



SAF-T-LINER C2 SCHOOL BUS

Driver's Manual

Introduction

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

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.).

This vehicle is equipped with an event data recorder (EDR). The main purpose of an EDR is to record data in certain crash or near-crash situations, such as air bag deployment or hitting a road obstacle, that will assist in understanding how a vehicle's systems

performed. The EDR is designed to record data related to vehicle dynamics and safety systems for approximately 60 seconds. This data can help provide a better understanding of the circumstances in which crashes and injuries occur. Data recorded includes the following items:

- how various systems in the vehicle were operating
- engine system information
- how far (if at all) the driver was depressing the accelerator
- if the driver was depressing the brake pedal
- how fast the vehicle was traveling

NOTE: Data is not recorded by the EDR under normal driving conditions. Personal data such as name, gender, age, and crash location are not recorded. However, other parties such as law enforcement could combine the EDR data with the type of personally identifying data routinely acquired during a crash investigation.

To read data recorded by an EDR, special equipment is required, and access to the vehicle or the EDR is needed. In addition to the vehicle manufacturer, other parties that have the special equipment, such as law enforcement, can read the information if they have access to the vehicle or the EDR.

Emissions and Fuel Efficiency Compliance

This vehicle must be regularly inspected and maintained as indicated in the *Saf-T-Liner C2 Maintenance Manual*, and in the *Pre- and Post-Trip Inspections and Maintenance* chapter in this manual, in order to continue satisfactory performance and ensure coverage of the vehicle under the manufacturer's warranty. Many maintenance procedures ensure that the vehicle and engine continue to comply with applicable emissions standards. Maintenance procedures, using components engineered to comply with greenhouse gas emissions and fuel efficiency regulations, may be performed by an authorized Daimler Trucks North America dealer, an independent outlet, or the vehicle owner or operator.

The vehicle owner is responsible for determining the suitability of replacement components to maintain

Foreword

compliance with federal and local jurisdictional regulations. Components including, but not limited to, low-rolling resistance tires are specifically designed and manufactured to exacting standards for regulatory fuel efficiency and greenhouse gas emissions compliance. It is important that these components are always replaced with components that meet or exceed the performance of the originally installed components.

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.

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

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Vehicle Identification

Vehicle Certification Plate and Data Plate

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

The certification plate is installed on the inside roof liner above the driver's window, or on the front bulkhead. The certification plate indicates compliance with all Federal Motor Vehicle Safety Standards (FMVSS) at the time of manufacture, gross axle weight rating (GAWR) front and rear, gross vehicle weight rating (GVWR), vehicle identification number (VIN), vehicle type, body identification, and build date. See [Fig. 1.1](#).

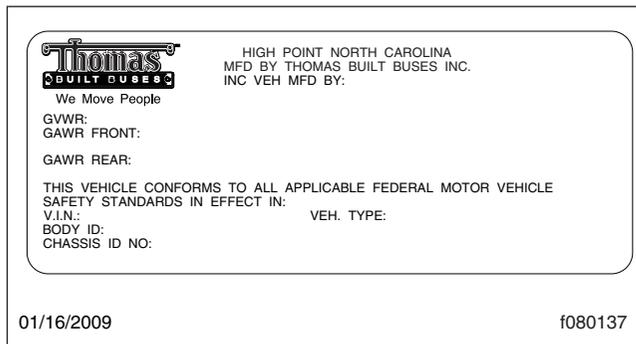


Fig. 1.1, Certification Plate

The data plate is installed on the inside roof liner above the driver's window, or on the front bulkhead, and lists manufacturing information. See [Fig. 1.2](#). Whenever contacting parts, service, or warranty personnel regarding the vehicle, the following three numbers will be requested:

- chassis identification number
- body identification number
- VIN

Federal Motor Vehicle Safety Standard Labels

NOTE: Due to the variety of Federal Motor Vehicle Safety Standard (FMVSS) certification requirements, not all of the labels shown will apply to your vehicle.

Buses purchased in the U.S. are marked as certified by means of an FMVSS certification label. See

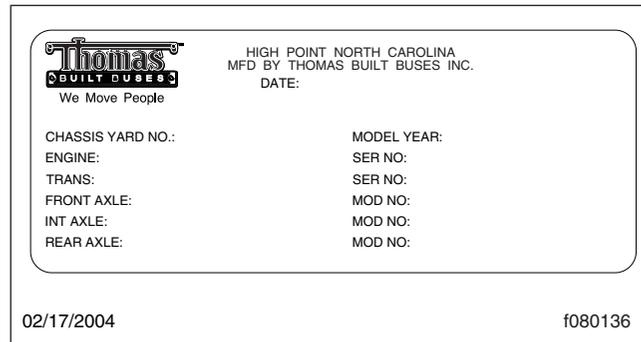


Fig. 1.2, Vehicle Data Plate

Fig. 1.3. The tire and rim information are combined into one label. This label is located in the driver area.

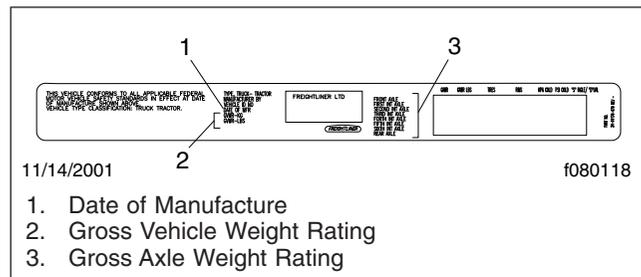


Fig. 1.3, Vehicle Certification Label

Chassis built without a cargo body that are intended for service in the U.S. have an incomplete vehicle certification label attached by the final-stage manufacturer. See [Fig. 1.4](#). This label will be attached to the incomplete vehicle document included with the vehicle, and certifies that the vehicle conforms to all applicable FMVSS regulations in effect on the date of completion.

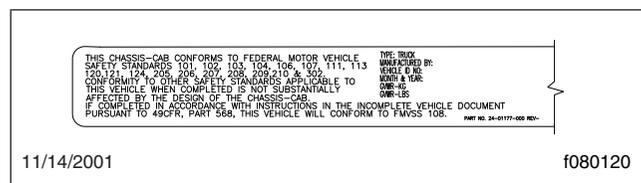


Fig. 1.4, Incomplete Vehicle Certification Label

The tire and rim portion of the FMVSS certification label certifies 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

Vehicle Identification

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

Aftertreatment System Indicators Label

Engines and vehicles manufactured after December 31, 2006 and domiciled in the U.S. or Canada are required to meet all EPA regulations effective as of the vehicle build date, and are equipped with an emission aftertreatment system (ATS). Vehicles domiciled outside of the U.S. and Canada may not have aftertreatment equipment, depending upon local statutory emissions guidelines. See [Table 1.1](#).

There is a warning label (placement will vary by bodybuilder) for important warning indicators in the instrument cluster that pertain to the ATS.

It is a violation of U.S. federal law to alter exhaust plumbing, ATS, or other components in any way that would bring the engine/vehicle 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.

Vehicle Emission Control Information Label

Model year 2013 and later vehicles meet additional requirements as specified by federal greenhouse gas

and fuel efficiency regulations (GHG14). Model year 2017 and later vehicles meet similar requirements as specified by GHG17 requirements. These vehicles may be equipped with components, such as low-rolling resistance tires, that increase fuel efficiency and reduce GHG emissions.

A Vehicle Emission Control Information label is located on the fan shroud. See [Fig. 1.8](#). It is the owner's responsibility to maintain the vehicle so that it conforms to EPA and NHTSA regulations.

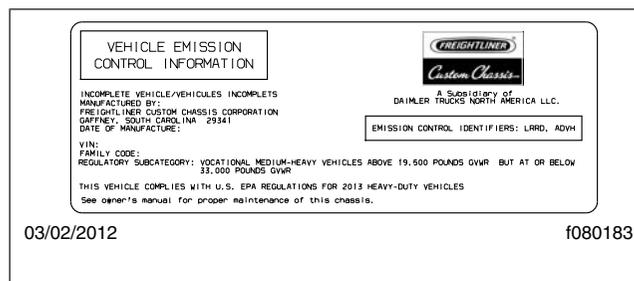


Fig. 1.8, Vehicle Emission Control Information Label

Applicable Emissions System Based on Build Date and EPA Regulations	
Build Date	Regulation: Emissions Components
January 1, 2007–December 31, 2009	EPA07 (reduce nitrogen oxides (NOx) emissions to 1.1 g/bhp-hr, and reduce particulate matter emissions to 0.01 g/bhp-hr): Aftertreatment device (ATD) containing a diesel particulate filter that traps soot and ash.*
January 1, 2010–December 31, 2012	EPA10 (reduce NOx emissions to 0.2 g/bhp-hr): EPA07-type ATD, with additional selective catalyst reduction (SCR) technology that utilizes diesel exhaust fluid (DEF) to convert NOx to nitrogen and water vapor.
From March 5, 2012–December 31, 2015	GHG14: Aerodynamic and fuel efficiency components including, but not limited to, tires, cab/sleeper side extenders, chassis fairings, bumper, hood, vehicle speed limiters, and idle reduction timers specifically designed to meet regulatory fuel efficiency and greenhouse gas emissions standards.
From January 1, 2016	GHG17: GHG14 components plus OBD16 instrumentation and sensor upgrades, and component technology that meets NHTSA and EPA 2017 fuel efficiency and greenhouse gas emission standards (GHG17) requirements.

* Cummins, Detroit, and Mercedes-Benz ATD's are also equipped with a diesel oxidation catalyst to break down pollutants.

Table 1.1, Applicable Emissions System Based on Build Date and EPA Regulations

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Vehicle Access

Assist Rails and Access Steps

WARNING

Wet or dirty shoe soles greatly increase the chance of slipping or falling. If shoe 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.

The two assist rails and three or four access steps are all part of the bus access system. Use these when entering or exiting the bus to increase security and comfort.

Folding Steps

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

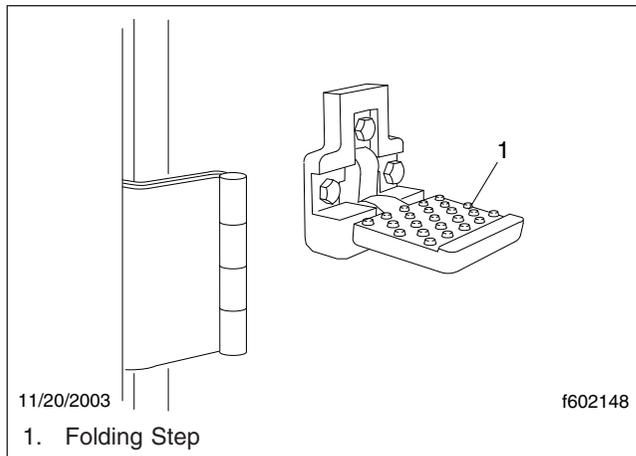


Fig. 2.1, Folding Step

Entering and Exiting the Bus

WARNING

Wet or dirty shoe soles greatly increase the chance of slipping or falling. If shoe 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.

Stepwell Light

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

Entering the Bus

1. Facing the steps, grasp the assist rail on either side of the steps. See Fig. 2.2. 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 middle step.
4. Place your right foot on the top step.

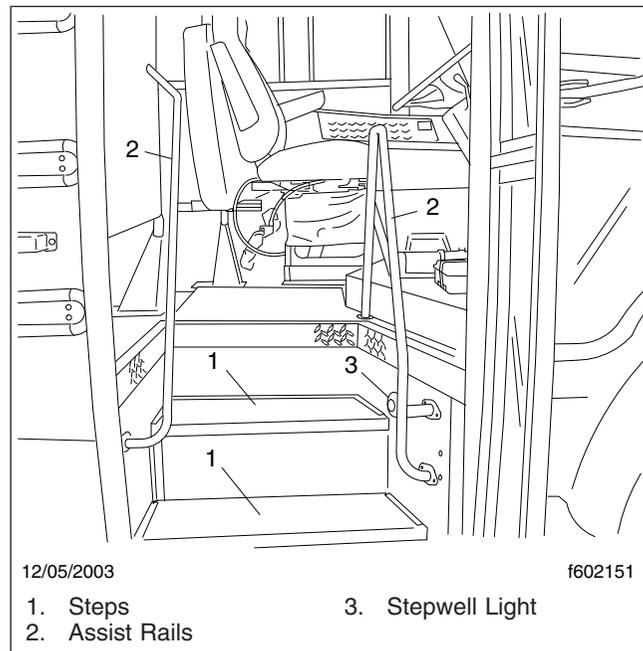


Fig. 2.2, Bus Entry and Exit

Exiting the Bus

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 middle step.
4. Step to the ground with your right foot first.

Front Door Opening and Closing

Buses with Exterior Door Control

Front Door Opening

1. Open the front entrance door by turning the exterior key switch to the open position and enter the vehicle.
2. Start the vehicle and allow it to warm up.
3. To close the door, move the paddle switch on the driver control panel to the DOOR CLOSED position. See [Fig. 2.3](#).

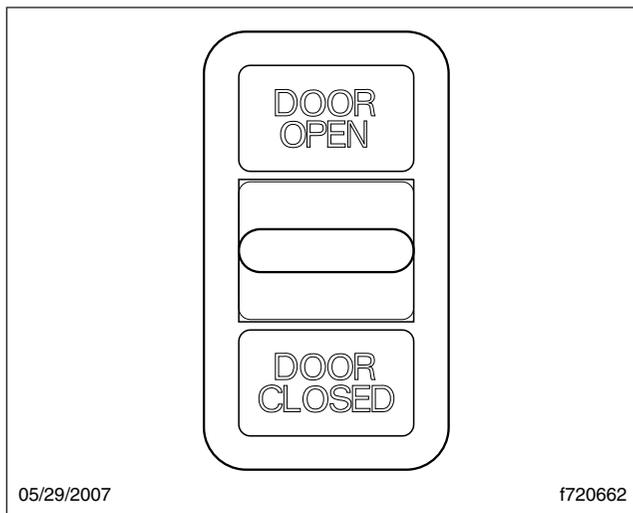


Fig. 2.3, Door Open/Door Closed Paddle Switch

Front Door Closing

1. Shut down the engine.
2. Move the paddle switch on the driver control panel to the DOOR OPEN position and exit the bus.
3. Turn the exterior key switch to the close position.

Buses without Exterior Door Control

Front Door Opening

1. Manually open the door.
2. After entering the vehicle, activate the emergency air release rocker switch located above the door. See [Fig. 2.4](#).
3. Start the vehicle and allow it to warm up.

4. To close the door, move the paddle switch on the driver control panel to the DOOR CLOSED position. See [Fig. 2.3](#).

Front Door Closing

1. Shut down the engine.
2. Activate the emergency air release rocker switch located above the door.
3. Manually push the door open and exit the vehicle.
4. 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 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 and lower the hood. Hood restraint cables prevent the hood from over-travel. An optional hood damper limits the closing speed. In the operating position, the hood is secured to the half-fenders by a hold-down latch on each side.

Vehicle Access

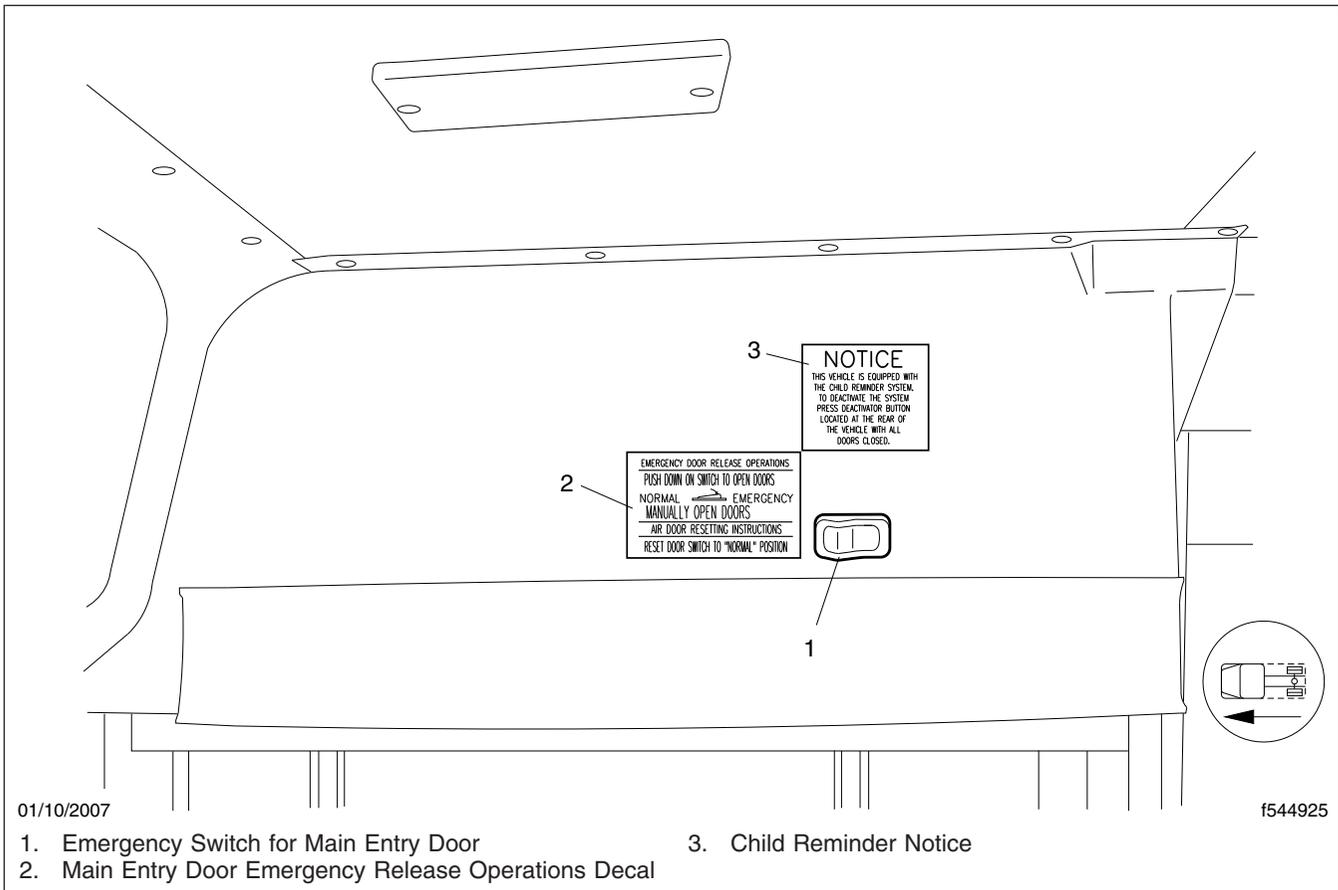


Fig. 2.4, Emergency Switch for Main Entry Door

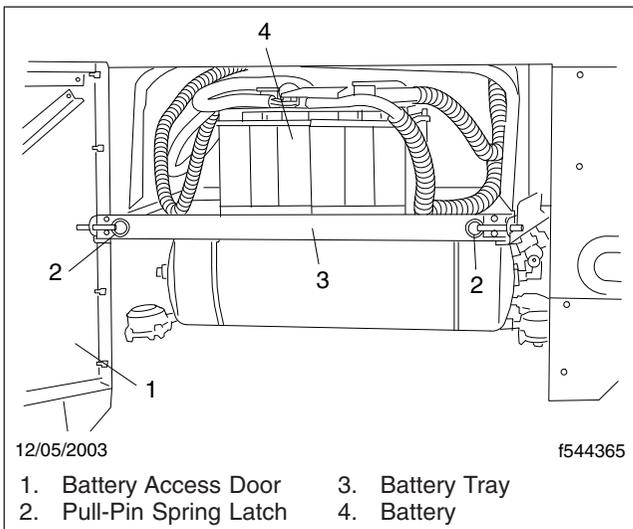


Fig. 2.5, Battery Access

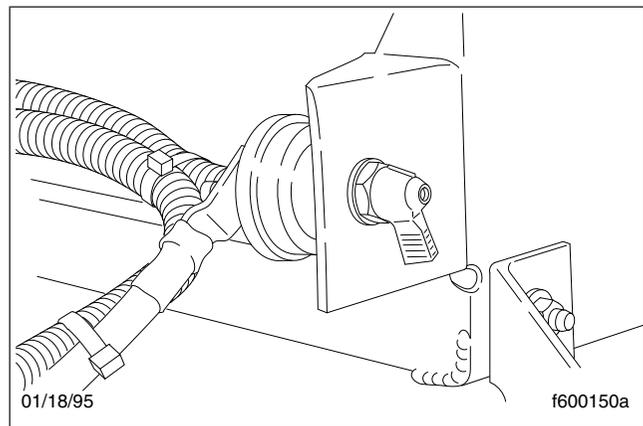


Fig. 2.6, Battery Disconnect Switch

Tilting the Hood

1. Apply the parking brakes.

2. Release both hood hold-down latches by pulling the ends outward. See [Fig. 2.7](#).

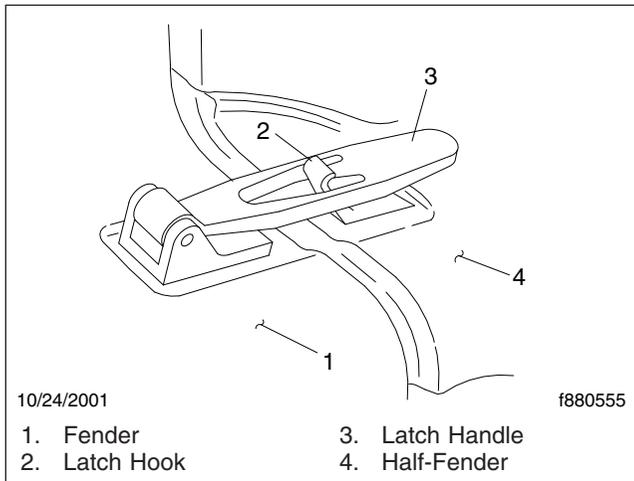


Fig. 2.7, Hood Hold-Down Latch

NOTICE

Do not let the hood free-fall to the fully open position. To do so could damage 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 the 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

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

The bus may have optional emergency roof escape hatches located near the front and rear of the bus. On buses equipped with an emergency roof escape hatch, the opening instructions are clearly displayed on the hatch cover. See [Fig. 2.8](#).

