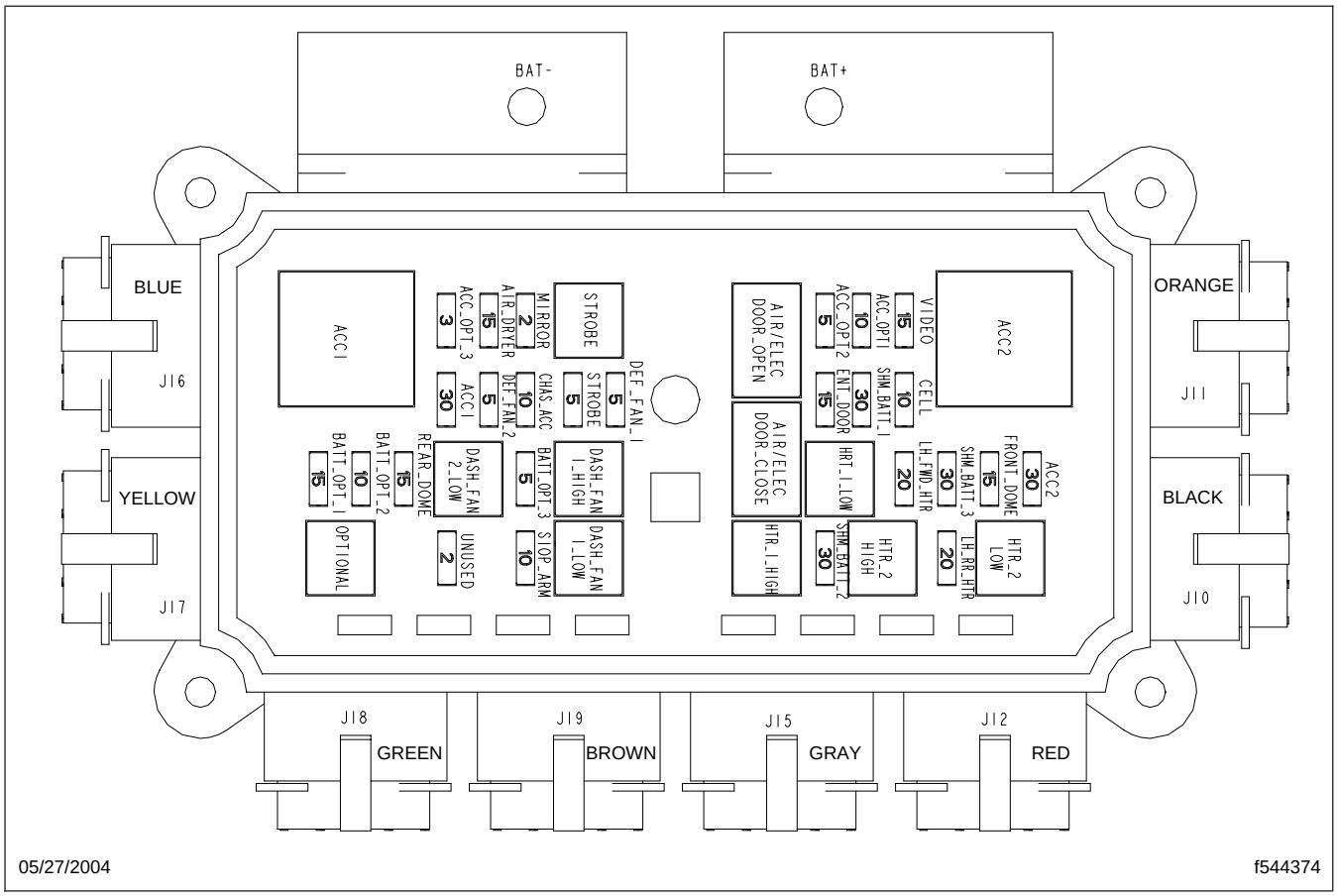


Fig. 6.3, Cab PDM

7

Mercedes-Benz Engines

EPA07 Aftertreatment System (ATS)

All on-road diesel engines built after December 31, 2006, (EPA07 engines) must meet strict new guidelines for reduced exhaust emissions of particulate matter and nitrogen oxides (NOx). NOx is limited to just over 1 gram per brake horsepower hour (g/bhp-hr) and particulate matter cannot exceed 0.01 g/bhp-hr.

EPA07-compliant engines require ultralow-sulfur diesel (ULSD) fuel, and they should never be run on fuel with sulfur content higher than 15 ppm. In addition, they require low-ash engine oil. The following guidelines must be followed or the warranty may be compromised.

- Use ultralow-sulfur diesel (ULSD) fuel with 15 ppm sulfur content or less, based on ASTM D2622 test procedure.
- Do not use fuel blended with used engine lube oil or kerosene.
- Engine lube oil must have a sulfated ash level less than 1.0 wt %; meeting the API CJ-4 index specifications.

IMPORTANT: Using non-specification fuels or oils can lead to shortened Diesel Particulate Filter (DPF) cleaning or exchange intervals. For example, using CI-4+ oil with 1.3% sulfated ash (30% more ash content) may result in the need for DPF cleaning or exchange 20 to 30% sooner than would normally be required.

The "exhaust system" in EPA07-compliant vehicles is called the aftertreatment system (ATS). The ATS varies according to engine manufacturer and vehicle configuration, but instead of a muffler, an aftertreatment system has a device that outwardly resembles a muffler, called the aftertreatment device (ATD).

IMPORTANT: See your engine operation manual for complete details and operation of the aftertreatment system.

Inside the ATD on Mercedes-Benz, Detroit Diesel, and Cummins engines, the exhaust first passes over the diesel oxidation catalyst (DOC), then it passes through the DPF, which traps soot particles. If exhaust temperature is high enough, the trapped soot is reduced to ash in a process called passive regeneration (regen). **Passive regeneration** occurs as the vehicle is driven normally under load; the driver is not even aware that it is happening. The harder an EPA07 engine works, the better it disposes of soot, as the exhaust heat alone is enough to burn the soot to ash. Over the course of a workday, however, passive regeneration cannot always keep the ATD filter clean, so the filter must undergo **active regeneration**. In active regeneration, extra fuel is injected into the exhaust stream to superheat the soot trapped in the DPF and turn it to ash. Active regeneration happens only when the vehicle is moving above a certain speed, determined by the engine manufacturer. Consult manufacturers' documentation for details.

Both active and passive regeneration happen automatically, without driver input.

Only when operating conditions do not allow for ATD filter cleaning by at-speed active or passive regeneration, the vehicle may require a driver-activated **parked regeneration**. The vehicle must be standing still, and the driver must initiate parked regen. Completing a parked regen takes 20 minutes to an hour, depending on ambient conditions.

⚠ DANGER

During parked regeneration, exhaust temperatures are very high, and could cause a fire, heat damage to objects or materials, or personal injury to persons near the exhaust outlet.

Before initiating a parked regeneration, make certain the exhaust outlets are directed away from structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by prolonged exposure to high heat.

The warning lamps in the driver message center alert the driver of a regen in progress, of high exhaust temperatures, of the need to perform a parked regen either soon or immediately, and of an engine fault that affects the emissions.

A slow (10-second) flashing of the high exhaust system temperature (HEST) lamp indicates that a parked regen is in progress, and the engine's high idle speed is being controlled by the engine software, not the driver.

A steadily illuminated high exhaust system temperature (HEST) lamp alerts the operator of high exhaust temperature during the regeneration process, if vehicle speed is below 5 mph (8 km/h). See **Fig. 7.1**.

The HEST lamp does not indicate the need for any kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or combust.

⚠ WARNING

When the HEST lamp is on, be certain that the exhaust pipe outlet is not directed at combustible material or toward anyone. To do so could cause damage to the vehicle and serious personal injury to others.

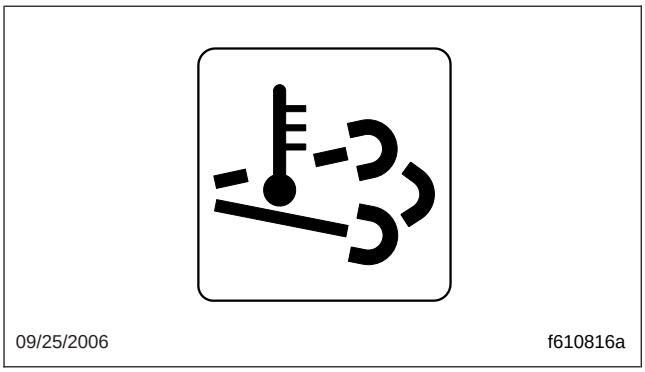


Fig. 7.1, High Exhaust System Temperature (HEST) Lamp

⚠ WARNING

Active regeneration can occur automatically any time the vehicle is moving. The exhaust gas temperature could reach 1500°F (800°C), which is hot enough to ignite or melt common materials, and to burn people. The exhaust can remain hot after the vehicle has stopped moving.

IMPORTANT: Due to the high exhaust temperature during the regen process, a diffuser is used to reduce the temperature at the exhaust pipe outlet. See **Fig. 7.2**. If the diffuser is damaged, it must be replaced to ensure proper operation of the vehicle and to reduce the possibility of damage or injury.

A steadily illuminated yellow Diesel Particulate Filter (DPF) lamp indicates a regen is required soon. Bring the vehicle to highway speeds to allow for an active regen, or a parked regen should be scheduled for the earliest convenient time. See **Fig. 7.3**.

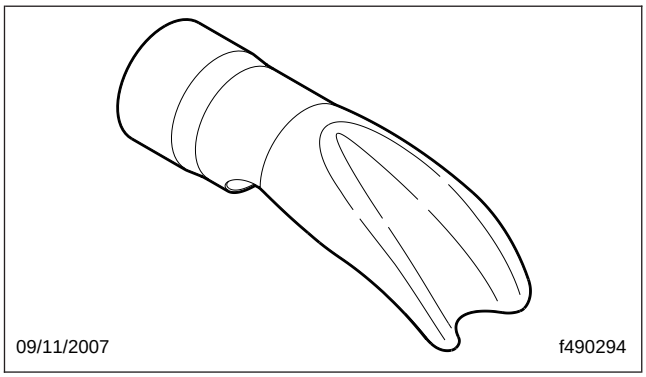


Fig. 7.2, Exhaust Diffuser

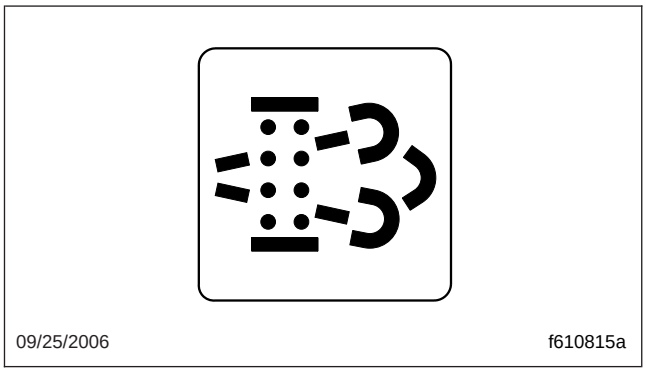


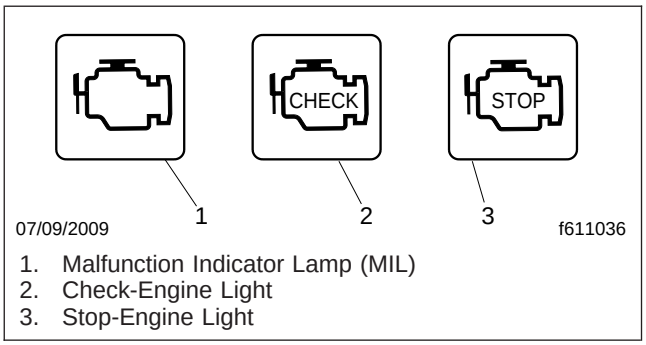
Fig. 7.3, Diesel Particulate Filter (DPF) Status Lamp

IMPORTANT: Failure to regen could cause engine problems, including derate or loss of power. As soon as allowed after the DPF lamp illuminates, maintain highway speeds to allow automatic regeneration, or park the vehicle in a safe location and perform a parked regen.

A DPF lamp blinking at the same time as a steadily illuminated yellow Check Engine lamp indicates that a parked regen must be performed immediately, or an engine derate will occur. If the red Stop Engine lamp illuminates with the blinking DPF lamp and the yellow Check Engine lamp, a parked regen must occur or an engine shutdown will occur. Park the vehicle and perform a parked regen. See **Fig. 7.4** and **Fig. 7.5**.

The DPF regen switch, located on the dash, may have three selectable positions:

- Request Regeneration



1. Malfunction Indicator Lamp (MIL)
2. Check-Engine Light
3. Stop-Engine Light

Fig. 7.4, Engine Protection Lamps

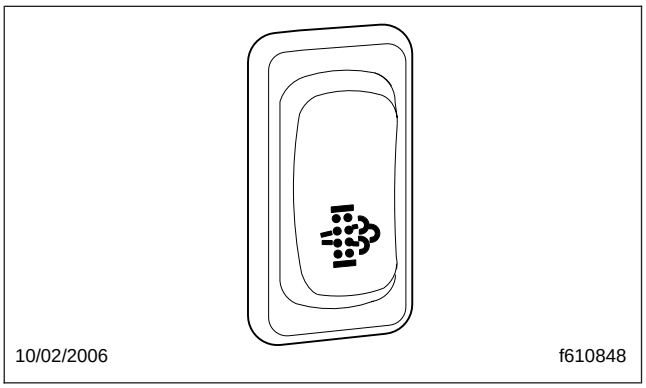


Fig. 7.5, Regen Switch

- Default (can include appropriate normal state condition—either in an automatic regeneration or inhibit state)
- Inhibit regeneration (optional when available)

NOTE: The regen switch can start a regen only when at least one of two conditions exists: either the DPF light is lit, or the engine software calls for it. If neither of those conditions exist, the regen switch cannot cause a regen to happen.

The function of the switch will vary by the engine make and model in the vehicle. See the engine operation manual for switch operation details.

When diesel particulate filter servicing is needed, it must be performed by an authorized technician, and a record must be maintained for warranty purposes. The record must include:

- date of cleaning or replacement;
- vehicle mileage;
- particulate filter part number and serial number.

A steadily illuminated Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the emissions. The MIL lamp applies to the Mercedes-Benz engine only. See **Fig. 7.6**.

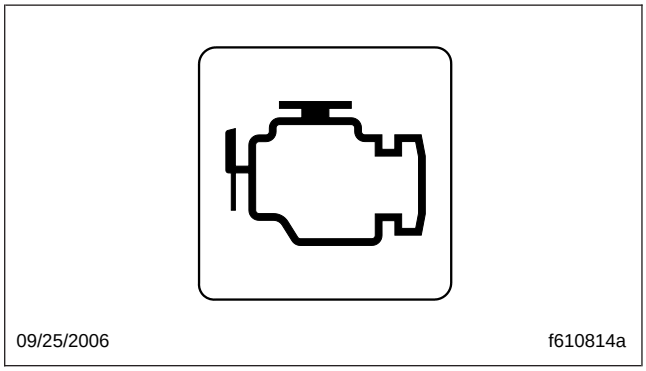


Fig. 7.6, Malfunction Indicator Lamp (MIL)

High-Soot-Load Idle Shutdown

Extended idle operation can cause soot to accumulate in the DPF, which can eventually trigger an ECM fault, cause the Stop Engine lamp to illuminate, and require replacement of the DPF. The High-Soot-Load Idle Shutdown feature (if equipped), determines if the extended engine idling needs to be shut down before there is a triggering of the stop engine warning.

The High-Soot-Load Idle Shutdown feature monitors the soot load during the idle or high-idle operation. If high-soot-load occurs, the DPF lamp will illuminate, then the "Check Engine" lamp will flash for 30 seconds, before the engine shuts down.

Engine Starting

For cold-weather starting, refer to the engine manufacturer's operator's manual for detailed instructions.

Whenever you start an engine, watch for any signs of engine problems. If the engine vibrates, misfires, or makes unusual noises, turn the engine off as soon as possible and determine the cause of the problem. Frequently, engine damage can be avoided by a quick response to early indications of problems.

Pre-Start

1. Perform the engine pretrip inspection and daily maintenance checks in **Chapter 12**.

2. Set the parking brake.
3. For manual transmissions, place the transmission in neutral and depress the clutch pedal.

   For automatic transmissions, make sure the transmission shift control is in neutral or park.

NOTE: On vehicles equipped with a neutral start switch, the transmission must be in neutral before the engine can be started.

4. Turn the ignition switch to the ON position. All the electronic gauges on the ICU (instrumentation control unit) complete a full sweep of their dials, the warning and indicator lights light up, and the buzzer sounds for three seconds.

IMPORTANT: On vehicles equipped with an intake air preheater, the INTAKE HEATER indicator stays on for a minimum of two seconds, regardless of coolant temperature. Wait until the INTAKE HEATER indicator goes out before attempting to start the engine.

Starting Precautions

⚠ WARNING

Starting fluid is highly flammable and explosive. It can cause serious injury or death if improperly handled. Do not use starting fluid on any engine not equipped with automatic ether injection.

Never pour fuel or other flammable liquid into the air inlet opening in the air intake in an attempt to start the vehicle. This could result in a flash fire causing serious personal injury or property damage.

NOTICE

Do not crank the engine for more than 30 seconds at a time. Wait two minutes after each try to allow the starter to cool. Failure to do so could cause starter damage.

NOTE: Some starters are equipped with optional overcrank protection. If overcranking occurs, a thermostat breaks the electrical circuit to the starter motor until the motor has cooled.

NOTICE

Protect the turbocharger during the start-up by not opening the throttle or accelerating the engine above 1000 rpm until minimum engine idle oil pressure registers on the gauge. Failure to do so could damage the turbocharger.

NOTICE

Never attempt to start any Mercedes-Benz electronic engine using ether or any other starting fluid. Serious engine damage could result.

1. Turn the ignition switch to the START position. Without touching the accelerator pedal, start the engine.
2. Idle the engine for one to three minutes at 600 to 850 rpm before operating the engine under load.
3. Check the oil pressure gauge for any drop in lubricating oil pressure or mechanical malfunction in the lubricating oil system. Minimum oil pressure at idle is 7 psi (50 kPa).

NOTICE

Do not rev the engine if the oil pressure gauge indicates no oil pressure. Shut down the engine if no oil pressure appears within approximately ten seconds. Check to determine the cause of the problem. Operating the engine with no oil pressure will damage the engine.

Starting After Extended Shutdown or Oil Change

An engine in storage for an extended period of time (over winter, for example) may accumulate water in the oil pan. Oil diluted by water cannot provide adequate bearing protection at start-up. For this reason, change the engine oil and filters after extended storage.

Engine Operation

IMPORTANT: For engine break-in, cold-weather operation, and high-altitude operation refer to the engine manufacturer's operator's manual for detailed instructions.

Operating any vehicle in an area where there are concentrated flammable vapors (such as diesel, gasoline, natural gas, or propane fumes) can create a hazardous situation. These vapors can be drawn into the engine through the air intake, and cause engine overspeed. Be especially cautious of low-lying or closed-in areas, and always check for signs that flammable vapors may be present.

⚠ DANGER

Do not operate the engine in an area where flammable vapors such as gasoline or diesel fumes are present. Shut down the engine when in an area where flammable liquids or gases are being handled. Failure to observe these precautions could result in serious injury or death.

All diesel engines have been built to comply with the requirements of the Federal (U.S.) Clean Air Act. Once the engine is placed in service, the responsibility for meeting both state and local regulations is with the owner/operator. Good operating practices, regular maintenance, and proper adjustments are factors that will help the engine to stay within the regulations.

Adequate maintenance of the engine, which is the responsibility of the owner/operator, is essential to keep the emission levels low.

While you are driving, watch for any signs of engine problems. If the engine overheats, uses excessive fuel or lubricating oil, vibrates, misfires, makes unusual noises, or shows an unusual loss of power, turn the engine off as soon as possible and determine the cause of the problem. Frequently, engine damage can be avoided by a quick response to early indications of problems.

NOTICE

Stop the engine at the first sign of malfunction. Almost all malfunctions give some warning to the operator before significant damage occurs. Many engines are saved because alert operators heed the warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine.

All electronic engines have an engine protection system designed to warn the driver of engine malfunctions. If the driver doesn't understand how the shutdown protection system works, an engine shutdown could occur, causing a safety hazard.

IMPORTANT: On vehicles with the shutdown protection system, a red engine protection (ENG PROT) warning light illuminates when the ignition switch is turned to the ON position.

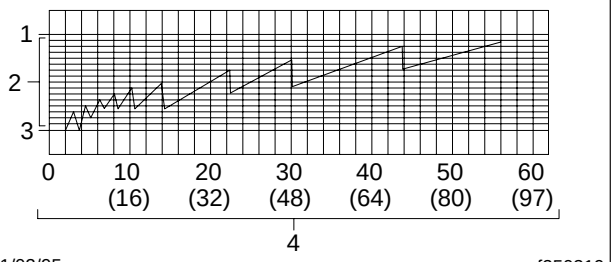
The warning and derate system does not cause an engine shutdown, but derates the engine, allowing it to be brought safely to a place where the engine can be serviced. See **Chapter 4** for information on the shutdown protection (standard) and warning/derate (optional) systems.

Do not allow the engine to idle for long periods of time. An idling engine wastes fuel and if left unattended, is also unsafe.

NOTE: Long periods of idling are not good for an engine because the combustion chamber temperatures drop so low that the fuel may not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can result in stuck valves.

For long powertrain life, use the following information when operating the engine and shifting gears.

1. Use the tachometer, if installed, to determine when to shift. Follow the pattern on the shift lever when moving through the gears.
2. Select a gear that allows a smooth, easy start without increasing engine speed above low idle or slipping the clutch. Release the clutch pedal smoothly. Jerky starts waste fuel and put stress on the drivetrain.
3. Continue to upshift until cruising speed is reached. Use only the rpm needed to make an upshift into the next gear. The engine speed needed to make an upshift increases as the vehicle speed increases or if upshifts are made on uphill grades.
4. If the vehicle can be operated in a higher gear after reaching the desired speed, select the highest gear available that will pull the load. Experience with your vehicle will show you what rpm is needed to make upshifts under various conditions. This progressive shifting technique will lower fuel costs because the engine will be operating at the lowest rpm needed to pull the load. See **Fig. 7.7** for a progressive shift pattern.



1. Governed RPM
2. Engine RPM Operating Range
3. Idle RPM
4. Miles (kilometers) Per Hour

Fig. 7.7, Progressive Shift Pattern

5. On uphill grades, let the engine lug down to peak torque rpm if you can make it to the top of a hill without downshifting. If necessary, downshift until a gear is reached in which the engine will pull the load and maintain its rpm. Select the correct gear, one that does not allow the engine to exceed its maximum speed.
6. On a downhill grade, do not coast or put the transmission in neutral. Use the brakes to limit the vehicle speed. Use lower gears in steep downhill driving. Normally, the gear used to descend a hill is the same gear (or one gear lower) than that used to climb a hill of the same grade.

   Proper operation and maintenance are key factors in obtaining the maximum life and economy of a vehicle engine. Follow the directions in this manual and the engine manufacturer's operator's manual for trouble-free, economical engine operation.

   Mercedes-Benz engines are equipped with the electronic engine control system, which monitors the engine as it is running.

   If the engine control unit (ECU) detects a fault serious enough to harm normal operation, the electronic engine system switches over to emergency running mode. When in emergency running mode, the engine operates at a constant 1300 rpm. This allows you to move the vehicle to a service location.

   - Depending on the vehicle gearing, the posted speed limit can sometimes allow operation in either of the top two gears; however, for improved operating efficiency (fuel economy and engine life), operate in the top gear at reduced rpm, rather than in the next lower gear at the maximum rpm.
   - Cruise at partial throttle whenever road conditions and speed requirements permit. This driving technique permits operating within the most economical power range of the engine.
   - Never allow the engine to exceed the high-idle governed speed (2700 rpm). Use the exhaust brake and the optional turbo or constant-throttle brake, if installed, to lower engine rpm below the high-idle governed speed.
   - Never allow the engine to idle for more than 30 minutes. Excessive idling can cause oil to leak from the turbocharger.

Engine Shutdown

Emergency Shutdown

Shut down the engine immediately, if any of the following occur —

- the oil pressure swings back and forth or falls sharply;
- engine power and rpm fall even though the accelerator pedal remains steady;
- the engine gives off heavy exhaust smoke;
- the coolant and/or oil temperature climb abnormally;
- abnormal sounds suddenly occur in the engine or turbocharger.

Normal Engine Shutdown

1. With the vehicle stopped, apply the parking brake and place the transmission in neutral.

NOTICE

Idle the engine one to two minutes before shutting it down, if this can be done without damage to the engine. After hard operation, shutting down the engine without idling may cause damage to the turbocharger.

2. Allow the engine to idle one to two minutes before shutting it down. This allows the lubricating

oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, and seals. The extreme heat may cause bearings to seize or oil seals to leak.

IMPORTANT: Bearings and seals in the turbocharger are subjected to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away by oil circulation, but if the engine is stopped suddenly, the turbocharger temperature may rise as much as 115°F (46°C).

NOTICE

Except in an emergency, do not shut down the engine when the coolant temperature is above 194°F (90°C). To do so could damage the engine.

3. Turn off the ignition switch to shut down the engine.

Engine Braking System, Optional

Engine Brake Switch, Optional

The engine brake switch controls the degree of engine braking. Normally there are two paddle switches, a two-position On/Off Switch to activate the engine brake, and a two-position Hi-Lo Switch to control the amount of engine braking.

To turn the two-position On/Off Switch on, raise the paddle. When the two-position switch is on, an amber LED (light-emitting diode) illuminates inside the switch.

To turn the two-position Hi-Lo Switch on high, raise the paddle (at the Hi-Lo icon). To turn the two-position Hi-Lo Switch on low, lower the paddle (at the ENG BRK legend). See **Fig. 7.8**.

A three-position switch is used on MBE900 engines equipped with both the regular engine brake and the constant-throttle (decompression) brake. It works the same as the two-position Hi-Lo switch, except that there is a third (off) position when the switch is left at its normal position.

When the panel lights are on, the Hi-Lo icon is backlit in amber on the three-position switch. On both the three-position switch and the two-position switch, the ENG BRK legend is backlit in green when the panel lights are on.

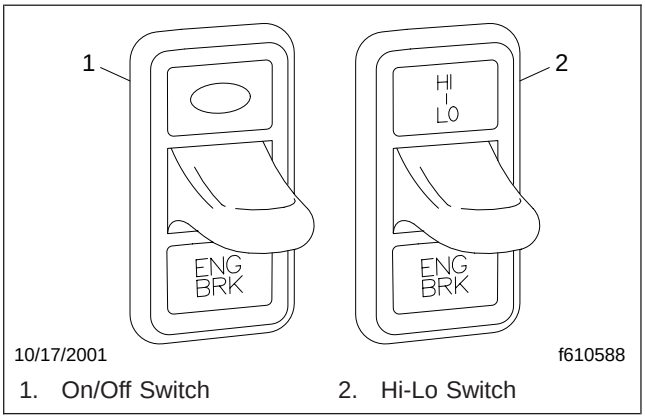


Fig. 7.8, Engine Brake Switches

Constant-Throttle Valves

To increase braking performance, Mercedes-Benz engines are equipped with constant-throttle valves (optional) in each combustion chamber. Small valves built into the cylinder head allow a small amount of compressed air to escape through the exhaust port during the combustion stroke. The constant-throttle valves are open during the entire time that the engine brake is activated. Although some braking ability is lost because the valves are constantly open, constant-throttle braking is quieter in operation than other types of engine brakes.

When both the exhaust brake and the constant throttles are installed, a three-position switch on the dash controls the amount of engine braking delivered. Like the exhaust brake, the constant throttles are deactivated when the accelerator or clutch pedal is depressed. The ABS system, when active, also deactivates constant-throttle braking.

The engine brake will deactivate if the engine speed falls below a preset level. This level is programmable but is set at the factory at 1100 rpm.

Exhaust Braking System, Optional

Exhaust Brake Switch, Optional

The optional exhaust brake is controlled by a dash-mounted rocker switch to help slow the vehicle when the accelerator is released.

To turn the exhaust brake on, press on the upper part of the rocker (at the light inside the switch). The exhaust brake turns off automatically. See **Fig. 7.9**.

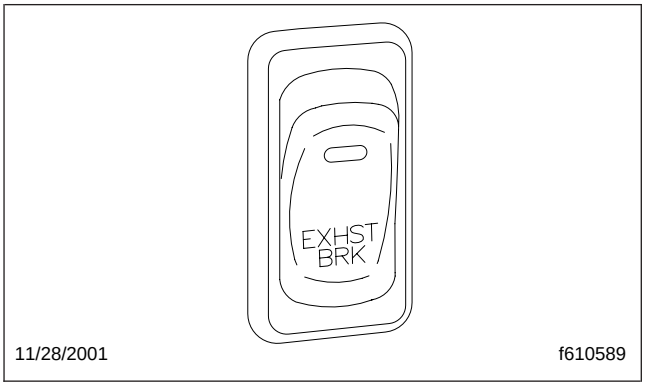


Fig. 7.9, Exhaust Brake Switch

When the exhaust brake switch is on, an amber LED illuminates inside the switch. When the panel lights are on, the EXHST BRK legend is backlit in green.

Mercedes-Benz Exhaust Brake

An exhaust brake is an optional auxiliary braking system that assists but does not replace the service brake system. The exhaust brake can be used alone or together with the constant-throttle valves for steep or long grades. The exhaust brake switch located on the control panel, in combination with the accelerator and clutch pedals, allows the driver to make maximum use of the exhaust brake in off-highway and mountain driving as well as in traffic or high-speed highway driving.

When only the exhaust brake is installed, a two-position switch on the dash controls the engine braking system. The exhaust brake is only active when the engine speed is between 1100 and 2700 rpm. Depressing the accelerator or clutch pedal deactivates the exhaust brake. The ABS system, when active, also deactivates the exhaust brake.

The exhaust brake is a butterfly valve mounted in the exhaust pipe. When the driver's foot is not on the accelerator pedal and the upper half of the exhaust brake switch is pressed in, with the amber light on the switch illuminated, an air cylinder shuts the butterfly valve, which restricts the flow of exhaust gases and retards the engine. This retarding action is carried through the engine and drivetrain, slowing the vehicle and reducing the need for frequent service brake applications.

Exhaust brakes are not intended for use as the primary braking system during vehicle operation.

Starting the Engine

Before starting the engine, make sure that the lower half of the exhaust brake switch is pressed in and the amber light is not illuminated. Do not turn the exhaust brake on until the engine has reached normal operating temperatures.

Operating Characteristics

⚠ WARNING

Do not use the exhaust brake when driving on slippery or low-traction road surfaces. Failure to follow this precaution could result in a loss of vehicle control and possible personal injury or property damage.

When you remove your feet from both the accelerator and clutch pedals and the upper half of the exhaust brake switch is pressed in with the amber light illuminated, the exhaust brake is applied. The following conditions should exist if the brake is operating properly.

- A slight change in the sound of the engine may be noticed when the exhaust brake is applied.
- Exhaust smoke should appear normal.
- Engine temperature should remain in the normal operating range.
- Road speed usually decreases when the exhaust brake is applied during a descent. When the vehicle is carrying a heavy load or the grade is extremely steep, you may need to apply the service brakes occasionally.
- Do not expect a retarding effect similar to sudden hard application of the service brakes. The exhaust brake retards the vehicle with a smooth braking effect.
- During a descent, the tachometer usually shows a drop in rpm depending on the grade and the vehicle load.
- Depending on the grade and vehicle load, you may or may not feel the retarding force acting against your body when the brake is applied.

The retarding force of the brake may not always be noticed, but it is actually preventing the vehicle from going much faster.