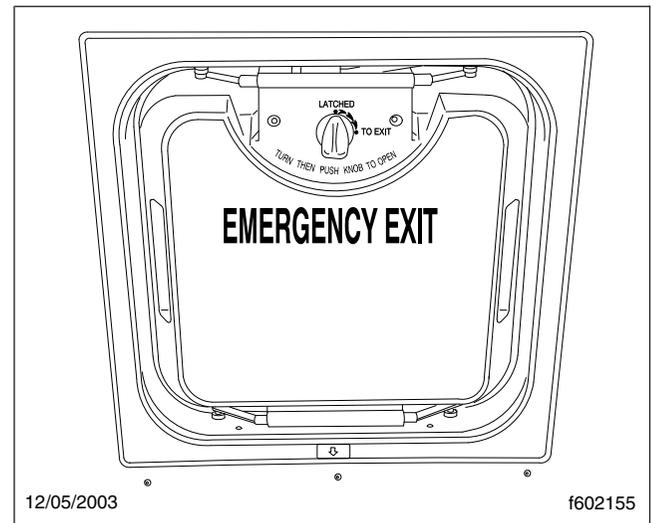


Fig. 2.8, Emergency Roof Escape Hatch

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 automatically lock 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 displayed on the window frame.

Vehicle Access

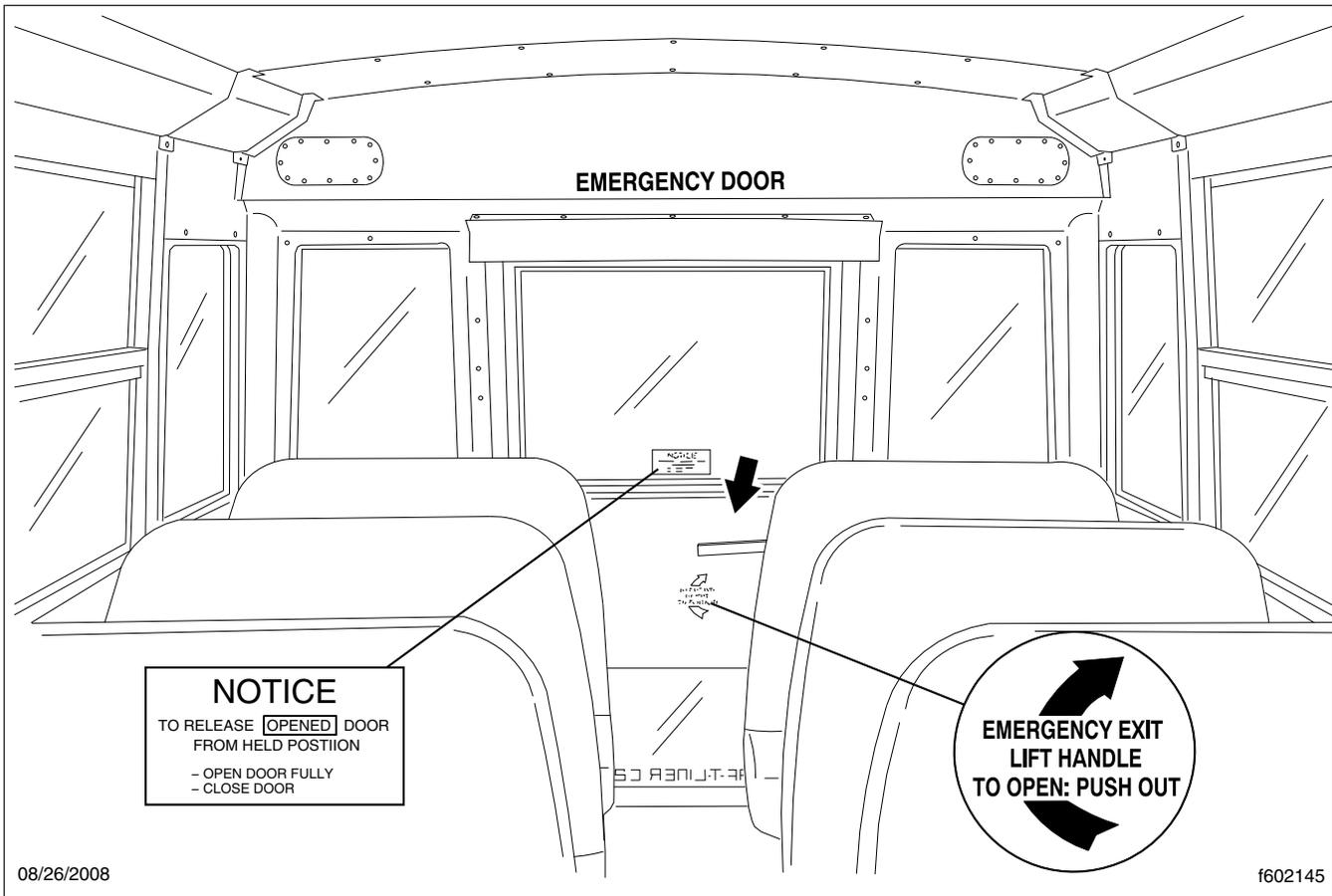


Fig. 2.9, Emergency Door

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 latch to open the window. A buzzer will activate when an emergency window exit is open. See [Fig. 2.11](#) and [Fig. 2.12](#).

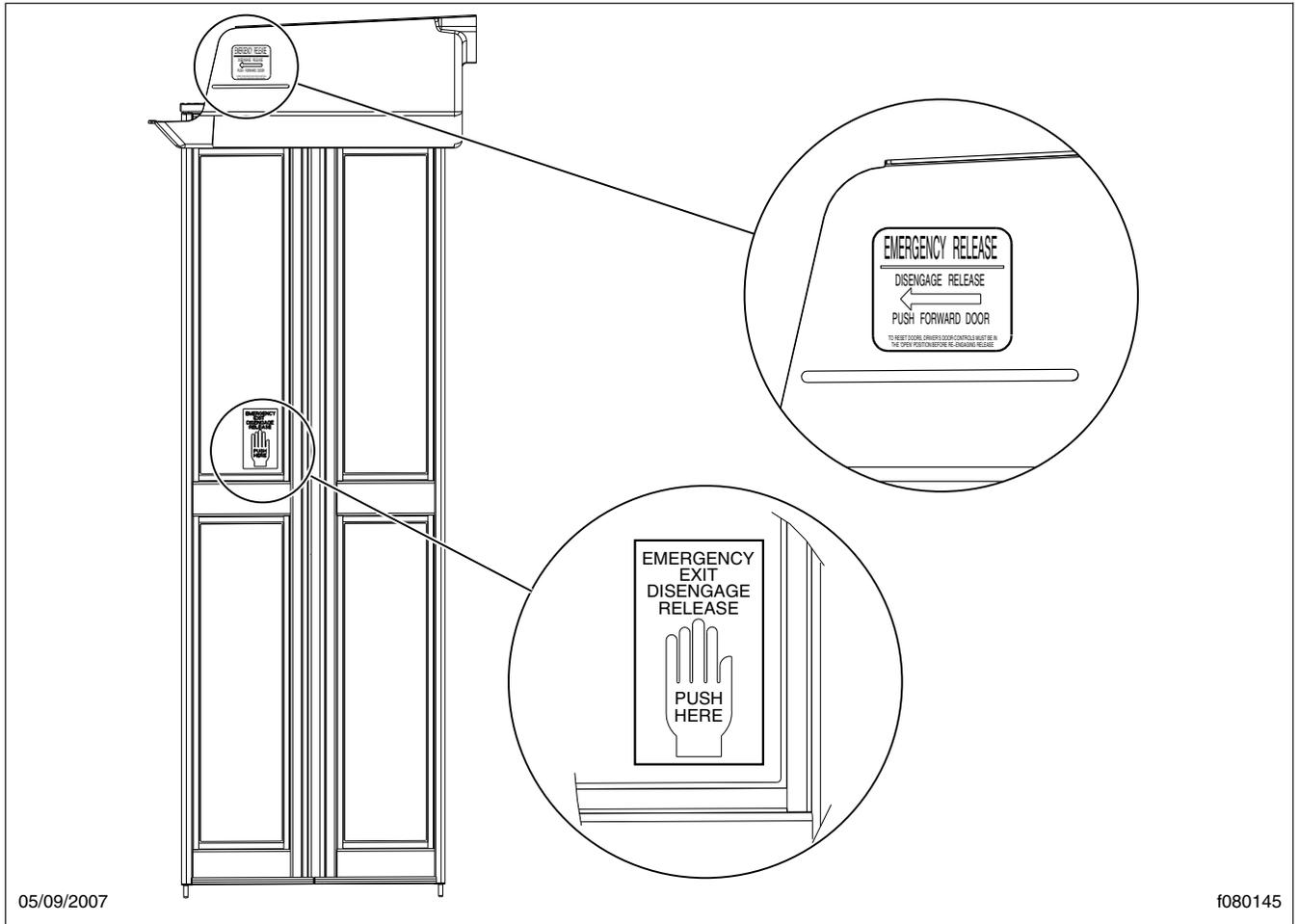


Fig. 2.10, Disengaging the Main Entry Door in an Emergency

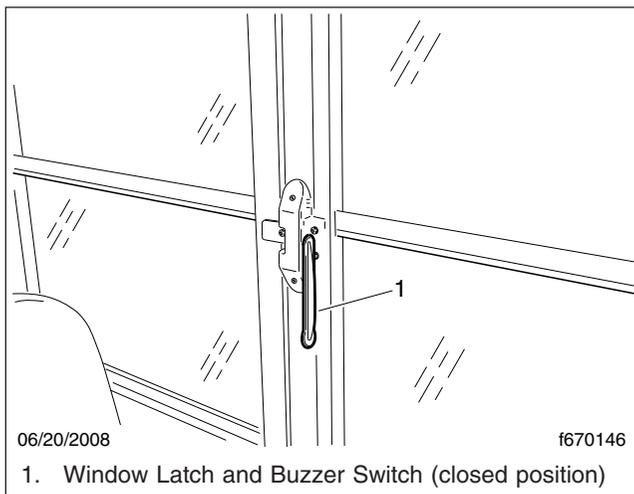


Fig. 2.11, Vertical Push-Out Window (closed position)

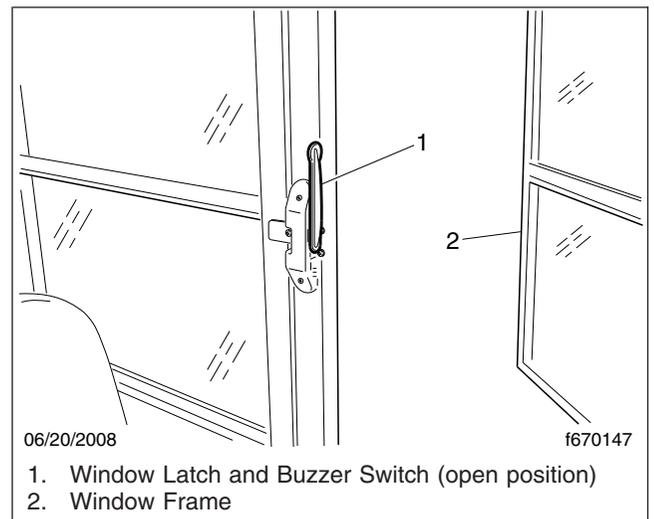


Fig. 2.12, Vertical Push-Out Window (open position)

3

Bus Features

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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](#).

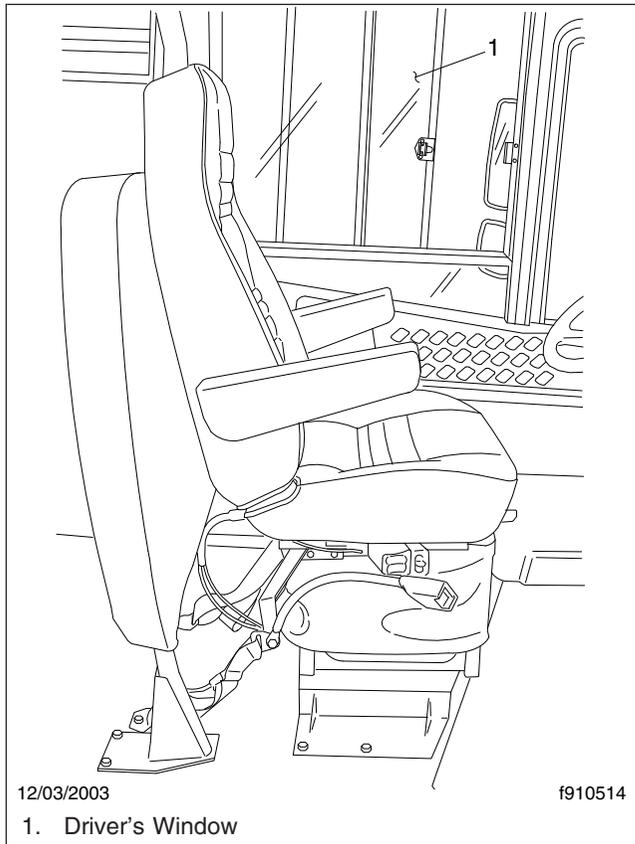


Fig. 3.1, Driver's Window

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.

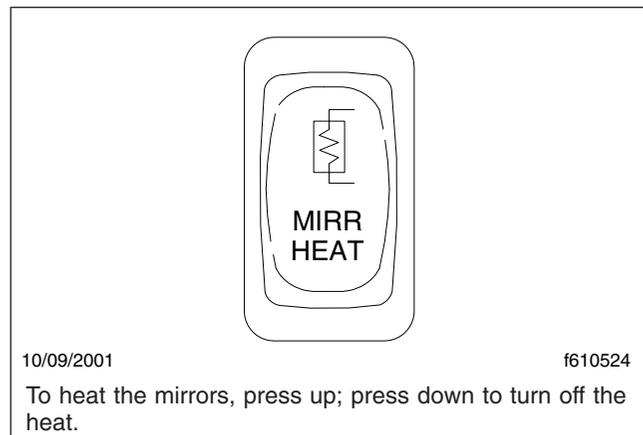


Fig. 3.2, Mirror Heat Switch

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](#).

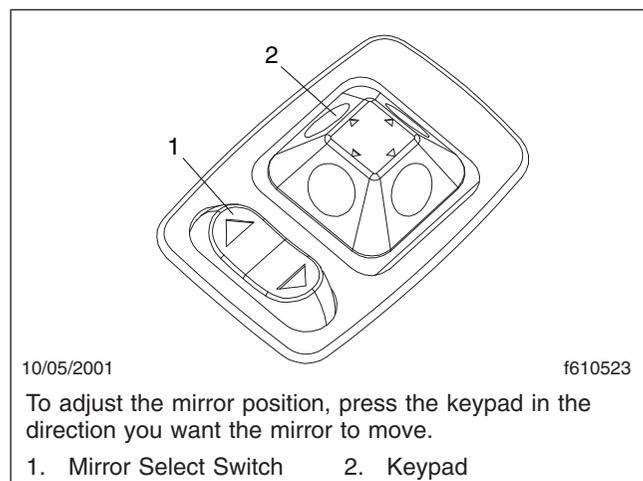


Fig. 3.3, Power Mirror Switch Pad

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.

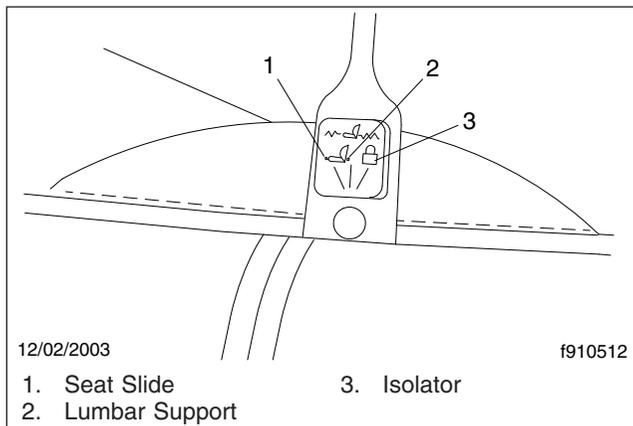


Fig. 3.4, Seat Slide and Isolator Lever

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](#).

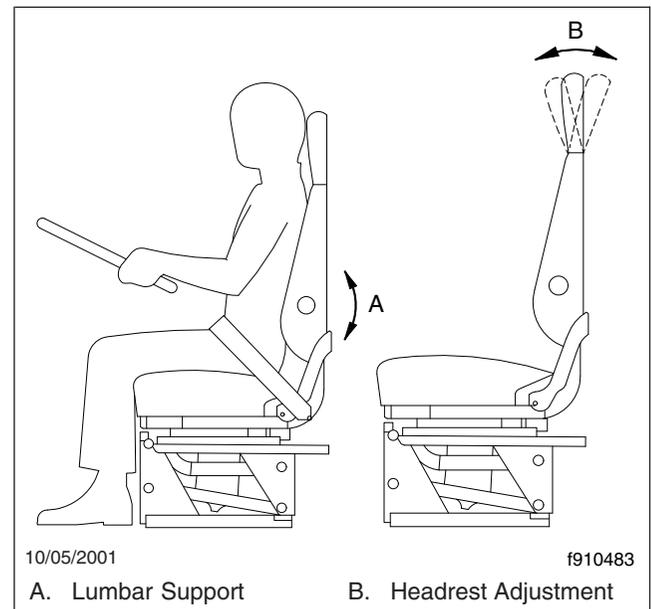


Fig. 3.5, Lumbar Support and Headrest Adjustment

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](#).
7. Seat Tilt: When this adjustment is made, the seat assembly, both backrest and seat cushion, tilts forward or backward. See [Fig. 3.6](#).

Bus Features

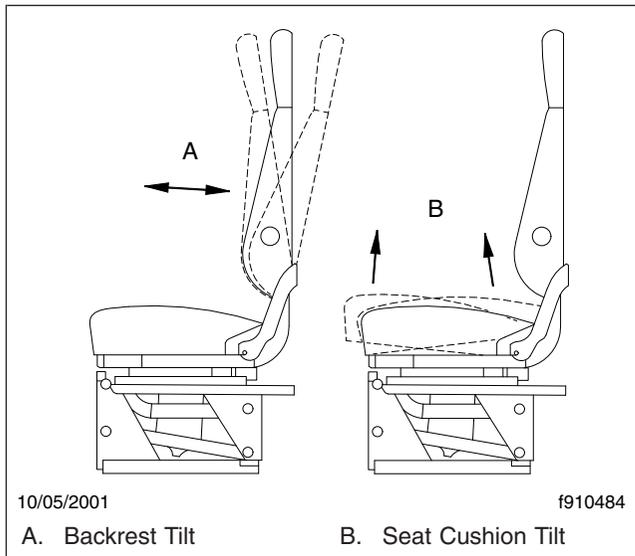


Fig. 3.6, Cushion Tilt Adjustments

- 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](#).

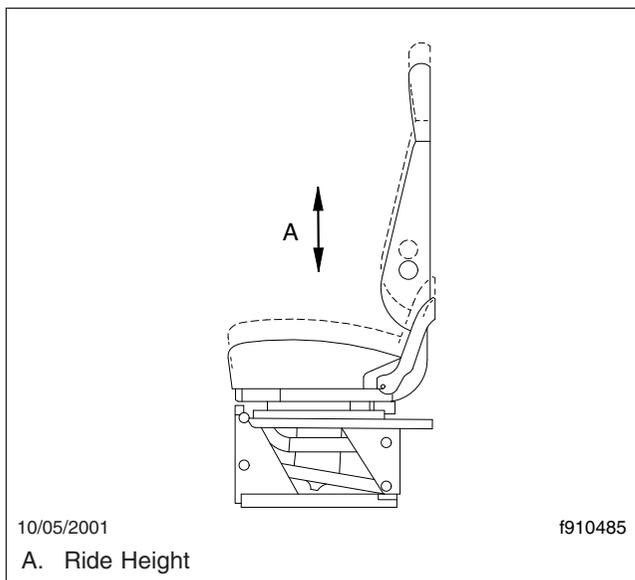


Fig. 3.7, Ride Height Adjustment

- 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](#).