Driving Downhill

While approaching a steep grade, make sure that the upper half of the exhaust brake switch is pressed in, with the amber light illuminated. The exhaust brake comes on as soon as you remove your foot from the accelerator pedal. While going down the grade, use a low enough gear to safely descend with a minimum application of the service brakes. As a general guideline, use the same gear as you would to ascend the hill.

NOTICE

Do not allow the engine to exceed its governed speed, or serious engine damage could result.

Apply the service brakes to reduce the engine rpm or make a slower descent by using a lower gear.

Shutting Down the Engine

Make sure the exhaust brake is turned off before shutting down the engine.

Pacbrake® Exhaust Brake, Optional

The Pacbrake exhaust brake is intended as a supplement to the service brakes and will *not* bring the vehicle to a complete stop. The Pacbrake will assist in the control or reduction of road speed in conjunction with, or independent of, the service brakes. The amount of retarding or braking force is controlled by the driver.

Pacbrake Operation

The Pacbrake is controlled by the exhaust brake switch and the throttle pedal. All applications are additionally affected, controlled, or governed by engine speed through transmission gear selection.

On some applications, when the Pacbrake is in use, it may be necessary to check that the cruise/RPM control is not set and that the throttle is in the idle position.

On some applications the engine, transmission, cruise/RPM control, and the Pacbrake exhaust brake may electronically interact with each other, which automatically operates their functions. Following are some examples of the programmed options that may be available with the cruise/RPM control in the on position.

- The coast mode engages the Pacbrake when the service brake is applied and disengages when the service brake is released.
- The latch mode engages the Pacbrake when the service brake is applied and the Pacbrake remains on after the service brake is released. The Pacbrake is disengaged when another input (depressing the throttle or clutch, engine speed drops below 800 rpm, or the exhaust brake switch is turned off) is supplied.
- The manual mode does not require the cruise/RPM control switch to be on and operates the Pacbrake manually at the driver's discretion.

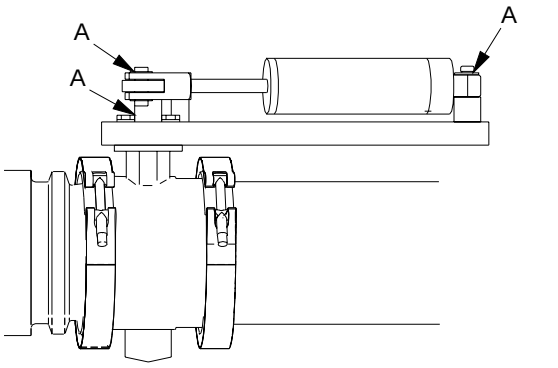
The amount of braking power the engine will develop is related to the speed (rpm) of the engine. The higher the engine rpm, the greater the retarding power.

Certain conditions may require that the transmission be downshifted in order to generate adequate rpm for the amount of retarding power required. Pacbrake exhaust brakes are designed and approved for safe use at 300 rpm above the engine's maximum governed rpm. Refer to individual engine manufacturer's specifications.

The Pacbrake will function best if it is used all of the time. However, if the vehicle is used inconsistently or seasonally, it may be necessary to perform a preventive maintenance procedure.

1. With the engine shut down, use any oil-free or nonpetroleum-based high-heat lubricant, and spray or coat a sufficient amount on the restricter valve shaft and the attaching locations at each end of the actuation cylinder. See **Fig. 7.10**.
2. With your hands or a pair of pliers, motion the valve several times to distribute the lubricant down the shaft and the attaching locations.

NOTE: Starting the engine and idling for short periods of time is not recommended. During a cold engine start-up, enough moisture is developed within the engine and the exhaust system to create a corrosion hazard that could affect the future operation of the Pacbrake. The brake housing may trap water in the valve shaft bore



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A. Lubrication Points

Fig. 7.10, Pacbrake Exhaust Brake and Air Cylinder

causing corrosion in an improper or nonfunctioning brake. If it is necessary to periodically start the engine, it is recommended that normal operating temperatures be attained before shutting down the engine.

8

Cummins Engines

EPA10 Aftertreatment System (ATS)

Principles of Operation

IMPORTANT: EPA10 emissions regulations apply to vehicles domiciled in Canada and the USA at the time of printing this manual. Vehicles that are domiciled outside of the USA and Canada may not have EPA10-compliant engines with an emission aftertreatment system, depending upon local statutory emissions guidelines.

The EPA mandates that all engines built after December 31, 2009 must reduce the level of emissions exhausted by the engine to the following levels:

- Nitrogen Oxides (NOx) – 0.2 g/bhp-hr
- Particulate Matter (PM) – .01 g/bhp-hr

To meet EPA guidelines, diesel engines installed in Freightliner Custom Chassis Corporation (FCCC) chassis for domicile in Canada and the USA use an aftertreatment system (ATS) with an aftertreatment device (ATD) and Selective Catalytic Reduction (SCR) technology to reduce NOx downstream of the engine.

NOTICE

Using non-specification fluids can result in serious damage to the ATS. It is extremely important that the following guidelines be followed for vehicles with EPA10-compliant engines, or damage may occur to the ATD, and the warranty may be compromised.

- Use ultralow-sulfur diesel with 15 ppm sulfur content or less.
- Do not use fuel blended with used engine lube oil or kerosene.
- Engine lube oil must have a sulfated ash level less than 1.0 wt %; currently referred to as CJ-4 oil.
- Use only certified diesel exhaust fluid (DEF) in the DEF tank.

After exhaust gasses leave the engine, they flow into the ATS. First they flow into a two-part ATD, comprised of a diesel oxidation catalyst (DOC), and a diesel particulate filter (DPF). The DPF traps soot particles, then exhaust heat converts the soot to ash in the DPF, in a process called regeneration (regen). The harder an engine works, the better it disposes of soot. When the engine is running under load and regen occurs without input, it is called passive regen. If the engine isn't running hot enough, the electronic controls may initiate an active regen, whereby extra fuel is injected into the exhaust stream before the diesel particulate filter, to superheat the soot trapped in the filter and burn it to ash. Both types of regen occur without driver input.

⚠ WARNING

Active regeneration can occur automatically any time the vehicle is moving. The exhaust gas temperature could reach 1500°F (800°C), which is hot enough to ignite or melt common materials, and to burn people. The exhaust can remain hot after the vehicle has stopped moving.

Operating at reduced engine load will allow soot to accumulate in the DPF. When this occurs, the DPF lamp illuminates, indicating that a regen must be performed, and the driver must either bring the vehicle up to highway speed to increase the load, or park the vehicle and initiate a parked regen. See *Parked Regen*, later in this chapter for instructions.

After the exhaust stream passes through the ATD, it flows through another canister housing the SCR device. A controlled quantity of diesel exhaust fluid (DEF) is injected into the exhaust stream, where heat converts it to ammonia (NH_3) gas. This mixture flows through the SCR device, where the ammonia gas reacts with the NOx in the exhaust, to produce harmless nitrogen (N_2) and water vapor (H_2O), which then exits out of the tailpipe.

ATS Warning Lamps

Warning lamps in the driver's message center alert the driver of situations with the aftertreatment system.

- An illuminated DPF lamp indicates a regen is needed.
- A slow, 10-second flashing of the HEST lamp alerts the driver that a parked regen is in progress, but the exhaust temperatures are still

relatively cool. It also indicates that the high-idle speed is being controlled by the engine software, not the driver.

- A steadily illuminated HEST lamp alerts the operator of high exhaust temperatures when vehicle speed is below 5 mph (8 km/h) while it is performing an automatic regen, and during a parked regen.
- An illuminated DEF warning lamp in the gauge, indicates that the DEF tank should be refilled at the next opportunity.

Parked Regen

⚠ DANGER

During parked regeneration, exhaust temperatures are very high, and could cause a fire, heat damage to objects or materials, or personal injury to persons near the exhaust outlet.

Before initiating a parked regeneration, make certain the exhaust outlets are directed away from structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by prolonged exposure to high heat.

A reference label is included with the driver's documentation package initially in the glove box, that explains the ATS warnings, and actions required to avoid further engine protection sequences. See **Fig. 8.1**

The regen switch, located on the dash, is used to initiate a parked regen of the aftertreatment device. See **Fig. 8.2.**

NOTE: The regen switch can initiate a parked regen only when the DPF lamp is illuminated (because the engine software is signaling for a parked regen.)

The regen-inhibit switch (optional when available) provides additional control over the aftertreatment regeneration process. Depressing the regen-inhibit switch will prevent a regen from occurring during a drive cycle. After the vehicle has been shut down and restarted, regens will occur normally unless the inhibit switch is pressed again. See **Fig. 8.3**.

To initiate a parked regeneration, perform the following steps.

1. Park the vehicle away from all combustible and flammable materials. Chock the tires. Start and warm the engine until the coolant temperature is at least 150°F (66°C).
2. Set the parking brake. If the parking brake was already set, you must release it, then set it again.

   For manual transmissions, fully depress the clutch pedal, put the transmission in neutral, then release the pedal.

   If the vehicle has a two-pedal automated transmission, shift it into gear, then back to neutral.

IMPORTANT: The driver must remain with the vehicle during the entire regen cycle.

3. Press and hold the regen switch for 4 seconds. The engine will increase rpm and initiate the regen process.
4. After the parked regen has run for 20 to 40 minutes, the regen cycle is completed. The engine idle speed will drop to normal, and the vehicle may be driven normally. The HEST lamp may be illuminated, but will go out when the vehicle speed exceeds 5 mph (8 km/h), or the system has cooled to normal operating temperature.
5. To stop a parked regen at any time during the process, engage the clutch, brake, or throttle pedal, or turn off the engine.

DPF Maintenance

Eventually ash will accumulate in the DPF and the filter will require servicing. DPF servicing must be performed by an authorized technician, following the engine manufacturer's instructions. A record must be maintained for warranty purposes, that includes:

- date of cleaning or replacement;
- vehicle mileage;
- particulate filter part number and serial number.

EPA10 Diesel Exhaust Fluid (DEF) and Tank

DEF

DEF is used in the aftertreatment system to lower NOx in the exhaust stream. DEF is colorless and close to odorless. (It may have a slightly pungent

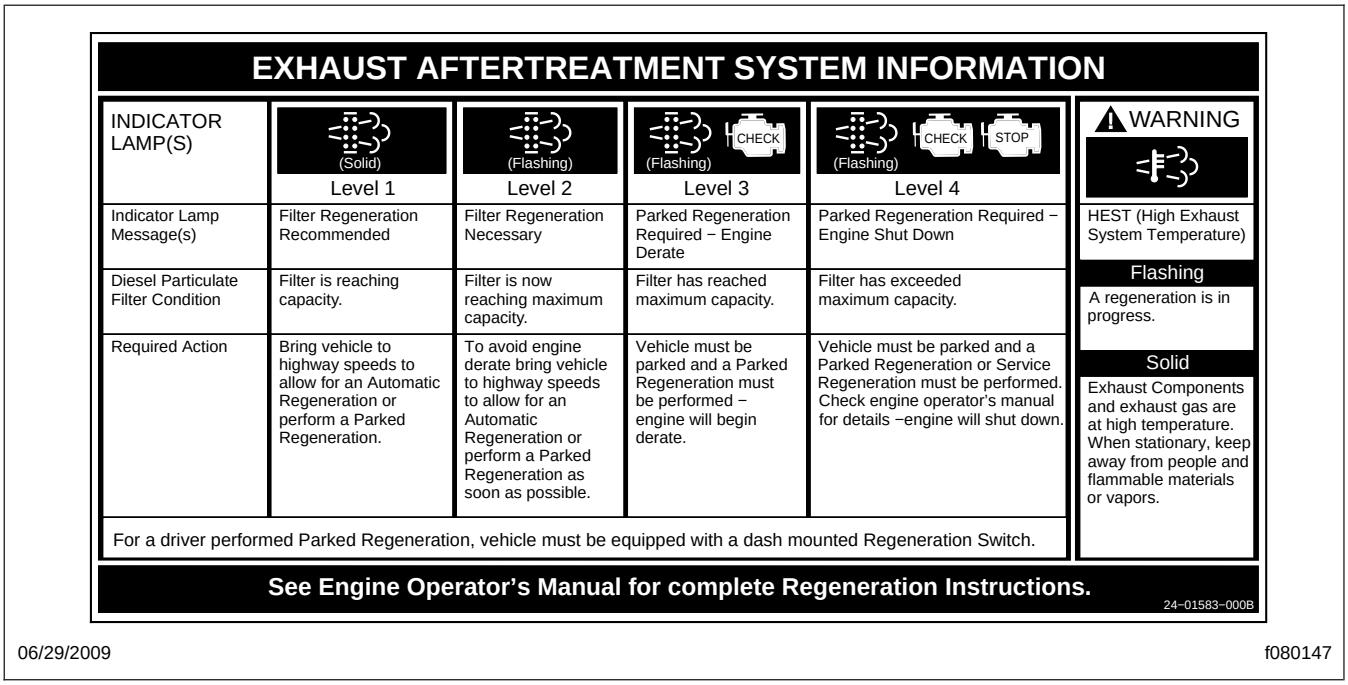


Fig. 8.1, Exhaust-Aftertreatment Warnings Reference Label

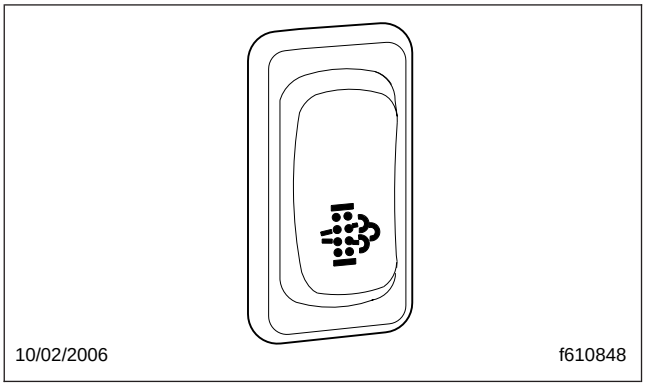


Fig. 8.2, Regen Switch

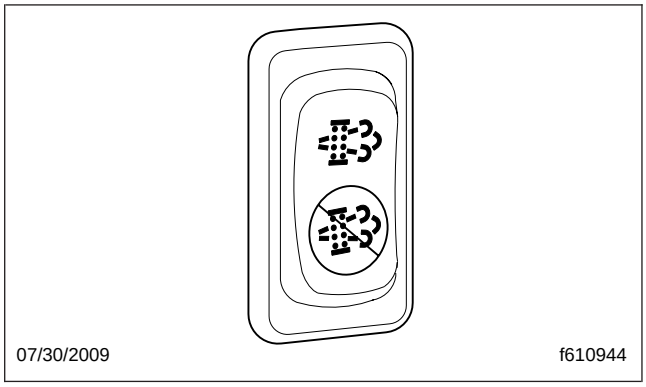


Fig. 8.3, Regen Inhibit Switch (optional when available)

odor similar to ammonia.) It is nontoxic, non-flammable and biodegradable. It is mildly corrosive to aluminum, but it will not affect the strength or structure of the aluminum. A white powder may be noticeable around components that the DEF comes in contact with. Around 12°F (-11°C) DEF freezes to slush, but is not damaged or destroyed if frozen, and is fully usable when thawed. The DEF supply lines are electrically heated and are purged when the engine is shut down. The DEF in the tank is allowed to freeze while the vehicle is non-operational. At start up, normal operation of the vehicle is not inhibited if the DEF is frozen; an immersion heater with engine coolant flowing through it will warm the DEF once the engine is running, to allow the SCR system to operate.

DEF Tank

EPA10-compliant vehicles are equipped with a DEF tank located between the aftertreatment system (ATS) and the fuel tank, or an optional location forward of the fuel tank. The DEF tank has a 19 mm filler neck inlet that prevents the hose from a diesel

outlet from being inserted, and has a blue cap for easy identification.

The DEF tank will require filling a minimum of approximately every second diesel refuel depending on the DEF tank capacity. The Saf-T-Liner C2 School Bus has an 11.5-gallon tank capacity. DEF consumption is approximately 2% of fuel consumption, dependent on vehicle operation. For every 50 gallons of diesel fuel consumed, approximately 1 gallon of DEF will be consumed.

Fuel/DEF Gauge

The fuel and DEF levels are measured in a dual purpose fuel/DEF gauge. See **Fig. 8.4**.

The diesel fuel level is indicated at the top of the gauge, and a low-fuel warning lamp illuminates amber when the diesel fuel level registers 1/8th of capacity.

The lower portion of the gauge has a DEF warning lamp that illuminates when the DEF tank is near empty, and a DEF lightbar that indicates the level in the DEF tank as follows.

- Between 75% and 100% full, four bars are illuminated green.
- Between 50% and 75% full, three bars are illuminated green.
- Between 25% and 50% full, two bars are illuminated green.
- Between 10% and 25% full, one bar is illuminated green.
- One bar illuminated amber—DEF very low, refill DEF.
- One bar flashing red—DEF empty, refill DEF.

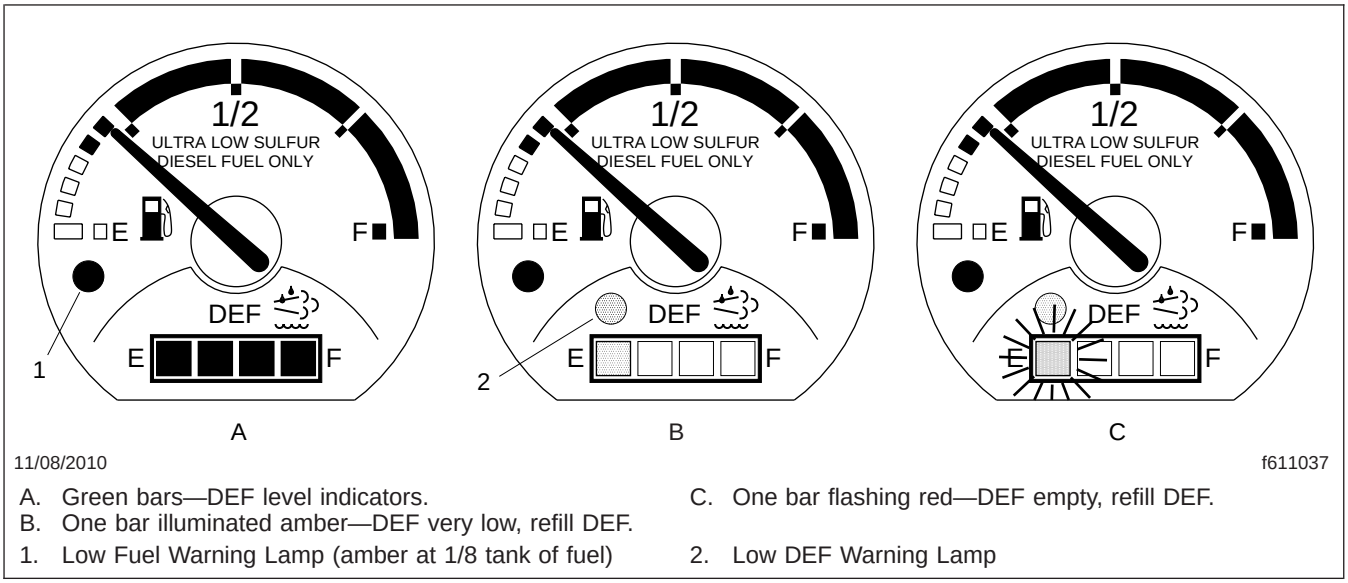
DEF Warnings and Engine Limits

IMPORTANT: Ignoring the DEF warning lights and not refilling the DEF will result in limited engine power with a speed limit of 5 mph (8 km/h) eventually being applied. See the Cummins Operation and Maintenance Manual for further information.

DEF Level Low—Initial and Critical Warnings

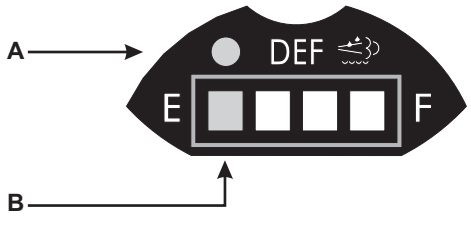
When the DEF level reads low the following warnings strongly encourage the driver to refill the DEF tank. See **Fig. 8.5**.

- The DEF warning lamp illuminates constantly (initial warning).



A. Green bars—DEF level indicators.
B. One bar illuminated amber—DEF very low, refill DEF.
C. One bar flashing red—DEF empty, refill DEF.
1. Low Fuel Warning Lamp (amber at 1/8 tank of fuel)
2. Low DEF Warning Lamp

Fig. 8.4, Fuel/DEF Gauge



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A. DEF Warning Lamp (solid amber)
B. DEF-Level Lightbar (1 bar solid amber)

Fig. 8.5, DEF Level Low Initial and Critical Warnings

- The DEF warning lamp flashes (critical warning).
- DEF-level lightbar illuminates solid amber.

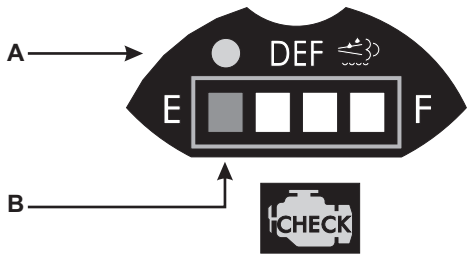
DEF Empty

When the DEF level reads empty, the following warnings are activated. See **Fig. 8.6**.

- One bar of the DEF-level lightbar flashes red.
- The DEF warning lamp flashes.
- The CHECK engine lamp illuminates.

Engine performance is limited, with progressively harsher engine power limits applied.

The DEF tank must be filled to cancel the warning sequence.



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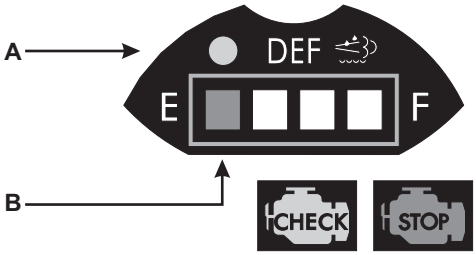
NOTE: Engine power is limited.
A. DEF Warning Lamp (flashing amber)
B. DEF-Level Lightbar (1 bar flashing red)

Fig. 8.6, DEF Empty Warning

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the red STOP engine lamp illuminates in addition to the DEF warning lamp and the CHECK engine warning lamp. See **Fig. 8.7**.

If the DEF tank is not refilled, a 5 mph (8 km/h) speed limit will be applied after the next engine shutdown, or while parked and idling.



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NOTE: The STOP engine, CHECK engine, and DEF lamps illuminate, engine power is limited, speed limit of 5 mph (8 km/h).
A. DEF Warning Lamp (flashing amber)
B. DEF-Level Lightbar (1 bar flashing red)

Fig. 8.7, DEF Empty and Ignored Warning

NOTICE

Once contaminated DEF or tampering has been detected in the SCR system, the vehicle must be taken to an authorized service center to check the SCR system for damage, and to deactivate the warning light and engine limits.

DEF Quality or SCR Tampering

If contaminated DEF or tampering is detected, the DEF warning light flashes, and engine performance is limited with progressively harsher engine power limits applied. If the fault is not corrected, the CHECK engine lamp illuminates, then the STOP engine lamp illuminates and a 5 mph (8 km/h) speed limit will be applied after the next engine shutdown, or while parked and idling. See **Fig. 8.7**.

EPA07 Aftertreatment System (ATS)

All on-road diesel engines built after December 31, 2006, (EPA07 engines) must meet strict new guidelines for reduced exhaust emissions of particulate matter and nitrogen oxides (NOx). NOx is limited to just over 1 gram per brake horsepower hour (g/bhp-hr) and particulate matter cannot exceed 0.01 g/bhp-hr.

EPA07-compliant engines require ultralow-sulfur diesel (ULSD) fuel, and they should never be run on fuel with sulfur content higher than 15 ppm. In addition, they require low-ash engine oil. The following guidelines must be followed or the warranty may be compromised.

- Use ultralow-sulfur diesel (ULSD) fuel with 15 ppm sulfur content or less, based on ASTM D2622 test procedure.
- Do not use fuel blended with used engine lube oil or kerosene.
- Engine lube oil must have a sulfated ash level less than 1.0 wt %; meeting the API CJ-4 index specifications.

IMPORTANT: Using non-specification fuels or oils can lead to shortened Diesel Particulate Filter (DPF) cleaning or exchange intervals. For example, using CI-4+ oil with 1.3% sulfated ash (30% more ash content) may result in the need for DPF cleaning or exchange 20 to 30% sooner than would normally be required.

The "exhaust system" in EPA07-compliant vehicles is called the aftertreatment system (ATS). The ATS varies according to engine manufacturer and vehicle configuration, but instead of a muffler, an aftertreatment system has a device that outwardly resembles a muffler, called the aftertreatment device (ATD).

IMPORTANT: See your engine operation manual for complete details and operation of the aftertreatment system.

Inside the ATD, the exhaust first passes over the diesel oxidation catalyst (DOC), then it passes through the DPF, which traps soot particles. If exhaust temperature is high enough, the trapped soot is reduced to ash in a process called passive regeneration (regen). **Passive regeneration** occurs as the vehicle is driven normally under load; the driver is not even aware that it is happening. The harder an EPA07 engine works, the better it disposes of soot, as the exhaust heat alone is enough to burn the soot to ash. Over the course of a workday, however, passive regeneration cannot always keep the ATD filter clean, so the filter must undergo **active regeneration**. In active regeneration, extra fuel is injected into the exhaust stream to superheat the soot trapped in the DPF and turn it to ash. Active regeneration happens only when the vehicle is moving above a certain speed, determined by the engine manufacturer. Consult manufacturers' documentation for details.

Both active and passive regeneration happen automatically, without driver input.

Only when operating conditions do not allow for ATD filter cleaning by at-speed active or passive regeneration, the vehicle may require a driver-activated **parked regeneration**. The vehicle must be standing still, and the driver must initiate parked regen. Completing a parked regen takes 20 minutes to an hour, depending on ambient conditions.

⚠ DANGER

During parked regeneration, exhaust temperatures are very high, and could cause a fire, heat damage to objects or materials, or personal injury to persons near the exhaust outlet.

Before initiating a parked regeneration, make certain the exhaust outlets are directed away from structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by prolonged exposure to high heat.

The warning lamps in the driver message center alert the driver of a regen in progress, of high exhaust temperatures, of the need to perform a parked regen either soon or immediately, and of an engine fault that affects the emissions.

A slow (10-second) flashing of the high exhaust system temperature (HEST) lamp indicates that a parked regen is in progress, and the engine's high idle speed is being controlled by the engine software, not the driver.

A steadily illuminated high exhaust system temperature (HEST) lamp alerts the operator of high exhaust temperature during the regeneration process, if vehicle speed is below 5 mph (8 km/h). See **Fig. 8.8**. The HEST lamp does not indicate the need for any

kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or combust.

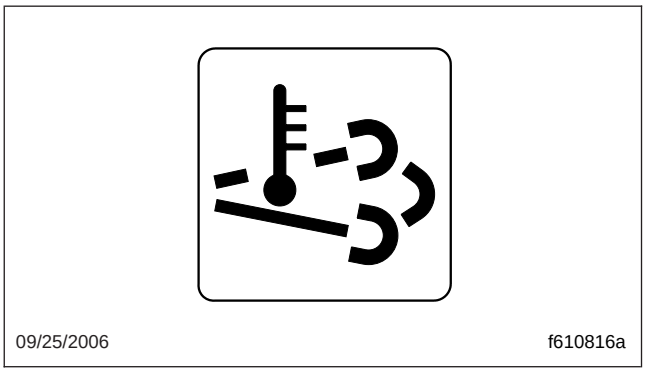


Fig. 8.8, High Exhaust System Temperature (HEST) Lamp

⚠ WARNING

When the HEST lamp is on, be certain that the exhaust pipe outlet is not directed at combustible material or toward anyone. To do so could cause damage to the vehicle and serious personal injury to others.

⚠ WARNING

Active regeneration can occur automatically any time the vehicle is moving. The exhaust gas temperature could reach 1500°F (800°C), which is hot enough to ignite or melt common materials, and to burn people. The exhaust can remain hot after the vehicle has stopped moving.

IMPORTANT: Due to the high exhaust temperature during the regen process, a diffuser is used to reduce the temperature at the exhaust pipe outlet. See **Fig. 8.9**. If the diffuser is damaged, it must be replaced to ensure proper operation of the vehicle and to reduce the possibility of damage or injury.

A steadily illuminated yellow Diesel Particulate Filter (DPF) lamp indicates a regen is required soon. Bring the vehicle to highway speeds to allow for an active regen, or a parked regen should be scheduled for the earliest convenient time. See **Fig. 8.10**.

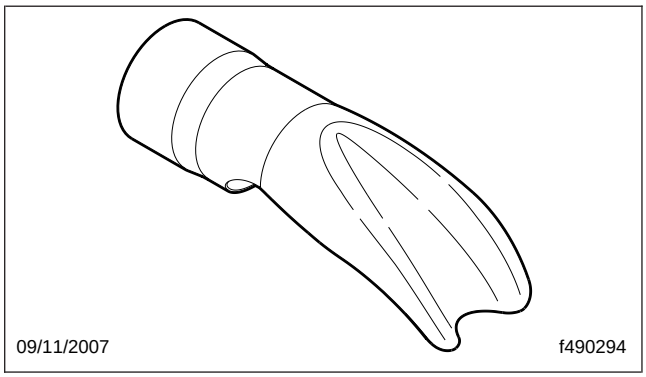


Fig. 8.9, Exhaust Diffuser

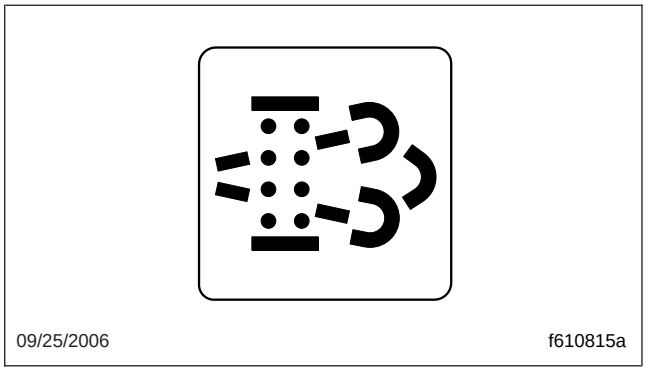


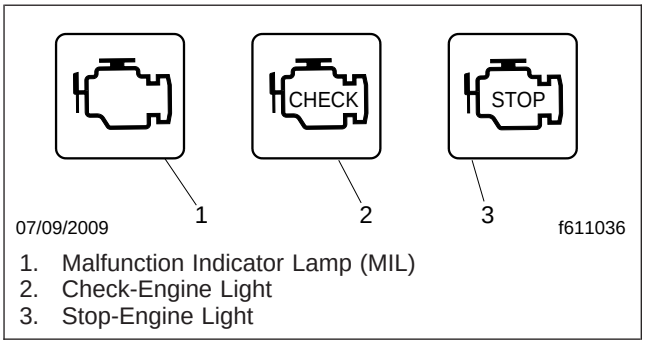
Fig. 8.10, Diesel Particulate Filter (DPF) Status Lamp

IMPORTANT: Failure to regen could cause engine problems, including derate or loss of power. As soon as allowed after the DPF lamp illuminates, maintain highway speeds to allow automatic regeneration, or park the vehicle in a safe location and perform a parked regen.

A DPF lamp blinking at the same time as a steadily illuminated yellow Check Engine lamp indicates that a parked regen must be performed immediately, or an engine derate will occur. If the red Stop Engine lamp illuminates with the blinking DPF lamp and the yellow Check Engine lamp, a parked regen must occur or an engine shutdown will occur. Park the vehicle and perform a parked regen. See **Fig. 8.11** and **Fig. 8.12**.