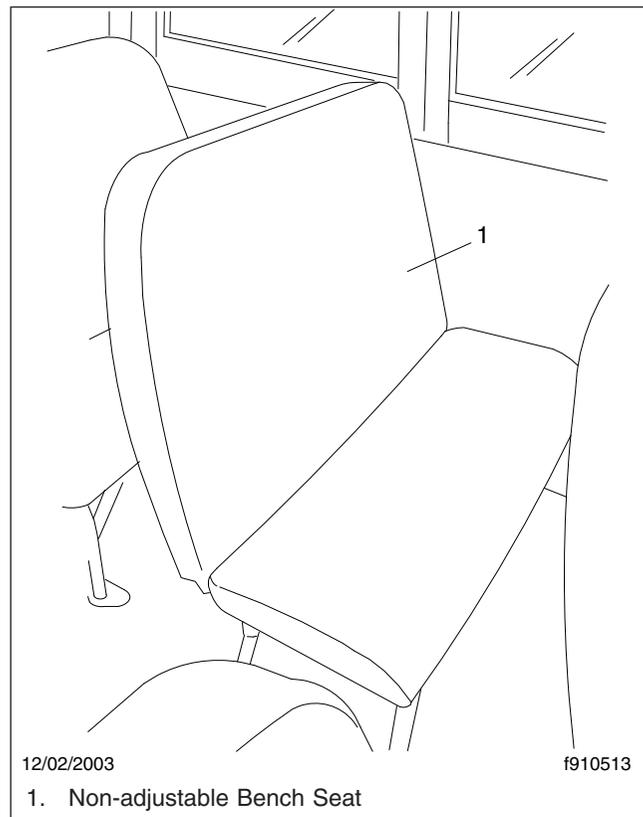


Fig. 3.8, Bench Seat

Track-Mounted Seats

IMPORTANT: Track-mounted seats are the only seats designed to be removed and reinstalled on the school bus. Any other seats are non-adjustable. For further information concerning track-mounted seats, see **Section 91.00, Subject 110** in the *Saf-T-Liner C2 School Bus Workshop Manual*.

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](#).

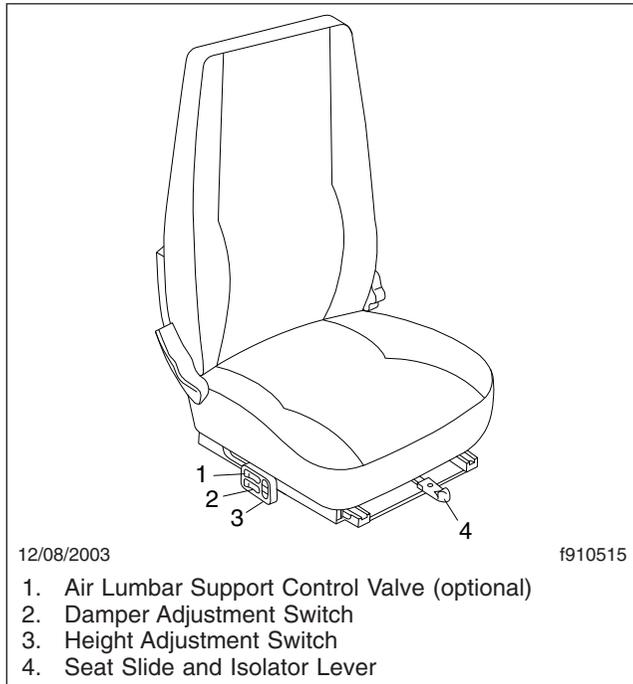


Fig. 3.9, Bostrom Seat

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](#).

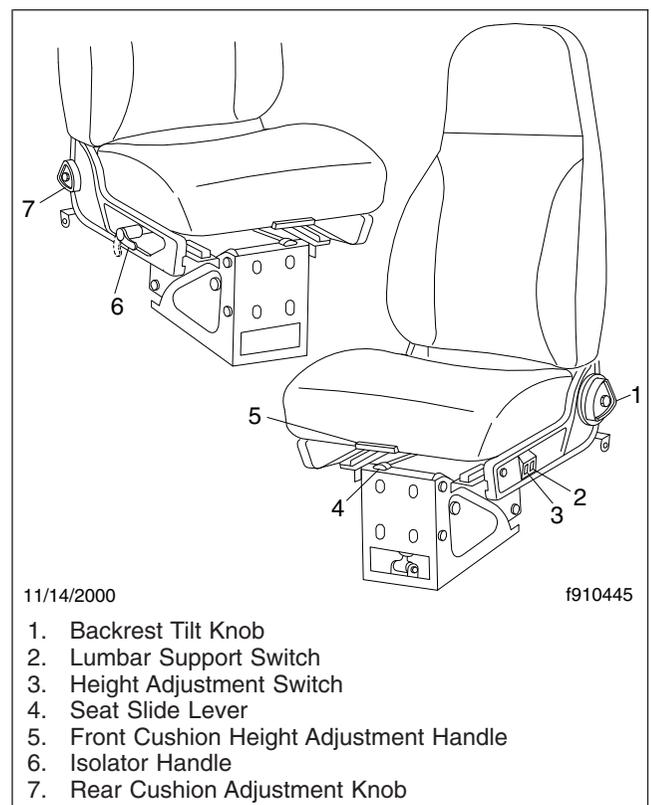


Fig. 3.10, National 2000 Series Seat

Bus Features

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.

For seats with air support, use the aft rocker switch on the control panel on the left-hand side of the seat.

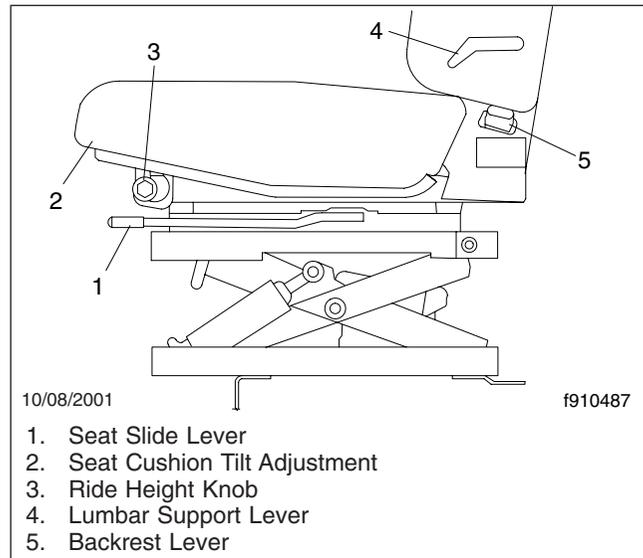


Fig. 3.11, Sears Low Profile Seat

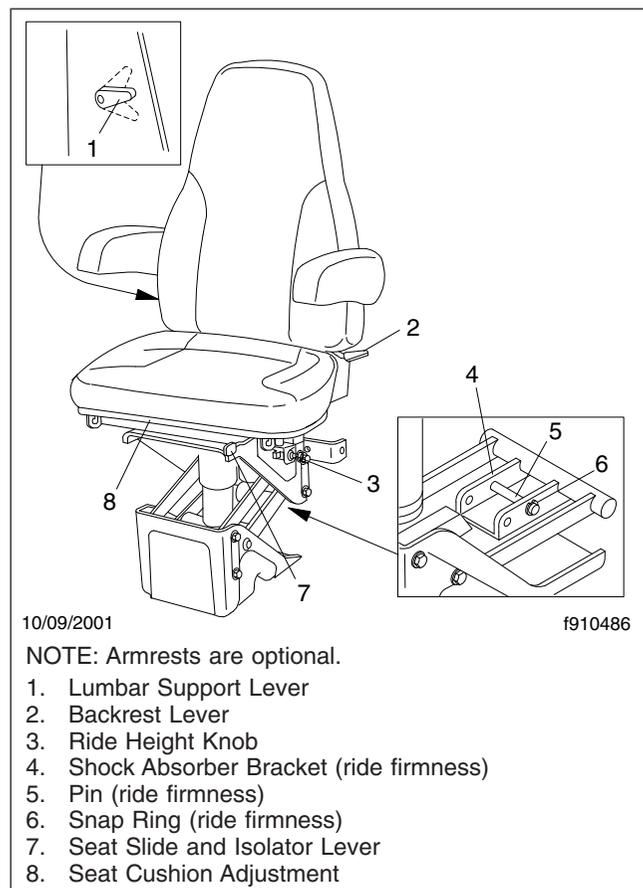


Fig. 3.12, Sears Fleetmaster Seat (with isolator)

Press up to make the seat firmer; press down to make the seat less firm. See [Fig. 3.13](#).

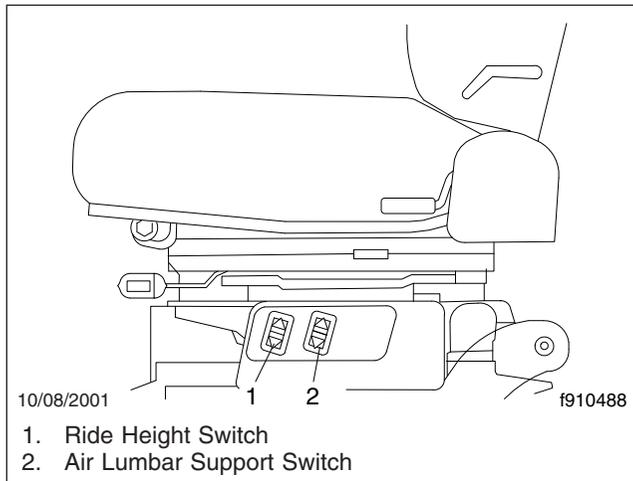


Fig. 3.13, Air Controls, Sears Seat

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](#).

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.

Bus Features

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 en-

gage 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](#).

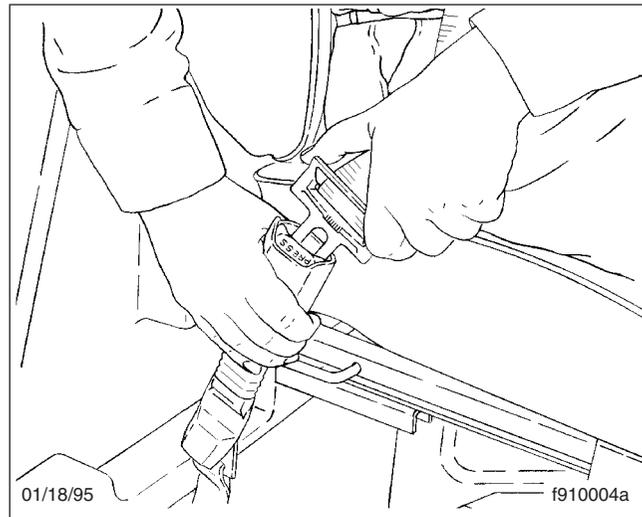


Fig. 3.14, Fastening the Three-Point Belt

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.
 - 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

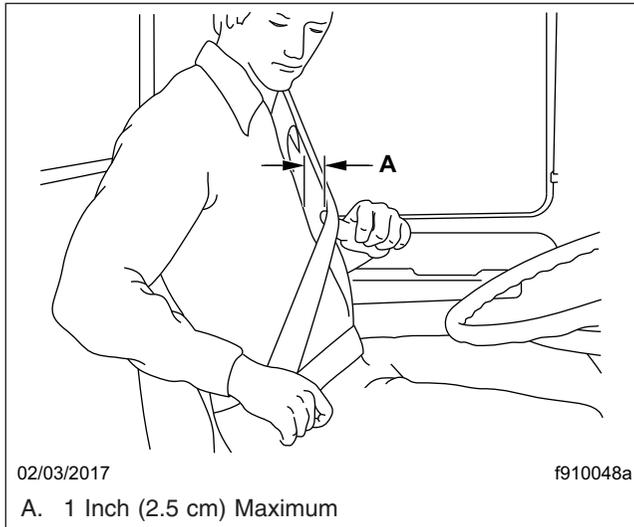


Fig. 3.15, Adjusting Shoulder Harness Clearance

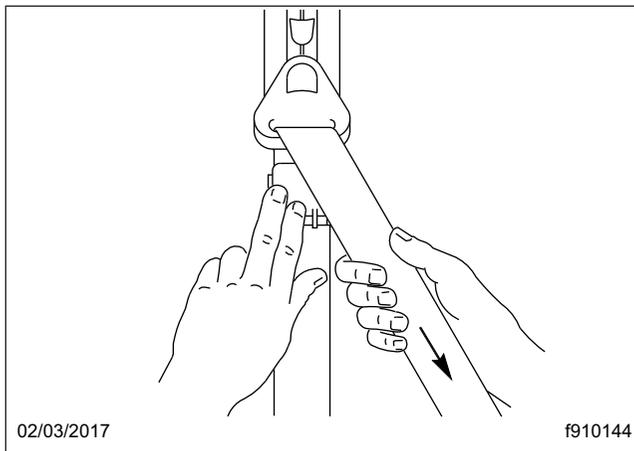


Fig. 3.16, Locking the Komfort Latch

against the shoulder belt, the Komfort Latch will automatically release, and will need to be reset.

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.

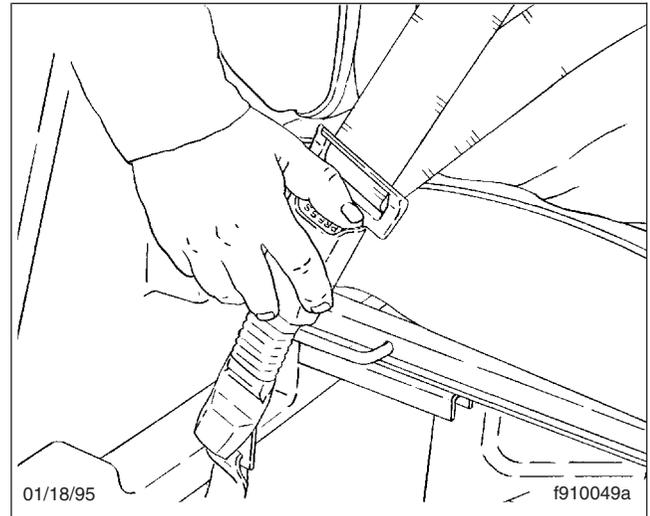


Fig. 3.17, Releasing the Three-Point Seat Belt

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](#).

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](#).

Bus Features

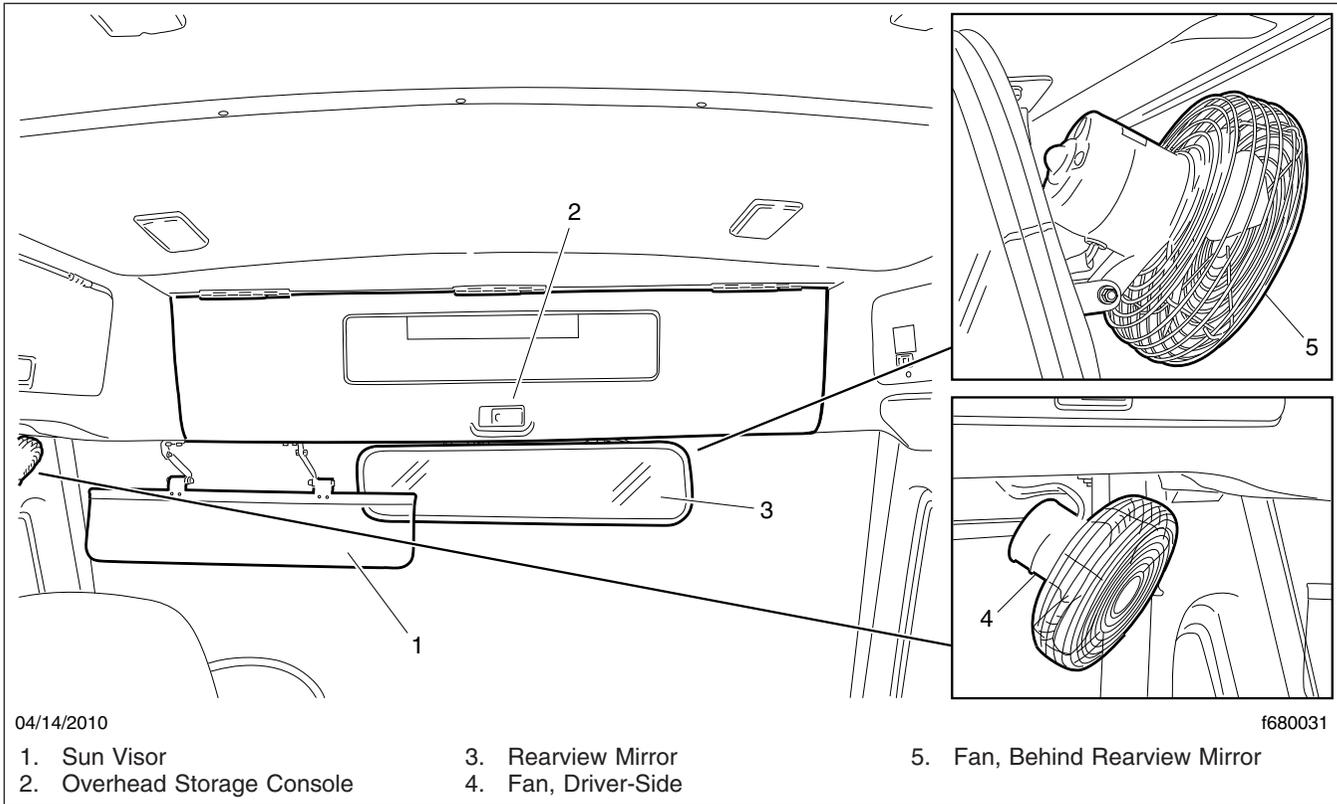


Fig. 3.18, Overhead Storage

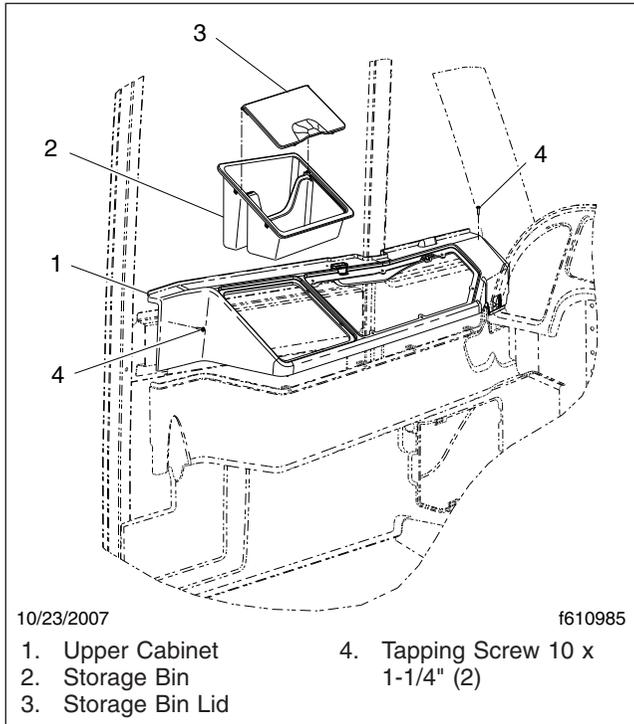


Fig. 3.19, Storage Bin and Lid

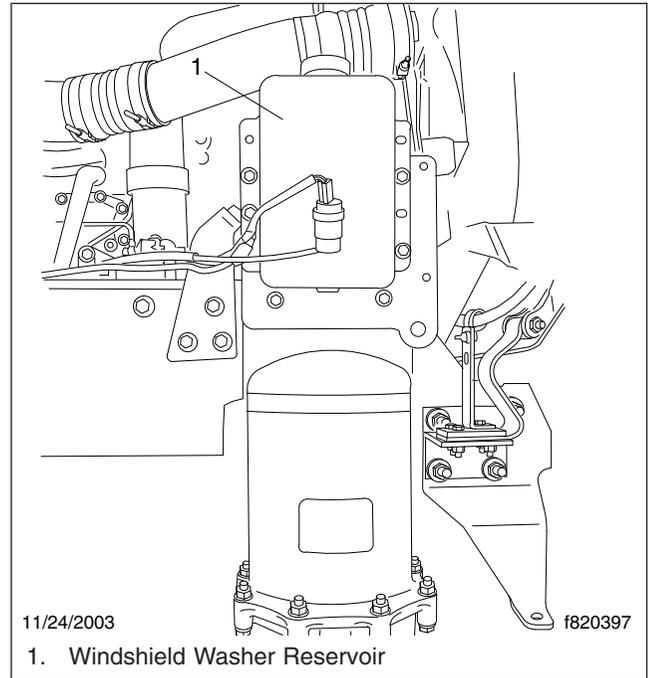


Fig. 3.21, Windshield Washer Reservoir

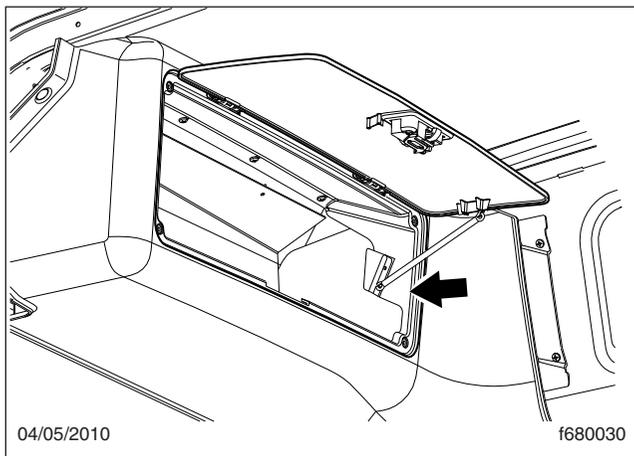


Fig. 3.20, Driver-Side Overhead Storage Box

4

Instruments

Instrumentation Control Unit	4.1
Warning and Indicator Lamps	4.4
Speedometer and Tachometer	4.8
Standard Instruments	4.8
Optional Instruments	4.10

Instruments

Instrumentation Control Unit

Figure 4.1 shows a typical set of instruments for vehicles equipped with the Saf-T-Liner C2 School Bus ICU3 instrument cluster.

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).

The ICU3 instrument cluster 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.

gauges such as those installed on the auxiliary dash panel. **Figure 4.2** shows a typical dash.