The DPF regen switch, located on the dash, may have three selectable positions:

- Request Regeneration



1. Malfunction Indicator Lamp (MIL)
2. Check-Engine Light
3. Stop-Engine Light

Fig. 8.11, Engine Protection Lamps

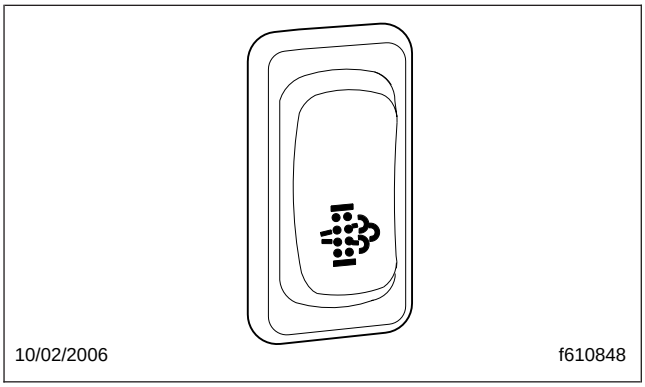


Fig. 8.12, Regen Switch

- Default (can include appropriate normal state condition—either in an automatic regeneration or inhibit state)
- Inhibit regeneration (optional when available)

NOTE: The regen switch can start a regen only when at least one of two conditions exists: either the DPF light is lit, or the engine software calls for it. If neither of those conditions exist, the regen switch cannot cause a regen to happen.

The function of the switch will vary by the engine make and model in the vehicle. See the engine operation manual for switch operation details.

When diesel particulate filter servicing is needed, it must be performed by an authorized technician, and a record must be maintained for warranty purposes. The record must include:

- date of cleaning or replacement
- vehicle mileage
- particulate filter part number and serial number

A steadily illuminated Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the emissions. The MIL lamp applies to the Mercedes-Benz engine only. See **Fig. 8.13**.

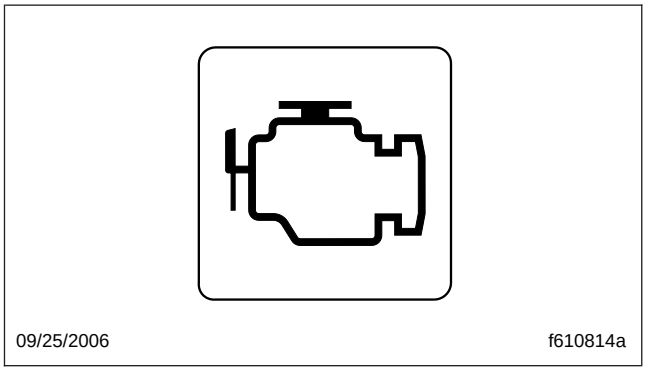


Fig. 8.13, Malfunction Indicator Lamp (MIL)

High-Soot-Load Idle Shutdown

Extended idle operation can cause soot to accumulate in the DPF, which can eventually trigger an ECM fault, cause the Stop Engine lamp to illuminate, and require replacement of the DPF. The High-Soot-Load Idle Shutdown feature (if equipped), determines if the extended engine idling needs to be shut down before there is a triggering of the stop engine warning.

The High-Soot-Load Idle Shutdown feature monitors the soot load during the idle or high-idle operation. If high-soot-load occurs, the DPF lamp will illuminate, then the "Check Engine" lamp will flash for 30 seconds, before the engine shuts down.

Engine Starting

For cold-weather starting, refer to the engine manufacturer's operator's manual for detailed instructions.

General Information

NOTE: Before starting the engine, read **Chapter 4** and **Chapter 5** in this manual for detailed information on how to read the instruments and operate the controls.

Before operating the vehicle, perform the engine pretrip inspection and daily maintenance checks in **Chapter 11** and **Chapter 12** of this manual.

NOTICE

When starting a vehicle equipped with a manual transmission and clutch lockout switch, the clutch pedal must be fully depressed during the entire start sequence. Failure to do so can cause the pinion to release and re-engage, which could cause ring gear and starter pinion damage.

If a vehicle does not start on the first attempt, make sure that the engine has completely stopped rotating before reapplying the starter switch. Failure to do so can cause the pinion to release and re-engage, which could cause ring gear and starter pinion damage.

Moving a vehicle with the starter and/or using the starter to bump the engine for maintenance procedures is strictly prohibited. Use of these methods to bump the engine over or move the vehicle can cause the pinion to release and re-engage, which could cause ring gear and starter pinion damage.

NOTICE

Never attempt to start any Cummins IS series electronic engine (ISB, ISC, ISL) using ether or any other starting fluid. Serious engine damage could result.

1. Set the parking brake.
2. Turn the ignition switch to the ON position. The low air pressure and low oil pressure warning lights (or messages) and buzzer operate until the engine is started and pressure is built up.
3. Make sure that the transmission shift control is in Neutral (N), Park (P), or the Park Brake (PB) position.

IMPORTANT: Do not depress the throttle pedal while starting the engine.

4. Turn the ignition switch to the START position. After the engine starts, release the key.

NOTICE

Do not crank the engine for more than 30 seconds at a time. Wait two minutes after each try to allow the starter to cool. Failure to do so could cause starter damage.

5. Bring the engine up to operating speed gradually as it warms up and develops stable oil pressure.

IMPORTANT: When the engine is started, it takes a short time to build up a lubricating oil film between the shafts and bearings, and between the pistons and cylinder walls. The oil pressure gauge indicates any drop in lubricating oil pressure within 15 seconds of engine startup. See the *Cummins Operation and Maintenance Manual* for minimum idle oil pressure specifications.

Starting After Extended Shutdown or Oil Change

NOTE: An engine in storage for an extended period of time (over winter, for example) may accumulate water in the oil pan. Oil diluted by water cannot provide adequate bearing protection at start-up. For this reason, change the engine oil and filters after extended storage.

Do the following steps after an oil change or after the engine has been shut down for more than three days:

1. Make sure the transmission is filled with the correct type of fluid, as recommended by the transmission manufacturer.
2. Make sure the fuel tank is full. If air has entered the fuel system, prime the fuel system, using the engine manufacturer's instructions.
3. If the engine is equipped with a fuel/water separator, drain off any accumulated water.
4. Check the drive belts to make sure they are in good condition and properly adjusted. Replace any drive belts that are cracked, worn, or glazed.
5. Check the turbocharger for signs of oil or exhaust leaks. Correct any problems before starting the engine.
6. Check the engine mounting bolts for tightness. Retighten them if necessary.
7. Make sure the battery cable connections are clean and tight. Check that the batteries are charged.
8. Start the engine. See the "Engine Starting" heading in this chapter.

Engine Operation

General Information

IMPORTANT: For cold-weather starting, engine break-in, and cold-weather operation, refer to the engine manufacturer's operator's manual for detailed instructions.

Operating vehicles in areas where there are concentrated flammable vapors (such as diesel, gasoline, or propane fumes) can create a hazardous situation. These vapors can be drawn into the engine through the air intake, and cause engine overspeed. Be especially cautious of low-lying or closed-in areas, and always check for signs that flammable vapors may be present.

⚠ DANGER

Do not operate the engine in an area where flammable vapors such as gasoline or diesel fumes are present. Shut down the engine when in an area where flammable liquids or gases are being handled. Failure to observe these precautions could result in serious injury or death.

All diesel engines have been built to comply with the requirements of the Federal (U.S.) Clean Air Act. Once an engine is placed in service, the responsibility for meeting both state and local regulations is with the owner/operator. Good operating practices, regular maintenance, and correct adjustments are factors that will help to stay within the regulations.

Adequate maintenance of the engine, which is the responsibility of the owner/operator, is essential to keep the emission levels low.

The driver should be familiar with the vehicle warning system in order to bring the vehicle to a safe stop if the engine malfunctions. If the driver doesn't understand how the warning system works, an engine shutdown could occur, causing a safety hazard. See **Chapter 5** for information on the control panel for these engines.

Follow the directions in the *Cummins Operation and Maintenance Manual* and in this manual for trouble-free, economical vehicle engine operation.

NOTICE

Stop the engine at the first sign of malfunction. Almost all malfunctions give some warning to the operator before significant damage occurs. Many engines are saved because alert operators heed the warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine.

1. Cummins diesel engines are designed to operate successfully at full throttle under transient conditions down to rated rpm. This is consistent with recommended operating practices.
2. Depending on the vehicle gearing, the posted speed limit can sometimes allow operation in either of the top two gears; however, for improved operating efficiency (fuel economy and engine life), operate in the top gear at reduced rpm rather than in the next lower gear at the maximum rpm.
3. Cruise at partial throttle whenever road conditions and speed requirements permit. This driving technique permits operating within the most economical power range of the engine.
4. When approaching a hill, open the throttle smoothly to start the upgrade at full power, then shift down as desired to maintain the optimum vehicle speed. The high torque of Cummins engines may permit topping some grades without shifting.
5. Cummins engines are designed to operate over a wide speed range. More frequent shifting than necessary does not allow proper utilization of this flexibility. The driver who stays in top gear and uses the wider speed range will achieve the best fuel economy.
6. The Cummins diesel engine is effective as a brake on downhill grades, but take care not to overspeed the engine going downhill. The governor has no control over engine speed when the engine is being pushed by the loaded vehicle.

NOTICE

Do not allow the engine to exceed its governed speed, or serious engine damage could result.

7. Never turn the ignition switch to the OFF position while going downhill. With the engine still in gear, fuel pressure will build up against the shutdown valve and can prevent it from opening when the ignition switch is turned to the ON position.
8. Use a combination of brakes and gears to keep the vehicle under control at all times, and to keep the engine speed below the rated governed rpm.
9. Check the coolant temperature and oil pressure gauges frequently.

NOTICE

Continuous operation below 140°F (60°C), above 212°F (100°C), or with the oil pressure below 10 psi (69 kPa), can damage the engine.

10. Do not idle the engine for more than 10 minutes. Long periods at low idle can damage the engine.

NOTE: Long periods of idling are not good for an engine because the combustion chamber temperatures drop so low that the fuel may not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can result in stuck valves.

11. If the engine starts to overheat, reduce the power output of the engine. Do one, or both, of the following: (1) Release pressure on the accelerator pedal; (2) Shift to a lower gear. If the temperature does not return to normal, shut down the engine.

Engine Shutdown

Shut down the engine immediately if:

- the oil pressure gauge needle swings back and forth or falls sharply;
- engine power and rpm fall, even though the accelerator pedal remains steady;
- the exhaust pipe gives off heavy smoke;
- the coolant and/or oil temperature climb abnormally;
- abnormal sounds suddenly occur in the engine or turbocharger.

IMPORTANT: Bearings and seals in the turbocharger are subjected to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away by oil circulation, but if the engine is stopped suddenly, the turbocharger temperature may rise as much as 115°F (64°C).

1. With the vehicle stopped, apply the parking brake, and place the transmission in Neutral (N) (manual transmissions).
2. Idle the engine for three to five minutes before shutting it down. This allows the lubricating oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, etc. This is especially important with turbocharged engines. The extreme heat can cause bearings to seize or oil seals to leak.

NOTE: Long periods of idling are not good for an engine because the combustion chamber temperatures drop so low that the fuel may not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can result in stuck valves.

NOTICE

Do not rev the engine before shutting it down. Revving the engine before shutdown will damage the turbocharger.

3. Shut down the engine by turning the ignition switch to the OFF position.

High Idle Options

NOTE: To operate the high idle options listed below, the vehicle must be stopped, the transmission shift lever placed in the Neutral (N) or Park (P) position, and the parking brake set.

IMPORTANT: Do not idle the engine for excessively long periods. The extreme heat can cause the bearings to seize or the oil seals to leak.

High Idle with Cruise Control

1. Place the shift lever in Neutral (N) or Park (P) and set the parking brake.

2. Press the cruise switch located on the dash to the ON position. Press the RESUME switch to accelerate the engine revolutions per minute (rpm) to the minimum set speed. To increase the engine rpm, press and hold the RESUME switch. To decrease the engine rpm, press and hold the SET switch.

NOTE: The rpm can also be increased by depressing the throttle pedal until the desired rpm is met, and then pressing the SET switch.

3. Disengage the cruise control by depressing the service brake pedal, or by moving the ON/OFF switch to the OFF position.

Voltage-Based Auto High Idle

1. Place the shift lever in Neutral (N) or Park (P) and set the parking brake.
2. The idle rpm will automatically increase when the voltage drops below 12.2 volts. The rpm will incrementally increase every five seconds until 13.4 volts is achieved and maintained.
3. The Voltage-Based Auto High Idle system is disengaged by depressing the service brake pedal.

IMPORTANT: The Voltage-Based Auto High Idle system will not return to normal operation until one of the following occurs: The parking brake is depressed and released, the key switch is turned to the OFF position, or the transmission gears are changed.

Fuel/Water Separator

Vehicles equipped with a Cummins ISB engine have a fuel/water separator mounted on the left frame member above the front spring mount.

IMPORTANT: Drain water and sediment from the fuel/water separator daily. Drain the water and sediment from the fuel/water separator into a container. Dispose of drained water and sediment in accordance with federal and local environmental regulations.

9

Drivetrain

Driving Precautions

The bus operator should use care when accelerating or downshifting on slippery road surfaces. Sudden acceleration or engine braking, caused by shifting to a lower gear range, can result in a loss of vehicle control. This is very important on snow- or ice-covered roads. See **Chapter 10** for brake operation.

If the bus is stuck in sand or mud, do not attempt to pull the bus out under its own power. Request professional towing assistance.

⚠ CAUTION

Do not attempt to rock the vehicle. If rocking the vehicle is necessary, even at low speeds, it may cause engine overheating, axle damage, transmission damage or failure, or tire damage.

Do not coast the vehicle in neutral. Severe transmission damage may result and the vehicle will not have the benefit of engine braking.

⚠ WARNING

To reduce the risk of personal injury, before going down a steep or long grade, reduce speed and downshift the transmission. Do not hold the brake pedal down too long or too often while going down a steep or long grade. This could cause the brakes to overheat, reducing their effectiveness. As a result, the vehicle will not slow down at the usual rate. Failure to take these steps could result in loss of vehicle control.

To avoid skidding on slippery roads, do not downshift into "1" (Low) at speeds above 20 mph (32 km/h).

On slippery surfaces, avoid quick movements of the steering wheel. Decrease your speed and allow for extra stopping distance required by these conditions. For non-ABS brakes, apply the brakes by pumping the pedal steadily and evenly to avoid wheel lock-up and loss of vehicle control.

Avoid driving through flooded areas unless you are sure the water is no higher than the bottom of the wheel rims. Drive through slowly. Allow adequate stopping distance since wet brakes do not grip well. After driving through water, gently apply the brakes several times while the vehicle is moving slowly to dry the brakes.

When driving on icy or graveled surfaces, reduce speed. Avoid sharp turning maneuvers.

Allison On-Highway Transmissions

The Allison on-highway transmissions are fully automatic and include the 2100 Series, 2200 Series, 2500 Series, and 3000 Series. Refer to **www.allisontransmission.com** for addtional information.

Safety Precautions

2100, 2200, and 2500 Series

⚠ WARNING

Do not leave the vehicle unattended with the engine running. If you leave the vehicle and the engine is running, the vehicle can move suddenly, which could result in personal injury or property damage.

On vehicles with Allison 2000 series transmissions, do the following steps if you have to leave the vehicle with the engine running (for example, when checking the transmission fluid).

Without Auto-Apply Parking Brake

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.
3. Put the transmission in neutral.
4. Apply the parking brake, and make sure it is properly engaged.
5. Chock the rear tires and take any other steps necessary to keep the vehicle from moving.

With Auto-Apply Parking Brake

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.
3. Put the transmission in PB (auto-apply parking brake).
4. Apply the parking brake (if so equipped), and make sure it is properly engaged.

5. Chock the rear tires and take any other steps necessary to keep the vehicle from moving.

Range Inhibit Indicator, 2000 Series

A RANGE INHIBIT indicator is a standard feature of the 2000 series transmissions. The RANGE INHIBIT indicator comes on to alert the driver that transmission operation is being inhibited and that the range shifts being requested by the driver may not occur. When certain operating conditions are detected by the TCM (transmission control module), the controls will lock the transmission in the current operating range.

Shift inhibits occur under the following conditions:

- Shifts from neutral to reverse or from neutral to a forward range when the engine is above idle, greater than 900 rpm.
- Forward/reverse directional shifts are typically not permitted if appreciable output shaft speed is detected.
- When some types of unusual transmission operating conditions are detected by the TCM, the TCM temporarily limits transmission operation until the vehicle can be driven to a service location. When this type of situation is detected, the TCM will lock the transmission in a safe gear range.
- The TCM will prevent shifts from park or neutral to range when auxiliary equipment is in operation.
- If a shift from a higher to a lower gear causes the engine to overspeed.

Operating Instructions, 2000 Series Transmissions

2000 series transmissions are electronically controlled. The shift selector provides four forward ranges and one reverse range. A T-handle shift control is used by the driver to select the ranges. See **Fig. 9.1**.

P (Park)

Use park when turning the engine on or off, to check vehicle accessories, or to operate the engine in idle for longer than 5 minutes. This position places the transmission in neutral and engages the park pawl of the transmission.

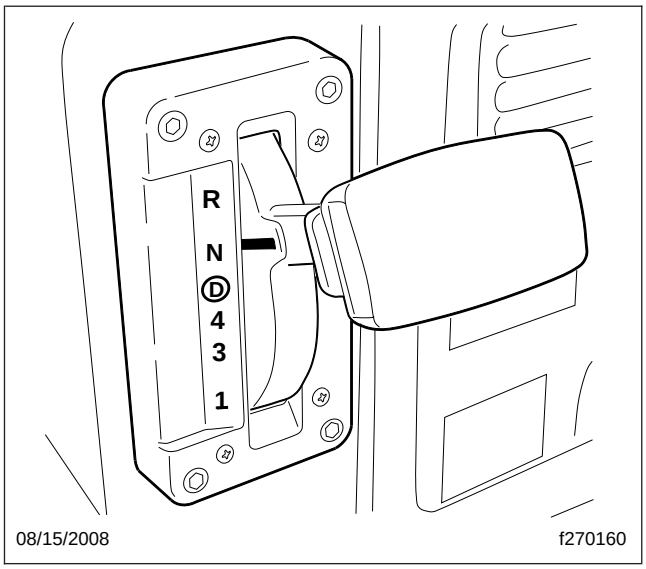


Fig. 9.1, T-Handle Shift Control

NOTE: This does not apply the parking brake.

NOTE: The park pawl is standard on the 2200 series transmission. The park pawl effectively grounds the transmission output shaft, thereby preventing rotation of the driveline. Provided the vehicle is stationary, selecting **P** (Park) on the shift selector places the transmission in **Neutral** and engages the park pawl.

PB (Auto-Apply Parking Brake, optional on 2000 Series)

The auto-apply parking brake places the transmission in neutral and applies the parking brake.

R (Reverse)

Reverse is used to back the vehicle. When the selector is in reverse, the reverse warning signal will sound. Always bring the vehicle to a complete stop before shifting from a forward range to reverse, or from reverse to a forward range.

Do not idle in reverse for more than 5 minutes. Select P (park), PB (auto-apply parking brake), if equipped, or N (neutral) when time at idle exceeds 5 minutes.

NOTE: The shift into reverse may not succeed if a range inhibitor is active. Check for illumination of the RANGE INHIBIT indicator.

N (Neutral)

The neutral position places the transmission in neutral. This position is used when starting the engine and for stationary operation.

When neutral is selected, the vehicle service brakes, parking brake, or emergency brake must be applied. Selecting neutral does not apply vehicle brakes unless an auxiliary system to apply the parking brake is installed.

Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and you could lose control of the vehicle.

D (Drive)

In the drive position, the transmission will initially go into first range when drive is selected. As vehicle speed increases, the transmission will upshift automatically through each available range up to fourth range or fifth range. As the vehicle slows, the transmission will downshift automatically.

When going downhill, downshift to a lower transmission range to increase engine braking and to help maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, the transmission may upshift to the next higher range, if the engine is exceeding its governed speed in the lower range.

NOTE: The shift into drive may not succeed if a range inhibitor is active. Check for illumination of the RANGE INHIBIT indicator.

4 and 3 (Fourth and Third Ranges, optional)

Use the fourth or third range for city traffic and for braking on steep downgrades.

3 and 2 (Third and Second Ranges, standard)

Use the third or second range for heavy city traffic and for braking on steeper downgrades.

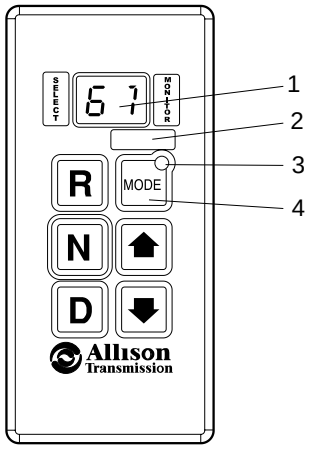
1 (First Range)

Use first range when pulling through mud or deep snow, when maneuvering in tight spaces, or when driving up or down very steep grades. First range provides the vehicle with its maximum driving torque and maximum engine braking effect.

NOTE: To have the transmission select these ranges automatically, leave the selector lever in D (drive).

Operating Instructions, 3000 Series

The Allison 3000 series transmission is electronically controlled and comes with a push-button shift control that provides five or six forward ranges and one reverse range. The push-button shift selector has an R (reverse), an N (neutral), a D (drive), an up arrow, a down arrow, a mode button, and a digital display. See **Fig. 9.2**.



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1. Digital Display
2. Mode Identification Label
3. Mode Indicator LED
4. Mode Button

Fig. 9.2, Push-Button Shift Selector

R (Reverse)

Press the R button to select reverse. The digital display will show R when reverse is selected. Always bring the vehicle to a complete stop and let the engine return to idle before shifting from a forward range to reverse, or from reverse to a forward range.

⚠ CAUTION

Extended idling in reverse may cause transmission overheating and damage.

Do not idle in reverse for more than 5 minutes. Select neutral when time at idle exceeds 5 minutes.

NOTE: The shift into reverse may not succeed if a range inhibitor is active. When reverse is selected, always be sure that R is not flashing.

N (Neutral)

⚠ WARNING

When starting the engine, make sure that the service brakes are applied. Failure to apply the service brakes may result in unexpected vehicle movement, which could cause severe personal injury or death. Failure to apply the vehicle parking brakes when the transmission is in neutral may allow the vehicle to move unexpectedly, possibly causing property damage or personal injury.

Press the N button to select neutral. The digital display will display N when neutral is selected. It is not necessary to press neutral before starting the vehicle. The ECU (electronic control unit) or TCM (transmission control module) automatically places the transmission in neutral at start-up.

When neutral is selected, the vehicle service brakes, parking brake, or emergency brake must be applied. Selecting neutral does not apply vehicle brakes unless an auxiliary system to apply the parking brake is installed.

⚠ WARNING

Do not coast in neutral. Coasting in neutral can cause an accident, possibly resulting in severe personal injury or death.

Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and you could lose control of the vehicle.

Always select neutral before turning off the engine.

D (Drive)

When the D button is pushed, the highest forward range will appear in the display. The transmission will normally go into first range when drive is selected (except for those units programmed to start in second range). As vehicle speed increases, the transmission will upshift automatically through each range. As the vehicle slows, the transmission will downshift automatically.

⚠ CAUTION

Do not idle in drive for more than 5 minutes. Extended idling in drive may cause transmission overheating and damage. Always select neutral if time at idle is longer than 5 minutes.

NOTE: The shift into drive may not succeed if a range inhibitor is active. When drive is selected always be sure that D is not flashing.

5, 4, 3, and 2 (Fifth, Fourth, Third, and Second Ranges)

Occasionally, road conditions, load, or traffic conditions will make it desirable to restrict automatic shifting to a lower range. Lower ranges provide greater braking for going down grades. The lower the range, the greater the braking effect.

Push the up or down arrows on the push-button shift selector to select individual forward ranges. The digital display will display your choice of range. When a lower range is selected, the transmission may not downshift until the vehicle speed or engine RPM (engine governed speed) is reduced.

⚠ WARNING

When going downhill, use a combination of downshifting, braking, and other retarding devices to control vehicle speed and the engine's rated governed speed. Failure to do so could reduce vehicle braking, possibly causing loss of vehicle control and resulting in personal injury or property damage.

When going downhill, downshift to a lower transmission range to increase engine braking and to help maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if the engine governed speed is exceeded in the lower range, the transmission may upshift to the next higher range.

1 (First Range)

Use the first range when pulling through mud or deep snow, when maneuvering in tight spaces, or

when driving up or down steep grades. First range provides the vehicle with its maximum driving torque and maximum engine braking effect. Push the down arrow until the first range appears on the display.

Up and Down Arrows

When a lower range is desired, after D has been pressed, press the down arrow until the desired range is shown on the display. Pressing the down arrow continuously causes the range position to continue to go down until the button is released or the lowest range is attained.

When the transmission is in drive and the down arrow has the transmission in a lower range position, press the up arrow to shift to a higher selector position. Continuously pressing the up arrow causes the range position to continue to rise until the button is released or the highest available position is attained.

Continuously pressing the up or down arrows does not override the transmission automatic shifting operation. If a higher or lower position is selected, the transmission continues shifting through the ranges according to the vehicle operating characteristics until the highest or lowest selection position is reached.

Mode Button

The MODE button starts a specialized input or output function that has been previously programmed into the ECU or TCM. Pressing the MODE button changes transmission operation for a specific function.

Mode Indicator LED

When the MODE button is pressed, the mode indicator LED illuminates. A mode identification label, located above the MODE button, identifies the function associated with a mode change.

Digital Display

The dual digital display shows both the selected range (SELECT) and actual range attained (MONITOR). The single digital display shows the selected range.

Oil Level Sensor

Allison 3000 Series transmissions have an electronic oil level sensor to read fluid level information. The fluid level diagnostic will display whether the oil level is OK, too low, or too high. It will also display a default code and indicate if the preconditions (of receiving the fluid level information) are not met.

IMPORTANT: Maintain the proper fluid level at all times. If the fluid level is too low, the converter and clutch do not receive an adequate supply of fluid. If the level is too high, the transmission may shift erratically or overheat.

To access the oil level display mode, park the vehicle on a level surface, shift to N (Neutral), apply the parking brake, and idle the engine. Then simultaneously press both the up and down arrows once. The oil level will display at the end of a two-minute countdown.

Diagnostic Codes

Diagnostic codes are numerical indications relating to a malfunction in transmission operation. These codes are logged in the TCM/ECU memory. The most severe or most recent code is listed first. A maximum of five codes (numbered d1-d5) may be listed in memory at one time. If the mode indicator LED is illuminated, the displayed code is active. If it is not illuminated, the displayed code is not active.

NOTE: During normal operation, an illuminated mode indicator LED signifies the specialized mode operation is in use.

To enter diagnostics mode, first park the vehicle and apply the parking brake. Then simultaneously press both the up and down arrows twice.

Eaton® Fuller® Straight-Shift Transmissions

Refer to the Eaton website for additional information, **www.roadranger.com**.

General Information, Straight-Shift

Eaton Fuller 5-speed FS models are fully synchronized. They have five forward speeds and one reverse. See **Fig. 9.3** for the shift pattern.

Eaton Fuller 6-speed FS and FSO models are fully synchronized. They have six forward speeds and one reverse. See **Fig. 9.4** for the shift pattern.

These transmissions are designed for use with on-highway, fuel economy engines where a minimum of

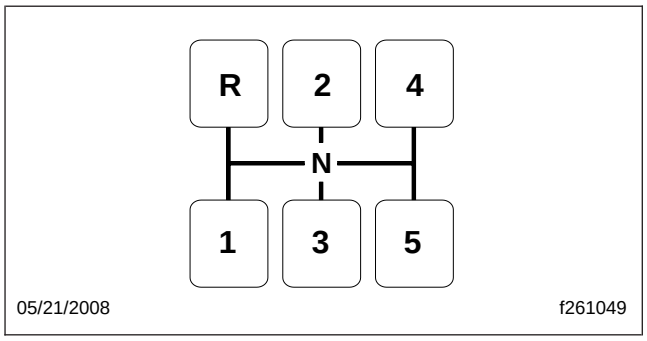


Fig. 9.3, Shift Pattern, 5-Speed FS Models

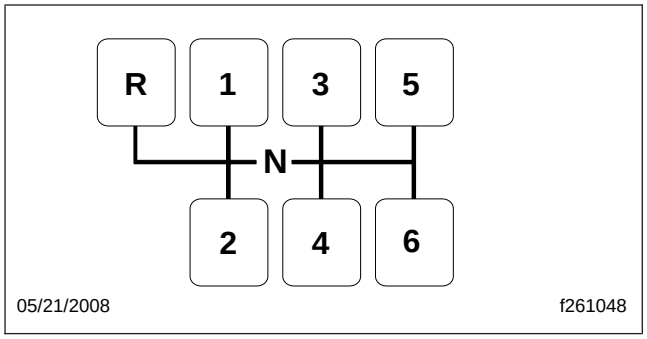


Fig. 9.4, Shift Pattern, 6-Speed FS and FSO Models

shifting is desired and less gear reduction is acceptable.

Operation, Straight-Shift

1. Always use first gear when starting to move the vehicle forward.

IMPORTANT: Do not rest your foot on the clutch pedal while driving. This causes partial clutch disengagement which could cause premature clutch wear.

2. On synchronized models, press the clutch pedal to the floor when shifting gears. Double-clutching is unnecessary.

   On unsynchronized models, press the clutch pedal to the floor to contact the clutch brake only when engaging the first or reverse gears.

NOTE: If the vehicle is moving when shifting, depress the pedal just far enough to disengage the clutch. Pressing it to the floor will engage the clutch brake, if so equipped, causing premature clutch brake wear.

3. To upshift, do the following steps:

   3.1 Accelerate to engine governed speed.

   3.2 On synchronized models, depress the clutch pedal and move the shift lever to second gear.

   On unsynchronized models, depress the clutch pedal and move the shift lever to neutral. Release the clutch pedal again. With the shift lever in neutral, depress the clutch pedal and move the shift lever to second gear.

   3.3 Release the clutch pedal and note the drop in engine rpm before accelerating up to engine governed speed again.

   3.4 Continue upshifting using the same sequence described in the previous step. Follow the pattern on the shift lever.

4. To downshift, do the following steps:

   4.1 Wait until the engine speed drops to the rpm noted immediately after the upshift.

   4.2 On synchronized models, depress the clutch pedal and move the shift lever to the next lower gear.

   On unsynchronized models, depress the clutch pedal and move the shift lever to neutral. Release the clutch pedal again. With the shift lever in neutral, depress the clutch pedal and move the shift lever to the next lower gear.

   4.3 Release the clutch pedal smoothly.

   4.4 Use the sequence described above to shift progressively down through each successive lower gear, as driving conditions require.

Clutches

Clutch Operation

Applying the Clutch Brake

The purpose of the clutch brake is to stop the transmission gears from rotating in order to engage the transmission gears quickly in making an initial start. To apply the clutch brake, put the transmission in neutral and press the clutch pedal to the floor.

⚠ CAUTION

Never apply the clutch brake while the vehicle is moving. The clutch pedal should never be pressed down fully before putting the transmission in neutral. Considerable heat will be generated, which will be detrimental to the friction discs, release bearings, and transmission front bearings.

Applying the clutch brake with the transmission still in gear puts a reverse load on the gear. At the same time, it will have the effect of trying to stop or decelerate the vehicle with the clutch brake. Rapid wear of friction discs will take place, necessitating frequent replacement.

Vehicle Overload, or Overloading the Clutch

⚠ CAUTION

Overloading will not only result in damage to the clutch, but also to the entire powertrain.

Clutches are designed for specific vehicle applications and loads. These limitations should not be exceeded.

Riding the Clutch Pedal

Riding the clutch pedal is destructive to the clutch. Partial clutch engagement permits slippage, and generates excessive heat. Riding the clutch pedal will also put a constant thrust load on the release bearing, which can thin out the lubricant. Release bearing failures can be attributed to this type of misuse.

Holding the Vehicle on an Incline With a Slipping Clutch

A slipping clutch accumulates heat faster than it can be dissipated, resulting in early clutch failures. Never use the clutch to hold a vehicle on a hill.

Coasting With the Clutch Released (pedal down) and the Transmission in Gear

⚠ WARNING

Do not allow the vehicle to coast with the clutch released (pedal down) and the transmission in gear. If the clutch facing is thrown off the disc, flying debris could cause injury to persons in the vehicle.

If the transmission remains in a low gear and the vehicle gains speed, as may occur on a downgrade, the input shaft and clutch driven disc will turn at speeds that are higher than normal. This occurs because the rear wheels and the driveline become the input for the transmission, and a higher-than-normal speed for a given transmission gear translates to a higher rpm value for the clutch driven disc.

Clutch driven discs are designed to allow for some amount of excess rotational speed, but the facing has a limited burst strength. If the clutch driven disc rpm increases too much, the clutch facing can be thrown off the disc(s).

Engaging the Clutch While Coasting

Engaging the clutch while coasting can result in tremendous shock loads and possible damage to the clutch as well as to the entire drivetrain.

Report Erratic Clutch Operation Promptly

Reporting erratic clutch operation as soon as possible will give maintenance personnel a chance to inspect the clutch components.

⚠ CAUTION

Operating the vehicle with incorrect clutch pedal free-travel could result in clutch damage. See Group 25 of the *Saf-T-Liner C2 School Bus Workshop Manual* for free-pedal adjustment procedures and specifications.

On mechanical clutch linkages, free-pedal travel should be included and commented on daily in the driver's report, since clutch free-pedal travel is the best guide to the condition of the clutch and the release mechanism.

Clutch Wear

The major reason clutches wear out too soon is excessive heat. Clutches are designed to absorb and dissipate more heat than encountered in typical operation. The temperatures developed in typical operation will not break down the clutch friction surfaces. However, if a clutch is slipped excessively or required to do the job of a fluid coupling, high temperatures develop quickly and destroy the clutch. Temperatures generated between the flywheel, driven discs, and pressure plates can be high enough to cause the metal to flow and the friction facing material to char and burn.

CAUTION

Do not allow sustained slippage of the clutch; this could severely damage the clutch disc, pressure plate, or flywheel. Damage caused by clutch slippage due to improper break-in is not warrantable.

Slipping and excessive heat are practically nonexistent when a clutch is fully engaged. But during the moment of engagement, when the clutch is picking up the load, it generates considerable heat. An incorrectly adjusted or slipping clutch will rapidly generate sufficient heat to destroy itself.

The most important items that a driver should be aware of to ensure long service life of the clutch include: starting in the right gear, recognizing clutch malfunctions, and knowing when to adjust a clutch.

Clutch Adjustments

Some clutches have an internal adjustment. See the applicable section in **Group 25** of the *Saf-T-Liner C2 School Bus Workshop Manual* for clutch adjustment procedures and specifications.

CAUTION

Operating the vehicle with the clutch incorrectly adjusted could result in clutch or clutch brake failure.

Clutch Lubrication

The release bearing should be lubricated at frequent intervals. See **Group 25** of the *Saf-T-Liner C2 School Bus Maintenance Manual* for intervals and procedures.

CAUTION

Failure to lubricate the release bearing as recommended could result in release bearing damage and damage to the clutch.

Meritor™ Drive Axles

Refer to the Meritor website for additional information, **www.arvinmeritor.com**.

Drive Axles With Differential Lock, Optional

The Meritor driver-controlled differential lock feature (side-to-side wheel lock, traction control, or traction equalizer) is available on single-drive or dual-drive rear axles. It is available on both axles of a dual-drive vehicle, or on one only. It is only available on drive axles. Differential lock must only be used under adverse road conditions where greater traction is needed. With differential lock on, the turning radius is increased and vehicle handling is affected. The differential lock switch allows the driver to lock the wheels on the same axle together. See **Fig. 9.5**. The red differential lock warning light illuminates on the dash message center when differential lock is engaged.

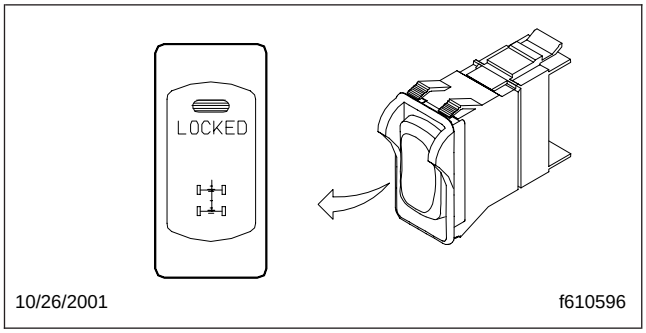


Fig. 9.5, Differential Lock Switch, Optional

Differential lock provides maximum traction under slippery conditions. When the differential lock is engaged, the clutch collar completely locks the differential case, gearing, and axle shafts together, maximizing the traction of both wheels and protecting against spinout.

Under normal traction conditions, do not use the differential lock feature.

Differential Lock Switch, Optional

CAUTION

Differential lock should only be engaged when the vehicle is stopped or moving slowly at low throttle. This will prevent internal axle damage.

Normally, when differential lock is available on dual-drive vehicles, one switch activates the lock on both rear drive axles. As an option, it is possible to have two differential lock switches, one for the forward rear and one for the rearmost drive axle. It is also possible for some vehicles to have differential lock on only one of the drive axles.

A two-position guarded rocker switch controls differential lock, causing the wheels on each axle governed by the switch to rotate together. See **Fig. 9.5**. To lock the wheels together, press the upper half of the rocker momentarily (at the red LED). To unlock the wheels, press the upper half of the rocker again.

IMPORTANT: The differential lock rocker switch is guarded to prevent unintentional switch activation. If the LED in the switch begins to blink during normal operation, when the switch has not been activated, this indicates an error condition. Bring the vehicle to an authorized Freightliner service facility as soon as possible.

When the differential lock switch is pressed, three responses are possible: a normal response, a slow response, and an abnormal response.

Normal Response: The LED in the switch blinks until the axle has responded to the request to lock the wheels. At this point, the LED comes on steady and stays illuminated. In normal operation, the wheels may lock so quickly that the blinking of the switch is barely noticeable.

If operation of the switch is not possible for any reason (ignition is turned off, vehicle is moving faster than 25 mph, etc.), the LED will stop blinking and turn off.

Slow Response: If operation of the switch is slowed for any reason (vehicle moving too fast, low air pressure, etc.), the switch will continue to blink until the wheels are able to lock. As in the normal response, the LED comes on steady and stays illuminated once the wheels have locked.

NOTE: If the vehicle is moving too fast, let up slightly on the accelerator. As the vehicle slows, the wheels will lock.

Abnormal Response: If the LED blinks for more than 30 seconds, the lock mechanism may not be fully engaged/disengaged. Bring the vehicle to an authorized Freightliner service facility for testing.

Differential Lock Operation

WARNING

Locking the wheels when the vehicle is traveling down steep grades or when the wheels are slipping could damage the differential and/or lead to loss of vehicle control, causing personal injury and property damage.

Lock the wheels only when the vehicle is standing still or moving at very low speed, less than 5 mph (8 km/h). Never lock the wheels when the vehicle is traveling down steep grades or when the wheels are slipping.

NOTE: On some vehicles, the differential lock system is connected through the low speed range of the transmission. If this system is used, the transmission must be in the low speed range for the wheels to fully lock.

WARNING

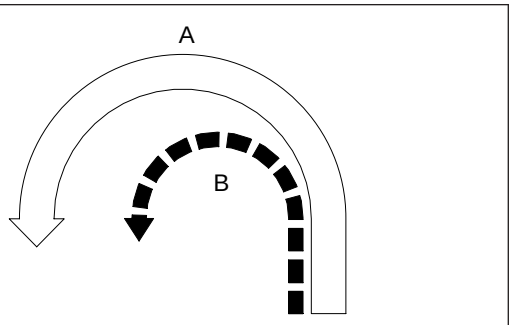
A vehicle with locked wheels can still slip sideways, causing possible loss of vehicle control, personal injury, and property damage.

Be especially careful when driving under slippery conditions with the wheels locked. Though forward traction is improved, the vehicle can still slip sideways.

If the vehicle is moving, maintain a constant vehicle speed when the differential lock is turned on. Briefly let up on the accelerator to relieve torque on the gearing, allowing the wheels to lock completely. When the wheels are fully locked, the turning radius will increase because the vehicle understeers. See **Fig. 9.6**. Drive cautiously and do not exceed 25 mph (40 km/h).

To disengage the differential lock after leaving poor road conditions, operate the differential lock switch as discussed above, while maintaining vehicle speed. Let up momentarily on the accelerator to allow the wheels to fully unlock, then resume driving at normal speed.

NOTE: If the differential lock system is connected with the transmission in its low speed range, shifting out of the low speed range will also disengage the differential lock function. The switch will blink until the wheels unlock, and then go out.



A. Turning Radius When the Differential Lock is Engaged (understeer condition)
B. Turning Radius When the Differential Lock is Disengaged

Fig. 9.6, Turning Radii

10

Brake Systems

Bosch Pin Slide Brakes

General Information

The Bosch hydraulic pin slide disc brake is a two-piston sliding caliper brake and is used at both the front and rear wheel locations. Each pin slide caliper disc brake wheel installation is made up of a caliper assembly, anchor plate assembly, and disc brake pads.

Caliper Assembly

The caliper assembly has two hydraulic piston bores. The piston bores contain pistons, piston seals, and piston boots. The caliper assembly attaches and slides on sealed pins located in the anchor plate. The caliper housing is the main component of the caliper assembly. The material of the caliper housing is ductile iron and has a protective coating to provide additional environmental protection. The disc brake caliper housing straddles the rotor, the inner pad, and the outer pad.

Anchor Plate Assembly

The anchor plate assembly includes lubricated floating guide pins sealed by rubber boots. The anchor plate abutments are protected by stainless steel slippers.

Disc Brake Pads

There are two pads per caliper assembly, and they are the inner and outer pads. The inner pad is located between the caliper piston and rotor. The outer pad is located between the rotor and caliper housing legs. The pads are made of friction material and a stamped steel backing plate.

Operation

Before driving the vehicle, secure all loose items in the vehicle so that they will not fly forward during a full brake application. Check that the brake system warning light is off after releasing the hand brake. If the warning light does not go off, correct the problem before continuing operation of the vehicle.

During normal braking stops, depress the foot brake control pedal until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop. Apply the hand parking brake if the vehicle is to be parked.

IMPORTANT: Make sure that the brake fluid in the master cylinder reservoirs is up to the level of the ridge that surrounds the reservoir. See **Fig. 10.1**. Use only DOT 3 or 4 brake fluid in the Bosch hydraulic pin slide brake system.

Meritor WABCO Pneumatic Antilock Braking System (ABS)

Pneumatic ABS is an electronic wheel speed monitoring and control system that works with the air brake system. It passively monitors vehicle wheel speed at all times, but *controls* wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard air brake system is in effect.

Pneumatic ABS Operation

The Meritor WABCO ABS is a four-sensor system. It combines one front-axle control channel with one rear-axle control channel to form one control circuit.

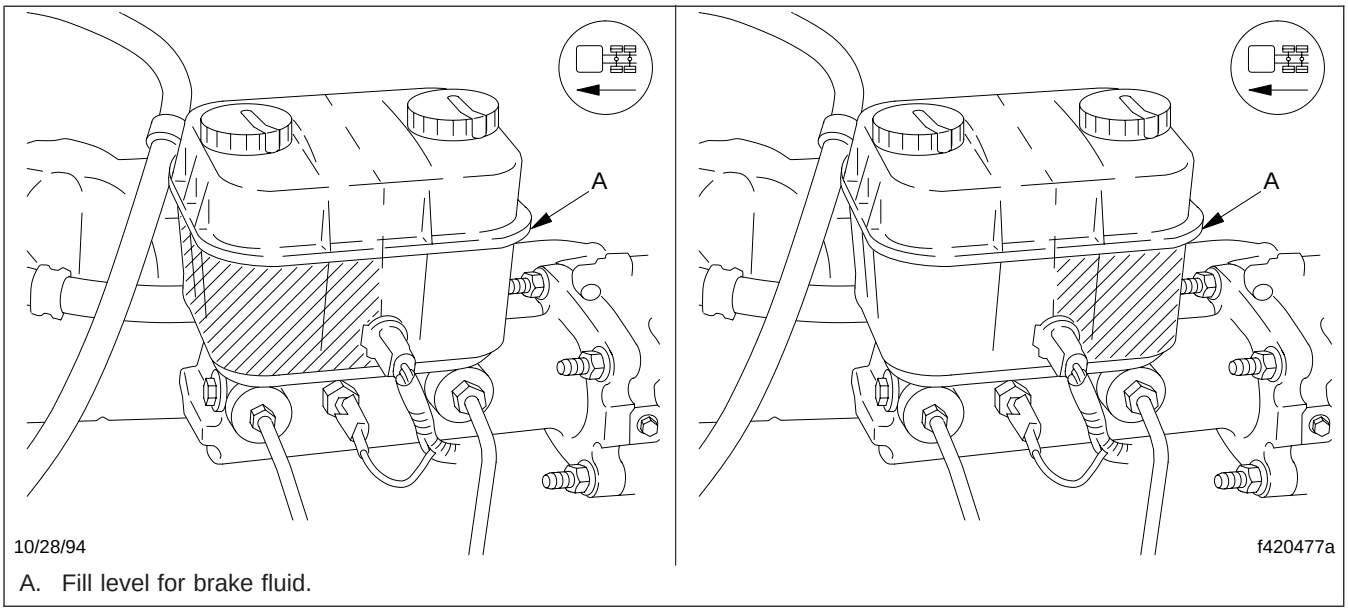
Example: The sensor and solenoid control valve at the left front wheel form a control circuit with the sensor and solenoid valve at the right rear axle.

ABS includes signal-generating tone wheels and sensors located in the wheel hubs of each sensed axle. The sensors transmit vehicle wheel speed information to an electronic control unit.

IMPORTANT: For proper ABS system operation, do not change tire sizes. The sizes of the tires installed during production are programmed into the electronic control unit. Installing different sized tires could result in a reduced braking force, leading to longer stopping distances.

During emergency or reduced traction stops, fully depress the brake pedal until the vehicle comes to a safe stop. Do *not* pump the brake pedal. With the brake pedal fully depressed, the ABS system will control all wheels to provide steering control and a reduced braking distance.

Although the ABS system improves vehicle control during emergency braking situations, the driver still has the responsibility to change driving styles depending on the existing traffic and road conditions. For example, the ABS system cannot prevent an accident if the driver is speeding or following too closely on slippery road surfaces.



A. Fill level for brake fluid.

Fig. 10.1, Master Cylinder Reservoir

The main circuit of the control unit interprets the speed sensor signals and calculates wheel speed, wheel retardation, and a vehicle reference speed. If the calculations indicate wheel lockup, the main circuit signals the appropriate solenoid control valve to reduce braking pressure.

The electronic control unit also has a safety circuit that constantly monitors the wheel sensors, solenoid control valves, and the electrical circuitry. During emergency braking, the solenoid control valve alternately reduces, increases, or maintains the supply of air pressure in the brake chamber, thereby preventing front and/or rear wheel lockup.

Even if the ABS system is partially or completely inoperative, normal braking ability is usually maintained.

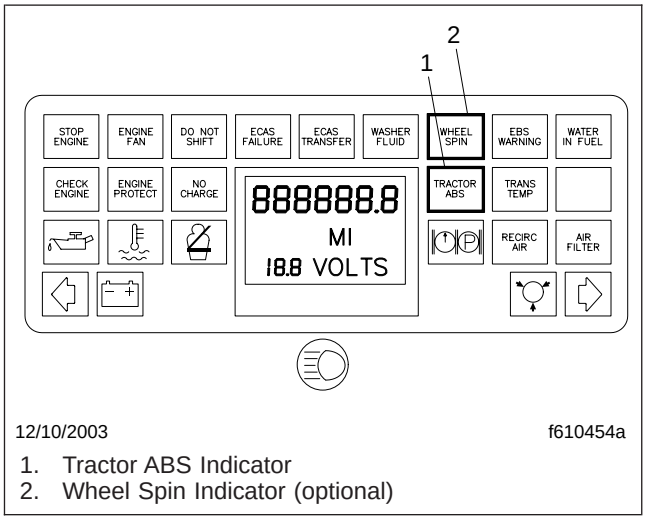
IMPORTANT: If a solenoid control valve (or combination solenoid control valve) is damaged and inoperative, normal braking may be impaired.

ABS Indicator Lights

IMPORTANT: If any of the ABS indicator lights do not work as described below, or come on while driving, *do not continue to operate the vehicle*; repair the ABS system immediately to ensure full braking capability.

ABS Light

The amber ABS indicator light comes on after turning on the ignition switch. See **Fig. 10.2**. The indicator light goes out only if all of the ABS components are working.



1. Tractor ABS Indicator
2. Wheel Spin Indicator (optional)

Fig. 10.2, ABS Indicator Lights

During vehicle operation, if the safety circuit senses a failure in any part of the ABS system (a sensor, solenoid control valve, wiring connection, short circuit, etc.), the ABS indicator light comes on and the control circuit where the failure occurred is switched to normal braking action. The remaining control circuit will retain the ABS effect.

Wheel Spin Light

The amber WHEEL SPIN indicator light illuminates if one of the drive wheels spins during acceleration. When the light illuminates, partially release the throttle pedal until the light goes out. The light goes out when the wheel stops spinning.

If slippery road conditions continue, turn on the differential lock switch. See **Chapter 9** for axle switch instructions.

⚠ CAUTION

Do not turn the differential lock switch on while the WHEEL SPIN indicator light is on. To do so could damage the rear axle.

Automatic Slack Adjusters

Automatic slack adjusters are required on all vehicles equipped with air brakes manufactured after October 20, 1994. Automatic slack adjusters should never be manually adjusted except during routine maintenance of the foundation brakes (e.g., replacing shoes), during slack adjuster installation, or in an emergency situation.

When the brake pushrod stroke exceeds the legal brake adjustment limit on a vehicle, there is likely a mechanical problem with the foundation brake components or the adjuster is improperly installed.

Visit a repair facility as soon as possible when brakes equipped with automatic slack adjusters are determined to be out of adjustment.

⚠ CAUTION

Manually adjusting an automatic slack adjuster to bring the pushrod stroke within legal limits is likely masking a mechanical problem. Adjustment is not repairing. In fact, continual adjustment of automatic slack adjusters may result in premature wear of the adjuster itself. Further, the improper adjustment of some automatic slack adjusters may cause internal damage to the adjuster, thereby preventing it from properly functioning.

Meritor Cam-Master Q Plus Brakes

Cam-Master® brakes are air-actuated, cam-operated, foundation brakes. The Q Plus increases service life and mileage between relines by providing more lining thickness. A specially designed S-cam and heavy-duty shoe return spring allow additional shoe travel required to fully wear the thicker lining blocks. An improved camshaft bushing contributes to longer service life.

Cam-Master Q Plus Operation

When the brake pedal is depressed, compressed air enters the brake chamber, causing the diaphragm to move a pushrod assembly.

The pushrod turns the slack adjuster and brake camshaft. As the camshaft turns, the S-type cam head forces the brake shoes against the brake drum and braking occurs.

When the brakes are released and air is exhausted from the brake chamber, the actuator return spring (within the brake chamber) and the brake shoe return spring return the camshaft, brake shoes, slack adjuster, and pushrod to their released positions.

Dual Air Brake System

A dual air brake system consists of two independent air brake systems that use a single set of brake controls. Each system has its own reservoir, plumbing, and brake chambers. The primary air system operates the service brakes on the rear axle; the secondary air system operates the service brakes on the front axle.

Primary Air Brake System

Loss of air pressure in the primary air system causes the rear service brakes to become inoperative. The front brakes will continue to be operated by the secondary air system.

Secondary Air Brake System

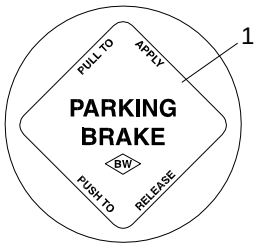
Loss of air pressure in the secondary air system causes the front axle brakes to become inoperative. The rear service brakes will continue to be operated by the primary air system.

Emergency Braking System

When air pressure is lost in either the primary or secondary air system, the air compressor will operate, but the air supply in the other system, the one that is not leaking, will not be replenished. There will be enough air in the other system to stop the vehicle safely. The dual air brake system thus provides emergency braking capability. When the low air pressure warning light and emergency buzzer first come on, stop the vehicle immediately. Do not drive the vehicle until the cause of the problem is corrected.

Parking Brakes

Pulling out the yellow diamond-shaped knob (parking brake control valve) on the auxiliary dash panel applies the parking brakes (spring brakes). See **Fig. 10.3**.



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1. Parking Brake Control Valve

Fig. 10.3, Parking Brake Control Valve

Air Brake Operation

WARNING

Do not operate the vehicle with the front brakes backed off or disconnected. Backing off or disconnecting the front brakes will not improve vehicle handling and may lead to loss of vehicle control, resulting in property damage or personal injury.

Before driving the vehicle, secure all loose items in the bus so that they will not fly forward during a full brake application.

Parking Brake Interlock, Optional

CAUTION

Do not continually press down on the parking brake control valve (yellow knob) without pressing down on the service brake pedal. This will damage the safety interlock.

The service brakes and parking brakes have a safety interlock that prevents the unintentional release of the parking brake. These instructions need to be followed for the appropriately equipped vehicle to release the parking brake interlock.

Service Brake Interlock Release

1. Push the service brake pedal.
2. Press the parking brake control valve (yellow knob).

Service Brake and Ignition Key Release

1. Turn the ignition key to the ON position.
2. Push the service brake pedal.
3. Press the parking brake control valve (yellow knob).

Service Brake, Ignition Key, Wheel Chair Lift Interlock Release

1. Turn the ignition key to the ON position.
2. Check to see that the wheel chair lift is in the stowed position.
3. Confirm that the wheel chair lift switch is in the OFF position.
4. Push the service brake pedal.
5. Press the parking brake control valve (yellow knob).

Transmission Shifter Interlock Release

1. If the vehicle is equipped with a wheel chair lift, make sure the lift is in the stowed position, and that the wheel chair lift switch is in the OFF position.

2. Push the service brake pedal to move the vehicle shifter out of the park position.

Operating the Brakes

To ensure safe operation and minimum brake wear, do the following steps when operating the brakes.

1. When the ignition switch is turned on, the low air pressure warning light (pressure circle icon) illuminates and the emergency buzzer sounds.
   - 1.1 Monitor the air pressure system by observing the low air pressure warning light, the emergency buzzer, and both the primary and secondary air pressure gauges.
   - 1.2 The warning light and buzzer shut off when air pressure in both systems reaches 65 to 75 psi (448 to 517 kPa).
2. Before driving your vehicle, continue to monitor the air pressure system until the air compressor has built up a minimum pressure of 95 psi (655 kPa) in both the primary and secondary air systems.
3. While driving, the low air pressure warning light and buzzer come on if air pressure drops below 65 to 75 psi (448 to 517 kPa) in either system.
   - 3.1 If this happens, check the air system pressure gauges to determine which system has low air pressure.
   - 3.2 Although vehicle speed can be reduced using the service brake, either the front or rear service brakes will not be operating, causing a longer stopping distance.
   - 3.3 Bring the vehicle to a safe stop and have the air system repaired before continuing.
4. During normal brake stops, depress the service brake until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop.

IMPORTANT: In the event of a total loss of service brakes, use the parking brake control valve (yellow knob) to bring the vehicle to a complete stop in the safest location possible.

5. When the forward speed of the vehicle has decreased almost to the idling speed of the engine, press in the clutch pedal (on manual transmissions) and shift the transmission to neutral. Apply the parking brakes, if the vehicle is to be parked.
6. If the brakes are wet, drive the vehicle in low gear and lightly apply the brakes to heat and dry them.

⚠ CAUTION

Do not use the spring parking brakes if the service brakes are hot, such as after descending a steep grade. Also, do not use the spring parking brakes during freezing temperatures if the service brakes are wet. To do so could damage the brakes if hot, or cause them to freeze during cold weather.

If the brakes are wet, drive the vehicle in low gear and lightly apply the brakes to heat and dry them. Allow hot brakes to cool before using the spring parking brakes. Always chock the tires.

7. Allow hot brakes to cool before using the parking brakes. Always chock the tires.

Caging the Parking Brakes

⚠ WARNING

Do not drive the vehicle with the parking brakes caged. If the vehicle is driven with the parking brakes caged, there would be no means of stopping the vehicle if a complete loss of air pressure occurred. This could result in serious personal injury or vehicle damage.

To move a vehicle with insufficient system air pressure, it is necessary to release the parking brake springs. Do this by caging (manually releasing) the parking brakes.

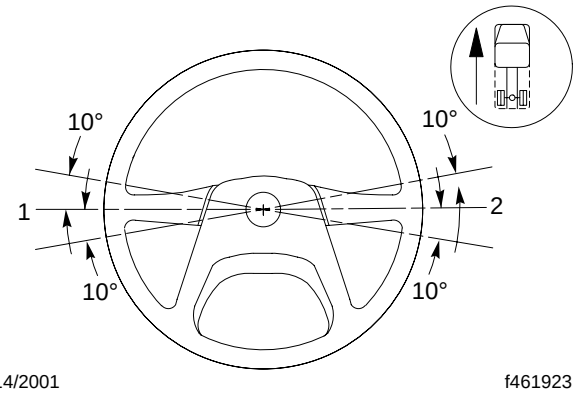
IMPORTANT: Before caging the parking brakes, make the connection to a towing vehicle or chock the tires.

After correcting the brake system problem, uncage the parking brakes before resuming normal vehicle operation.

Steering System

When there is no load on the vehicle and the front tires are pointed straight ahead, the standard steering wheel spokes should be at the 3 o'clock and 9

o'clock positions, or within 10 degrees of these positions. See **Fig. 10.4**.



NOTE: The standard steering wheel is shown.

1. 9 o'Clock
2. 3 o'Clock

Fig. 10.4, Steering Wheel Centered

Power Steering System

The power steering system consists of a steering gear (which includes a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder), hydraulic hoses, power steering pump, power steering reservoir, and other components. Some models are also equipped with a separate hydraulic power cylinder on the right side of the front axle.

The power steering pump, driven by the engine, provides the power assist for the steering system. If the engine is not running, there is no power assist.

If the power assist feature does not work due to hydraulic fluid loss, steering pump damage, or some other cause, bring the vehicle to a safe stop. Do not drive the vehicle until the cause of the problem is corrected.

⚠ WARNING

Driving the vehicle without the power-assist feature of the steering system requires much greater effort, especially in sharp turns or at low speeds, which could result in an accident and possible injury.

Drivers should use the power available with a power steering system carefully. If the front tires become lodged in a deep chuckhole or rut, drive the vehicle out instead of using the steering system to lift the tires from the hole. Also, avoid turning the tires when they are against a curb as this places a heavy load on steering components and could damage them.

11

Pre- and Post-Trip Checklists

Pre- and Post-Trip Checklists

Pretrip and Post-Trip Inspection General Information

Regulations in both Canada and the United States clearly indicate that it is the driver's responsibility to perform an inspection and ensure the complete roadworthiness of a vehicle, before placing it into service for the day. Commercial vehicles may be subject to inspection by authorized inspectors, and an unsafe vehicle can be put "out of service" until the driver or owner repairs it.

Use the pretrip inspection checklist to ensure that vehicle components are in good working condition before each trip. Use the weekly and monthly post-trip inspection checklists to note any items that require attention before the next trip. A driver that is familiar with the vehicle, and drives it regularly, can perform the daily inspections, then add the weekly and monthly post-trip inspections as scheduled. If the driver does not operate the vehicle on a consistent basis, all three of the inspection procedures should be performed before the trip.

Pretrip and post-trip inspections cannot be done quickly. However, careful inspections save time by eliminating stops later to adjust items overlooked or forgotten.

Numbers in parentheses within each of the checklists reference the corresponding detailed instructions found under "Daily (D), Weekly (W), or Monthly (M) Procedures in **Chapter 12**.

If any system or component does not pass this inspection, it must be corrected before operating the vehicle. Whenever equipment requires adjustment, replacement, repair, addition of lubricants, or a change of lubricants, see the *Saf-T-Liner C2 School Bus Workshop Manual* for procedures and specifications, or take the vehicle to an authorized Freightliner Custom Chassis dealer.

IMPORTANT: The pretrip and post-trip checklists in this chapter, and the maintenance procedures detailed in **Chapter 12** and in the *Saf-T-Liner C2 School Bus Maintenance Manual* are **not all inclusive**. Also, refer to the inspection and maintenance instructions of the major component manufacturers.

Daily Pretrip Inspection and Maintenance Checklist

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

See **Table 11.1** for a checklist of the procedures that should be performed daily, before the first trip.

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
_____	Drain manually drained air reservoirs (that are not equipped with automatic drain valves)	D1
Check _____	surge tank coolant level	D2
Inspect _____	radiator and charge air cooler	D3
Inspect _____	engine for fuel, oil, or coolant leaks	D4
Check _____	intake-air restriction indicator and air intake system	D5
Check _____	engine oil level	D6
Check _____	automatic transmission fluid level, if equipped	D7
Check _____	fuel/water separator for contaminants and leaks, if equipped	D8
Inspect _____	fuel tank(s), fuel lines, and connections	D9
Check _____	fuel level	D10
Check _____	diesel engine fuel cap vent area is clean	D10
Check _____	front and rear suspension components	D11
Check _____	oil- and air-pressure warning systems	D12
Check _____	horn	D13
Check _____	backup alarm, if equipped	–
Check _____	headlights, mirrors, and window glass	D14
Inspect _____	air brake chambers and pushrods	D15
Inspect _____	slack adjusters	D16
Check _____	tire pressure	D17
Inspect _____	tire condition	D18
Check _____	rims and wheels	D19
Check _____	air brake system	D20
Check _____	parking brakes	D21
Inspect _____	frame rails (missing bolts), crossmembers (bent or loose)	–
Check _____	mud flaps (aren't damaged, at least 10 inches above the ground, and brackets are secure)	–
Check _____	exhaust system (mounted securely, connected tightly, no signs of leaks such as soot trails)	–
Inspect _____	Bendix Hydro-Max® Power Booster	D22
Inspect _____	engine and chassis wiring	D23
_____	remove chocks and test service brakes	D24
Inspector_____ Date _____		

Table 11.1, Daily Pretrip Inspection and Maintenance Checklist

Weekly Post-Trip Inspection and Maintenance Checklist

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

See **Table 11.2** for a checklist of the procedures that should be performed weekly, post-trip.

Procedure Performed (check off)	Weekly Post-Trip Inspections/Checks	Procedure Reference
_____	Manually drain air reservoirs that are equipped with automatic drain valves	—
Inspect _____	batteries and battery cables	W1
Check _____	wheel bearing lubricant level	W2
Inspect _____	steering components	W3
Check _____	drive belts	W4
Check _____	drive belt tension	W5
Inspect _____	seat belts and tether belts	—
Inspector_____ Date _____		

Table 11.2, Weekly Post-Trip Inspection and Maintenance Checklist

Monthly Post-Trip Inspection and Maintenance Checklist

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

See **Table 11.3** for a checklist of the procedures that should be performed monthly, post-trip.