Dash Message Center

The dash message center is the heart of the instrument cluster. It has two parts, a set of 27 warning and indicator lamps similar to those found on a conventional lightbar, and a dash driver display screen. 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 lamps. Warning messages and diagnostic fault codes will appear in

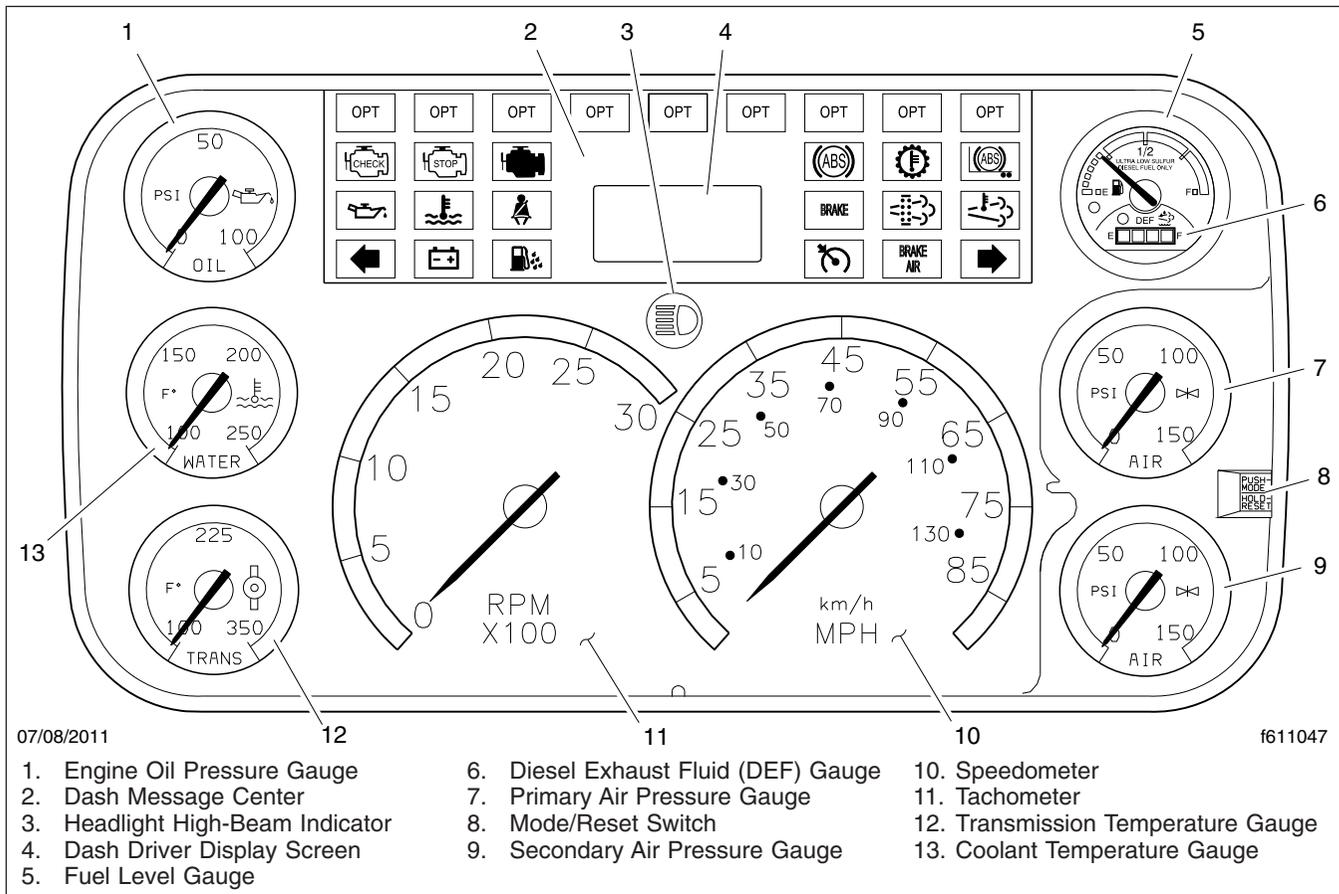


Fig. 4.1, Gauge Layout (typical, U.S.), EPA10 and Newer Engines

The Saf-T-Liner C2 School Bus instrument clusters have the capability to drive independent stand-alone

the driver display screen. For more information on this system, see the heading "Ignition Sequence" in this chapter.

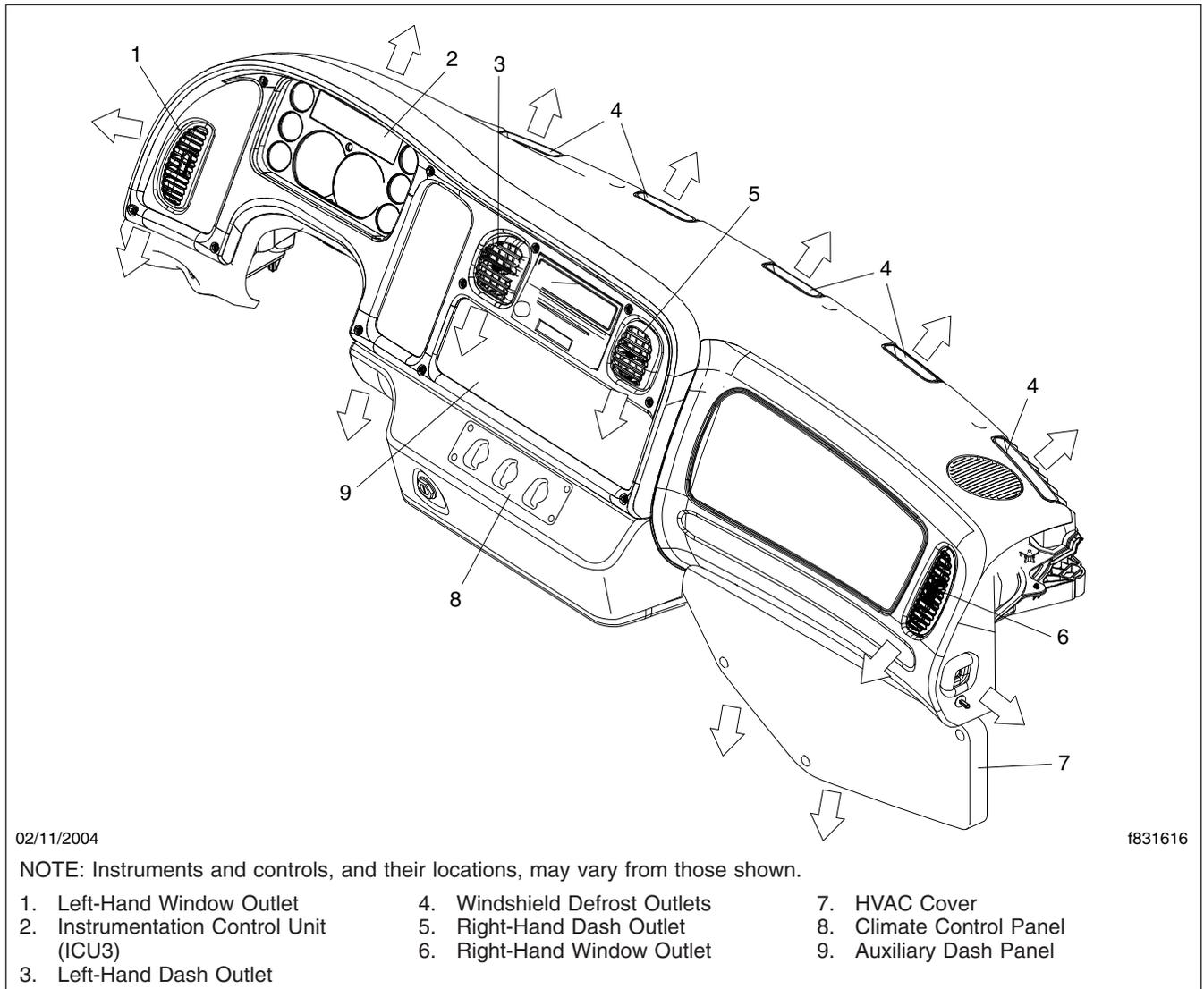


Fig. 4.2, Dash Panel Layout (typical)

Ignition Sequence

The dash message center goes through a prescribed ignition sequence each time the ignition switch is turned on. See [Fig. 4.3](#) 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 lamps illuminate, 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 lamps illuminate during the ignition sequence:

- Fasten Seat Belt Warning
- 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 lamps, including Check Engine and Stop Engine

Instruments

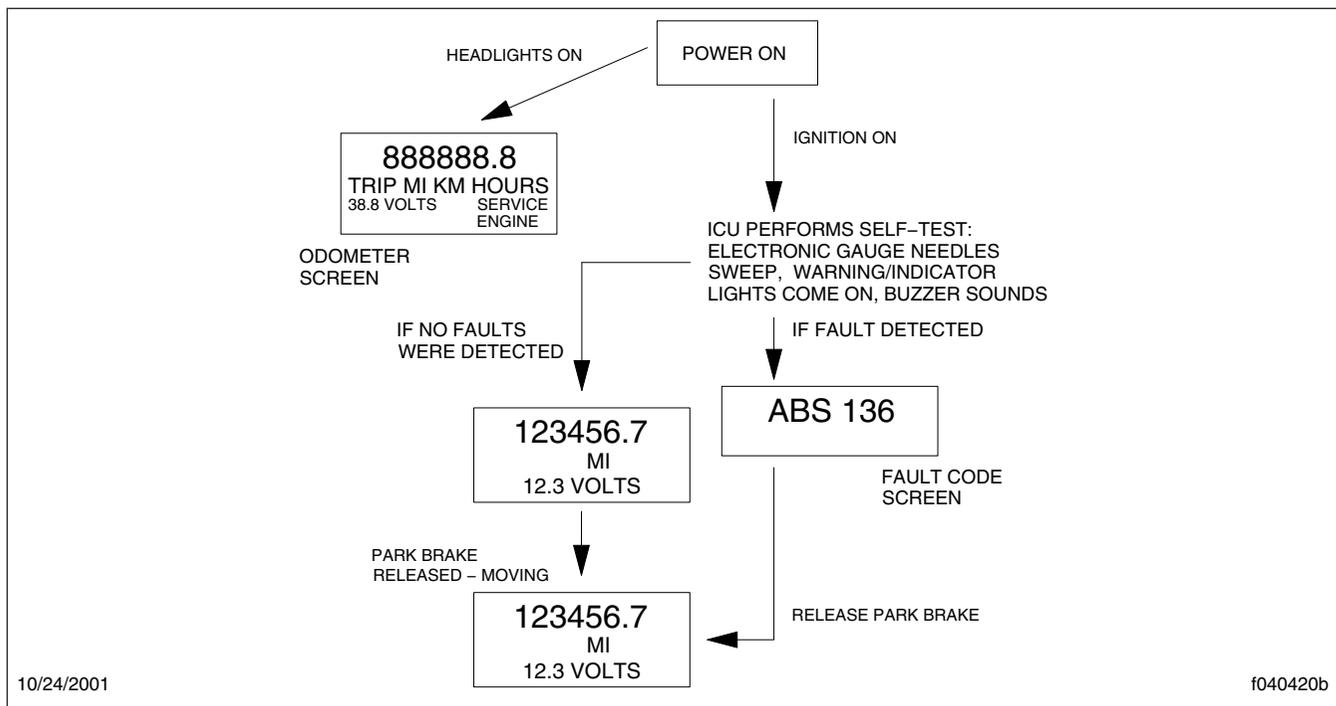


Fig. 4.3, Ignition Sequence

- All ABS indicator/warning lamps, including Wheel Spin, and Tractor ABS (if installed)

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

When the ignition switch is 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
- Fourth line: SERVICE 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.

NOTE: If active faults are present, take the vehicle as soon as possible to an authorized Thomas Built Bus service facility.

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

Some examples of mission critical faults include:

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

NOTE: The check engine lamp 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.

IMPORTANT: If the legend SERVICE ENGINE does appear on the driver display screen while operating the vehicle, bring the vehicle to an authorized Thomas Built Bus 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 1,000,000, 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, shown in Fig. 4.4, 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.

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

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

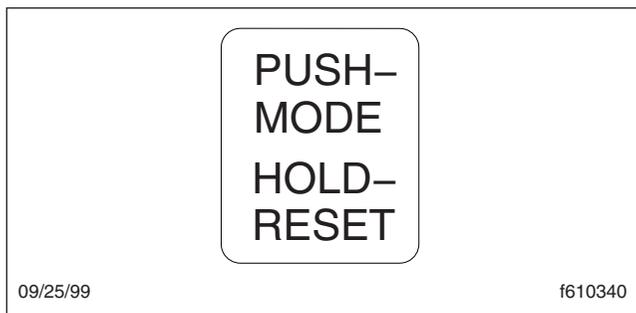


Fig. 4.4, Mode/Reset Switch

- 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 Lamps

There can be up to 27 warning and indicator lamps (telltales) installed in the dash message center. See Fig. 4.5. There are four rows of lamps. Lamps installed in the top row are optional and their positions may vary. The lamps in the bottom three rows are installed in fixed positions on all vehicles. Most are standard, but a few are optional.

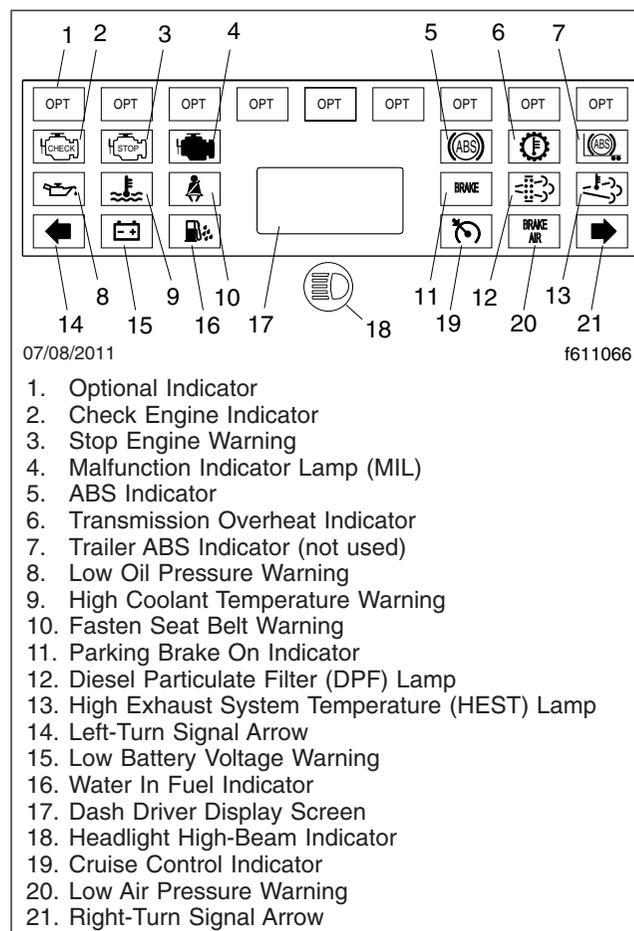


Fig. 4.5, ICU3 Warning and Indicator Lamps, EPA10 and Newer Engines

Instruments

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

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

A description of the standard warning and indicator lamps are listed below.

Check Engine Indicator

The amber check engine indicator lamp (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 lamp will illuminate to alert the driver to correct the condition as soon as possible. If the condition gets worse, the stop engine lamp will illuminate.

NOTE: If the check engine lamp illuminates during vehicle operation, take the vehicle directly to an authorized Thomas Built Bus service facility.

Stop Engine Warning

The red stop engine warning lamp (STOP ENGINE 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 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 stop engine lamp 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.

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.

ABS Indicator

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

NOTE: For more information about this lamp and the ABS system, see [Chapter 10](#).

Transmission Overheat Indicator

The amber transmission overheat indicator lamp (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.

Low Oil Pressure Warning

The red low oil pressure warning lamp (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)
Cummins ISB	10 (69)	30 (207)

* Oil pressure is 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.

Table 4.1, Oil Pressure Specifications

High Coolant Temperature Warning

The red high coolant temperature warning lamp (thermometer icon) and emergency buzzer activate whenever the coolant temperature goes above a preset maximum specified by the engine manufacturer; 225°F (107°C) for Cummins engines.

Fasten Seat Belt Warning

The red fasten seat belt warning lamp (seat belt icon) illuminates for 3 seconds after the ignition switch is turned on.

When the engine is operating, and the driver's seat belt is unfastened and the park brake is not set, the seat belt warning lamp illuminates and a warning chime activates. The warning chime will remain active for 10 seconds. The warning lamp remains illuminated until the driver's seat belt is fastened.

Brake System Warning/Parking Brake On Indicator

The red brake system warning/parking brake on indicator lamp (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.

Diesel Particulate Filter (DPF) Lamp

Solid illumination 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 shut-down 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.

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 Voltage Warning

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

Water In Fuel Indicator

The amber water in fuel indicator illuminates when the system detects water in the fuel tank.

NOTICE

Water in the fuel/water separator will appear as beads. With the engine off, drain the separator only enough to remove the water; about two teaspoons at a time. Do not drain the separator completely or it will be necessary to prime the fuel system before the vehicle can be started again.

WARNING

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

Drain any water collected in the fuel/water separator.

Headlight High-Beam Indicator

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

Cruise Control Indicator

A green indicator illuminates when the cruise control is activated.

Low Air Pressure Warning

The red low air pressure warning lamp (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 lamp and buzzer also activate during operation whenever air pressure in the primary or

Instruments

secondary air reservoir falls below 65 to 75 psi (448 to 517 kPa).

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.

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, which is 225°F (107°C).
- 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).

Optional Indicator Lamps

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

Air Filter Indicator

The optional amber air filter indicator lamp (AIR FILTER legend) illuminates when the air cleaner filter element is clogged, restricting the intake air flow below 25 inH₂O.

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

IMPORTANT: Never attempt to clean the air filter.

Alternator No Charge Indicator

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

Check Transmission Indicator (diesel engine only)

NOTE: Although it appears in the row of optional indicator lamps, the check transmission indicator is a standard indicator.

The check transmission indicator lamp, shown in [Fig. 4.6](#), notifies the driver of three things. The indicator lamp has a solid illumination and any of the following items could be the cause for activating the lamp:

- oil life monitor (determines when the oil needs to be changed)
- filter life monitor (determines when the filter[s] need to be changed)
- transmission health monitor (determines when clutch maintenance is required)

When the check transmission indicator illuminates, refer to the *Allison Operator's Manual* or contact customer support at Allison Transmission to determine the specific cause activating the indicator.

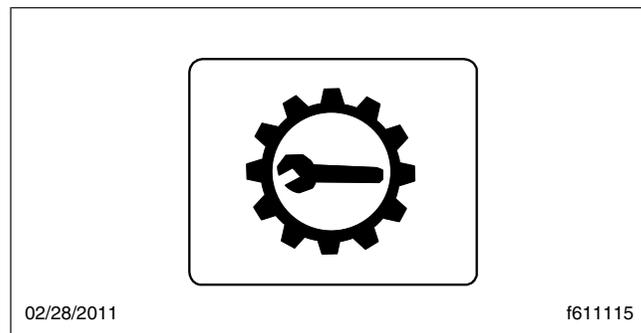


Fig. 4.6, Check Transmission Indicator, Diesel Engine

Electronic Stability Control (ESC) Indicator

The ESC indicator, shown in [Fig. 4.7](#) for the indicator lamp used on the ICU3 instrument panel and [Fig. 4.8](#) for the indicator lamp used on the Ametek instrument panel, illuminates when the ESC system activates.



Fig. 4.7, ESC Indicator Lamp, ICU3 Panel



Fig. 4.8, ESC Indicator Lamp, Ametek Panel

Wait to Start Indicator

NOTE: Although it appears in the row of optional indicator lamps, the wait to start indicator is a standard indicator.

The amber wait to start indicator, shown in Fig. 4.9, illuminates with the ignition switch in the ON position prior to engine start-up. To avoid generating a system fault code, do not crank the engine until the wait to start indicator goes out.

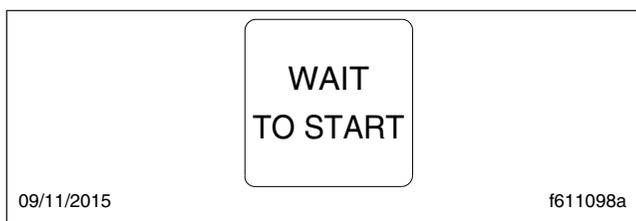


Fig. 4.9, Wait to Start Indicator

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. 4.10.

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

Tachometer

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. 4.10.

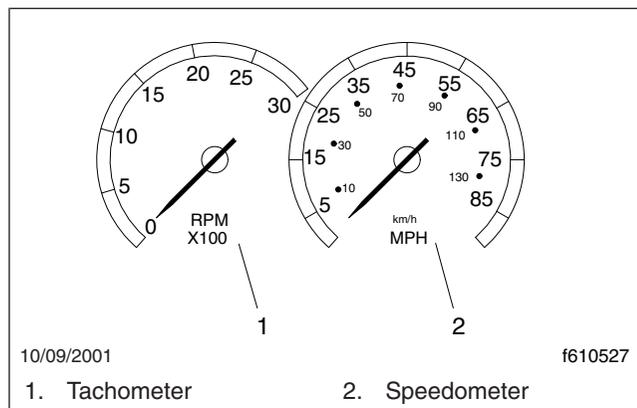


Fig. 4.10, Speedometer and Tachometer (U.S. version)

Standard Instruments

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. 4.11. If the engine oil pressure falls below the preset levels shown in Table 4.1, first, the check engine lamp will illuminate, and, if the condition does not improve, the stop engine lamp 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.