Procedure Performed (check off)	Monthly Post-Trip Inspections/Checks	Procedure Reference
_____	Clean the battery terminals	M1
Inspect _____	radiator hoses and heater hoses	M2
Check _____	fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 4 brake fluid)	—
Check _____	fluid level in the hydraulic brake fluid reservoir, if equipped	M3
Check _____	steering wheel play	M4
Check _____	outer surfaces of the hood and body (for visible surface breaks and damage, as well as corrosion and paint condition)	—
Inspect _____	brake lining wear	M5
Inspect _____	driveshaft	—
Inspect _____	condition of floor covering and upholstery	—
Check _____	operation of roof hatches and warning buzzers	—
Check _____	operation and locking of emergency doors	—
Inspect _____	wiper blades	—
Inspect _____	body mounting bolts and clips securely fastened	M6
Inspector_____ Date _____		

Table 11.3, Monthly Post-Trip Inspection and Maintenance Checklist

12

Pre- and Post-Trip Inspections Maintenance

Daily Pretrip Inspection and Maintenance Procedures

Whenever equipment requires adjustment, replacement, repair, addition of lubricants, or a change of lubricants, see the *Saf-T-Liner C2 School Bus Workshop Manual* for repair procedures and specifications. Specific references to the manual will be found where appropriate.

1. *Drain manually drained air reservoirs (that are not equipped with automatic drain valves).*

   Water and oil normally enter the air reservoir in the form of vapor because of the heat generated during compression. After the water and oil condense, drain the resulting emulsion as follows:

   1.1 Open the wet tank valve. The drain cock or pull chain drain is located on the forward end of the supply air reservoir, which is connected directly to the air compressor. Block the valve open.

⚠ WARNING

When draining the air reservoir, do not look into the air jets or direct them toward anyone. Dirt or sludge particles may be in the airstream and could cause injury.

   1.2 Exhaust the remaining air and moisture from the system by opening the drain cocks on the bottoms of the remaining air reservoirs. Block the valves open.

   1.3 Water and oil emulsion often form pockets that will not drain while compressed air is in the reservoirs. Because of these pockets, leave the valves blocked open during the first part of the pretrip inspection.

2. *Check the coolant level in the surge tank.*

   See **Fig. 12.1**. If the coolant is low, add a 50/50 mixture of water and the type of antifreeze currently installed in your vehicle. Fill the surge tank with coolant to the MAX line when the tank is cool. See **Table 12.1** for approved coolants. If the surge tank was empty, start the engine after refilling, then check the level again when the engine is at operating temperature.

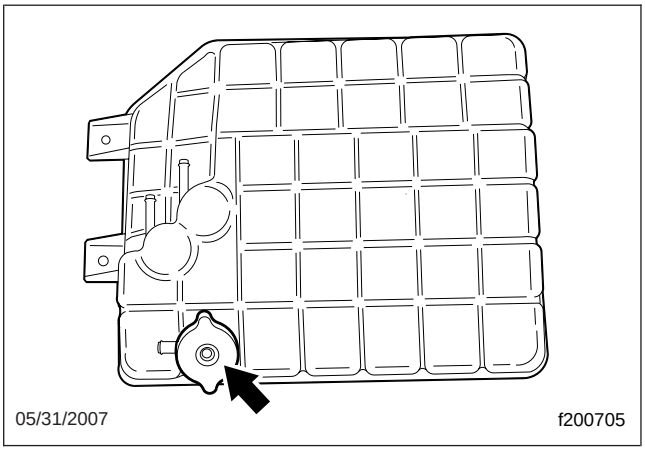


Fig. 12.1, Surge Tank Fill Cap

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 12.1, Approved Coolants

NOTICE

Coolant must be filled to the full line of the surge tank. Low coolant could result in engine overheating, which could cause engine damage.

3. *Inspect the radiator and charge air cooler.*

   3.1 Inspect the radiator and charge air cooler for clogged fins. Use compressed air or water directed from the fan side of the core to backflush any material restricting airflow.

   3.2 Inspect the radiator and charge air cooler for damage and accumulated debris. Straighten bent or damaged fins to permit airflow across all areas of the cores.

   NOTE: When traveling through areas of high insect concentration, it may be necessary to clean the exterior of the radiator or the

charge air cooler core as often as every 200 miles (322 km).

3.3 Also inspect and clean the condenser. If clogged, the condenser can restrict airflow through the radiator.

3.4 Check the radiator for leaks. If leaks are found, have the radiator repaired or replaced. Take the vehicle to an authorized Freightliner Custom Chassis dealer for assistance.

4. *Inspect the engine for fuel, oil, and coolant leaks.*

Correct any leaks found, by taking your vehicle to an authorized Freightliner Custom Chassis dealer for assistance.

5. *Inspect the air intake system for leaks or damage.*

NOTICE

Failure to maintain a sealed air intake system could allow entry of dirt and contaminants into the engine. This could adversely affect engine performance and result in engine damage.

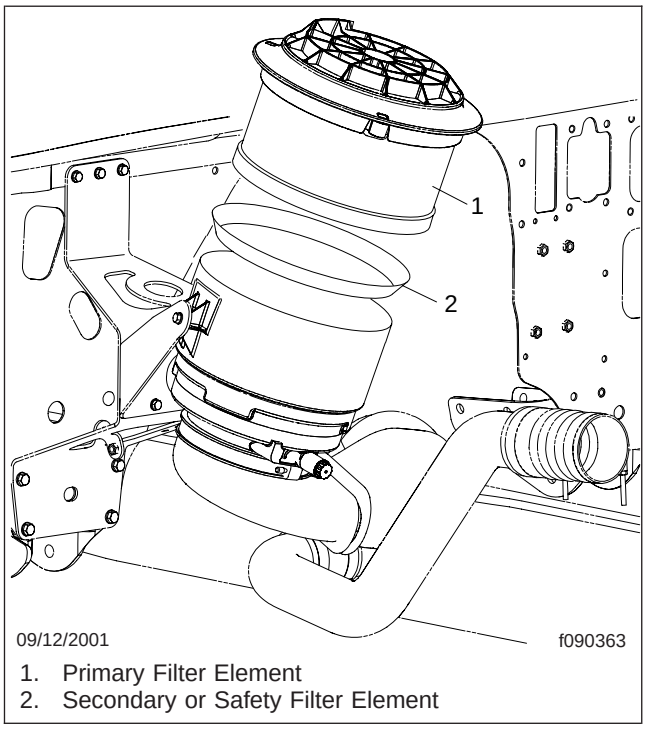
5.1 Check the intake-air restriction indicator.

5.2 Replace the primary filter element in the air cleaner if the yellow signal stays locked at 25 inH_2O for Cummins or Mercedes-Benz engines. See **Group 09** of the *Saf-T-Liner C2 School Bus Workshop Manual* for filter element replacement instructions, or take the vehicle to an authorized Freightliner Custom Chassis dealer. See **Fig. 12.2**.

NOTE: After replacing the filter element, reset the restriction indicator by pressing the rubber reset button.

5.3 Inspect the secondary or safety filter element in the air cleaner when replacing the primary element, and replace it when clogged or dirty. This element should be replaced with every third primary element replacement.

5.4 Check the engine air intake piping from the air cleaner to the engine intake. Inspect the piping for loose connections, cracks, torn or collapsed hoses, punctures, and other damage. Tighten loose connections, and have damaged components replaced. Make sure the piping system is airtight so that all intake air passes through the air cleaner.



1. Primary Filter Element
2. Secondary or Safety Filter Element

Fig. 12.2, Air Cleaner Filter Elements

6. *Check the engine oil level.*

Check the engine oil level with the vehicle parked on a level surface. See **Fig. 12.3**. The oil level should show between the MIN (lower) and MAX (upper) marks on the dipstick. Add enough oil to bring the level up to the operating range. See the engine manufacturer's operation and maintenance manuals for recommended lubricants and capacities.

NOTICE

Operating the engine with the oil level below the minimum fill (or "add") mark or above the maximum fill (or "full") mark could result in engine damage.

NOTE: To prevent a false low oil reading, let the engine sit for at least 10 minutes before you

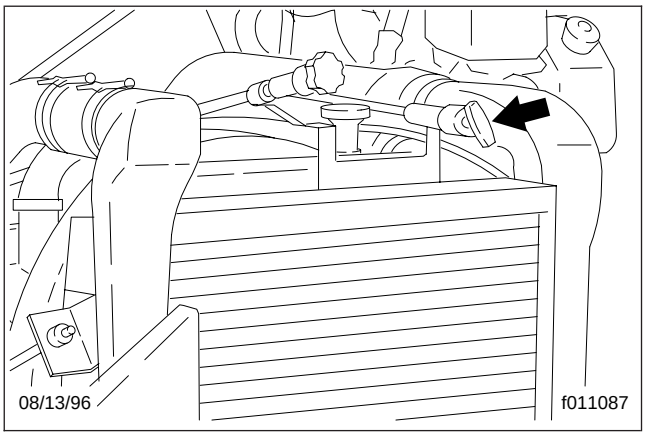


Fig. 12.3, Check the Engine Oil Level (typical)

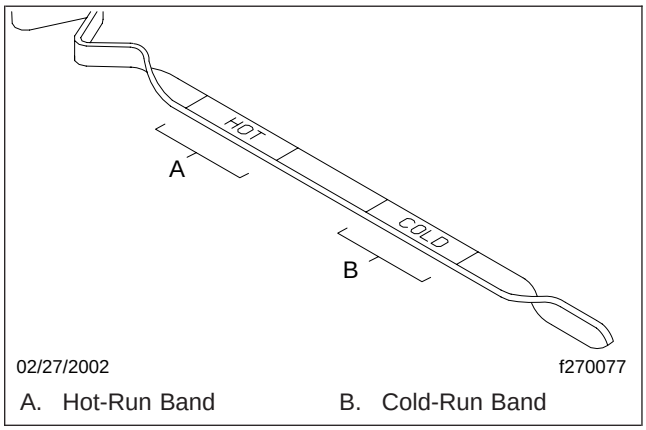


Fig. 12.4, Automatic Transmission Dipstick Markings

check the oil level, or check the oil level in the morning before starting the engine.

7. *Check the oil level in the automatic transmission.*

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

With the vehicle on a level surface, check the oil level in the transmission using the following procedure:

- Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.
- With the parking brake applied, shift to Neutral (N). Let the engine run at idle.
- 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. 12.4**.
- 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. See the *Saf-T-Liner C2 School Bus Maintenance Manual* for fluid types and capacities.

8. *Check the fuel/water separator for contaminants and leaks.*

   Place a suitable container under the fuel/water separator. Check the water level in the sight bowl, if equipped. Drain any water found. To drain the water, loosen the valve at the bottom and allow the water to run out. Close and tighten the valve finger-tight.

IMPORTANT: When draining fluid from a fuel/water separator, drain the fluid into an appropriate container and dispose of it properly. Many states now issue fines for draining fuel/water separators on the ground. On all types of separators, stop draining fluid when you see fuel come out of the separator drain valve.

9. *Inspect the fuel tanks, fuel lines, and connections.*

   9.1 Check that the fuel tanks are secured to their mounting brackets and that the mounting brackets are secured to the frame.

   9.2 Replace leaking fuel tanks.

   9.3 If lines or connections are leaking or chafed, have them repaired or replaced.

   For repair and/or replacement procedures, see **Group 47** of the *Saf-T-Liner C2 School Bus Workshop Manual*, or take the vehicle to an authorized Freightliner Custom Chassis dealer.

   9.4 If equipped with fuel tank shutoff valves, be sure the valves are fully open.

⚠ WARNING

Never operate the engine with the fuel tank shutoff valves partly closed. This could damage the fuel pump, causing sudden loss of engine power,

possibly resulting in serious personal injury due to reduced vehicle control.

10. *Check the fuel level in the fuel tank(s).*

    On vehicles equipped with a diesel engine, be sure that the fuel cap vent area is clean. Check the fuel/water separator (if so equipped) for leaks and, if needed, prime the fuel tank system.

⚠ WARNING

Never fill fuel tanks to more than 95 percent of their liquid capacity. This could make them more likely to rupture from impact, possibly causing fire and resulting in serious personal injury or death by burning.

IMPORTANT: Use only ultralow-sulfur diesel (ULSD) fuel with 15 ppm sulfur content or less, based on ASTM D2622 test procedure. Failure to use ultralow-sulfur diesel fuels may void the warranty on emissions components.

10.1 To keep condensation to a minimum, fill diesel fuel tanks at the end of each day, but not to more than 95 percent of liquid capacity. Select the proper grade of fuel, as specified by the engine manufacturer.

⚠ WARNING

Do not mix gasoline or alcohol with diesel fuel. This mixture could cause an explosion, possibly resulting in serious personal injury or death. Do not fill the fuel tanks in the presence of sparks, open flames, or intense heat. These could ignite the fuel, possibly causing severe burns.

10.2 Always strain or filter diesel fuel before putting it into the tanks. This will lengthen the life of the engine fuel filter and reduce the chances of dirt entering the engine.

11. *Inspect the front and rear suspension components, including springs, spring hangers, shocks, and suspension brackets.*

    11.1 Check for broken spring leaves, loose U-bolts, cracks in the suspension brackets, and loose fasteners in the spring hangers and shackles.

    11.2 Inspect the shock absorbers for loose fasteners and leaks.

    11.3 Tighten all loose fasteners and have any components replaced that are worn, cracked, or otherwise damaged.

    11.4 On vehicles with air suspensions, check for leaks. Check air suspension components for cuts and bulges.

⚠ WARNING

Do not replace individual leaves of a damaged front or rear suspension leaf spring assembly; replace the complete spring assembly. Visible damage, such as 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. If cracks or breaks exist on front spring assemblies in either of the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.

12. *Check the oil- and air-pressure warning systems.*

    When the engine is started, oil- and air-pressure warnings will come on until the oil and air pressure rise above a preset minimum. After starting the engine, make sure the oil- and air-pressure warning systems are operating and that the buzzer stops sounding when the preset minimum is reached.

    12.1 If the warning systems do not come on when the ignition is turned on, have the systems repaired.

    12.2 If the air pressure in both systems is above the preset minimum when the engine is started, test the low air pressure system by lowering the pressure to below this range, or until the warning system comes on.

    NOTE: The air pressure in both the primary and secondary air reservoir systems must be above 65 psi (448 kPa) on most vehicles.

13. *Make sure that the electric horn works.*

    If a horn is not working, have it replaced before trip departure.

14. *Make sure all the exterior lights are working.* Check the high and low beams of the headlights. Clean the windshield, side, and rear windows (if equipped) with a long-handled or telescoping window cleaning device and standard cleaning solutions. Stand only on the ground, on a step-ladder, or an elevated walkway. The vehicle entry/exit steps and handholds are not designed for this purpose. The tires, fenders, engine, and other under-hood components do not have adequate gripping surfaces and handholds.

15. *Inspect the air brake chamber and the air brake chamber pushrods.*

⚠ DANGER

Do not loosen or remove the parking brake clamp ring for any purpose. See Fig. 12.5. The parking/emergency brake section of the brake chamber is not intended to be serviced. Serious injury or death may result from sudden release of the power spring.

Before doing any repairs or adjustments on a service/parking brake chamber, read the applicable warnings and instructions in Group 42 of the *Saf-T-Liner C2 School Bus Workshop Manual*.

16. *Inspect the slack adjusters.*

    Inspect the slack adjuster boot for cuts or tears. If the boot is damaged, have it replaced. See **Fig. 12.6**.

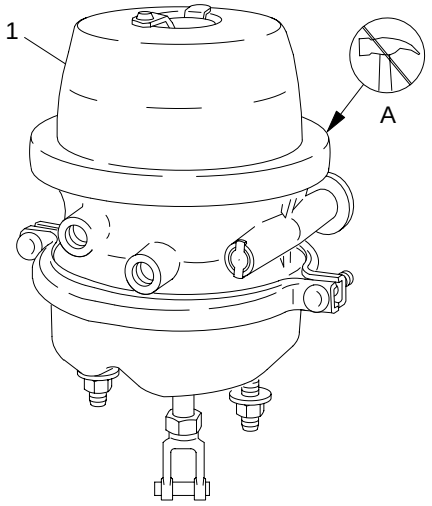
17. *Check tire inflation pressures using an accurate tire pressure gauge.*

    Tires should be checked when cool. For inflation pressures and maximum loads (per tire) see the tire manufacturer's guidelines.

⚠ WARNING

Do not operate the vehicle with underinflated or overinflated tires. Incorrect inflation can stress the tires and make the tires and wheels susceptible to damage, possibly leading to wheel or tire failure and loss of vehicle control, resulting in serious personal injury or death.

17.1 If a tire has been run flat or underinflated, check for possible wheel or tire damage before adding air.



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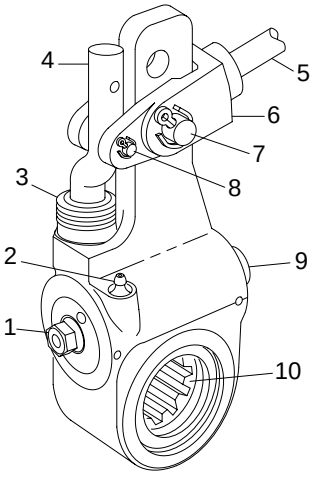
A. Do not remove this clamp ring.
1. MGM TR-T (TR Series) Brake Chamber shown

Fig. 12.5, Parking Brake Chamber Clamp



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1. 7/16-inch Adjusting Nut
2. Grease Fitting
3. Boot
4. Link
5. Brake Chamber Piston Rod
6. Clevis
7. 1/2-inch Clevis Pin
8. 1/4-inch Clevis Pin
9. Grease Relief Opening
10. Slack Adjuster Spline

Fig. 12.6, Automatic Slack Adjuster (typical)

Moisture inside a tire can result in body ply separation or a sidewall rupture. During tire inflation, compressed air reservoirs and lines must be kept dry. Use well maintained inline moisture traps and service them regularly.

IMPORTANT: A weekly pressure loss of 4 psi (28 kPa) or more in a tire may indicate damage. The tire should be inspected and if necessary, repaired or replaced.

17.2 Inflate the tires to the applicable pressures if needed.

17.3 Be sure valve stem caps are on every tire and that they are screwed on finger-tight.

IMPORTANT: The load and cold inflation pressure must not exceed the wheel manufacturer's recommendations, even though the tire may be approved for a higher load inflation. Some wheels are stamped with a maximum load and maximum cold inflation rating. If they are not stamped, consult the wheel manufacturer for the correct tire inflation pressure for the vehicle load. If the load exceeds the maximum wheel capacity, the load must be adjusted or reduced.

18. *Inspect each tire for wear, bulges, cracks, cuts, penetrations, and oil contamination.*

18.1 Check the tire tread depth. If tread is less than 4/32 inch (3 mm) on any front tire, or less than 2/32 inch (1.5 mm) on any rear tire, replace the tire.

18.2 Inspect each tire for bulges, cracks, cuts, and penetrations.

18.3 Inspect each tire for oil contamination. Fuel, oil, gasoline, and other petroleum derivatives, if allowed to contact the tires, will soften the rubber and destroy the tire.

19. *Check the wheel nuts for indications of looseness. Examine each wheel component.*

19.1 Remove all dirt and foreign material from the assembly. Dirt or rust streaks from the stud holes, metal buildup around stud holes, or out-of-round or worn stud holes may be caused by loose wheel nuts. See **Fig. 12.7** and **Fig. 12.8**.

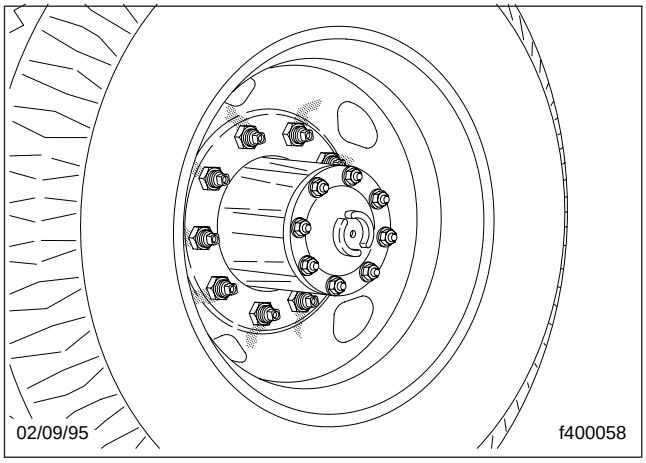


Fig. 12.7, Dirt and Rust Streaks from the Stud Holes

19.2 Examine the wheel components (including studs and nuts) for cracks or other damage.

See **Group 33** or **Group 35** of the *Saf-T-Liner C2 School Bus Workshop Manual* for service procedures on the studs and hubs, and see **Group 40** in the same manual for wheel and tire servicing, or take the vehicle to an authorized Freightliner Custom Chassis dealer.

⚠ WARNING

Have any worn or damaged wheel components replaced by a qualified person using the wheel manufacturer's instructions and the wheel industry's standard safety precautions and equipment. Otherwise a vehicle or workshop accident could occur, possibly resulting in serious personal injury or death.

19.3 Make sure all wheel nuts are tightened 450 to 500 lbf·ft (610 to 678 N·m) for Accuride wheels with unlubricated threads. Use the tightening pattern in **Fig. 12.9** for 10-hole wheels and **Fig. 12.10** for 8-hole wheels. See **Group 40** of the *Saf-T-Liner C2 School Bus Workshop Manual*.

NOTICE

Insufficient wheel nut torque can cause wheel shimmy, resulting in wheel damage, stud breakage, and extreme tire tread wear. Excessive

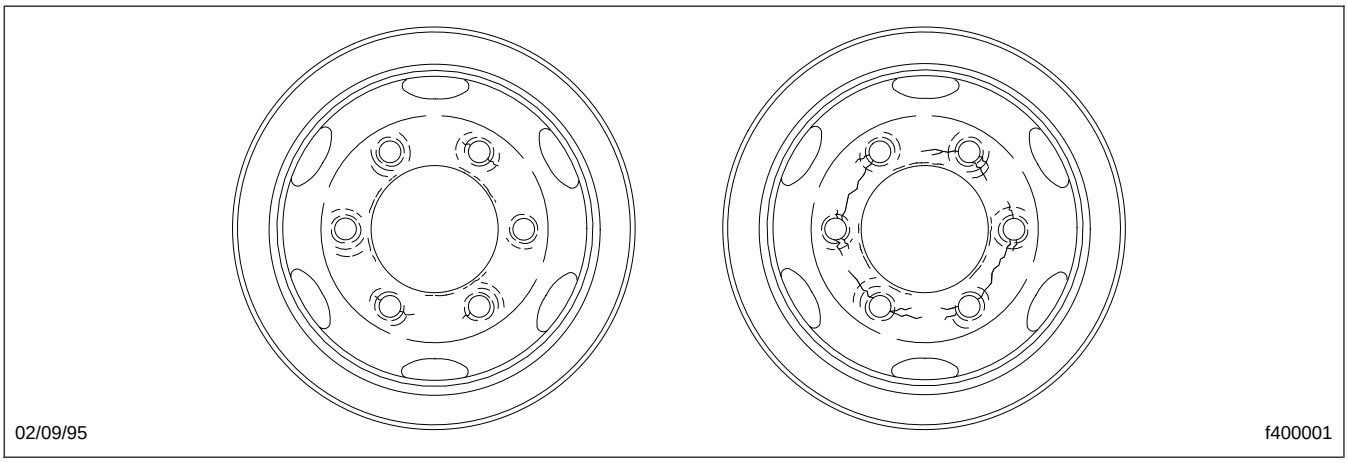


Fig. 12.8, Worn Stud Holes

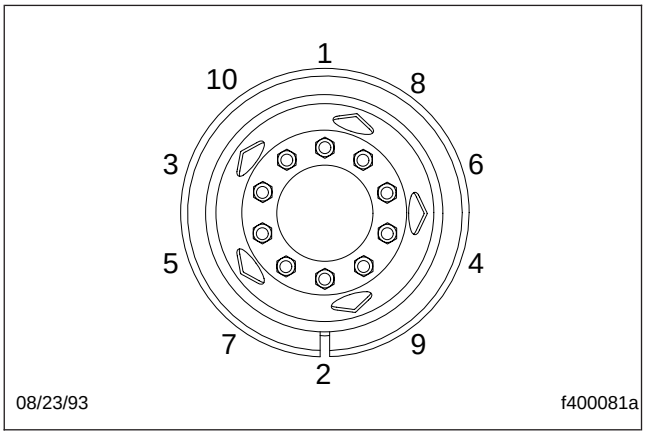


Fig. 12.9, Tightening Pattern, 10-Hole Wheels

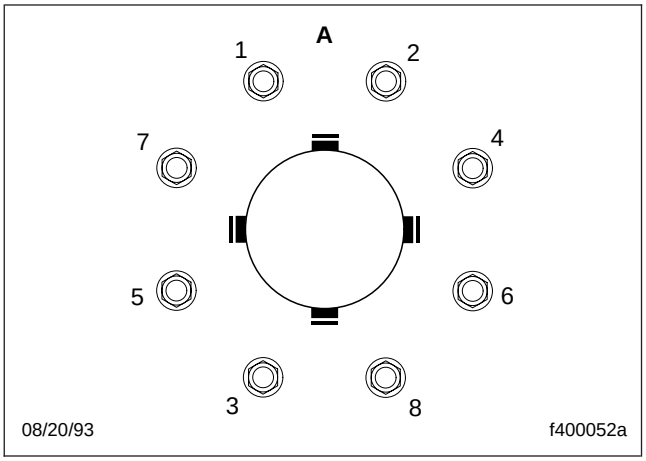


Fig. 12.10, Tightening Pattern, 8-Hole Wheels

wheel nut torque can break studs, damage threads, and crack discs in the stud hole area. Use the recommended torque values and follow the proper tightening sequence.

NOTE: Vehicles operating under severe or adverse conditions should be checked more frequently.

20. *Check the air brake system for proper operation.*

20.1 Check the air governor cut-in and cut-out pressures as follows.

Run the engine at fast idle. The air governor should cut out the air compressor at approximately 120 psi (827 kPa). With the engine idling, apply the brake pedal several times. The air governor should cut in the air compressor at approximately 100 psi (690 kPa). If the air governor does not cut in and out as described above, it must be adjusted to these specifications. If the air governor cannot be adjusted or repaired, replace it before operating the vehicle.

20.2 Check the air pressure buildup times as follows.

With the air system fully charged to 120 psi (827 kPa), make one full brake application and note the air pressure reading on the gauge. Continue to reduce the air pressure by moderate brake applications to a maximum of 90 psi (621 kPa), then run the engine at governed rpm. If the

time required to raise the air pressure to 120 psi (827 kPa) (from the pressure noted after one brake application) is more than 30 seconds, eliminate any leaks or replace the air compressor before operating the vehicle.

20.3 Check the air pressure reserve as follows.

With the air system fully charged to 120 psi (827 kPa), stop the engine and note the air pressure. Then make one full brake application and observe the pressure drop. If it drops more than 25 psi (172 kPa), all areas of leakage must be eliminated before operating the vehicle.

20.4 Check the air leakage in the system as follows.

With the parking brake (spring brake) applied, the transmission out of gear, and the tires chocked, charge the air system until cut-out pressure of 120 psi (827 kPa) is reached.

With the service brakes released, shut down the engine, wait 1 minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

Charge the air system until cut-out pressure of 120 psi (827 kPa) is reached. With the parking brakes released and the service brake applied, shut down the engine, wait 1 minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

If leakage exceeds the limits shown in **Table 12.2**, repair all areas of leakage before driving the vehicle.

Maximum Allowable Service Brake Leakage	
Brakes Released	**Brakes Applied**
2 psi/min. (14 kPa/min)	3 psi/min. (21 kPa/min)

Table 12.2, Maximum Allowable Service Brake Leakage

21. *Test the parking brake on a 20 percent grade.*

Apply the hand brake with the vehicle on a 20 percent grade (or as steep a grade that the vehicle may normally be parked on). The ramp surface should be made of Portland cement or equivalent. If the parking brake does not hold the vehicle, repair the parking brake system.

22. *Inspect the operation of the Hydro-Max® brake booster, as follows.*

22.1 With the engine off, depress the brake pedal; the warning light and buzzer should come on, and the electric motor should run.

22.2 Start the engine and allow the gauges to sweep. Depress the brake pedal; no warning lights, buzzer, or electric motor should come on.

23. *Inspect the engine and chassis wiring.*

Check for loose wiring, chafed insulation, and damaged or loose hold-down clamps. Tighten loose wires or hold-down clamps; replace damaged wiring or clamps.

24. *Test the service brakes.*

When starting to move the vehicle and before picking up speed, test the brakes with the foot pedal and parking brake control valve (yellow knob) or if equipped with the foot pedal parking brake control to be sure they will bring the vehicle to a safe stop.

Weekly Post-Trip Inspection and Maintenance Procedures

1. *Inspect the batteries and battery cables.*

⚠ WARNING

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. To prevent possible personal injury, always wash your hands after handling battery parts and related accessories.

1.1 Check the battery cables for chafing and proper routing. Be sure the battery hold-down is secure. If it is loose, tighten the hold-down bolts; if it is damaged, replace it. Replace the battery cable if damaged.

1.2 If the battery is equipped with a built-in hydrometer, examine the hydrometer. If a green dot shows in the sight glass, the battery is sufficiently charged.

If the sight glass is dark, the charge is low and the battery must be recharged.

If the sight glass is clear, the battery has a low level of electrolyte and must be replaced.

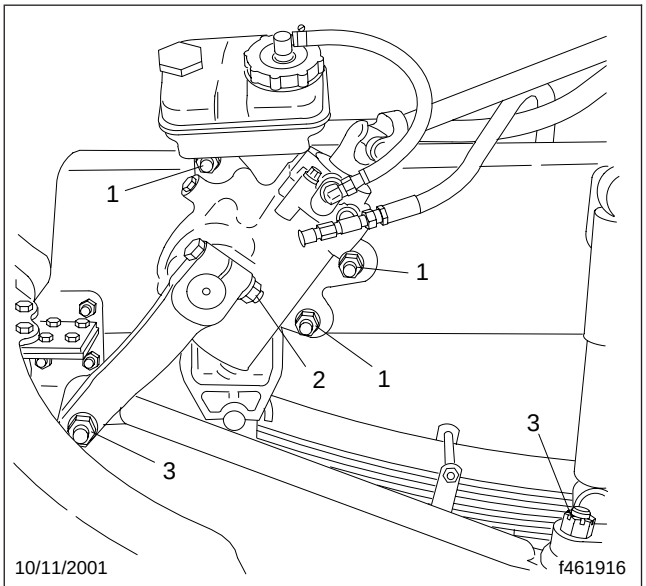
2. *Check the level of the wheel bearing lubricant in the hub cap at each end of the front axle.*

If needed, fill the hubs to the level indicated on the hub cap. See **Chapter 16**, for recommended lubricants.

IMPORTANT: Before removing the fill plug, always clean the hub cap and plug.

3. *Examine the steering components.*

See **Fig. 12.11**. If repairs are needed, see **Group 46** of the *Saf-T-Liner C2 School Bus Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner Custom Chassis dealer.



1. Steering Gear Mounting Bolt
2. Pitman Arm Pinch Bolt Nut
3. Drag Link Nut

Fig. 12.11, Steering Gear Fasteners

3.1 Check the mounting bolts and pitman arm nut, for tightness.

3.2 Check the drag link nuts for missing cotter pins.

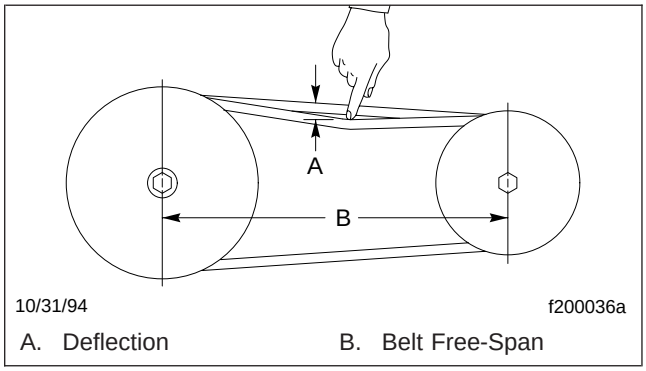
3.3 Inspect the steering drive shaft and steering linkage for excessive looseness, or other damage.

3.4 Tighten loose nuts and have damaged parts replaced as needed.

4. *Check the condition of the drive belts.*

Check the fan belt(s), alternator belt, and refrigerant compressor belt for signs of glazing, wear (frayed edges), damage (breaks or cracks), or oil contamination. If a belt is glazed, worn, damaged, or oil soaked, replace the belt, following the instructions in **Group 01** of the *Saf-T-Liner C2 School Bus Workshop Manual.*

5. *Check the drive belt for proper tension.* Use your index finger to apply approximately 25 pounds (11 kg) of force at the center of the belt free-span. See **Fig. 12.12**. Deflection should be one belt thickness per 1 foot (300 mm) of belt free-span. If the tension is more than or less than this value, measure it with a belt-tension gauge and adjust it to the proper tension. See **Group 01** of the *Saf-T-Liner C2 School Bus Workshop Manual* for instructions.



A. Deflection B. Belt Free-Span

Fig. 12.12, Checking Belt Tension

NOTE: On Cummins engines, a belt tensioner automatically adjusts the fan and alternator belt to correct tension. If the belt slips, repair or replace the tensioner. For instructions, see the *Cummins Engine Operation and Maintenance Manual*.

Monthly Post-Trip Inspection and Maintenance Procedures

WARNING

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. To prevent possible personal injury, always wash your hands after handling battery parts and related accessories.

1. *Clean the batteries.*

   1.1 Remove any corrosion from the hold-down and the top of the battery.

NOTICE

Take care to keep the vent plugs tight so that the neutralizing solution does not enter any of the battery cells and damage the battery.

   1.2 Use a soda solution to neutralize the acid present, then rinse off the soda solution with clean water.

   1.3 If the battery posts or cable terminals are corroded, disconnect the terminals from the posts. Clean them with a soda solution and a wire brush. After cleaning, connect the terminals to the battery posts, then apply a thin coat of petroleum jelly to the posts and terminals to help retard corrosion.

2. *Inspect the radiator and heater hoses, including the clamps and support brackets.*

   2.1 Make sure the radiator inlet and outlet hoses are pliable and are not cracking, weakening, or ballooning.

   2.2 Make sure the heater hoses are pliable and are not cracking or ballooning. Replace hoses that show signs of cracking, weakening, or ballooning.

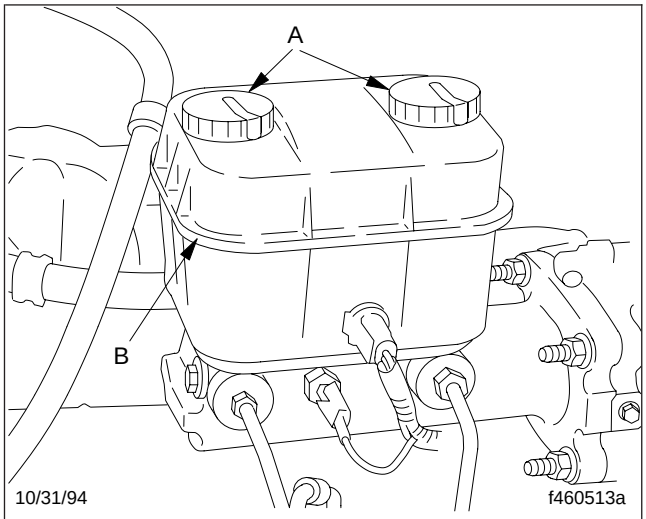
   2.3 Tighten hose clamps as necessary, but do not overtighten, as hose life can be adversely affected.

   2.4 Be sure the hose support brackets are securely fastened. Make sure the hoses are not located near sources of wear, abrasion, or high heat.

IMPORTANT: Replace all hoses, including heater hoses, at the same time. Service-type knitted or braided yarn-reinforced neoprene hose is acceptable. Silicone hoses having an extended service life can be substituted for the reinforced neoprene type. See the *Freightliner Service Parts Catalog* or contact your Freightliner Dealer.

3. *Check the fluid level in the hydraulic brake fluid reservoir, if so equipped.*

   If needed, fill the reservoir up to the ridge that surrounds the reservoir. Use only heavy-duty brake fluid, DOT 3. See **Fig. 12.13**.

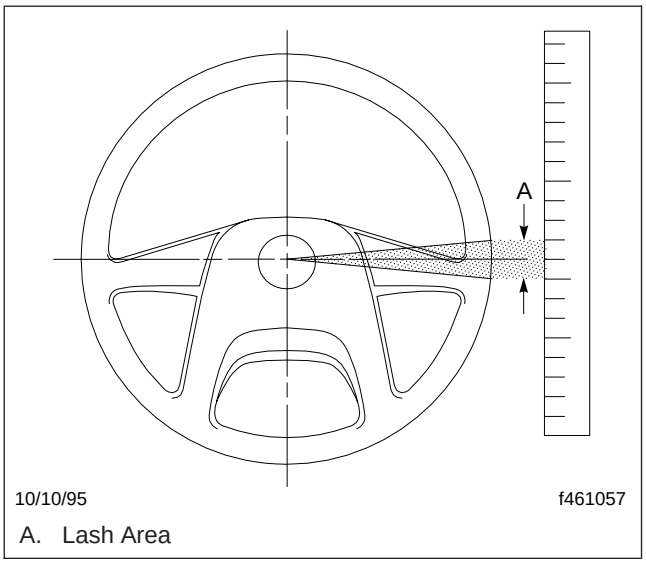


A. Open caps and check fluid level.
B. Fill to this level.

Fig. 12.13, Check the Hydraulic Brake Fluid Level (typical)

4. *Check the steering wheel for excessive play.*

   With the front tires pointing straight ahead, turn the steering wheel until motion is observed at the front wheels. Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels. Measure the lash (free play) at the rim of the steering wheel. See **Fig. 12.14**.



A. Lash Area

Fig. 12.14, Measuring Lash at the Steering Wheel

Excessive lash exists if steering wheel movement exceeds 4-3/4 inches (121 mm) with an 18-inch (457 mm) steering wheel. If there is excessive lash, check the steering system for wear or incorrect adjustment of the linkage and steering gear before operating the vehicle.

5. *Check the brake lining wear on vehicles equipped with air brakes.* Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.

   5.1 Apply the parking brakes, and chock the tires to prevent vehicle movement.

   5.2 If the axle assembly is not equipped with a dust shield or backing plate, measure the axle brake lining thickness. If *any* of the brake linings are worn to less than 3/16 inch (4.8 mm) at the thinnest point, replace the linings on *all* brake assemblies on that axle. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for lining replacement instructions and camshaft end play inspection.

   5.3 If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs to inspect the brake lining thickness. If any of the brake linings are worn to less than approximately 3/16 inch (4.8 mm) at the thinnest point, replace the linings on all brake assemblies on that axle. See **Group 42** of the *Saf-T-Liner C2 School Bus Workshop Manual* for lining replacement instructions and camshaft end play inspection.

   5.4 Install the inspection plugs in the dust shields or backing plates, if so equipped.

   5.5 Remove the chocks from the tires.

NOTE: The number and location of body mounting bolts and clips vary, depending on the options and wheelbase of each vehicle.

6. *Check that the body mounting bolts and clips are securely fastened.* If needed, tighten the bolts 30 lbf·ft (41 N·m). **Figure 12.15** shows an example of body mounting bolts and a clip.

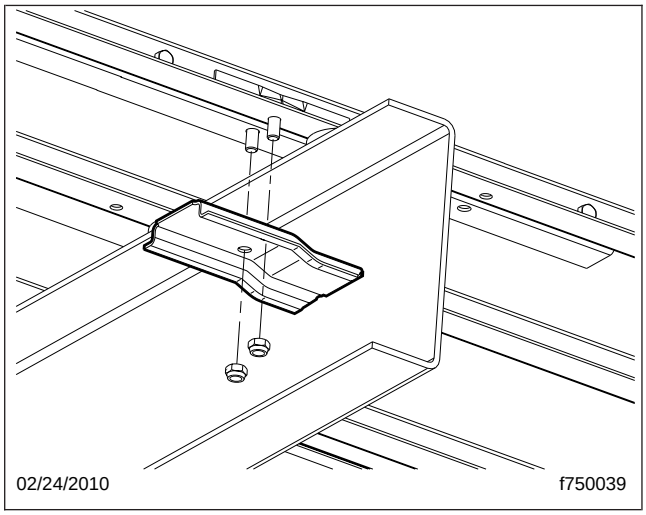


Fig. 12.15, Body Mounting Bolts and Clip (number and location vary)

13

Cleaning and Care

Cleaning and Care

Washing and Polishing

To protect the finish of your new vehicle, follow these guidelines carefully:

- During the first 30 days, rinse your vehicle frequently with water. If the vehicle is dirty, use a mild liquid soap. Do not use detergent.
- During the first 30 days, do not use anything abrasive on your vehicle. Brushes, chemicals, and cleaners may scratch the finish.
- During the first 120 days, do not wax your vehicle.

To extend the life of your vehicle's finish, follow these guidelines:

- Avoid washing your vehicle in the hot sun. Always use water. After the vehicle is completely washed, dry it with a towel or chamois.
- Do not dust painted surfaces with a dry cloth, as this will scratch the paint.
- Do not remove ice or snow from a painted surface with a scraper of any sort.
- To prevent damage to the finish, wax it regularly. If the finish has become dull, before waxing, remove oxidized paint using a cleaner specifically designed for this purpose. Remove all road tar and tree sap before waxing. Freightliner recommends that a quality brand of cleaner or cleaner-polish and polishing wax be used.
- Do not let diesel fuel or antifreeze stand on a painted surface. If either should occur, rinse the surface off with water.
- To prevent corrosion, have any nicks or other damage on the finish touched up as soon as possible.
- Park your vehicle in a sheltered area whenever possible.

Care of Fiberglass Parts

Wash unpainted fiberglass air fairings and shields monthly with a mild detergent, such as dishwashing liquid. Avoid strong alkaline cleansers.

Apply a wax specifically designed for fiberglass.

Care of Chrome Parts

To prevent rust, keep chrome parts clean and protected at all times. This is especially important during winter driving and in coastal areas where there is exposure to salt air.

When cleaning chrome parts, use clean water and a soft cloth or sponge. A mild detergent may also be used.

Sponge gently, then rinse. If necessary, use a non-abrasive chrome cleaner to remove stubborn rust or other material. Do not use steel wool.

To help protect the chrome after cleaning, apply a coat of polishing wax to the surface. Never use wax on parts that are exposed to high heat, such as exhaust pipes.

Dashboard Care

Periodically wipe the dashboard with a water-dampened cloth. A mild detergent can be used, but avoid using strong detergents.

⚠ CAUTION

Do not use Armor-All Protectant®, STP Son-of-a-Gun®, or other equivalent treatments. These cleaners contain vinyl plasticizers that can cause stress crazing in the interior plastic panels, which can result in cracking of the panels.

Vinyl Upholstery Cleaning

To prevent soiling, frequent vacuuming or light brushing to remove dust and dirt is recommended. Harsh cleaning agents can cause permanent damage to vinyl upholstery. To preserve the upholstery and prevent damage, carefully review the following sections for recommended cleaning procedures. Waxing or refinishing improves soil resistance and cleanability for all vinyls. Any hard wax, such as that used on automobiles, may be used.

Ordinary Dirt

Wash the upholstery with warm water and mild soap, such as saddle or oil soap. Apply soapy water to a large area and allow to soak for a few minutes, then rub briskly with a cloth to remove the dirt. This can be repeated several times as necessary.

If dirt is deeply imbedded, use a soft bristle brush after applying the soap.

If dirt is extremely difficult to remove, wall-washing preparations normally found around the home can be used. Powdered cleaners, such as those used for sinks and tiles, are abrasive and must be used with caution as they can scratch the vinyl or give it a permanent dull appearance.

Chewing Gum

Harden the gum with an ice cube wrapped in a plastic bag, then scrape it off with a dull knife. Any remaining traces of gum can be removed with an all-purpose light oil (peanut butter will also work) and wiped off.

Tars, Asphalts, and Creosote

Tars, asphalts, and creosote stain vinyl after prolonged contact. They should be wiped off immediately and the area carefully cleaned, using a cloth dampened with naphtha.

Paint, Shoe Heel Marks

Paint should be removed immediately. Do not use paint remover or liquid-type brush cleaner on vinyl. An unprinted cloth, dampened with naphtha or turpentine may be used. Use care to prevent contact with parts of the upholstery that are not vinyl.

Sulfide Stains

Sulfide compounds, such as those found in eggs and some canned goods, can stain after prolonged contact with vinyl. These stains can be removed by placing a clean, unprinted piece of cloth over the spotted area and pouring a liberal amount of 6 percent hydrogen peroxide onto the cloth. Allow the saturated cloth to remain on the spot for 30 to 60 minutes. For stubborn spots, allow the hydrogen-peroxide saturated cloth to remain on the area overnight. Use caution to prevent the solution from seeping into the seams or it will weaken the cotton thread.

Nail Polish and Nail Polish Remover

Prolonged contact with these substances causes permanent damage to vinyl. Careful blotting immediately after contact minimizes damage. Do not spread the liquid during removal.

Shoe Polish

Most shoe polishes contain dyes which penetrate vinyl and stain it permanently. Shoe polish should be wiped off as quickly as possible using naphtha or lighter fluid. If staining occurs, try the procedure used for sulfide stains.

Ball Point Ink

Ball point ink can sometimes be removed if rubbed immediately with a damp cloth, using water or rubbing alcohol. If this does not work, try the procedure used for sulfide stains.

Miscellaneous

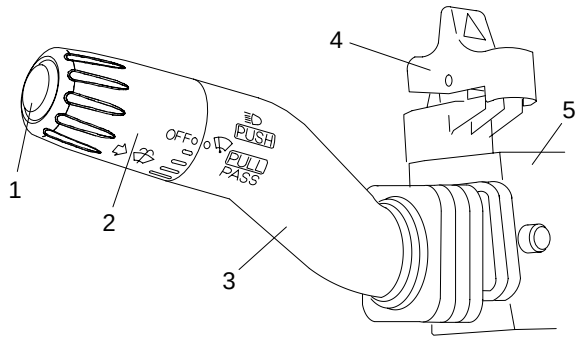
If stains do not respond to any of the treatments described above, it is sometimes helpful to expose the vinyl to direct sunlight for up to 30 hours. Mustard, ball point ink, certain shoe polishes, and dyes often bleach out in direct sunlight leaving the vinyl undamaged.

14

In an Emergency

Hazard Warning Lights

The hazard warning light flasher is part of the multifunction turn signal switch. It is a red rocker switch located on the top of the multifunction switch module. See **Fig. 14.1**.



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Press down on the upper part of the rocker to activate the flashers.

1. Washer Button
2. Wiper Control Dial
3. Turn Signal Lever
4. Hazard Flasher (red)
5. Multifunction Switch Module

Fig. 14.1, Hazard Warning Flashers

To flash the hazard warning lights, press down on the upper part of the rocker (towards the dash). To stop the hazard warning lights, press down on the lower part of the rocker (towards the steering wheel).

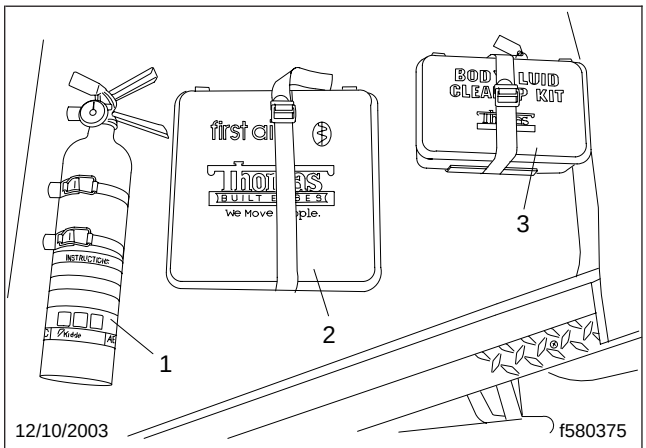
Fire Extinguisher

A fire extinguisher is located on the floor, to the right of the driver's area at the front of the bus. See **Fig. 14.2**.

Emergency Kit, Optional

An optional emergency kit is located to the right of the driver's area at the front of the bus or in a compartment over the driver's seat. The kit includes one or more of the following: a first aid kit, a reflective vest, a triangular reflector, a flare kit. See **Fig. 14.2**.

If there is an emergency while driving, cautiously pull off the road. Turn on the hazard warning lights. Place the flares and reflector along the side of the road to alert other drivers that an emergency situation exists.



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1. Fire Extinguisher
2. First Aid Kit
3. Body Fluid Cleanup Kit

Fig. 14.2, Emergency Equipment

WARNING

Use extreme care when placing flares in emergency situations that involve exposure to flammable substances such as fuel. An explosion or fire could occur causing serious personal injury.

Emergency Starting With Jumper Cables

When using jumper cables, follow the instructions below.

WARNING

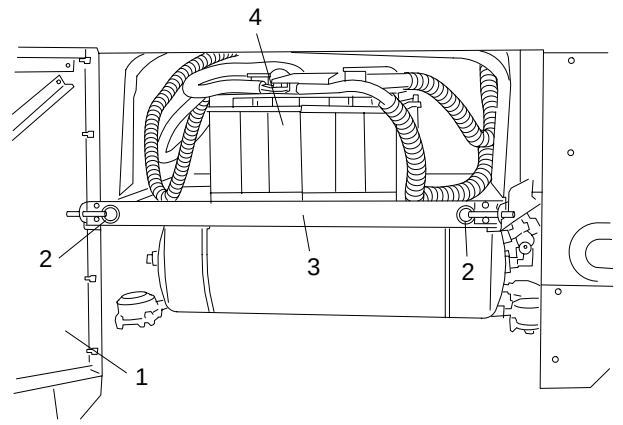
Batteries release explosive gas. Do not smoke when working around batteries. Put out all flames and remove all sources of sparks or intense heat in the vicinity of the battery. Do not allow the vehicles to touch each other. Do not lean over the batteries when making connections, and keep all other persons away from the batteries. Failure to follow these precautions could lead to severe personal injury as a result of an explosion or acid burns.

NOTICE

Make sure both starting systems have the same voltage outputs, and avoid making sparks. Otherwise the vehicle charging systems could be severely damaged. Also, do not attempt to charge isolated, deep-cycle batteries with jumper cables. Follow the battery manufacturer's instructions when charging deep-cycle batteries.

NOTE: On vehicles equipped with an optional jump-start post, attach the positive cable clamp to that post instead of to the battery.

1. Apply the parking brake and turn off the lights and all other electrical devices.
2. To gain access to the batteries, open the battery compartment. See **Fig. 14.3**. For detailed instructions, see **Chapter 2**.



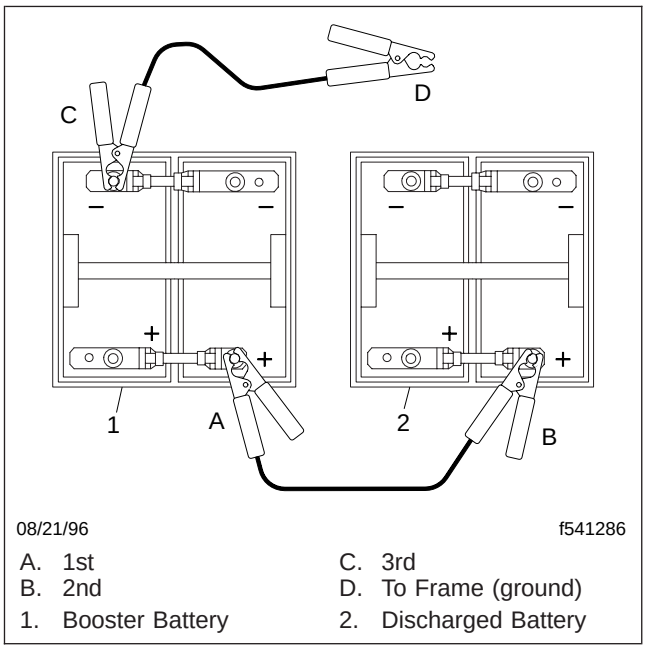
1. Battery Access Door
2. Pull-Pin Spring Latch
3. Battery Tray
4. Battery

Fig. 14.3, Battery Access

NOTICE

Always connect the battery, jumper cables, and charger correctly (positive-to-positive and negative-to-negative). Connecting a charging device backwards (positive-to-negative) will blow fuses that power the bulkhead module (BHM) and chassis module (CHM), and the devices they control will not work.

3. Connect an end of one jumper cable to the positive terminal of the booster battery (or jump-start post if so equipped), and connect the other end of the cable to the positive terminal of the discharged battery (or jump-start post if so equipped). See **Fig. 14.4**.



A. 1st
B. 2nd
C. 3rd
D. To Frame (ground)
1. Booster Battery
2. Discharged Battery

Fig. 14.4, Jumper Connections

⚠ WARNING

Do the next step exactly as instructed and do not allow the clamps of one cable to touch the clamps of the other cable. Otherwise, a spark could occur near a battery, possibly resulting in severe personal injury from explosion and acid burns.

4. Connect one end of the second jumper cable to the negative terminal of the booster battery, and connect the other end of the cable to a ground at least 12 inches (300 mm) away from the batteries of the vehicle needing the start. The vehicle frame is usually a good ground. Do *not* connect the cable to or near the discharged batteries.
5. Start the engine of the vehicle with the booster batteries, and let the engine run a few minutes to charge the batteries of the other vehicle.

6. Attempt to start the engine of the vehicle with the batteries receiving the charge. Do not operate the starter longer than 30 seconds, and wait at least two minutes between starting attempts to allow the starter to cool.
7. When the engine starts, let it idle a few minutes.

⚠ WARNING

Do the next step exactly as instructed and do not allow the clamps of one cable to touch the clamps of the other cable. Otherwise, a spark could occur near a battery, possibly resulting in severe personal injury from explosion and acid burns.

8. Disconnect the grounded cable from the frame or other non-battery location, then disconnect the other end of the cable.
9. Disconnect the remaining cable from the newly charged battery (or jump-start post if so equipped) first, then disconnect the other end.
10. Close the battery compartment. For detailed instructions, see **Chapter 2**.

Towing

⚠ WARNING

Do not tow an unbraked vehicle if the combined weight of both vehicles is more than the sum of the gross axle weight ratings (GAWR) of the towing vehicle. Otherwise brake capacity will be inadequate, which could result in personal injury or death.

IMPORTANT: When it is necessary to tow the vehicle, make sure the instructions below are closely followed to prevent damage to the vehicle.

When towing or pushing any vehicle equipped with an Allison transmission, disconnect the driveshaft at the rear axle and support it as necessary, regardless of the distance or speed traveled.

NOTE: Towing rules and regulations vary from federal, state, local, and transit authority. These laws must be followed when towing the bus.

Front Towing Hookup

NOTICE

The vehicle should never be towed from the rear. The gross axle weight rating (GAWR) of the front axle may not be sufficient to support the increased load when towing from the rear. This could damage the front axle.

1. Disconnect the battery ground cables.

NOTICE

Failure to remove the axle shafts when towing the vehicle with the rear wheels on the ground could result in damage to the transmission and other parts.

2. Remove both drive axle shafts.
3. Cover the ends of the hubs with metal plates or plywood cut to fit the axle opening, and drilled to fit the axle shaft studs. This prevents lubricant from leaking out and will keep contaminants from getting into and damaging the wheel bearings and axle lubricant.

NOTICE

Failure to protect the frame rails from the chains could cause damage, leading to eventual frame failure.

4. Remove the bumper.
5. Attach the towing device. Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the towing-vehicle operator.
6. Lift the vehicle and secure the safety chains. If extra towing clearance is needed, remove the front wheels.
7. Connect the clearance lights, taillights, and signal lights. Connect any special towing lights required by local regulations.

⚠ WARNING

Failure to chock the tires or connect the tow truck's air brake system before releasing the spring parking brakes could allow the disabled

vehicle to suddenly roll. This could cause property damage or personal injury.

8. Chock the tires on the disabled vehicle and connect the towing vehicle's air brake system to the vehicle being towed. Then, release the spring parking brake and remove the chocks.

Emergency Exits

Emergency Door

An emergency exit door is located at the rear of the bus. The emergency door has a locking capability in the open position to allow a clear exit from the bus. The release handle for the emergency exit door is protected to prevent accidental opening. Instructions for opening the emergency exit door are clearly displayed on the door face. See **Fig. 14.5**.

A warning buzzer in the bus activates when the release handle is not in the locked position.

IMPORTANT: The vehicle should not be driven if an emergency exit buzzer is sounding.

Using the Main Entry/Exit Door in an Emergency

In an emergency, it may be necessary to use the red switch above the main door to open the door. Push down on the red switch to open the door, then push the door open. See **Fig. 14.6** and **Fig. 14.7**.

Emergency Roof Escape Hatches, (optional)

The bus may contain emergency roof escape hatches located near the front and rear of the bus, according to Federal or State regulations. On buses equipped with an emergency roof escape hatch, the opening instructions are clearly displayed on the hatch cover. See **Fig. 14.8**.

Emergency Window Exits

The bus has windows designated as emergency exits. To open the windows in emergency situations, follow the instructions that are clearly displayed on the window frame.

NOTE: Some states require that the operating instructions be located on the window glass.

Running Out of Fuel

⚠ WARNING

Do not mix gasoline or alcohol with diesel fuel. This mixture could cause an explosion. When filling fuel tanks, do not smoke or use an open flame near the fuel tanks. Combustion of diesel fuel oil or fuel vapors could result, possibly causing personal injury or property damage.

1. If possible, stop the vehicle on a level surface, away from traffic.
2. Apply the parking brake.

IMPORTANT: Any time the vehicle runs out of fuel, the fuel system should be primed. This will purge any trapped air in the system and allows fuel to fill the fuel filter.

3. See the engine manufacturer's manual for instructions to prime the fuel system.
4. If further assistance is needed, call the Freightliner Customer Assistance Center at 1-800-385-4357 or 1-800-FTL-HELP.

NOTICE

Do not crank the engine for more than 30 seconds at a time during the following procedure. Wait two minutes after each try to allow the starter to cool. Failure to do so could cause starter damage.

5. Add fuel to the fuel tank.
6. After adding fuel to the fuel tank, start the engine. Once the vehicle is running, let the engine idle until it operates smoothly before driving the vehicle.

Changing a Flat Tire

IMPORTANT: If a flat tire occurs while driving, gradually decrease vehicle speed. Holding the steering wheel firmly, move to a safe place on the side of the road.

1. Stop the vehicle on a level surface, away from traffic.
2. Apply the parking brake, place the transmission in neutral (N), and shut down the engine.

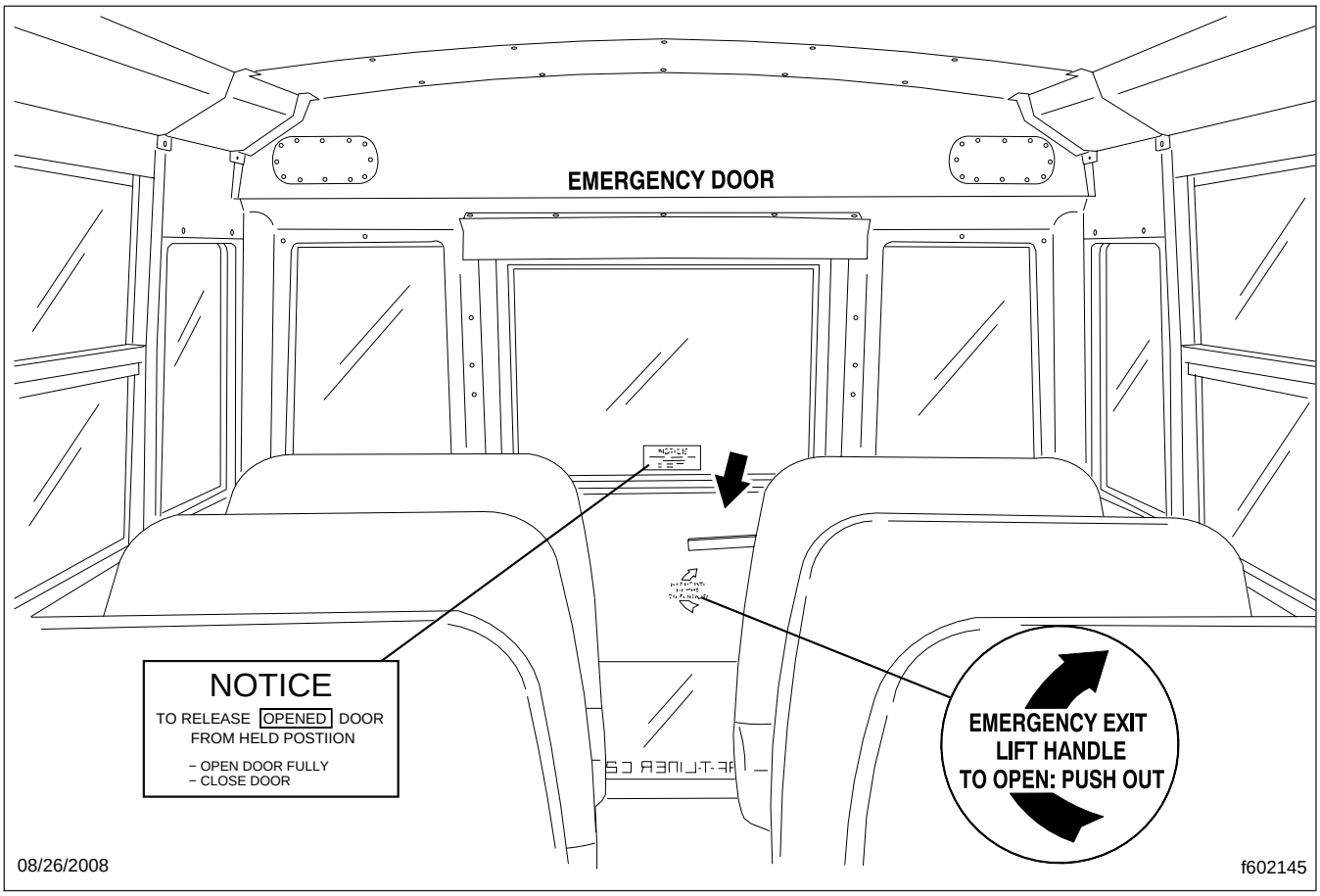


Fig. 14.5, Emergency Door

3. Turn on the emergency flashers.
4. Block the wheel diagonally opposite the wheel being changed.
5. Remove the spare wheel, jack, jack handle, and lug wrench from storage.