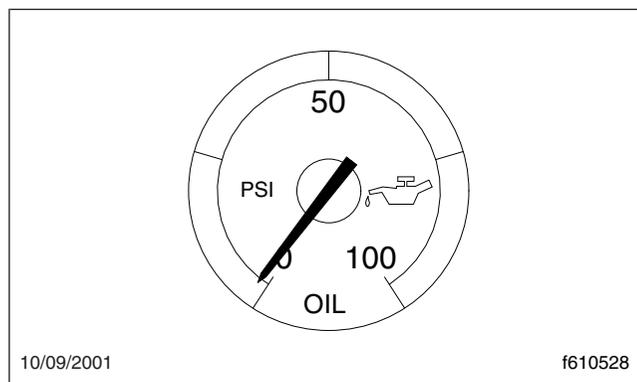


Fig. 4.11, Engine Oil Pressure Gauge

Instruments

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. 4.12](#). If the temperature remains below 160°F (71°C) or exceeds 225°F (107°C), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

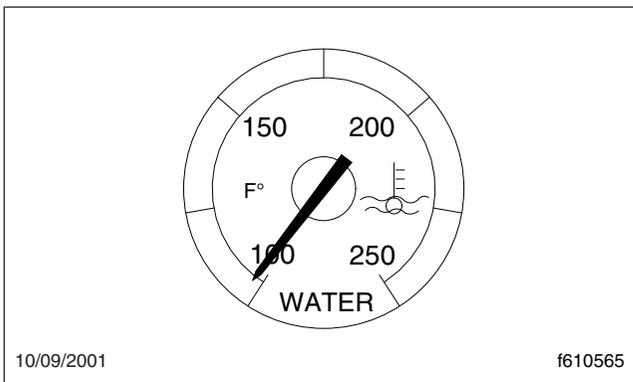


Fig. 4.12, Coolant Temperature Gauge

The coolant temperature gauge is mission-critical. See [Fig. 4.12](#). If the coolant temperature rises above 225°F (107°C), first, the check engine lamp will illuminate, and, if the condition does not improve, the stop engine lamp 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.

Fuel/Diesel Exhaust Fluid (DEF) Gauge

For engines that are EPA10-compliant or newer, the fuel and DEF levels are measured in a dual purpose fuel/DEF gauge. See [Fig. 4.13](#).

The diesel fuel level is indicated at the top of the gauge, with a low-level warning lamp that illuminates when the diesel fuel level registers 1/8th of capacity. One fuel gauge is standard. If equipped with a sec-

ond (optional) fuel gauge, each fuel tank level is indicated on a separate gauge.

The DEF level is indicated in the lower portion of the gauge. There is a low DEF level warning lamp that illuminates when the DEF level reaches 10% of capacity. See [Chapter 8](#) for details of the DEF gauge functions.

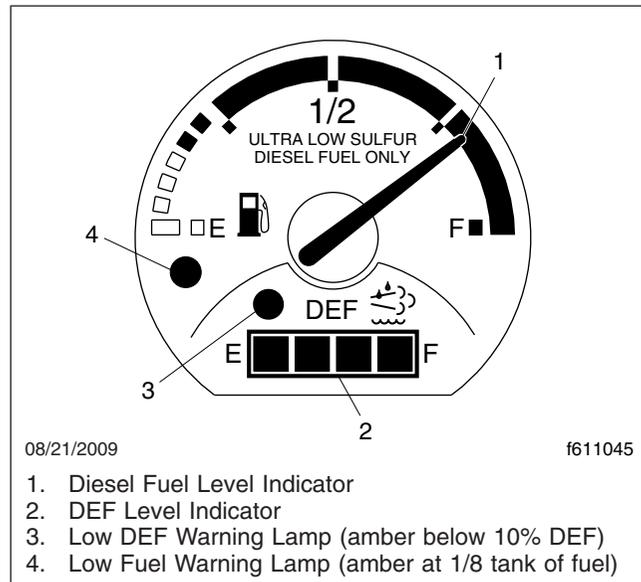


Fig. 4.13, Fuel/DEF Gauge, EPA10

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. 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 property damage, 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. 4.14](#).

Air pressure gauges are required on all vehicles with air brakes. A low-air-pressure warning lamp and buzzer, connected to both the primary and secondary systems, activate when air pressure in either system

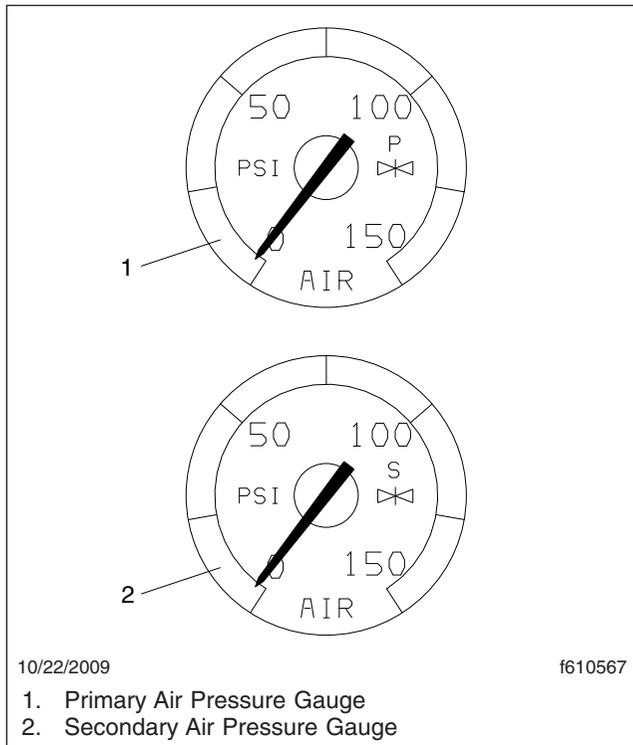


Fig. 4.14, Air Pressure Gauges

drops below a minimum pressure of 65 to 75 psi (448 to 517 kPa).

When the engine is started, the warning lamp 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 ve-

hicle 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.

Air Intake Restriction Gauge

The air intake restriction gauge indicates the vacuum on the engine side of the air cleaner. On standard installations, it is mounted on the air intake duct in the engine compartment. See [Fig. 4.15](#). As an option for easier viewing, the intake-air restriction indicator can be mounted on the dash, usually on the right-hand control panel.

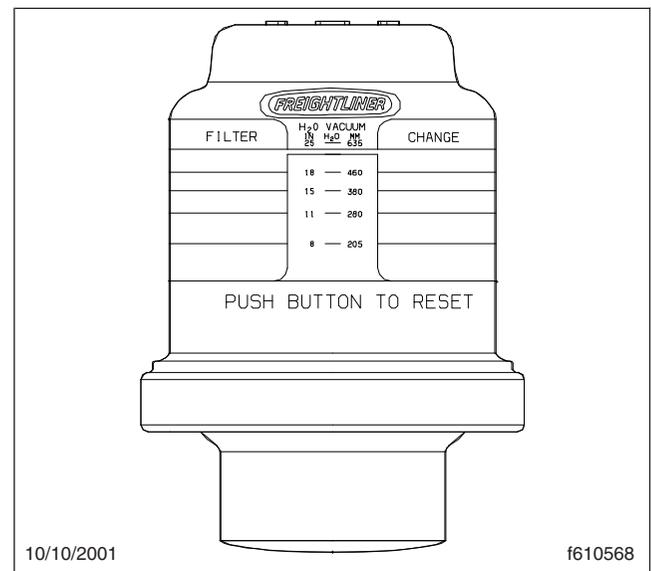


Fig. 4.15, Air Intake Restriction Indicator

Air intake restriction vacuum is measured in inches of water (inH₂O). For vehicles equipped with a graduated indicator or a restriction gauge on the dash, check the gauge with the engine off. If the yellow signal stays locked in the red zone once the engine is shut down, or is at or above 25 inH₂O, the air cleaner element needs to be replaced.

Instruments

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

Ammeter

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.

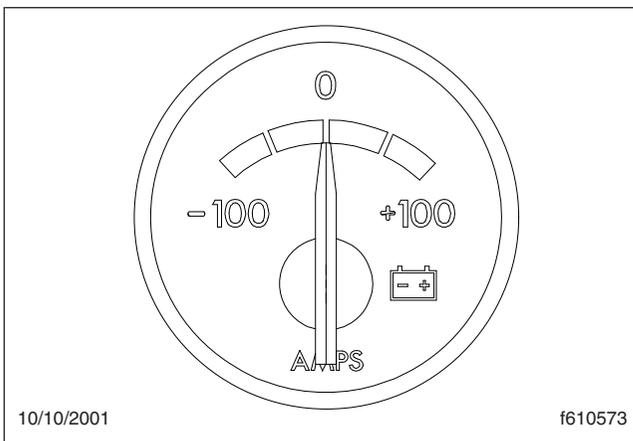


Fig. 4.16, Ammeter

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 vehicle 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 Detroit™ and Meritor™ drive axles. See [Fig. 4.17](#).

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

Digital Clock

The optional digital clock has black characters on a constantly backlit green display, with a bright-

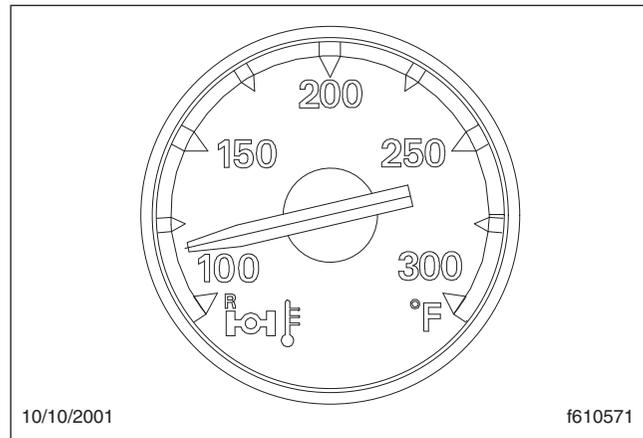


Fig. 4.17, Axle Oil Temperature Gauge

ness that automatically adjusts for day or night. The clock has a 24-hour alarm, with a three-minute snooze feature. See [Fig. 4.18](#).

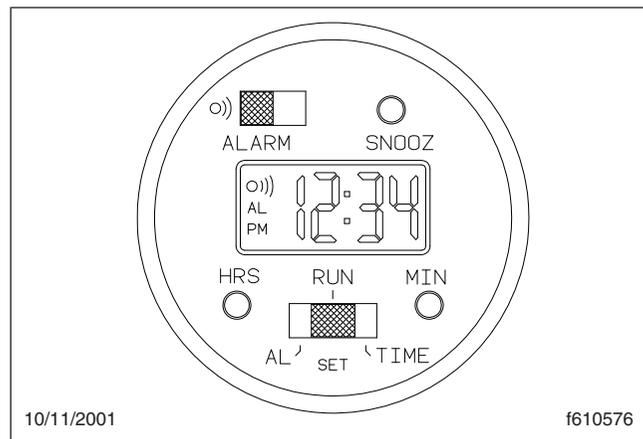


Fig. 4.18, Digital Clock

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 used to set the time of day; remember to set the hour for AM (no letters in the corner of the display), or PM 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 between 180 to 225°F (82 to 107°C) for Cummins ISB 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](#).

Pyrometer

An optional pyrometer can be installed on the exhaust pipe. A pyrometer registers the exhaust temperature near the turbocharger. See [Fig. 4.20](#). Maximum exhaust temperature for the Cummins ISB engine is 1290°F (700°C).

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.

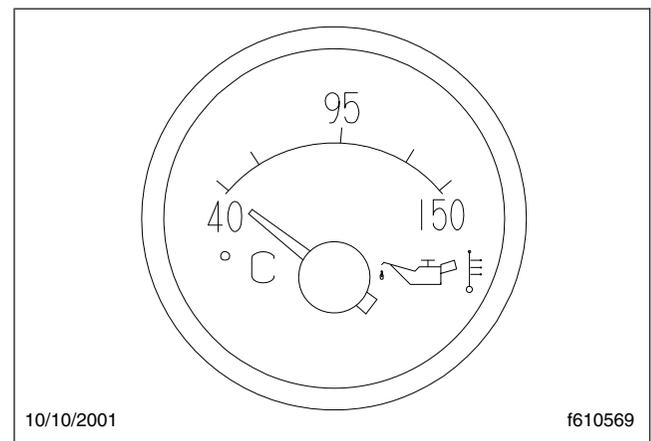


Fig. 4.19, Engine Oil Temperature Gauge

Transmission Fluid Temperature Gauge

During normal operation, the transmission fluid temperature gauge reading should not exceed 250°F (121°C). See [Fig. 4.21](#).

Instruments

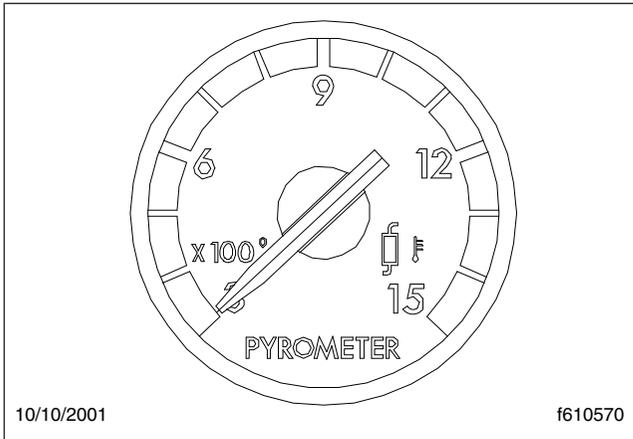


Fig. 4.20, Pyrometer

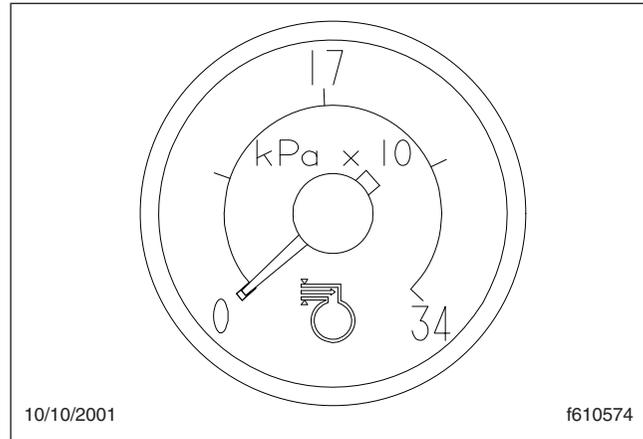


Fig. 4.22, Turbo Boost Pressure Gauge

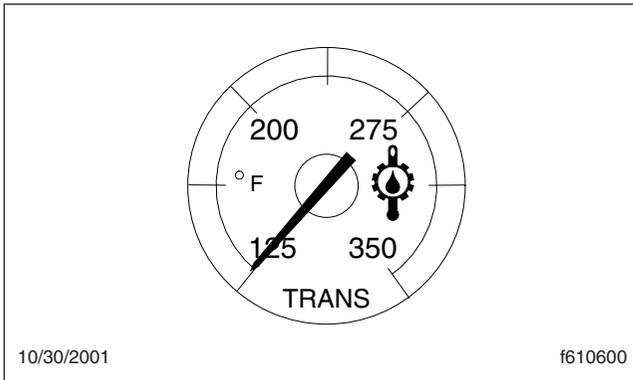


Fig. 4.21, Transmission Fluid Temperature Gauge

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.

Turbocharger Boost Pressure Gauge

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](#).

5

Controls

Ignition Switch and Key	5.1
Lighting Controls	5.1
Multifunction Turn Signal Switch	5.2
Driver Switch Panel Controls	5.4
Aftertreatment System (ATS) Regen Switch	5.5
Automatic Tire Chain Control	5.6
Horn Control	5.6
Steering Controls	5.6
Powertrain Controls	5.7
Braking Controls	5.11
Heater/Air Conditioner/Defrost Control Panel	5.11

Controls

Ignition Switch and Key

The ignition switch has four positions: ACCESSORY, OFF, ON, and START. See [Fig. 5.1](#).

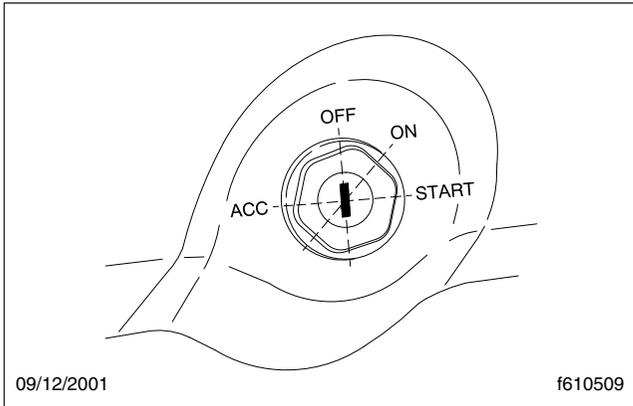


Fig. 5.1, Ignition Switch Positions

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): 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 components that are operable in the OFF position are operable in the ACCESSORY position.

All electrical systems are operable in the ON position. The warning lights and the buzzer for low air pressure and low oil pressure operate until minimum pressures are built up.

Turn the key fully clockwise to the START position to start the engine. When the engine starts, release the key.

Lighting Controls

The lighting controls operate through switches located on the dash. Two types of dash switches are used:

- Paddle switches have a single paddle located in the center of the switch. The paddle can be raised or lowered to perform a function.
- Rocker switches can be pressed up or down 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 light-emitting diode (LED).

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. 5.2](#). 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.

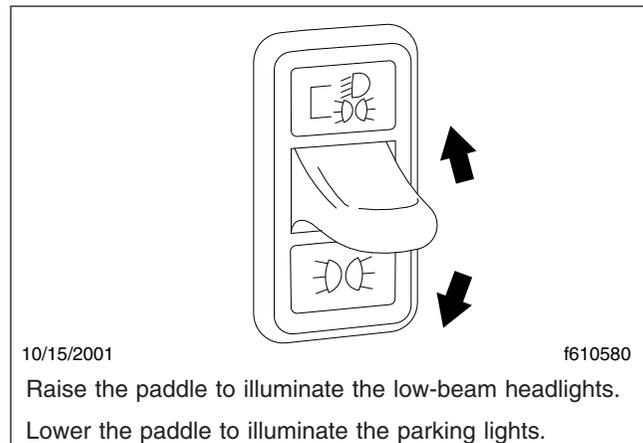


Fig. 5.2, Headlight/Parking Light Switch

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).

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.

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. 5.3](#). To brighten the panel lights, press the upper part of the switch (at the "INCR+" legend). To dim the panel lights, press the lower part of the switch (at the "DECR-" legend).

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

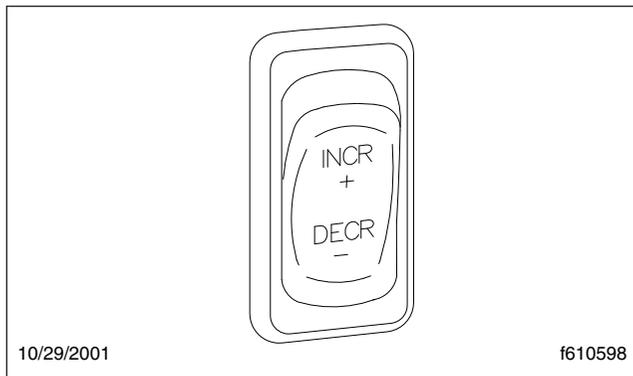


Fig. 5.3, Panel Light Increase/Decrease Switch

Footwell Light

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

Interior Dome 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. 5.4](#) for the rear dome light.

Interior Dome Light Replacement

To replace the interior light(s) do the following. See [Fig. 5.4](#).

1. Remove the two Phillips screws that attach the lens.

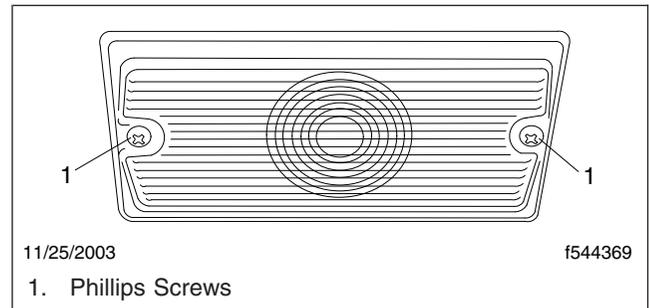


Fig. 5.4, Dome Light

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 left-hand side of the steering column. This switch has the following functions:

- turn signals
- windshield wipers and washers
- high-beam headlights
- hazard warning lights

See [Fig. 5.5](#) for the multifunction switch and its component parts.

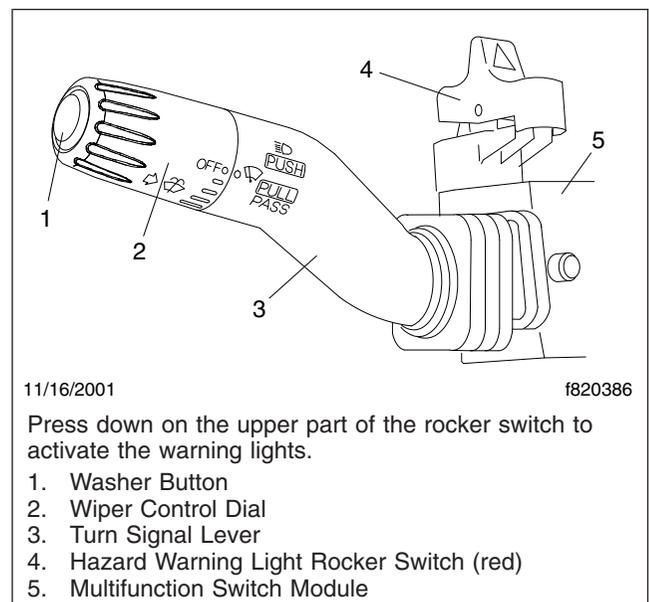


Fig. 5.5, Multifunction Turn Signal Switch

Controls

Turn Signal Lever

The turn signal lever is mounted on the steering column. See [Fig. 5.6](#). Moving the lever down activates the left turn signal lights; moving it up activates the right turn signal lights.