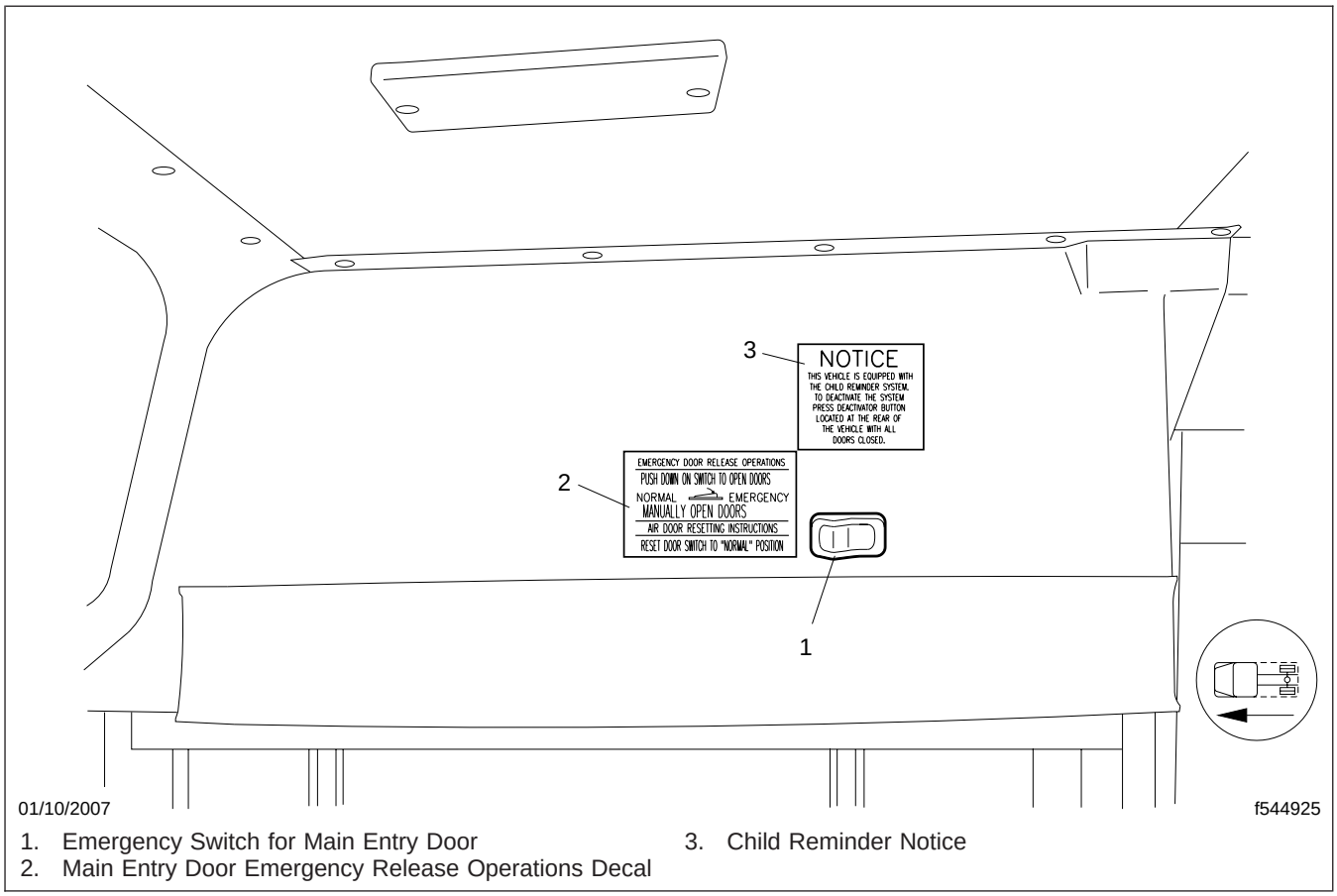
IMPORTANT: The jacking point for the front wheels is on the front axle beam and other locations shown in **Fig. 14.9**. The jacking point for rear wheels is on the rear axle and at the locations on the rear suspension H-frame, shown in **Fig. 14.9**.

Only use the front bumper locations if the bus is equipped with a jackable bumper. Do not position the jack under the dropped frame rails in the center section of the bus.

6. Place the jack on a solid surface. Insert the jack handle and pump the handle slightly. *Do not raise the wheel off of the ground yet.* Loosen the wheel lug nuts, but do not remove them.

IMPORTANT: The dual rear wheels are attached using two-element lug nuts. The larger nut retains the outer dual. The inner square stud retains the inner dual. Remove and install these nuts separately. The rear dual outer lug nut must be loosened to check and retighten the inner nut.

7. Raise the vehicle until the wheel is off of the ground. Remove the lug nuts and the wheel.
8. Install the spare wheel and lug nuts. Make sure that the beveled sides of the nuts face inward, or, on hub-piloted wheels, make sure that the hub-pilot pad is centered at the top.



1. Emergency Switch for Main Entry Door
2. Main Entry Door Emergency Release Operations Decal
3. Child Reminder Notice

Fig. 14.6, Emergency Switch for Main Entry Door

IMPORTANT: When a tire is changed, the vehicle should be taken to a mechanic as soon as possible, to have the lug nuts tightened properly with an impact air gun.

9. In a star pattern, tighten the nuts evenly until snug. See **Group 40** of the *Saf-T-Liner C2 School Bus Workshop Manual* for wheel tightening patterns and torque specifications. Lower the vehicle until the wheel touches the ground. Tighten the nuts.
10. Finish lowering the vehicle to the ground, then remove the jack.
11. Remove the block, then stow the jack, jack handle, and lug wrench.
12. After operating the vehicle for 50 to 100 miles (80 to 160 km), retighten the wheel nuts to the specified torque values.

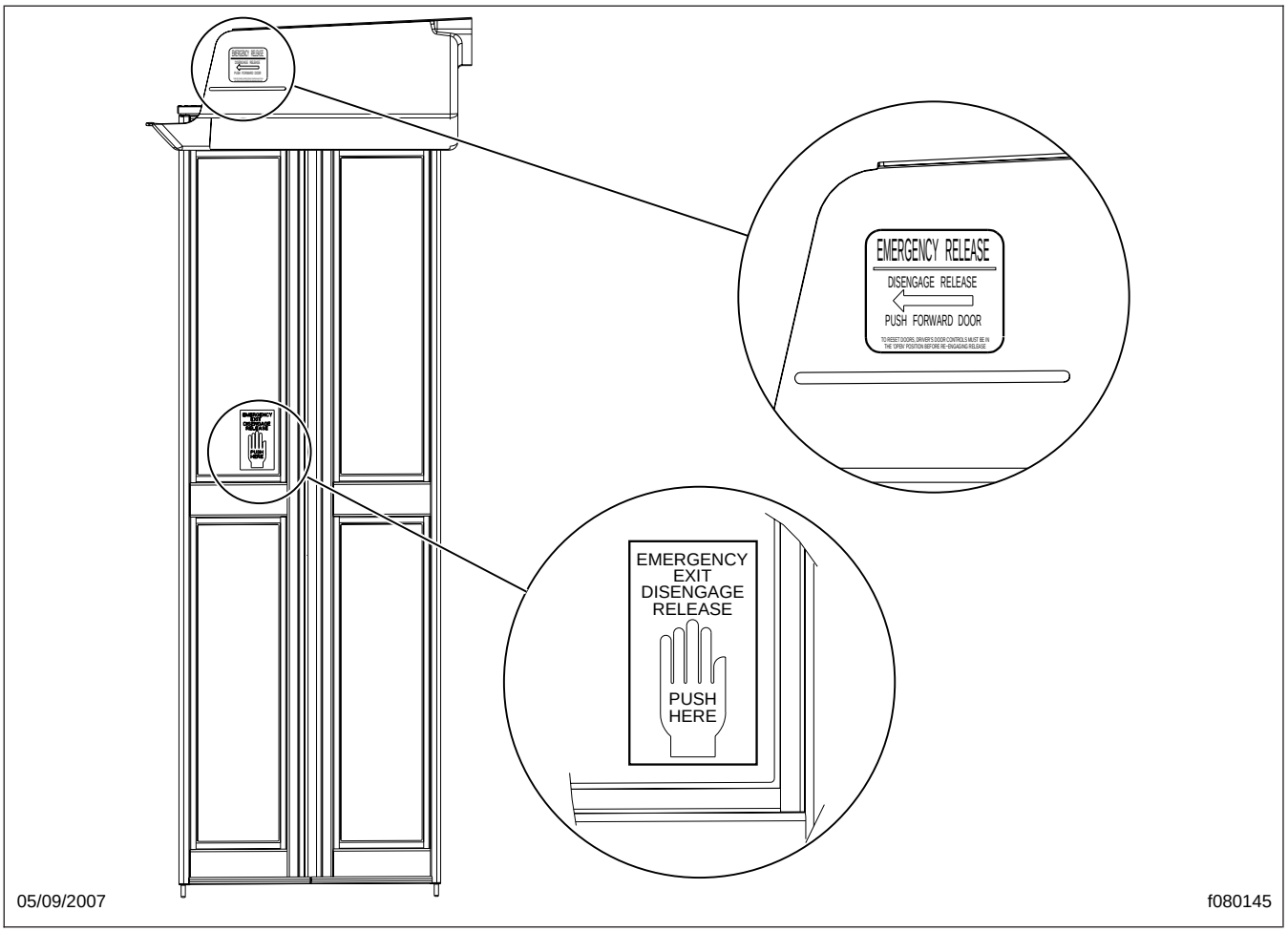


Fig. 14.7, Disengaging the Main Entry Door in an Emergency

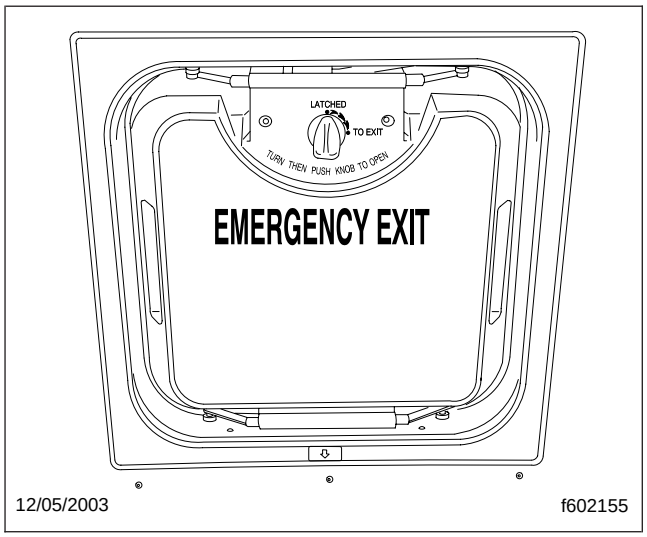


Fig. 14.8, Emergency Roof Escape Hatch

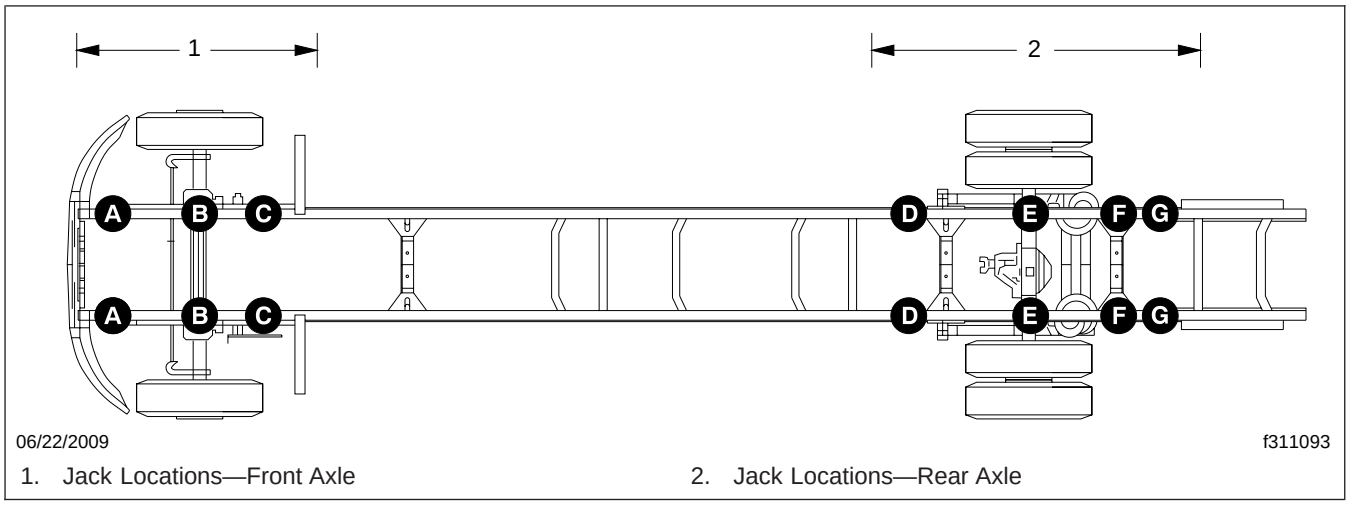


Fig. 14.9, Jack Placement

15

Headlight Aiming

Headlight Aiming

Preliminary Checks

Before checking or adjusting the headlight aim, do the following.

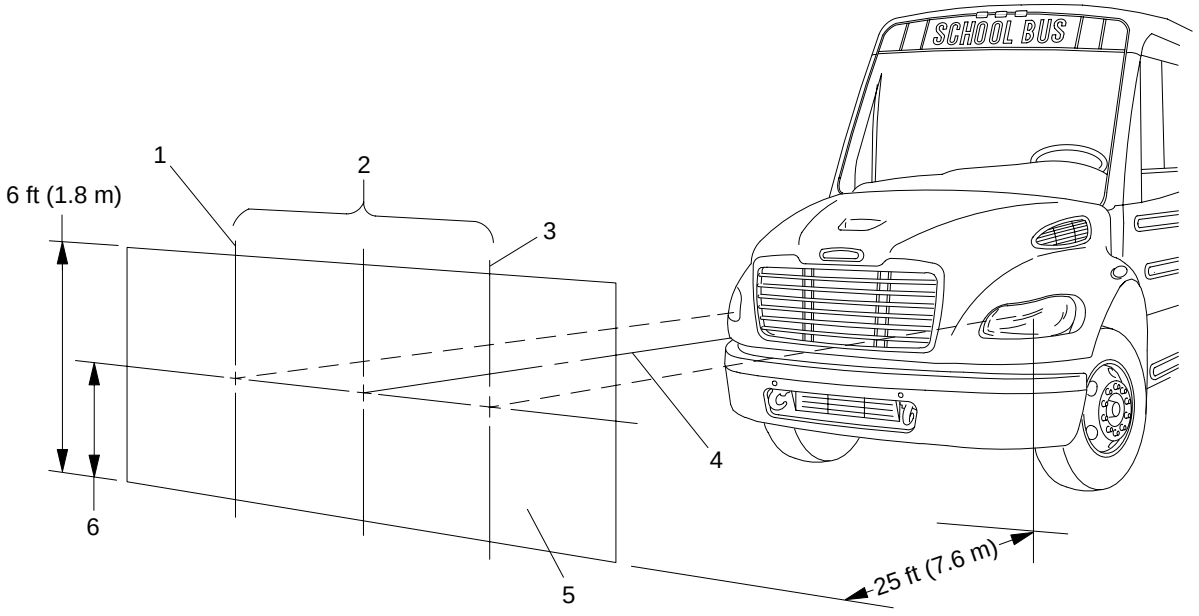
- Remove large amounts of mud or ice from the underside of the fenders.
- Check the springs for sagging or broken leaves.
- Check the suspension for proper functioning of the leveling mechanism. On buses with air suspensions, make sure that the height is properly adjusted.
- Check for damage to the hood and hinge assembly. Repair as necessary.
- Clean the headlight lenses.
- With the vehicle unloaded, check that the tires are inflated to the recommended air pressure.

Checking Headlight Aim

1. Park the vehicle on a level surface 25 ft (7.6 m) from a screen or wall that can be used for aiming the headlights. Shut down the engine, apply the parking brake, and chock the front tires. See **Fig. 15.1**.

NOTE: The low-beam headlight is the top bulb in the dual-beam assembly.

2. On each headlight, find the bulb center. See **Fig. 15.2**.
3. Measure the distance from the ground to the center of each low-beam bulb. Note those distances.
4. On the screen or wall 25 ft (7.6 m) away, make the appropriate markings directly across from each headlight and at the same height as measured for the headlight.



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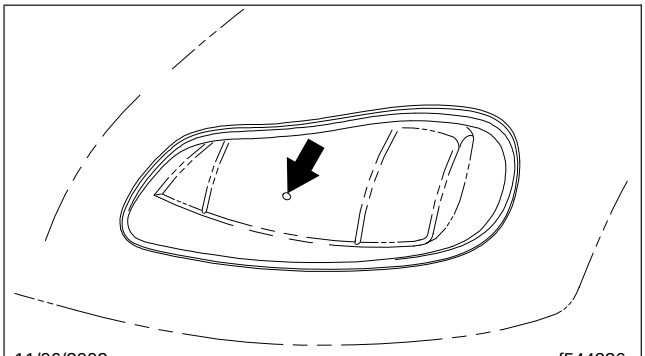
1. Vertical Centerline of Right Headlight
2. Distance Between Headlights
3. Vertical Centerline of Left Headlight
4. Projected Vehicle Centerline
5. Screen or Wall
6. Height of Lamp Centers

Fig. 15.1, Headlight Aiming Screen or Wall



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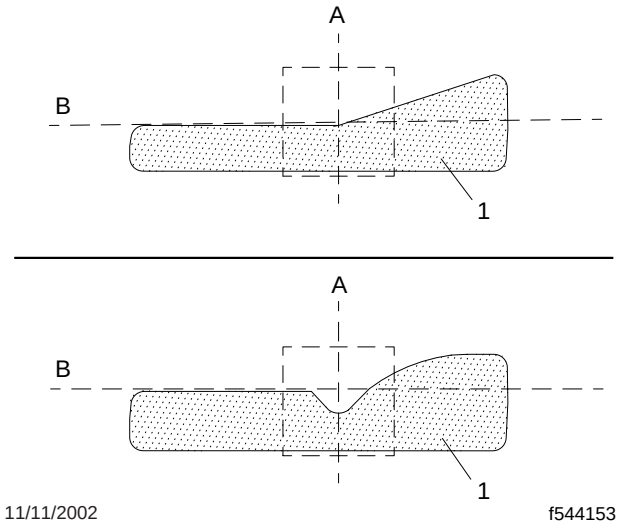
Measure beam height from the ground to the small dot roughly in the center of the headlight lens.

Fig. 15.2, Headlight Beam Height Adjusting Dot

5. Turn on the headlights to the low-beam setting. See **Fig. 15.3** for the ideal and acceptable patterns for both headlights.



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NOTE: The top view shows the ideal beam pattern; the bottom view shows an acceptable standard.

A. Vertical Centerline
B. Horizontal Centerline
1. Bright Area

Fig. 15.3, Headlight Beam Pattern

- If either or both headlights do not aim into the inner edges of the centerline, follow the adjusting procedure below.
- If both headlights come close to the inside of each headlight centerline (as shown), no further work is needed. Turn off the headlights and remove the chocks from the front tires.

Adjusting Headlight Aim

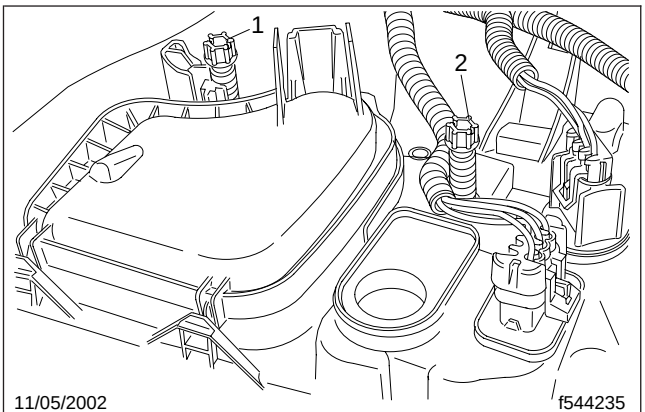
1. Lift the flap over the rear end of the headlight bucket to expose the two plastic adjusting knobs on each headlight. See **Fig. 15.4**.

NOTE: Horizontal aim should not be adjusted in the field.

2. With the vehicle parked 25 ft (7.6 m) from the screen or wall, put the headlights on low beams, and turn both adjusting knobs the same amount, as needed to adjust the lights until the beam pattern meets the acceptable standard in **Fig. 15.5**.

NOTE: Blocking off each light is not necessary, but it can help to present a clearer beam pattern.

3. Remove the chocks from the front tires.



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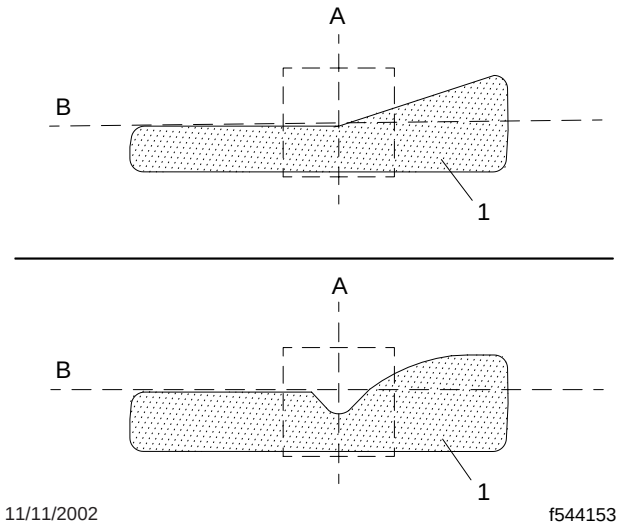
NOTE: The right-hand side headlight bucket is shown. The left-hand side is opposite.

1. Inboard Adjusting Knob
2. Outboard Adjusting Knob

Fig. 15.4, Headlight Adjusting Knobs

Headlight Aiming



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NOTE: The top view shows the ideal beam pattern; the bottom view shows an acceptable standard.

A. Vertical Centerline B. Horizontal Centerline
1. Bright Area

Fig. 15.5, Headlight Beam Pattern

16

Hybrid Electric Vehicle

Hybrid Electric Vehicle (HEV) Overview

A hybrid electric vehicle (HEV) has both a diesel engine and an electric motor. Engine torque is augmented with electrical torque. The electric motor is powered by batteries, which are charged by regenerative braking.

The batteries cannot move the vehicle for long distances at highway speeds. In the event of a diesel engine failure, drive the vehicle to a safe location as quickly as possible.

Eaton Corporation developed and supplies the hybrid electric system for Freightliner Trucks. The primary system components are the hybrid drive unit (or HDU, which includes the electric generator/motor and automated transmission), power electronics carrier (PEC), and the motor inverter/controller.

Freightliner Trucks designed the stand-alone liquid cooling system required to support the operation of Eaton's HEV system. Its primary system components are the electric water pump, reservoir/expansion tank, radiator, electric radiator fan, and coolant plumbing.

Regenerative Braking

Regenerative braking reduces vehicle speed by converting some of the vehicle's kinetic energy into electric energy to charge the hybrid system's batteries. When the accelerator pedal is at idle while coasting, or the service brake is depressed to slow the vehicle, the hybrid system charges the batteries.

The regeneration will feel as if the brake is being lightly applied when you remove your foot from the accelerator pedal. The full power of the service brake is always available to the driver, and regenerative braking is automatically shut off during an ABS (antilock brake system) event.

The Eaton Hybrid Control Unit will automatically shut off regenerative braking when the batteries are fully charged.

Hill Start Aid

Hill Start Aid (HSA) is a system used on the HEV Saf-T-Liner C2 School Bus to prevent the vehicle from rolling backward when it is stopped on a grade, in gear, and the driver is not applying the service brake.

IMPORTANT: HSA being active does not mean that the brakes are being applied; only that the system is prepared to engage the brakes when needed.

While at a stop, the transmission will broadcast the J1939 message indicating "ready" or "not ready". If the transmission is broadcasting the "not ready" message, the ABS will activate HSA. When active, HSA monitors vehicle speed and brake pressure (force applied to the brake pedal). If vehicle speed is 0 and there is a decrease in brake pressure, HSA will engage the brakes for up to 3 seconds while it waits for the "ready" message. If the message is not received within 3 seconds, HSA will continue to hold the vehicle for up to 60 seconds. HSA will continue to engage the brake until it receives the message from the transmission or the driver reapplies their foot to the brake pedal.

The transmission will not broadcast the "ready" message until it sees a throttle input. If the transmission does not broadcast the "ready" message within 60 seconds of HSA engaging the brakes, the ABS system will release the brakes and the vehicle will roll freely if urge torque is not available.

High-Voltage Safety Features

The HEV has high-voltage safety cables and a service switch on the PEC. Areas of the vehicle that contain hazardous voltage are marked with a warning label as shown in **Fig. 16.1**.

Fig. 16.1, Hazardous Voltage Warning Label

High-voltage safety cables are covered in orange insulation and labeled near each connector end. Each high-voltage component is tagged with a warning or danger label. See **Fig. 16.2**.

Fig. 16.2, High Voltage Cables Warning Label

IMPORTANT: The service switch on the PEC should only be used for an emergency shut-down, or when the service manual or trouble-shooting guide calls for work on the high-voltage system. The service manual and troubleshooting guide for the hybrid electric system are available from **www.roadranger.com**.

The red service switch is located next to the high-voltage cable connections at one end of the PEC. Pushing in the red service switch will shut down the engine. The hybrid system will be disabled, and the high-voltage batteries in the PEC, though still live, are isolated in the PEC.

NOTE: The PEC may be mounted in an area with limited access.

For information on emergency shutdowns, see "In Case of an Emergency" in this chapter.

Cooling System

The HEV requires a liquid cooling system for the HDU, inverter, DC/DC Converter. The HEV cooling system is separate from the engine cooling system.

For coolant, use a 50/50 mixture of water and extended-life antifreeze — the same coolant specified for the vehicle.

Safety Precautions

The hybrid electric vehicle (HEV) has high-voltage components, including 340-volt Direct Current (DC) batteries and a 500-volt Alternating Current (AC) motor.

Never touch or cut high-voltage cables or connectors. If it is necessary to remove occupants using cutting equipment, avoid high-voltage cables and the Power Electronics Carrier (PEC). See **Fig. 16.3** for the location of the high-voltage cables and PEC.

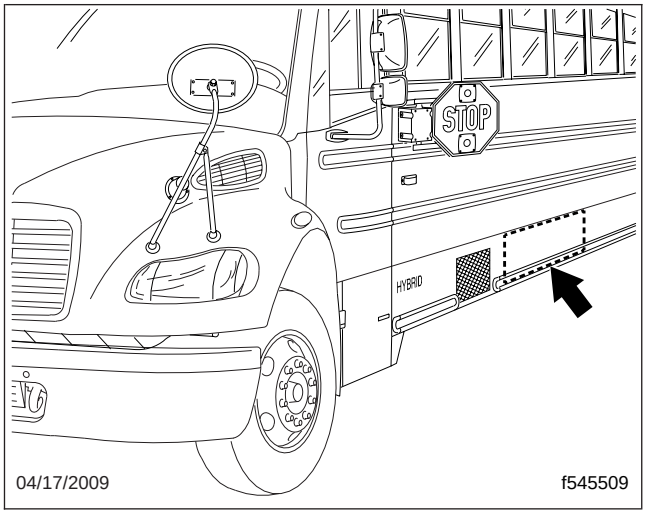


Fig. 16.3, High Voltage Cables and Power Electronics Carrier (PEC) Location

DANGER

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

Avoid direct pressure wash on high-voltage PEC connections and the air intake and exhaust on the PEC.

Engine Starting and Shutdown

The Cranking System

The primary engine starter is the electric motor in the HDU, which cranks the engine very quickly. The back-up cranking system is the standard 12-volt starter on the engine. If the hybrid system is offline or the hybrid batteries are insufficiently charged, the vehicle will automatically use the 12-volt cranking system to start the engine.

Starting

1. Set the parking brake.
2. Place the key in the ignition, and turn it clockwise to the "ON" position to initiate power to the hybrid system.

Wait for the gauges on the instrument panel to complete two sweeps (one from left to right, and one from right to left) and return to their normal ranges.

3. Ensure the transmission is in park/neutral. The gear display should display a solid P or N.

⚠ WARNING

Never start the engine unless the transmission is in neutral and the brake is applied. Accidental movement of the vehicle could result in property damage, personal injury, or death.

4. Turn the key clockwise to the START position. The engine will crank after a brief delay. As soon as the engine starts, release the key, allowing it to return to the "ON" position. The engine will continue to run with the key in the "ON" position.
5. Apply the service brake, then release the parking brake.
6. With the service brake applied, press the desired mode on the shift control to put the vehicle into gear.
7. Slowly release the service brake.

NOTE: The vehicle may be powered by the electric motor or the diesel engine, depending on battery charge and the demand for driveline torque. If the electric motor alone is powering the driveline, the diesel engine will stay at idle.

Engine Shutdown

1. Place the transmission in neutral by selecting N on the shift control.

IMPORTANT: The transmission must be in neutral for proper shutdown.

2. Set the parking brake.
3. Turn the key counterclockwise to the "OFF" position.

NOTE: Intermittent noises such as clicking and transmission shifting may be audible from the transmission while it completes a self-test and shutdown.

T-Handle Shifter

The Hybrid Saf-T-Liner C2 School Bus is equipped with an Eaton automated manual transmission. A T-handle shift control is used by the driver to select the transmission ranges. See **Fig. 16.4**.

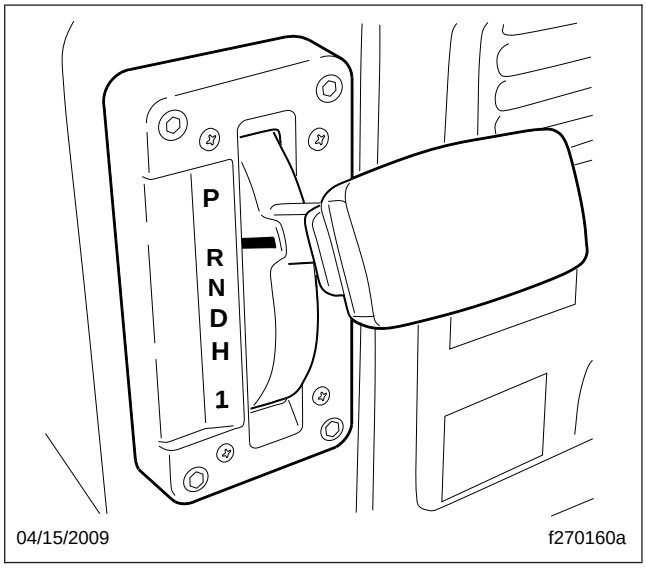


Fig. 16.4, T-Handle Shift Control

P (Park)

Use park when turning the engine on or off, to check vehicle accessories, or to operate the engine in idle for longer than 5 minutes. This position places the transmission in neutral and engages the park pawl of the transmission.

NOTE: This does not apply the parking brake.

The park pawl effectively grounds the transmission output shaft, thereby preventing rotation of the driveline. Provided the vehicle is stationary, selecting **P** (Park) on the shift selector places the transmission in **Neutral** and engages the park pawl.

R (Reverse)

The reverse position selects the reverse gear once the vehicle speed is less than 2 mph (3 km). When the selector is in reverse, the reverse warning signal will sound. Always bring the vehicle to a complete stop before shifting from a forward range to reverse, or from reverse to a forward range.

Do not idle in reverse for more than 5 minutes. Select P (park), or N (neutral) when time at idle exceeds 5 minutes.

N (Neutral)

The neutral position places the transmission in neutral. This position is used when starting the engine and for stationary operation.

When neutral is selected, the vehicle service brakes, parking brake, or emergency brake must be applied. Selecting neutral does not apply vehicle brakes unless an auxiliary system to apply the parking brake is installed.

Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and you could lose control of the vehicle.

D (Drive)

The drive position selects the default start gear and automatically upshifts and downshifts. In the drive position, the transmission will initially go into first range when drive is selected. As vehicle speed increases, the transmission will upshift automatically through each available range up to fourth range or fifth range. As the vehicle slows, the transmission will downshift automatically.

When going downhill, downshift to a lower transmission range to increase engine braking and to help maintain control. During downhill operation, the transmission may upshift to the next higher range, if the engine is exceeding its governed speed in the lower range.

H (Hold)

This hold position on the T-handle shifter holds the transmission in the current gear.