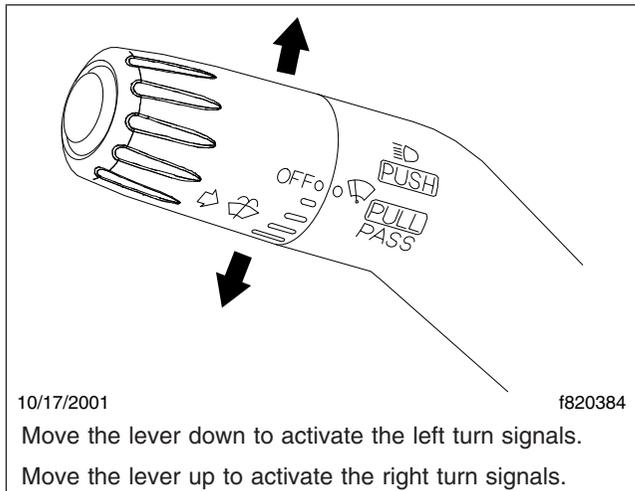


Fig. 5.6, Turn Signal Controls

When a turn signal is activated, a green indicator arrow flashes at the far left or far right of the instrument 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. 5.7](#). There are five delay settings, marked on the dial by lines of increasing length, and two steady speed settings, LO and HI.

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

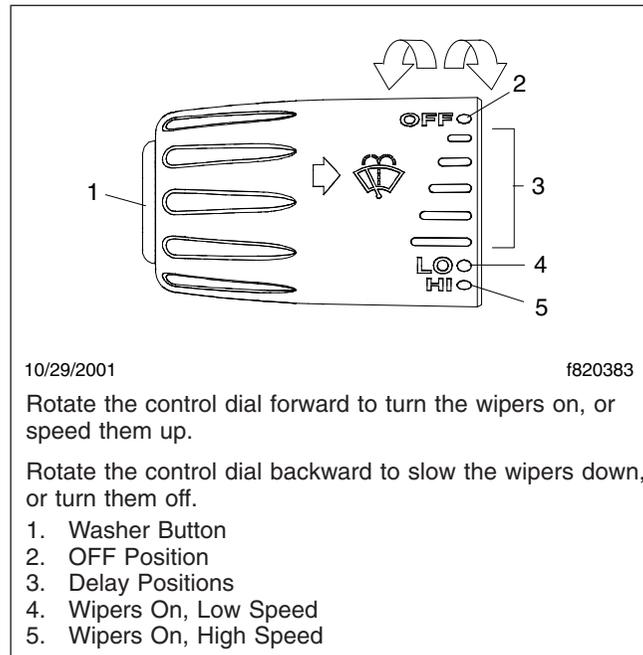


Fig. 5.7, Wiper/Washer Controls

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.

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. 5.8](#).

When the high beam headlights are on, a blue light illuminates on the instrument panel 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 momentarily.

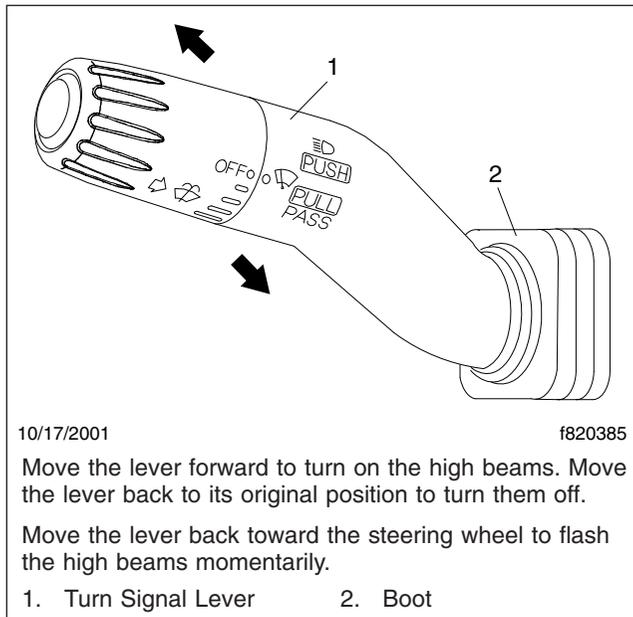


Fig. 5.8, Headlight High Beams

The headlight low beams remain on continuously during high beam operation. If the low beam headlights are turned off using 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. 5.5](#). When the warning lights are activated, all of the turn signal lights (front, side, and rear) and the two green indicator arrows on the instrument panel will blink on and off.

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

Driver Switch Panel Controls

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. 5.9](#) and [Fig. 5.10](#). 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.
 - Noise Suppression (not shown)—When activated, the noise suppression system will simultaneously turn off all noise-producing accessories with one switch. Noise-producing accessories include 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 that all of the seats are empty. There are two ways to deactivate the buzzer, depending on how the bus was built: either press the reset switch located at the rear driver-side of the bus, or open the rear emergency exit door within 60 seconds.
- 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 and the driver must repeat the steps to press the reset switch at the rear of the bus or open the rear emergency exit door.

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

Multiple options are available on the driver switch panel depending on individual school districts. These options will be on the second and third rows of the driver switch panel.

Controls

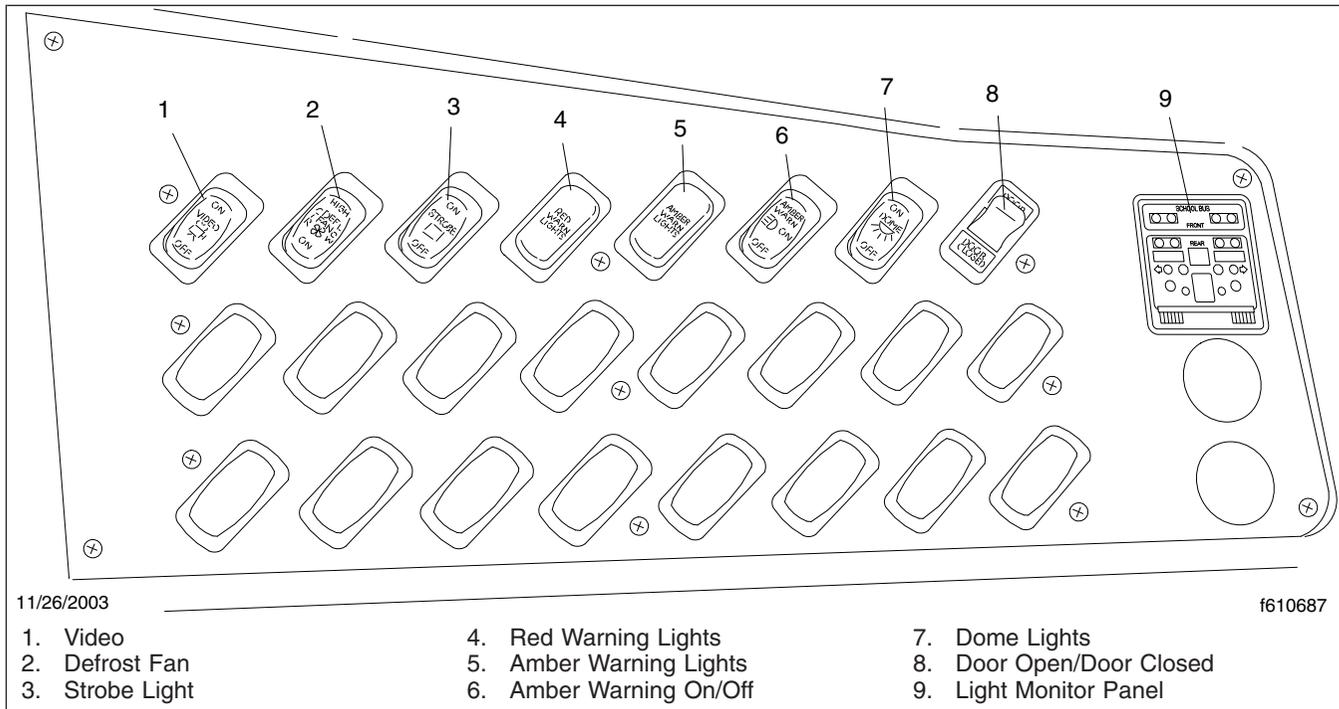


Fig. 5.9, Driver Switch Panel (typical)

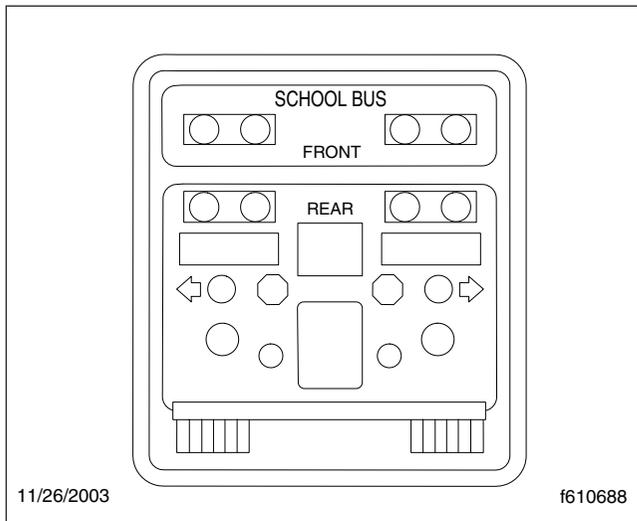


Fig. 5.10, Light Monitor Panel

A regen switch, located on the dash, allows the driver to control three states. See [Fig. 5.11](#). These include:

- request regeneration

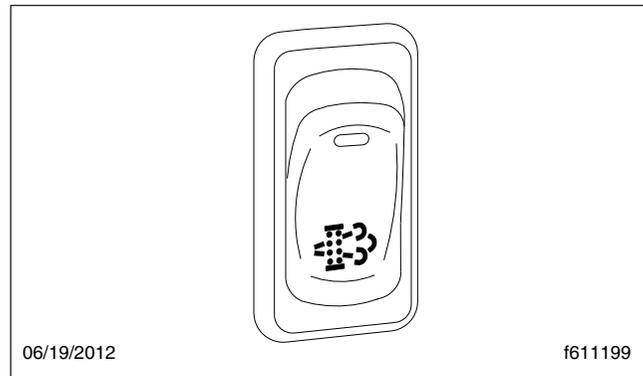


Fig. 5.11, Regen Switch

Aftertreatment System (ATS) Regen Switch

NOTE: Some alternative fueled vehicles are not equipped with a regeneration (regen) switch.

- default (automatic regeneration)
- inhibit regeneration

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

Automatic Tire Chain Control

Automatic tire chains are optional. See [Fig. 5.12](#) for an example of the automatic tire chain switch. An LED in the switch illuminates when the tire chains are activated.

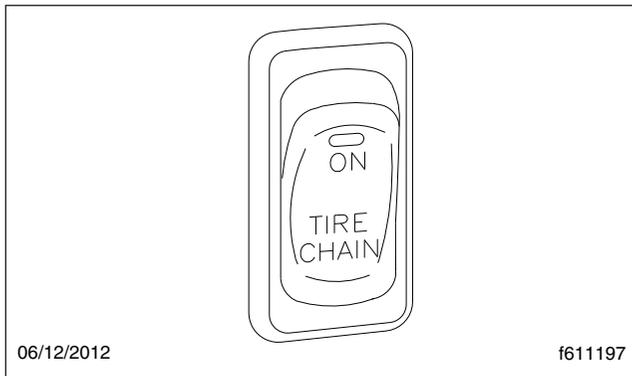


Fig. 5.12, Automatic Tire Chain Switch

Engaging/Disengaging the Tire Chains

IMPORTANT: The tire chains must be engaged and disengaged while moving, and before slippage occurs.

1. The tire chains must be engaged from the dash mounted switch when traveling between 5 to 25 mph (8 to 40 km/h). If the tire chains need to be engaged from a standstill, spin the tires at 5 mph (8km/h) before engaging the chains. This will prevent the chains from becoming tangled. Do not spin the tires too fast, as this will increase the time it takes to gain traction.
2. When the tire chains are no longer needed, they must be disengaged when traveling between 5 to 30 mph (8 to 48 km/h).
3. When approaching an icy grade and the tire chains have not been engaged, adjust speed to 25 mph (40 km/h) and engage the tire chains. Then, slowly regain and maintain speed.

Use of the Tire Chains While They Are Engaged

1. For maximum efficiency of the tire chains, maintain a minimum speed of 5 mph (8 km/h).

2. Do not exceed 30 mph (48 km/h) with the tire chains engaged.
The LED in the automatic tire chain switch flashes when vehicle speed reaches 35 mph (56 km/h) or more, notifying the driver to reduce speed.
3. When climbing a hill with the tire chains, try to maintain momentum. This will improve the performance of the tire chains.
4. For the best results while moving, accelerate slowly. Spinning the wheels will result in a loss of traction.
5. When using the tire chains in reverse, they will work best at speeds above 5 to 8 mph (8 to 13 km/h).
6. The tire chains are not as effective when snow depths exceed 6 to 8 inches (15 to 20 cm).
7. The vehicle can stop on the chains, and then start moving again, provided the switch is still in the engaged position.

Braking and Stopping

1. When stopping on snowy or icy roads, engage the chains before stopping to increase traction, and to increase traction when restarting.
2. Avoid locking the brakes while braking under any conditions.
3. After stopping, start moving slowly to increase traction. Do not spin the tires.

Horn Control

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

The button for the horn is located in the center of the steering wheel. To sound the horn, press down on the button. See [Fig. 5.13](#).

Steering Controls



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.

Controls

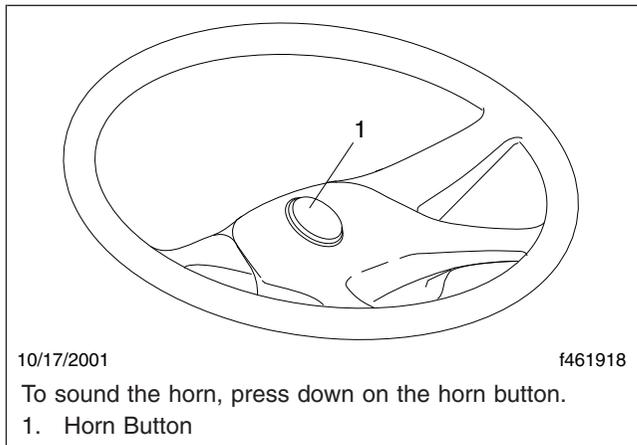


Fig. 5.13, Horn Control

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.

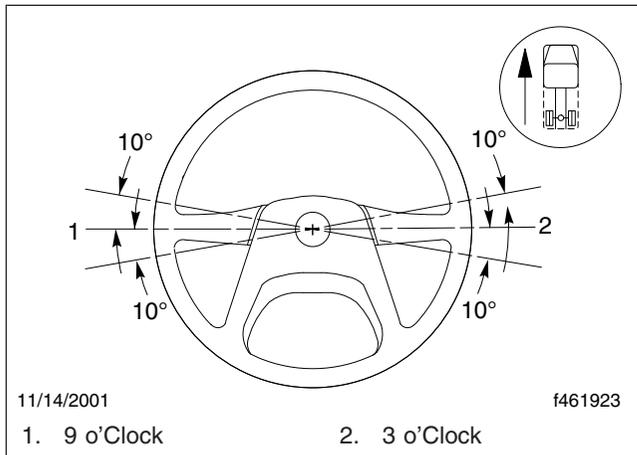


Fig. 5.14, Steering Wheel Centered

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**.

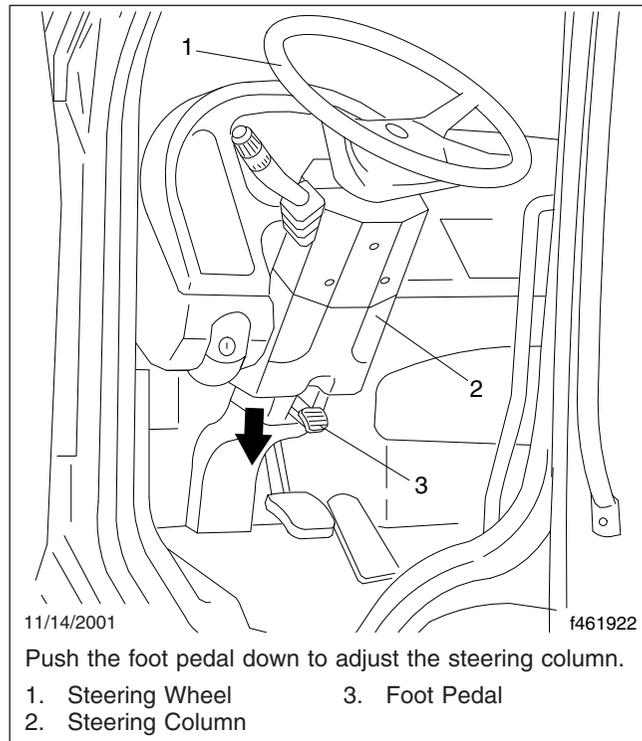


Fig. 5.15, Adjustable Steering Column

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.

Powertrain Controls

Cruise Control Switch



Do not use the cruise control system when driving conditions do not permit maintaining a constant speed, such as heavy traffic or on roads that are winding, icy, snow covered, slippery, or roads with a loose driving surface. Failure to follow this precaution could cause a collision or loss of vehicle control, possibly resulting in personal injury or property damage.

NOTE: Maximum cruise control speed varies according to vehicle specifications, but cannot be higher than 75 mph (121 km/h).

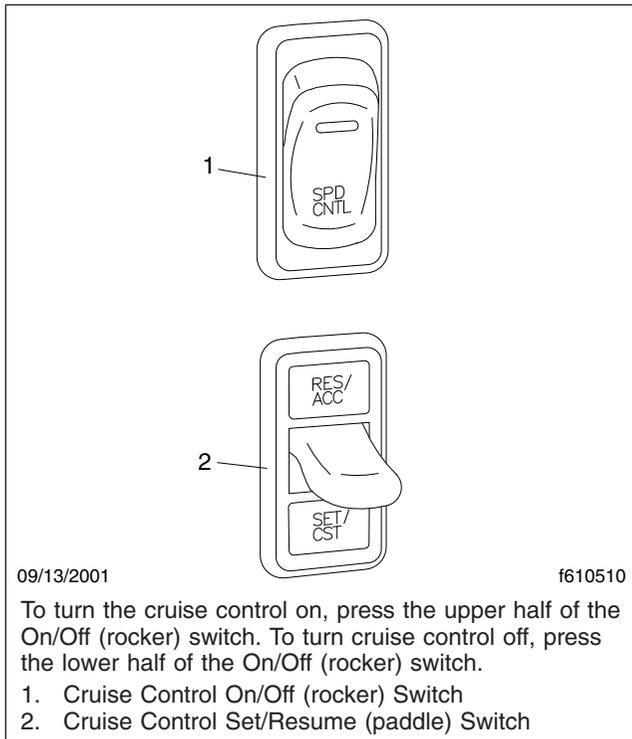


Fig. 5.16, Cruise Control Switches, Dash-Mounted

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.
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 Set/Resume switch paddle.

2. To disengage the cruise control, do these steps:
 - 2.1 Depress the brake pedal.
 - 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.

Fast Idle System

If the vehicle has this feature, it is available for use only with cruise control. There are three preset speeds available: 800, 900, or 1000 rpm.

The fast idle system can be used to increase engine idle speed whenever the following conditions are met.

- The brake pedal is not pressed.
- The vehicle must not be moving and the throttle must not be pressed.

Fast Idle Operation

1. To enable the fast idle system, press and release the cruise control On/Off rocker switch.
2. For the preset fast idle, press and release the cruise control set switch. This will set the preset fast idle speed.

Controls

IMPORTANT: The fast idle system does not have any type of light activation in the instrument panel. The only light that will be illuminated is the cruise indicator.

Any of the following actions will turn off the fast idle system:

- Applying the brake.
- The transmission shifter is moved out of Park (P) or Neutral (N); this will engage the transmission.
- Pressing and releasing the cruise control On/Off rocker switch when it is on.

Exhaust Brake Switch

An exhaust brake is an optional auxiliary braking system that assists, but does not replace the service brake system. The 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 the upper part of the rocker 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.

Transmission

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.

T-Handle Shift Selector

Vehicles equipped with a standard Allison On-Highway Series automatic transmission, have a T-handle shift selector. See [Fig. 5.18](#).

When the transmission is in D (drive), the vehicle will operate in 4th and 5th gear as needed. To shift down into a lower gear, pull the lower half of the T-handle selector up. Select the gear needed and release the lower half of the T-handle selector.