1 (Low Gear)

Use first range when pulling through mud or deep snow, when maneuvering in tight spaces, or when driving up or down very steep grades. First range provides the vehicle with its maximum driving torque and maximum engine braking effect.

Hybrid Electric Vehicle (HEV) System Fault Lamps

There are two lamps on the dashboard that indicate a hybrid system fault is active — the red STOP HYBRID lamp and the amber CHECK HYBRID lamp. See **Fig. 16.5**. When the red STOP HYBRID lamp is illuminated, do not drive the vehicle; have it towed to a Freightliner dealer or an authorized service center for repairs. When the amber CHECK HYBRID lamp is illuminated, the vehicle can still be driven, though it may operate without the assistance of the hybrid electrical system.

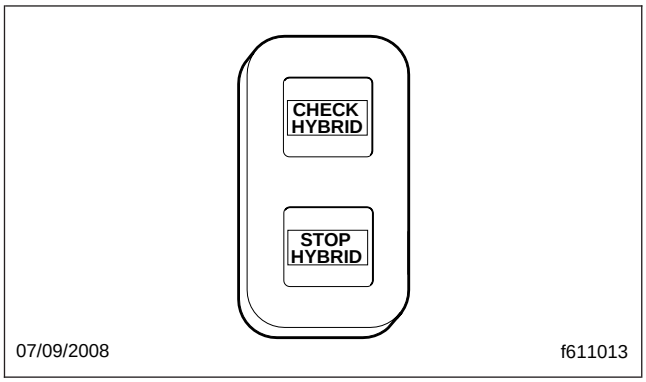


Fig. 16.5, Hybrid System Fault Lamps

A gear display, located on the dash above the fault lamps, will show the current gear selected, and any fault codes for the transmission. F will flash for a fault code, and the hybrid system fault lamps will illuminate. If the gear display flashes CA, the driver is being notified about clutch abuse.

Disabling the Hybrid Electric Vehicle (HEV) System

The following information describes the three methods to disable the HEV system.

Option 1 (preferred method)

Turn off the ignition.

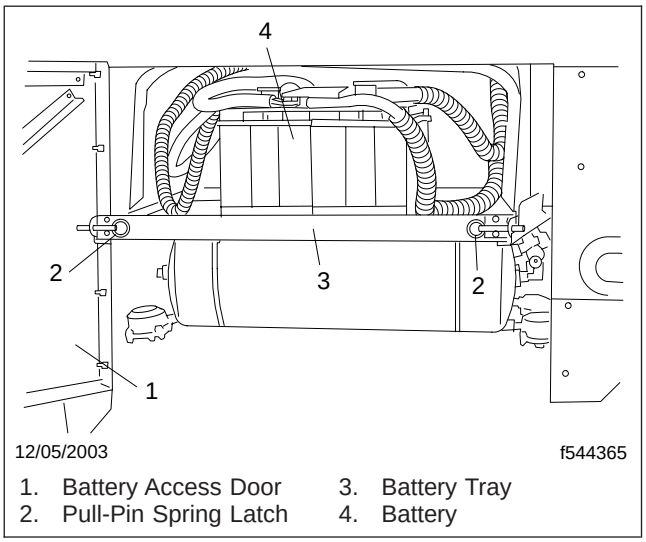
- The engine will shut down.
- The dash lights will shut down.
- The HEV system will shut down.

- The HEV batteries are still active, but are isolated in the Power Electronics Carrier (PEC).

Option 2

Disconnect the low-voltage (12 volt) vehicle batteries. See **Fig. 16.6**.

- The engine will shut down.
- The HEV system will shut down.



1. Battery Access Door
2. Pull-Pin Spring Latch
3. Battery Tray
4. Battery

Fig. 16.6, Battery Access

- The HEV batteries are still active, but are isolated in the PEC.

Option 3

Push in the service switch in the Power Electronics Carrier and shut down the engine.

IMPORTANT: The red service switch on the PEC should only be used for an emergency shutdown or when the service manual or troubleshooting guide directs the hybrid-trained technician to perform work on the high-voltage system.

- Push in the service switch on the PEC and shut down the engine. See **Fig. 16.7**.
- Hybrid system will be disabled
- HEV batteries are still "live" but are isolated in the PEC.

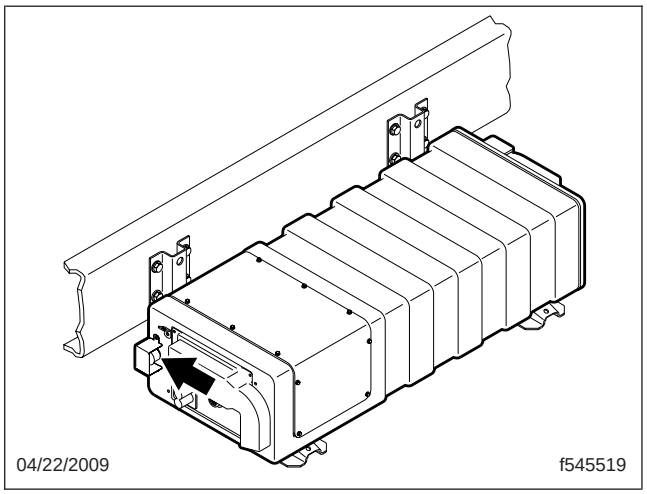


Fig. 16.7, Service Switch

IMPORTANT: These procedures should only be used for an emergency. If service is required on the vehicle, refer to the "Hybrid Services Shutdown" procedure found in TRSM1000 located on **www.roadranger.com**.

In Case of an Emergency

Emergency Shutdown

IMPORTANT: After disabling the vehicle, power is maintained in the high-voltage electrical system for up to 5 minutes.

There are three options for performing an emergency shutdown. The preferred method is to turn off the ignition key. The second option is to disconnect the low-voltage (12-volt) vehicle batteries. The final method is to push in the service switch on the Power Electronics Carrier. In either case, the engine will shut down, dash lights will shut down, the hybrid electrical system will shut down, and the high-voltage batteries in the Power Electronics Carrier (PEC) will remain "live" but isolated in the PEC.

In Case of an Accident or Fire

If the HEV becomes involved in an accident or fire, be aware of the following:

- Use CO2 or dry chemical extinguishers. Lithium ion batteries are contained in the Power Electronics Carrier (PEC).

- Do not cut into high-voltage cables. The high-voltage wiring is covered in orange insulation or convoluted tubing and marked with warning labels at the connectors.
- Do not cut into or open the PEC.
- Do not cut into or open the inverter.

If it is necessary to remove occupants using cutting equipment, avoid high-voltage cables and the PEC. See **Fig. 3**.

Jumpstarting

Jumpstarting vehicles equipped with the Eaton® Hybrid System is identical to non-hybrid vehicles, which use the vehicle 12-volt battery system.

Towing (HEV)

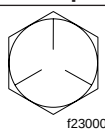
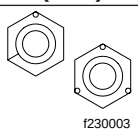
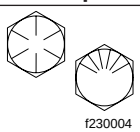
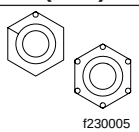
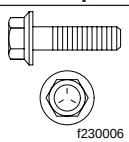
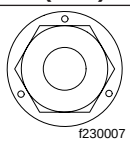
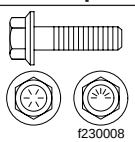
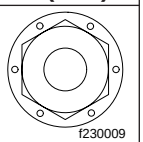
When towing the vehicle, the output shaft of the transmission must not be allowed to spin or turn. If the vehicle is towed with the drive wheels still in contact with the road surface, the vehicle axle shafts or driveline must be removed or disconnected. See "Towing" in **Chapter 14**.

17

Specifications

Specifications

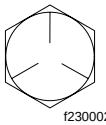
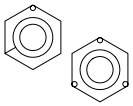
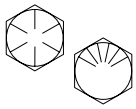
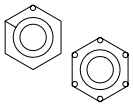
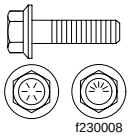
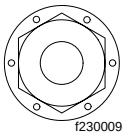
Torque Charts

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)		—		—	

* FCCC 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 17.1, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads

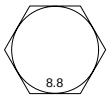
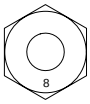
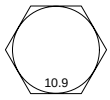
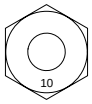
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) * Plain (Unplated) Threads †						
Thread Diameter—Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf·ft (N·m)		Torque: lbf·ft (N·m)		Torque: 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 17.3**. FCCC recommends that all plated and unplated fasteners be coated with oil before installation.

Table 17.2, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads

Specifications

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)	

* FCCC 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 17.3, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads

Conversion Charts

Metric/U.S. Customary Conversion					
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 17.4, Metric/U.S. Customary Conversion

Temperature Conversion							
When You Know	**Subtract**	**Then Divide By**	**To Get**	**When You Know**	**Multiply By**	**Then Add**	**To Get**
degrees Fahrenheit (°F)	32	1.8	degrees Celsius (°C)		1.8	32	degrees Fahrenheit (°F)

Table 17.5, Temperature Conversion

Specifications

Fluid and Lubricant Specifications

See **Table 17.6** for fluid and lubricant specifications.

Fluid and Lubricant Specifications	
Component	**Recommended Fluid or Lubricant**
Front Axle Spindle Pins, Tie Rods, Drag Link, Intermediate Steering Shaft, Front Brake and Pedal Shafts, Slip Spline and Universal Joints	Multipurpose Grease Lithium 12- Hydroxy Stearate NLGI No. 2; for temperatures below 0°F (–18°C), use MIL-G-10924B
Hydraulic Brake Master Cylinder	Heavy-Duty DOT 3 Brake Fluid
Brake and Pedal Pivots	Starplex 2 (lithium soap-based grease)
Engine	See Manufacturer's Recommendations
Transmission	Mobil Delvac Synthetic ATF
Fuel	Ultralow-Sulfur Diesel Fuel CMS 20067 (CNG Engines)
Disc Brake Caliper Rails	FCCC No. 4JD623 Brake Caliper Slide Grease
Rear Axle Differential	See Manufacturer's Recommendations
Hydraulic System Reservoir	Dexron® III ATF or equivalent
Engine Coolant	50% Water/50% Ethylene Glycol Antifreeze

Table 17.6, Fluid and Lubricant Specifications

Replacement Light Bulbs

See **Table 17.7** for a listing of replacement light bulbs.

Replacement Light Bulbs	
Light Location	**Lamp Trade Number**
Warning Panel Lights	53 or LB–0108
Headlights MB and XB; High Beam Low Beam Gauge Illumination	2A1 1A1 2B1 53, 194 or LB–0107
Automatic Transmission Gear Selector	53

Table 17.7, Replacement Light Bulbs

Bulkhead Module Fault Codes

The information below contains all proprietary Bulkhead Module (BHM) fault codes for J1587 and J1939 datalink protocols, how to view these codes, and what they mean. The fault codes can be seen on the instrument cluster. The mode/reset switch is used to scroll through the displays on the message display screen. For more information on the mode/reset switch see **Chapter 4**. Each fault code contains three distinct pieces of information, as described below.

NOTE: In ServiceLink, J1587 fault codes are shown under J1708. J1587 and J1708 are essentially the same datalink protocol.

J1587 fault codes consist of the following, in this order:

- Module Identifier (MID)—Identifies which Electronic Control Unit (ECU) the fault is coming from. The J1587 MID identifying all Bulkhead Information Module faults is 164.
- Subsystem Identifier (SID)—Indicates what function on the ECU has failed. All J1587 SIDs for the BHM are listed in **Table 17.8**.
- Failure Mode Indicator (FMI)—Indicates in what way the function failed.

NOTE: References such as BHM B1.A (beginning with SID 050 in **Table 17.8**) indicate that the fault is sensed to be coming from the Bulkhead Module, connector B1, pin A. Similarly, CHM indicates the Chassis Module, and

EXM1-5 indicates the first through fifth Expansion Module on a vehicle.

J1939 faults consist of the following, in this order:

- Source Address (SA)—identifies which ECU the fault is coming from. The J1939 SA identifying all Bulkhead Module faults is 33.
- Suspect Parameter Number (SPN)—Indicates what function on the ECU has failed. All J1939 SPNs for the BHM are listed in **Table 17.9**.
- Failure Mode Indicator (FMI)—Indicates in what way the function failed.

Also included is a reference table of all FMIs for both datalink protocols. See **Table 17.10**.

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
000	Backlighting Dimmer Switch Fault	7
001	Clutch Switch Fault	7
002	Reserved for Future Use	—
003	Headlamp Switch Disagreement—Both Park and On Inputs are CLOSED	7
004	Stalk Switch High Beam Input Fault	2
005	Ignition Switch Fault	7
006	Marker Interrupt Switch Fault	7
007	Stalk Switch Disagreement—Both Wiper High and Wiper Low Inputs are ON	2
008	Stalk Switch Disagreement—Wiper On/Off Input is OFF and Wiper High or Low Input is ON	2
009	Wiper Park Input Fault	7
010	ICU3-M2 Hazard Switch CAN Feedback Error	2
011	Stalk Switch Left Turn Signal Input Fault	2
012	Stalk Switch Right Turn Signal Input Fault	2
013	Stalk Switch Washer Switch Input Fault	2
014	Stalk Switch Wiper On/Off Input Fault	2
015	Stalk Switch Wiper Low Input Fault	2
016	Stalk Switch Wiper High Input Fault	2
017	Wheel Based Vehicle Speed CAN Message Error	2
018	Wake up Hardware Fault (modules are kept awake)	7
019	Unknown Keep Awake Fault (modules are kept awake)	7
020	Extra Smart Switch	7
021	Duplicate Smart Switch	7
022	Missing Smart Switch	7
025	End of Frame Air Unexpected Pressure Feedback	7
026	End of Frame Air No Pressure Feedback	7
027	Axle Lift Unexpected Pressure Feedback	7
028	Axle Lift No Pressure Feedback	7
031	Suspension Proportioning Unexpected Pressure Feedback	7
032	Suspension Proportioning No Pressure Feedback	7
033	Cigar Lighter Output Fault	7
034	BHM/ICU3-M2 Ignition Mismatch	7
035	BHM/ICU3-M2 Hazard Switch Mismatch	2
036	BHM/ICU3-M2 Wiper Park Mismatch	2
037	Missing Transmission CAN Message	9
038	Missing Chassis Module CAN Message	9

Specifications

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
039	Remote Bucket Switch Stuck Fault	7
040	Axle Lift 2 Feedback Fault	7
041	Axle Lift 2 No Feedback Fault	7
042	PTO 1 Feedback Fault	7
043	PTO 1 No Feedback Fault	7
044	PTO 2 Feedback Fault	7
045	PTO 2 No Feedback Fault	7
046-049	Reserved for Future Use	—
050	BHM B1.A	3,4
051	BHM B1.F, B1.P, B2.K, B2.L, B6.A8	5,6
052	BHM B1.J	3,4
053	BHM B1.K, B5.C	5,6
054	BHM B1.L	5,6
055	BHM B1.N	3,4
056	BHM B1.R	5,6
057	BHM B2.M	5,6
058	BHM B3.D	3,4
059	BHM B3.E	3,4,5,6
060	BHM B3.F	5,6
061	BHM B3.G	5,6
062	BHM B3.H	5,6
063	BHM B4.B	5,6
064	BHM B4.E, B4.F	3,4,5,6
065	BHM B4.G	3,4
066	BHM B4.K	3,4
067	BHM B4.M, B5.E	3,4,5,6
068	BHM B5.A, B7.A12	5,6
069	BHM B6.A9, B6.A10	5,6
070	BHM B5.B	5,6
071	BHM B5.D	5,6
072	BHM B5.F	3,4,5,6
073	BHM B5.G	3,4,5,6
074	BHM B5.H, B7.A1	3,4,5,6
075	CHM C1.A, C1.H, C1.J	5,6
076	CHM C1.G, C2.H, C3.N	5,6
077	CHM C1.L	5,6
078	CHM C1.N	5,6
079	CHM C1.P, C2.E, C3.R	5,6
080	CHM C2.A	3,4
081	CHM C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
082	CHM C3.A	3,4,5,6
083	CHM C3.C, C3.D	5,6
084	CHM C3.E	3,4
085	CHM C3.F	3,4
086	CHM C3.J	3,4

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
087	CHM C3.K	5,6
088	CHM C3.L	5,6
089	CHM C4.F	5,6
090	CHM C4.J	3,4
091	CHM C4.K	5,6
092	CHM C4.P	3,4
093	CHM C5.A	3,4
094	CHM C5.B	3,4
095	CHM C5.F	3,4
096	CHM C5.G	3,4
097	CHM C5.H	3,4
098	CHM C5.J	3,4
099	CHM C5.L	3,4
100	CHM C5.M	3,4
101	EXM1 C1.A, C1.H, C1.C	5,6
101	EXM1 C4.K	5,6
101	EXM1 C3.L	5,6
101	EXM1 C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
101	EXM1 C1.N	5,6
101	EXM1 C1.L	5,6
101	EXM1 C1P, C2.E, C3.R	5,6
101	EXM1 C1.G, C2.H, C3.N	5,6
101	EXM1 C2.A	3,4
101	EXM1 C3.A	3,4,5,6
101	EXM1 C3.C, C3.D	5,6
101	EXM1 C3.K	5,6
101	EXM1 C4.F	5,6
101	EXM1 C5.H	3,4
101	EXM1 C5.C	3,4
101	EXM1 C5.L	3,4
101	EXM1 C5.M	3,4
101	EXM1 C3.E	3,4
101	EXM1 C3.F	3,4
101	EXM1 C3.C	3,4
101	EXM1 C4.C	3,4
101	EXM1 C4.P	3,4
101	EXM1 C5.A	3,4
101	EXM1 C5.B	3,4
101	EXM1 C5.F	3,4
101	EXM1 C5.G	3,4
102	EXM2 C1.A, C1.H, C1.C	5,6
102	EXM2 C4.K	5,6
102	EXM2 C3.L	5,6
102	EXM2 C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
102	EXM2 C1.N	5,6

Specifications

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
102	EXM2 C1.L	5,6
102	EXM2 C1P, C2.E, C3.R	5,6
102	EXM2 C1.G, C2.H, C3.N	5,6
102	EXM2 C2.A	3,4
102	EXM2 C3.A	3,4,5,6
102	EXM2 C3.C, C3.D	5,6
102	EXM2 C3.K	5,6
102	EXM2 C4.F	5,6
102	EXM2 C5.H	3,4
102	EXM2 C5.C	3,4
102	EXM2 C5.L	3,4
102	EXM2 C5.M	3,4
102	EXM2 C3.E	3,4
102	EXM2 C3.F	3,4
102	EXM2 C3.C	3,4
102	EXM2 C4.C	3,4
102	EXM2 C4.P	3,4
102	EXM2 C5.A	3,4
102	EXM2 C5.B	3,4
102	EXM2 C5.F	3,4
102	EXM2 C5.G	3,4
103	EXM3 C1.A, C1.H, C1.C	5,6
103	EXM3 C4.K	5,6
103	EXM3 C3.L	5,6
103	EXM3 C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
103	EXM3 C1.N	5,6
103	EXM3 C1.L	5,6
103	EXM3 C1P, C2.E, C3.R	5,6
103	EXM3 C1.G, C2.H, C3.N	5,6
103	EXM3 C2.A	3,4
103	EXM3 C3.A	3,4,5,6
103	EXM3 C3.C, C3.D	5,6
103	EXM3 C3.K	5,6
103	EXM3 C4.F	5,6
103	EXM3 C5.H	3,4
103	EXM3 C5.C	3,4
103	EXM3 C5.L	3,4
103	EXM3 C5.M	3,4
103	EXM3 C3.E	3,4
103	EXM3 C3.F	3,4
103	EXM3 C3.C	3,4
103	EXM3 C4.C	3,4
103	EXM3 C4.P	3,4
103	EXM3 C5.A	3,4
103	EXM3 C5.B	3,4

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
103	EXM3 C5.F	3,4
103	EXM3 C5.G	3,4
104	EXM4 C1.A, C1.H, C1.C	5,6
104	EXM4 C4.K	5,6
104	EXM4 C3.L	5,6
104	EXM4 C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
104	EXM4 C1.N	5,6
104	EXM4 C1.L	5,6
104	EXM4 C1P, C2.E, C3.R	5,6
104	EXM4 C1.G, C2.H, C3.N	5,6
104	EXM4 C2.A	3,4
104	EXM4 C3.A	3,4,5,6
104	EXM4 C3.C, C3.D	5,6
104	EXM4 C3.K	5,6
104	EXM4 C4.F	5,6
104	EXM4 C5.H	3,4
104	EXM4 C5.C	3,4
104	EXM4 C5.L	3,4
104	EXM4 C5.M	3,4
104	EXM4 C3.E	3,4
104	EXM4 C3.F	3,4
104	EXM4 C3.C	3,4
104	EXM4 C4.C	3,4
104	EXM4 C4.P	3,4
104	EXM4 C5.A	3,4
104	EXM4 C5.B	3,4
104	EXM4 C5.F	3,4
104	EXM4 C5.G	3,4
105	EXM5 C1.A, C1.H, C1.C	5,6
105	EXM5 C4.K	5,6
105	EXM5 C3.L	5,6
105	EXM5 C2.F, C4.C, C4.D, C4.L, C4.M	3,4,5,6
105	EXM5 C1.N	5,6
105	EXM5 C1.L	5,6
105	EXM5 C1P, C2.E, C3.R	5,6
105	EXM5 C1.G, C2.H, C3.N	5,6
105	EXM5 C2.A	3,4
105	EXM5 C3.A	3,4,5,6
105	EXM5 C3.C, C3.D	5,6
105	EXM5 C3.K	5,6
105	EXM5 C4.F	5,6
105	EXM5 C5.H	3,4
105	EXM5 C5.C	3,4
105	EXM5 C5.L	3,4
105	EXM5 C5.M	3,4

Specifications

J1587 SIDs for Bulkhead Module (BHM) MID 164		
SID	**Description**	**Possible FMI**
105	EXM5 C3.E	3,4
105	EXM5 C3.F	3,4
105	EXM5 C3.C	3,4
105	EXM5 C4.C	3,4
105	EXM5 C4.P	3,4
105	EXM5 C5.A	3,4
105	EXM5 C5.B	3,4
105	EXM5 C5.F	3,4
105	EXM5 C5.G	3,4
106	Reserved for Future Use	—
107	SHM J1.A, J1.E	6
108	SHM J3.G (PWM)	6
109	SHM J3.M(PWM)	6
110	SHM J3.F	5,6
111	SHM J3.K	5,6

Table 17.8, J1587 SIDs for Bulkhead Module (BHM) MID 164

J1939 SPNs for Bulkhead Module (BHM) SA 33		
SPN	**Description**	**Possible FMI**
70	Parking Brake Switch	2
80	Washer Fluid Level	2
84	Wheel Based Vehicle Speed	19
96	Fuel Level	19
97	Water In Fuel Indicator	19
163	Transmission Current Range	12,19
177	Transmission Oil Temperature Sensor	3,4
523	Transmission Current Gear	12,19
524	Transmission Selected Gear	12,19
597	ABS Service Brake Switch	2
598	Clutch Switch	7
879	Front Left Turn Signals Output Fault	5,6
881	Front Right Turn Signals Output Fault	5,6
882	Park/Marker Lights Output Fault	4,5,6
973	Engine Retarder Selection	19
1487	Backlighting Dimmer Switch Fault	7
1550	A/C Clutch Output Fault	5,6
2003	Missing Transmission CAN Message	9
2071	Missing Chassis Module CAN Message	9
6891	ID/Marker/Clearance Lamps—HW Override Output Fault	5,6
6892	Upper Right Tail Lamp Output Fault	5,6
6893	Upper Left Tail Lamp Output Fault	5,6
6894	Rear Passenger Dome Lamp Output Fault	6
6895	Front Passenger Dome Lamp Output Fault	6
6896	Right Side Air/Electric Entrance Door—Close—Output Fault	6

J1939 SPNs for Bulkhead Module (BHM) SA 33		
SPN	**Description**	**Possible FMI**
6897	Right Side Air/Electric Entrance Door—Open—Output Fault	6
6898	Right Side Turn Signal Output Fault	5,6
6900	Left Side Turn Signal Output Fault	5,6
6901	Stepwell Lights Output Fault	5,6
6902	Left Upper Backup Lamp Output Fault	5,6
6903	Right Upper Backup Lamp Output Fault	5,6
6904	Rear Right Turn Signal Output Fault	5,6
6905	Rear Left Turn Signal Output Fault	5,6
6906	PTO 2 No Feedback Fault	7
6907	PTO 2 Feedback Fault	7
6908	PTO 1 No Feedback Fault	7
6909	PTO 1 Feedback Fault	7
6910	Axle Lift 2 No Feedback Fault	7
6911	Axle Lift 2 Feedback Fault	7
6912	Remote Bucket Switch Stuck Fault	7
6915	Lamp and Gauge Ignition Output Fault	4,5,6
6916	BHM/ICU3-M2 Wiper Park CAN Message Mismatch	2
6917	BHM/ICU3-M2 Hazard Switch CAN Message Mismatch	2
6918	Missing Smart Switch	7
6919	Duplicate Smart Switch	7
6920	Extra Smart Switch	7
6921	Unknown Keep Awake Fault (modules are kept awake)	7
6922	Wake up Hardware Fault (modules are kept awake)	7
6923	Wiper Parked Input Fault	7
6924	Stalk Switch Disagreement—Wiper On/Off Input is OFF and Wiper High or Low Input is ON	2
6925	Stalk Switch Disagreement—Both Wiper High and Wiper Low Inputs are ON	2
6926	Marker Interrupt Switch Fault	7
6927	Utility Lamp Output Fault	3,4,5,6
6928	Suspension Proportioning No AMU Pressure Feedback	7
6929	Suspension Proportioning Unexpected AMU Pressure Feedback	7
6930	Suspension Proportioning Solenoid Output Fault	3,4,5,6
6934	Spotlights Output Fault	3,4,5,6
6936	Rear 2 Differential Lock AMU Pressure Feedback Fault	7
6937	Rear 2 Differential Lock Solenoid Output Fault	3,4,5,6
6938	Rear 1 Differential Lock AMU Pressure Feedback Fault	7
6939	Rear 1 Differential Lock Solenoid Output Fault	3,4,5,6
6940	Optional Feature Output Fault	3,4,5,6
6941	Heated Mirrors Output Fault	3,4,5,6
6942	Interaxle AMU Pressure Feedback Fault	7
6943	Interaxle Solenoid Output Fault	3,4,5,6
6944	Fuel Water Separator Heater Output Fault	4,5,6
6945	Front Differential Lock AMU Pressure Feedback Fault	7
6946	Front Differential Lock Solenoid Output Fault	3,4,5,6
6947	Fog Lamp Output Fault	5,6
6954	End of Frame Air No AMU Pressure Feedback	7

Specifications

J1939 SPNs for Bulkhead Module (BHM) SA 33		
SPN	**Description**	**Possible FMI**
6955	End of Frame Air Unexpected AMU Pressure Feedback	7
6956	End of Frame Air Solenoid Output Fault	3,4,5,6
6957	Daytime Running Lights (DRL) Output Fault	5,6
6958	Brake Line Air Dryer Output Fault	3,4,5,6
6959	Axle Shift AMU Pressure Feedback Fault	7
6960	Axle Shift Solenoid Output Fault	3,4,5,6
6961	Axle Lift No AMU Pressure Feedback	7
6962	Axle Lift Unexpected AMU Pressure Feedback	7
6963	Axle Lift Solenoid Output Fault	3,4,5,6
6964	Air Horn Solenoid Output Fault	5,6
6965	BHM VBAT 5 Input Fault	3,4
6966	BHM VBAT 4 Input Fault	3,4
6967	BHM VBAT 3 Input Fault	3,4
6968	BHM VBAT 2 Input Fault	3,4
6969	BHM VBAT 1 Input Fault	3,4
6970	Wiper High Output Fault	5,6
6971	Wiper Low Output Fault	5,6
6972	Stalk Switch Wiper High Input Fault	2
6973	Stalk Switch Wiper Low Input Fault	2
6974	Stalk Switch Wiper On/Off Input Fault	2
6975	ICU3-M2 Wiper Park CAN Feedback Error	2
6976	Washer Pump Output Fault	5,6
6977	Stalk Switch Washer Switch Input Fault	2
6978	Stalk Switch Right Turn Signal Input Fault	2
6979	Stalk Switch Left Turn Signal Input Fault	2
6980	Right Stop Lamp Output Fault	5,6
6981	Left Stop Lamp Output Fault	5,6
6982	Wake up Hardware Fault	5,6
6983	Starter Relay (Mag Switch) Output Fault	5,6
6984	Ignition System, Accessory Power Outputs Fault	5,6
6985	Ignition System, Ignition Power Outputs Fault	2,5,6
6986	Ignition Switch Fault	7
6987	Tail/Clearance/License Plate Lights Output Fault	5,6
6988	Left Low Beam Output Fault	5,6
6989	Right Low Beam Output Fault	5,6
6990	Left High Beam Output Fault	5,6
6991	Right High Beam Output Fault	5,6
6992	Stalk Switch High Beam Input Fault	2
6993	Headlamp Switch Disagreement—Both Park and On Inputs are CLOSED	7
6994	ICU3-M2 Hazard Switch CAN Feedback Error	19
6995	Horn Output Fault	3,4,5,6
6996	Dome Lamps Switched Power Output Fault	5,6
6997	Cigar Lighter Output Fault	3,4,5,6
6998	Dome Lamps Battery Power Output Fault	5,6
6999	Backup Lamps/Alarm Output Fault	5,6

J1939 SPNs for Bulkhead Module (BHM) SA 33		
SPN	**Description**	**Possible FMI**
7000	Panel Lamp Backlighting PWM Output Fault	3,4,5,6

Table 17.9, J1939 SPNs for Bulkhead Module (BHM) SA 33

Failure Mode Identifiers		
FMI	**J1939 Description**	**J1587 Description**
00	Data valid but above normal operational range—Most severe level	Data valid but above normal operational range (engine overheating)
01	Data valid but below normal operational range—Most severe level	Data valid but below normal operational range (engine oil pressure too low)
02	Data erratic, intermittent, or incorrect	Data erratic, intermittent, or incorrect
03	Voltage above normal or shorted high	Voltage above normal or shorted high
04	Voltage below normal or shorted low	Voltage below normal or shorted low
05	Current below normal or open circuit	Current below normal or open circuit
06	Current above normal or grounded circuit	Current above normal or grounded circuit
07	Mechanical system not responding or out of adjustment	Mechanical system not responding properly
08	Abnormal frequency, pulse width, or period	Abnormal frequency, pulse width, or period
09	Abnormal update rate	Abnormal update rate
10	Abnormal rate of change	Abnormal rate of change
11	Root cause not known	Failure mode not identifiable
12	Bad intelligent device or component	Bad intelligent device or component
13	Out of Calibration	Out of Calibration
14	Special Instructions	Special Instructions
15	Data valid but above normal operational range—Least severe level	Reserved for future assignment by the SAE Subcommittee
16	Data valid but above normal operational range—Moderately severe level	—
17	Data valid but below normal operational range—Least severe level	—
18	Data valid but below normal operational range—Moderately severe level	—
19	Received network data in error	—
20	Reserved for SAE Assignment	—
21	Reserved for SAE Assignment	—
22	Reserved for SAE Assignment	—
23	Reserved for SAE Assignment	—
24	Reserved for SAE Assignment	—
25	Reserved for SAE Assignment	—
26	Reserved for SAE Assignment	—
27	Reserved for SAE Assignment	—
28	Reserved for SAE Assignment	—
29	Reserved for SAE Assignment	—
30	Reserved for SAE Assignment	—

Specifications

Failure Mode Identifiers		
FMI	**J1939 Description**	**J1587 Description**
31	Not available or condition exists	—

Table 17.10, Failure Mode Identifiers

Index

F

H

I

Index

T

V

W