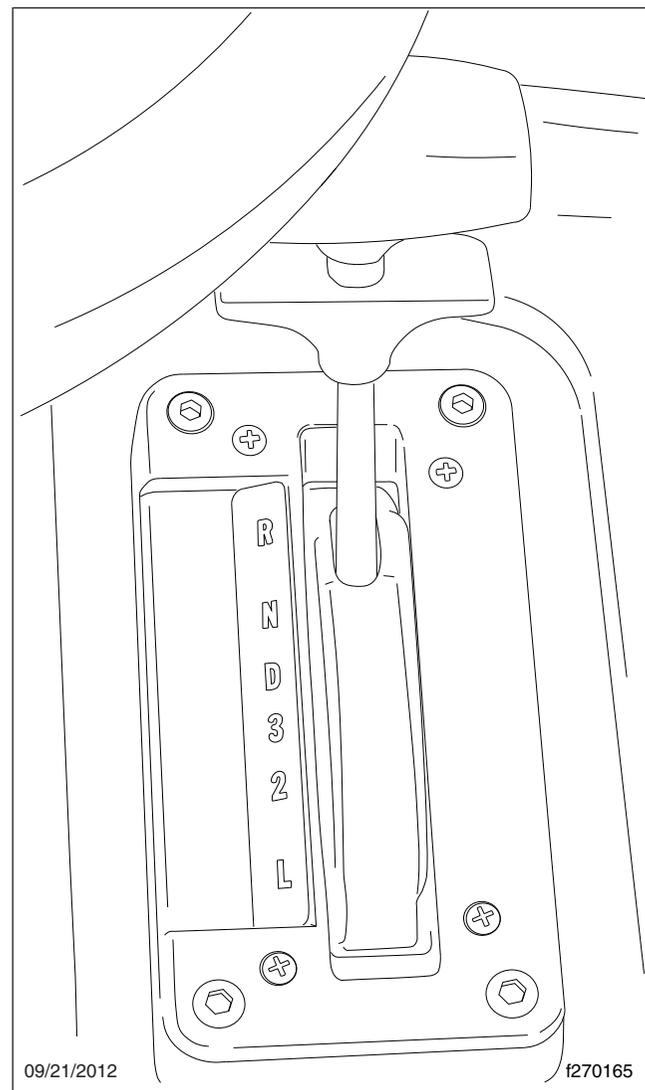


Fig. 5.18, T-Handle Shift Selector

On vehicles with an Allison MD Series automatic transmission or an Eaton Autoshift automated transmission, a push-button shift selector, shown in [Fig. 5.19](#), provides four, five, or six forward ranges

and one reverse range. See [Chapter 9](#) for more information about the push-button shift selector.

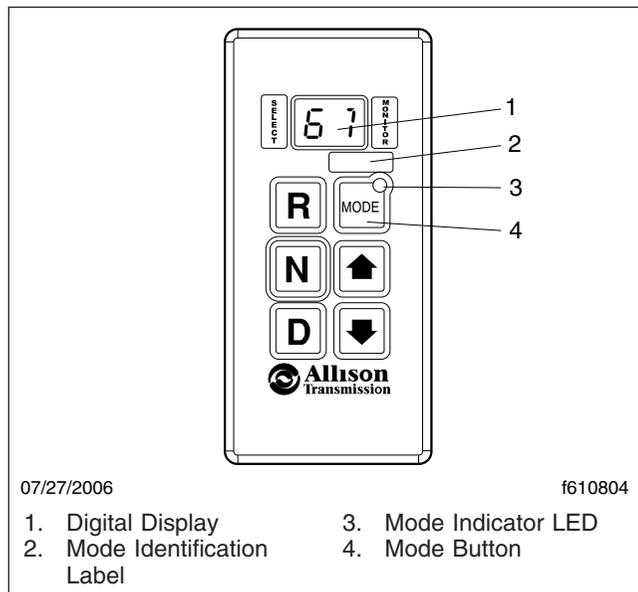


Fig. 5.19, Push-Button Shift Selector

Transmission Mode Switch

Some vehicles are equipped with a transmission mode switch, shown in [Fig. 5.20](#). The transmission mode switch is a fuel conservation option that allows the driver to choose either performance or economy shifting. When the switch is in the on position (the top of the rocker switch is pushed down), the transmission shift pattern changes from primary (performance) shift mode to secondary (economy) shift mode. When the transmission mode switch is in the off position (the bottom of the rocker switch is pushed down), the transmission reverts back to the primary shift mode.

NOTE: Primary and secondary shift mode calibration varies by vehicle.

Axle Switches

All axle switches contain a red LED 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](#).

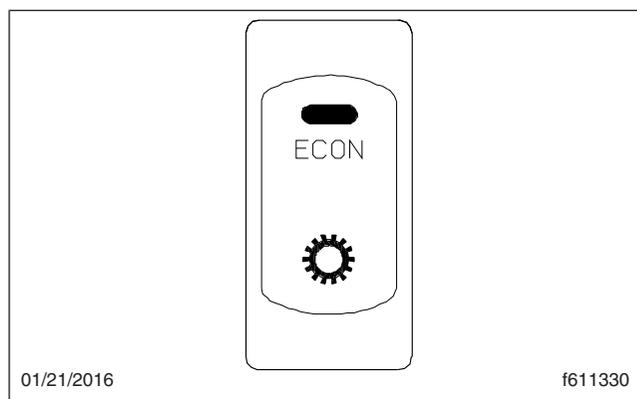


Fig. 5.20, Transmission Mode Switch

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](#).

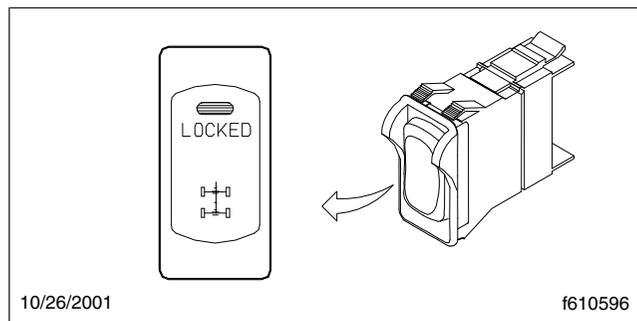


Fig. 5.21, Differential Lock Switch

To lock the wheels together, press the upper half of the rocker switch momentarily. To turn off differential lock, press the upper half of the rocker switch 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.

Controls

Take the vehicle to an authorized Freightliner dealer as soon as possible.

Interaxle Lock Switch

NOTICE

Do not turn the interaxle lock switch on 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](#).

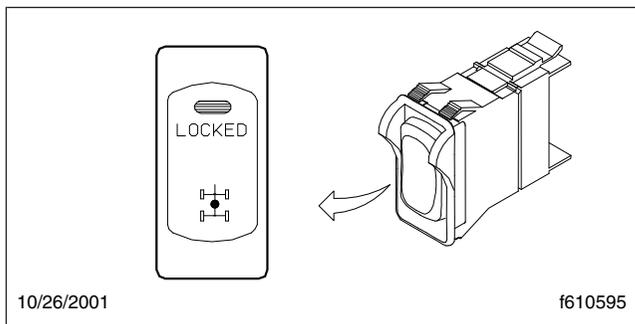


Fig. 5.22, Interaxle Lock Switch

To lock the axles together, press the upper half of the rocker switch momentarily. To turn off interaxle lock, press the upper half of the rocker switch 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](#). Pull the knob to apply the parking brakes; push the knob in to release 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).

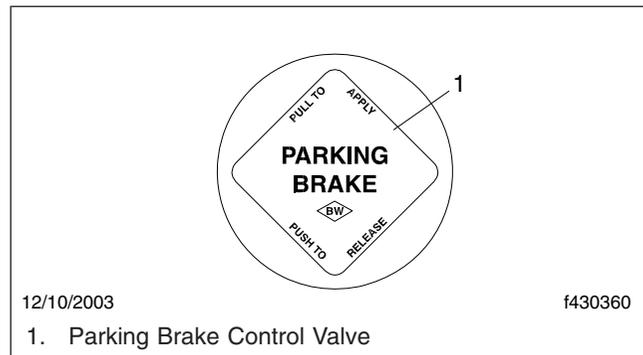


Fig. 5.23, Parking Brake Control Valve

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 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](#).

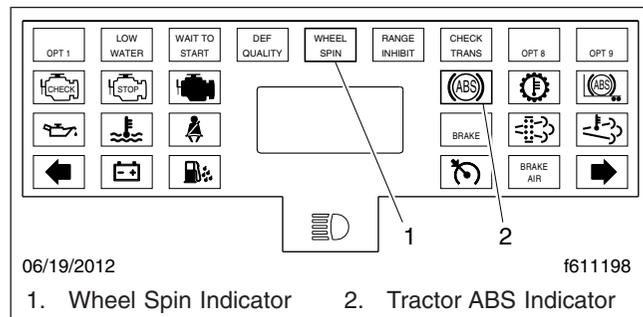


Fig. 5.24, ABS Indicator Lights

See the brake system operating instructions in [Chapter 10](#) for more information about ABS.

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. 5.25](#). On vehicles with air conditioning, the panel also contains a telltale LED and an air recirculation button.

Climate Control Panel

The climate control panel controls the HVAC for the driver. The climate control panel without air conditioning is shown in [Fig. 5.25](#). The climate control panel with air conditioning is shown in [Fig. 5.26](#).

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 Operator's 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 clockwise to a higher number. To decrease the airflow, turn the switch counterclockwise 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 the driver to control the flow of air through the face outlets, the floor outlets, the defrost (windshield) outlets, or a combination of these outlets. Nine air selection modes are available on a system without air conditioning. See [Fig. 5.27](#). A system with air conditioning has 11 air selection modes, four of which are air conditioning modes. See [Fig. 5.28](#).

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/**

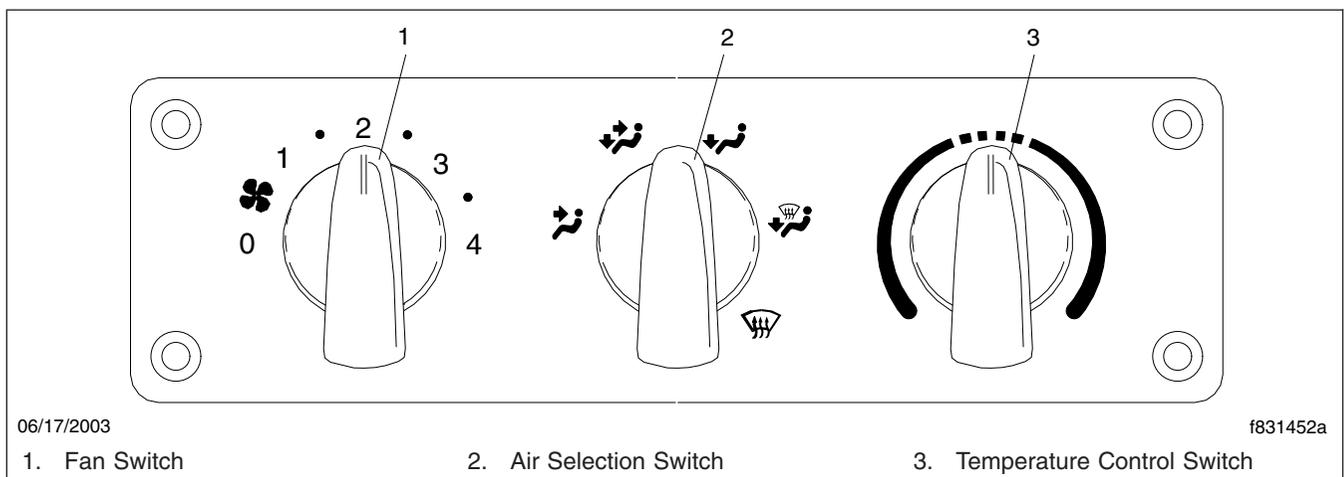


Fig. 5.25, Climate Control Panel Without Air Conditioning

Defrost Mode: Directs 75 percent of the airflow through the floor outlets and 25 percent through the defrost outlets.

Controls

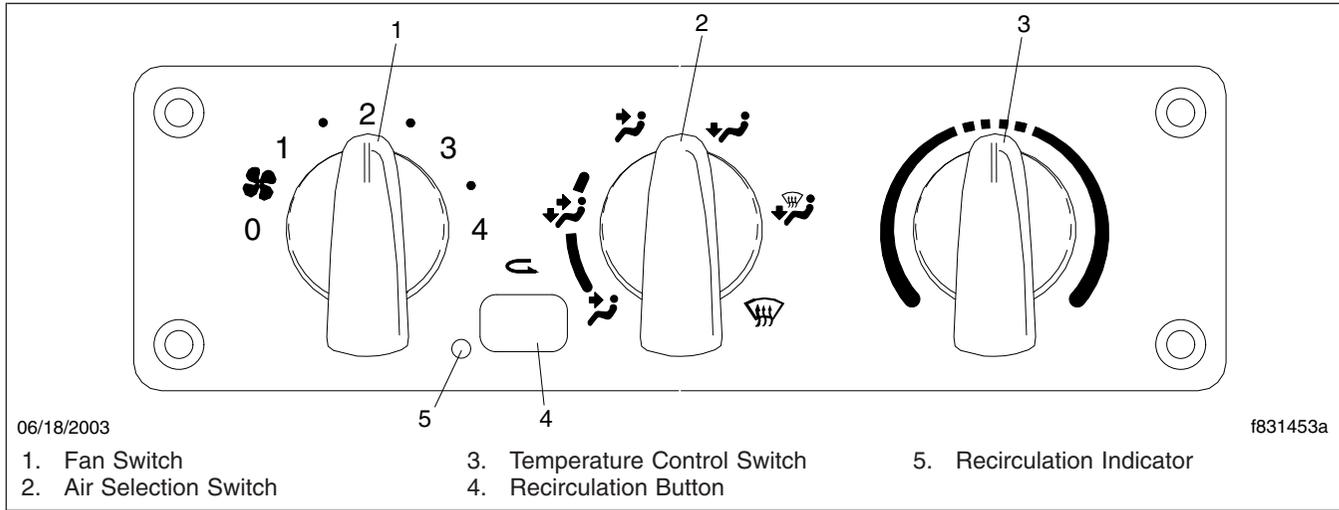


Fig. 5.26, Climate Control Panel With Air Conditioning

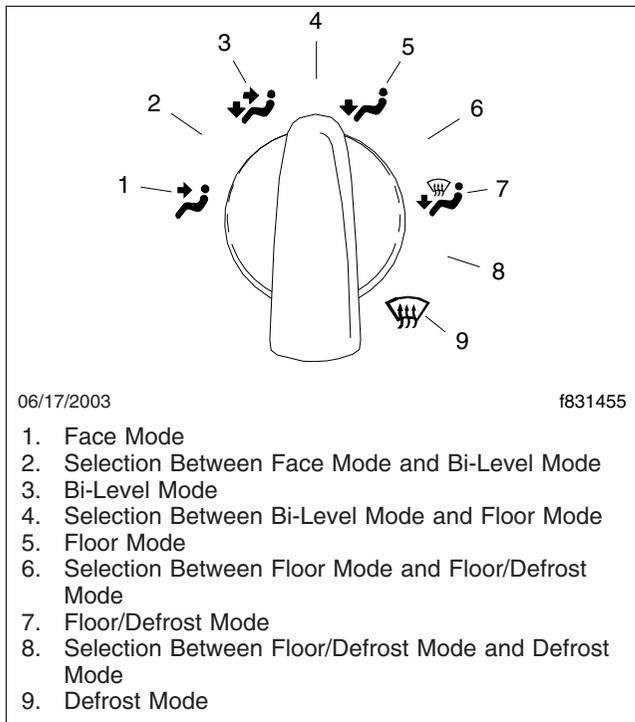


Fig. 5.27, Air Selection Switch Without Air Conditioning

7. **Floor/Defrost Mode:** Directs the airflow equally to the floor outlets and the defrost outlets.
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.

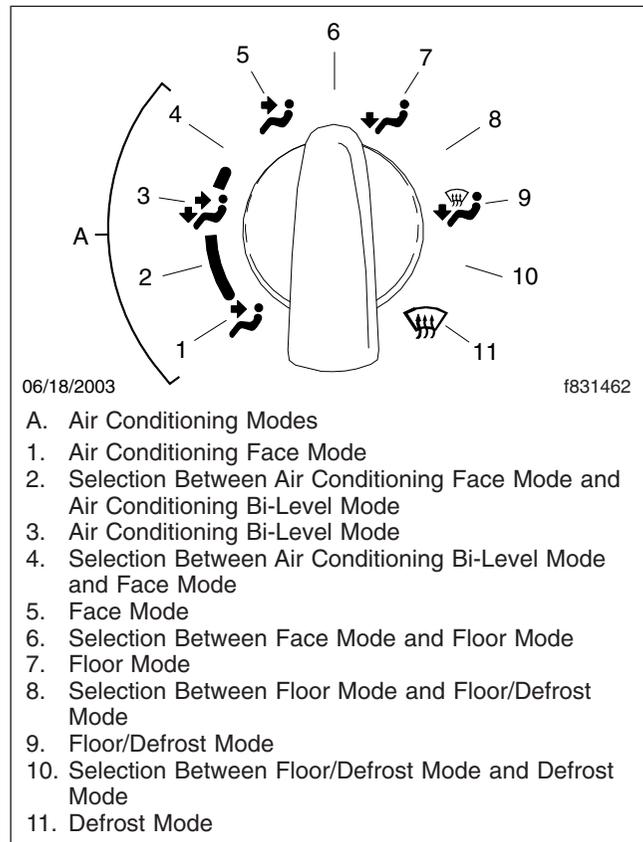


Fig. 5.28, Air Selection Switch With Air Conditioning

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 illuminate. See [Fig. 5.26](#).

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.

IMPORTANT: 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

Controls

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 an authorized Freightliner dealer for repairs.

Booster Pump

The booster pump switch activates 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

Electrical Systems

Electrical System General Information	6.1
Power Distribution Modules	6.1

Electrical Systems

Electrical System General Information

The Saf-T-Liner C2 uses an electrical system where 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 requires special skills and equipment and should only be performed by a qualified technician. Take the vehicle to an authorized Thomas Built Bus dealer when service is needed.

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 location 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

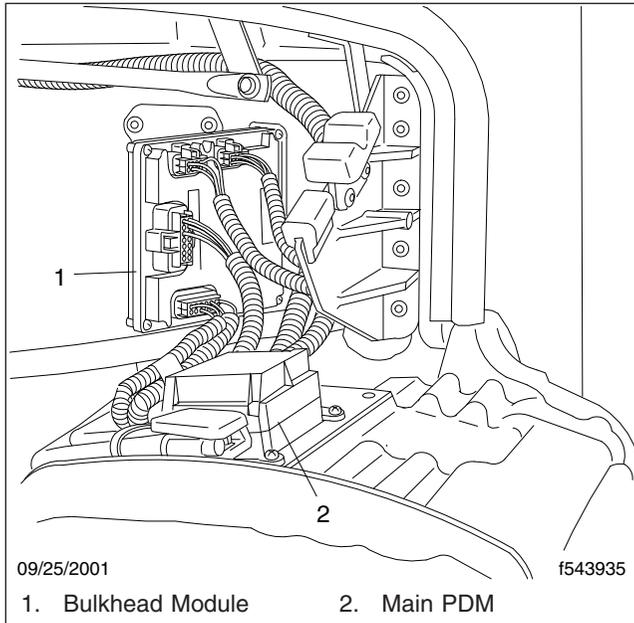


Fig. 6.1, Location of the Main PDM

Electrical Systems

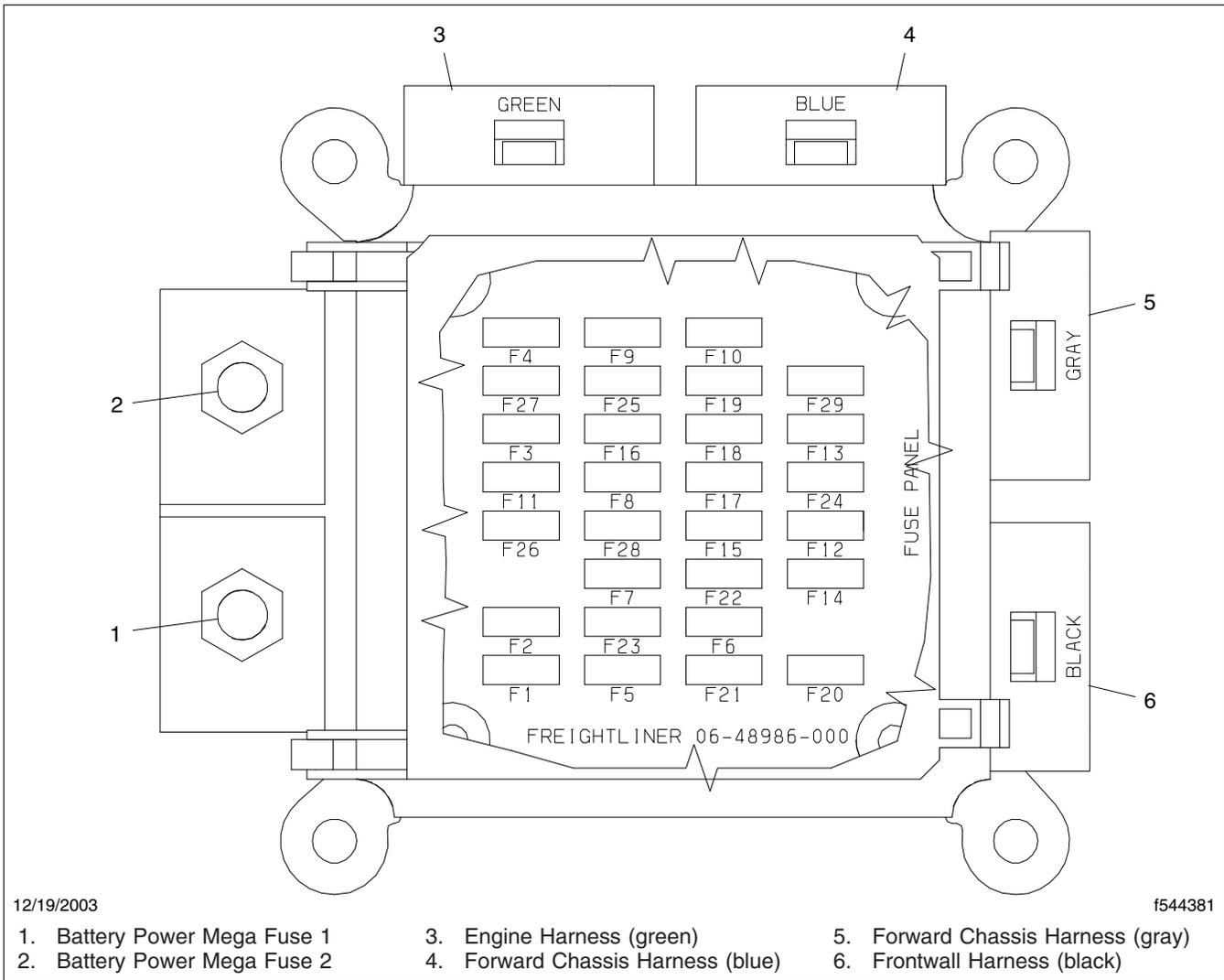


Fig. 6.2, Main PDM

7

Engines

Engine Starting	7.1
Engine Operation	7.2
Engine Shutdown	7.3

Engines

Engine Starting

For cold-weather starting, refer to the *Cummins Operation and Maintenance 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 pre-trip inspection and daily maintenance checks in **Chapter 11** and **Chapter 12** of this manual.

NOTICE

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.

The amber wait to start indicator illuminates with the ignition switch in the ON position prior to engine start-up. To avoid generating a system fault code, do not crank the engine until the wait to start indicator goes out.

3. Make sure that the transmission shift control is in Neutral (N), or if so equipped, the Park (P) or Park Brake (PB) position.

 **WARNING**

Never start the engine unless the parking brake is applied. Accidental movement of the vehicle could result in property damage, personal injury, or death.

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

IMPORTANT: For cold-weather starting, engine break-in, and cold-weather operation, refer to the *Cummins Operation and Maintenance 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.

Engines

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/RUN 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.

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.

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 (46°C).

1. With the vehicle stopped, place the transmission in Neutral (N), or if so equipped, the Park (P) or Park Brake (PB) position.
2. Set the parking brake.
3. 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.

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

8

Exhaust Aftertreatment Systems

Aftertreatment System, EPA10 and Newer Engines	8.1
Diesel Exhaust Fluid and Tank, EPA10 and Newer Engines	8.3

Exhaust Aftertreatment Systems

Aftertreatment System, EPA10 and Newer Engines

Engines manufactured between January 1, 2010 and December 31, 2012 meet EPA10 requirements. Engines manufactured from January 1, 2013 meet NHTSA and EPA 2014 fuel efficiency and greenhouse gas emission standards (GHG14) requirements. Engines manufactured from January 1, 2016 meet NHTSA and EPA 2017 fuel efficiency and greenhouse gas emission standards (GHG17) requirements.

Model year 2013 and later vehicles meet additional requirements as specified by GHG14 requirements. Model year 2017 and later vehicles meet similar requirements as specified by GHG17 requirements. These vehicles are equipped with components that increase fuel efficiency and reduce GHG emissions.

IMPORTANT: Depending on local jurisdictional guidelines, vehicles that are domiciled outside of the U.S. and Canada may not have emissions aftertreatment systems (ATS) that are compliant with EPA regulations.

Principles of Operation

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, engines that are compliant with EPA10 and newer regulations use an aftertreatment system (ATS) with an aftertreatment device (ATD) and Selective Catalytic Reduction (SCR) technology to reduce NOx downstream of the engine.

NOTICE

Follow these guidelines for engines that comply with EPA10 or newer regulations, 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 CK-4 oil.
- Use only certified diesel exhaust fluid (DEF) in the DEF tank.

NOTICE

FA-4 engine lube oil is available, but is not compatible with all engines. See the engine manufacturer's operation manual to determine if FA-4 oil can be used in your vehicle's engine. Failure to do so could lead to engine damage and is not warrantable.

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

IMPORTANT: See the engine manufacturer's operation manual for complete details and operation of the ATS.

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 anytime the vehicle is moving. The exhaust gas temperature could reach 1500°F (816°C), which is hot enough to cause a fire, heat damage to objects or materials, or personal injury to persons near the exhaust outlet. See *Regen-Inhibit Switch* later in this chapter for instructions on preventing automatic regen if necessary.

The exhaust temperature can remain high even after the vehicle has stopped. When stopping the vehicle shortly after an automatic regen, ensure the exhaust outlets are directed away from structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by exposure to high heat.

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 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 NO_x 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 ATS.

- 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



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.

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

Exhaust Aftertreatment Systems

EXHAUST AFTERTREATMENT SYSTEM INFORMATION					
INDICATOR LAMP(S)	 (Solid) Level 1	 (Flashing) Level 2	 (Flashing) CHECK Level 3	 (Flashing) CHECK STOP Level 4	 WARNING
Indicator Lamp Message(s)	Filter Regeneration Recommended	Filter Regeneration Necessary	Parked Regeneration Required – Engine Derate	Parked Regeneration Required – Engine Shut Down	HEST (High Exhaust System Temperature)
Diesel Particulate Filter Condition	Filter is reaching capacity.	Filter is now reaching maximum capacity.	Filter has reached maximum capacity.	Filter has exceeded maximum capacity.	Flashing A regeneration is in progress.
Required Action	Bring vehicle to highway speeds to allow for an Automatic Regeneration or perform a Parked Regeneration.	To avoid engine derate bring vehicle to highway speeds to allow for an Automatic Regeneration or perform a Parked Regeneration as soon as possible.	Vehicle must be parked and a Parked Regeneration must be performed – engine will begin derate.	Vehicle must be parked and a Parked Regeneration or Service Regeneration must be performed. Check engine operator's manual for details –engine will shut down.	Solid Exhaust Components and exhaust gas are at high temperature. When stationary, keep away from people and flammable materials or vapors.
For a driver performed Parked Regeneration, vehicle must be equipped with a dash mounted Regeneration Switch.					
See Engine Operator's Manual for complete Regeneration Instructions.					
<small>24-01583-0008</small>					

Fig. 8.1, Exhaust-Aftertreatment Warnings Reference Label

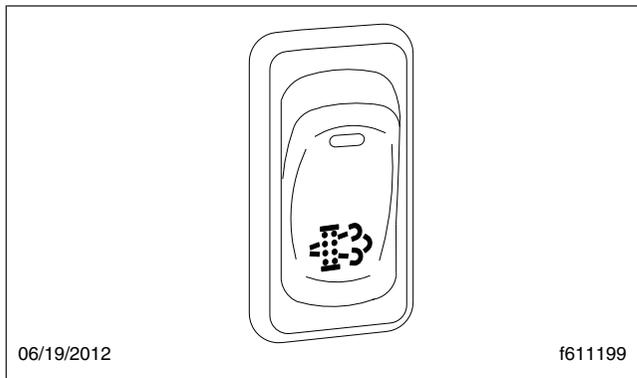


Fig. 8.2, Regen Switch

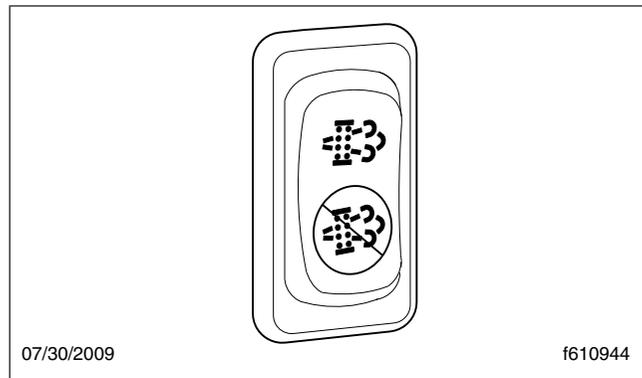


Fig. 8.3, Regen Inhibit Switch (optional when available)

speed exceeds 5 mph (8 km/h), or the system has cooled to normal operating temperature.

- To stop a parked regen at any time during the process, depress the 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.

Diesel Exhaust Fluid and Tank, EPA10 and Newer Engines

Diesel Exhaust Fluid

Diesel exhaust fluid (DEF) is used in the ATS to lower NOx in the exhaust stream. DEF is colorless and close to odorless (it may have a slightly pungent

odor similar to ammonia). It is nontoxic, nonflammable, and biodegradable. It is mildly corrosive to aluminum, but does not affect the strength or structure of the aluminum.

White crystals may be noticeable around components that come into contact with DEF. The crystals are easily removed with water.

DEF consumption varies depending on ambient conditions and vehicle application.

Freezing Conditions

DEF freezes to slush at around 12°F (-11°C). It is not damaged or destroyed if frozen, and is fully usable when thawed. The DEF in the tank is allowed to freeze while a 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 warms the DEF once the engine is running, allowing the SCR system to operate.

Pre-2013 DEF supply lines are electrically-heated and are purged when the engine is shut down; complete purging of the DEF lines requires approximately five minutes after the engine is shut down.

DEF supply lines with engine model year 2013 and newer are designed to survive freezing conditions while containing DEF, so purging is not required.

DEF Tank

Engines that are compliant with EPA10 and newer regulations are equipped with a DEF tank located between the 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](#).

Fuel level is indicated at the top of the gauge. Below the fuel level, a low fuel warning lamp illuminates

amber when the fuel level drops below 1/8th of the 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.

- Four bars illuminated green—Between 75% and 100% full
- Three bars illuminated green—Between 50% and 75% full
- Two bars illuminated green—Between 25% and 50% full
- One bar illuminated green—Between approximately 10% and 25% full
- One bar illuminated amber—DEF 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 Warning

When the DEF level reads low the following warnings strongly encourage the driver to refill the DEF tank. See [Fig. 8.5](#).

- The CHECK engine lamp flashes for 30 seconds when the vehicle is started.
- The DEF warning lamp illuminates.
- One bar of the DEF-level lightbar illuminates solid amber.

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

DEF Level Low—Critical Warning

When the DEF level reads low, the following warnings are activated. See [Fig. 8.6](#).

- The CHECK engine lamp flashes for 30 seconds when the vehicle is started.
- The DEF warning lamp illuminates.
- One bar of the DEF-level lightbar flashes red.

Exhaust Aftertreatment Systems

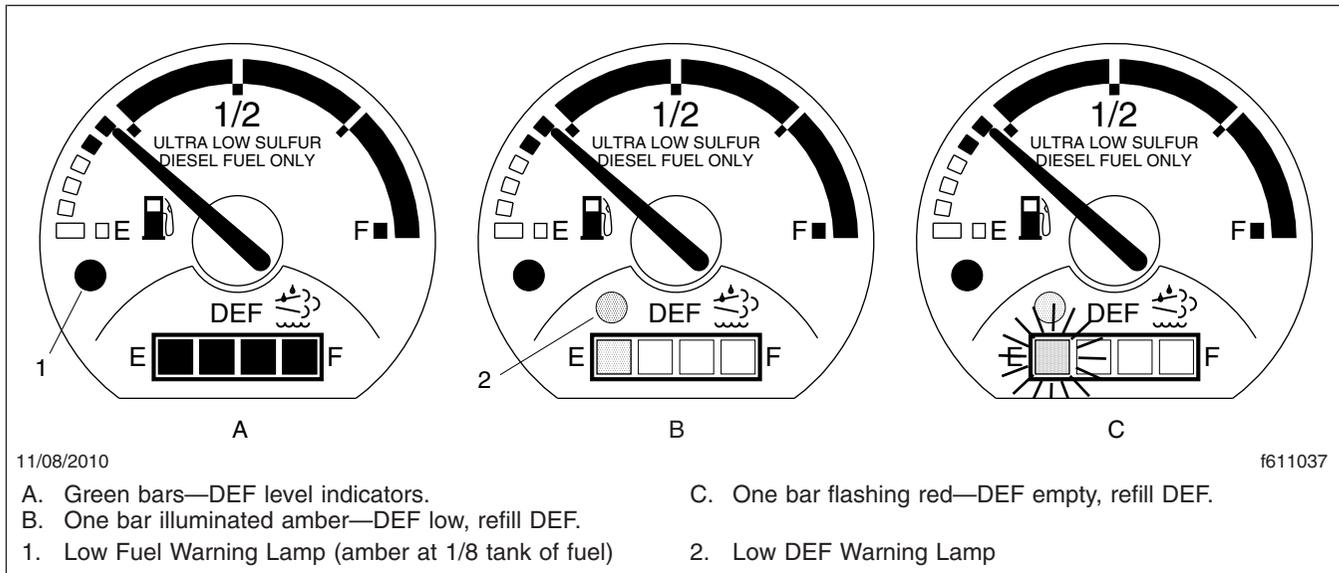


Fig. 8.4, Fuel/DEF Gauge

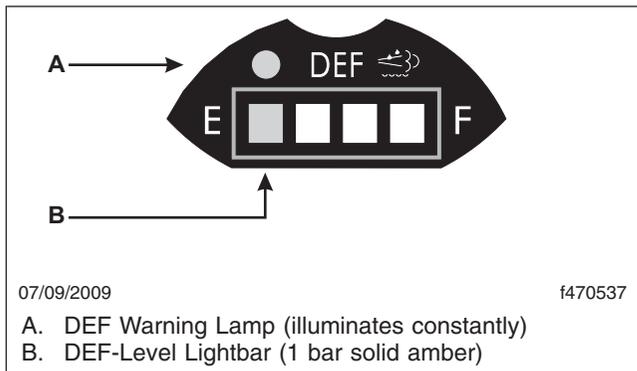


Fig. 8.5, DEF Level Low—Initial Warning

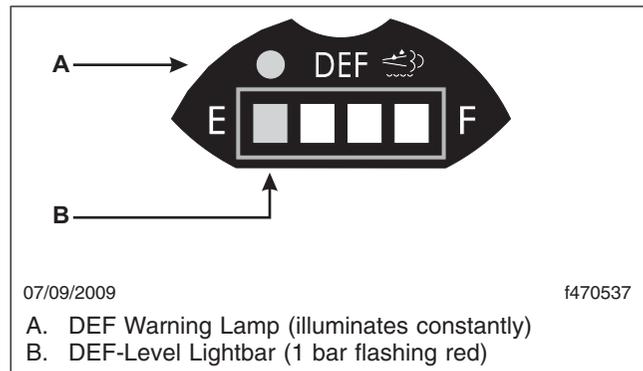


Fig. 8.6, DEF Level Low—Critical Warning

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

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

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

DEF Empty

When the DEF level reads empty, the following lamps notify the driver. See [Fig. 8.7](#).

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

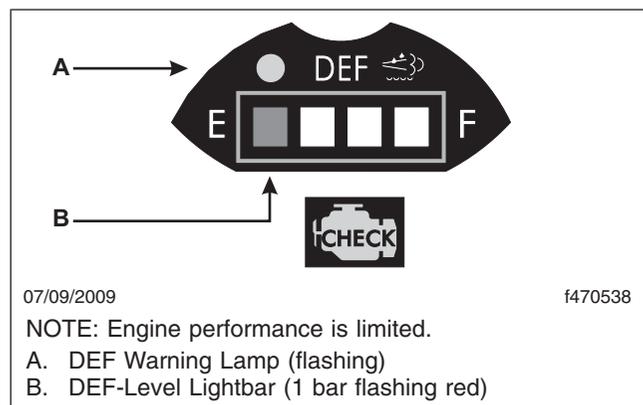


Fig. 8.7, DEF Empty Warning

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the DEF warning lamp flashes, one bar of the DEF-level lightbar flashes red, and the red STOP engine lamp illuminates in addition to the CHECK engine warning lamp. See [Fig. 8.8](#).

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.

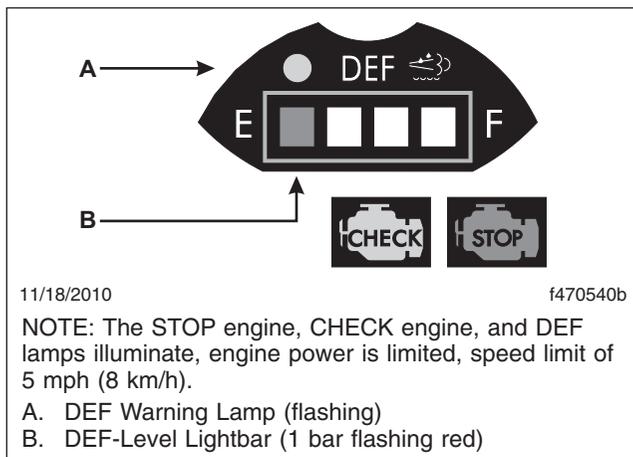


Fig. 8.8, DEF Empty and Ignored Warning

DEF Quality or SCR Tampering

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.

If contaminated DEF or tampering is detected, the DEF warning light flashes, and engine power is limited with progressively harsher limits applied. If the fault is not corrected, the STOP engine light illuminates and a 5 mph (8 km/h) speed limit is applied after the next engine shutdown, or while parked and idling. See [Fig. 8.8](#).

9

Drivetrain

Driving Precautions	9.1
Allison On-Highway Transmissions	9.1
Drive Axles, Detroit™ and Meritor™	9.5

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.

NOTICE

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 **L** (low) at speeds above 20 mph (32 km/h).

On slippery surfaces, avoid quick movements of the steering wheel. Decrease 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, 2350 Series, 2500 Series, and 3000 Series. Refer to www.allisontransmission.com for additional information.

Safety Precautions 2000 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 transmission control module (TCM), 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 another 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, if so equipped, 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 is standard on the 2200 series transmission. The park pawl effectively grounds

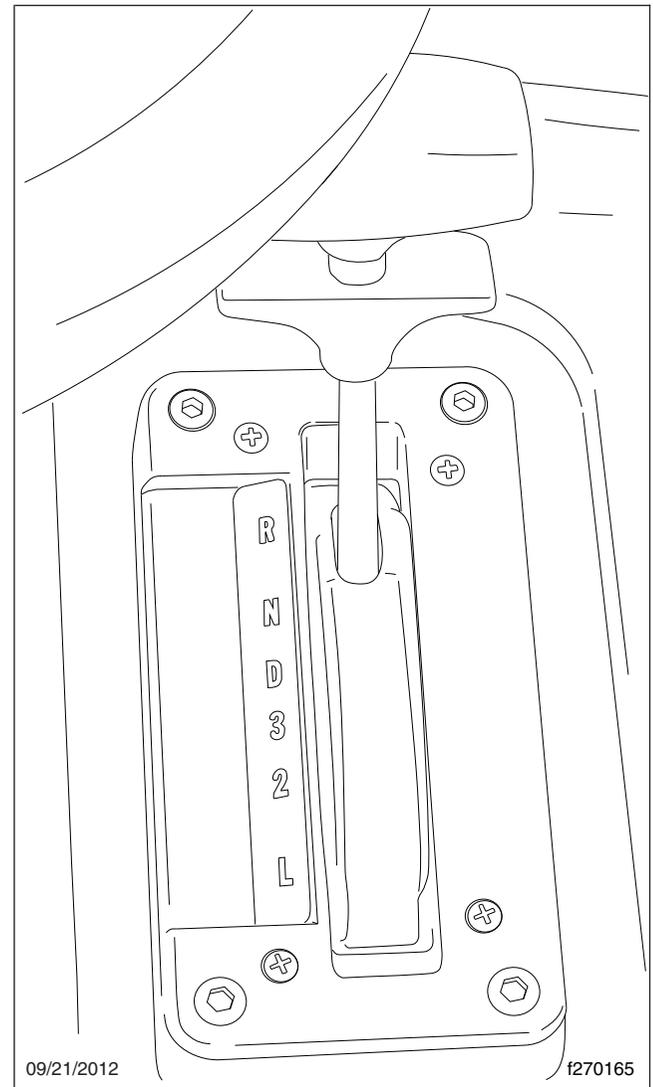


Fig. 9.1, T-Handle Shifter (standard)

the transmission output shaft, thereby preventing rotation of the driveline. Provided the vehicle is stationary, selecting **P** (park) on the shift selector, if so equipped, 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.

Drivetrain

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. When time at idle exceeds 5 minutes, select **N** (neutral), or if so equipped, **P** (park) or **PB** (auto-apply parking brake).

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. 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.

This position is used when starting the engine and for stationary operation. It is also used to shut down the vehicle when **P** (park) or **PB** (auto-apply parking brake) are not available on the shifter. In this case, the parking brake must be applied.

Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and the driver 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 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.

3 and 2 (Third and Second Ranges)

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

L (Low Range)

Use low range when pulling through mud or deep snow, when maneuvering in tight spaces, or when driving up or down very steep grades. Low 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 **R** (reverse), **N** (neutral), and **D** (drive) ranges, up and down arrows, a mode button, and a digital display. See [Fig. 9.2](#).

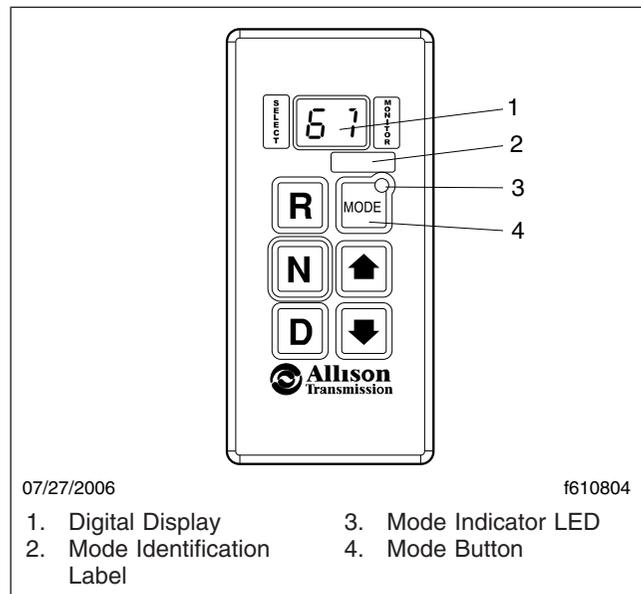


Fig. 9.2, Push-Button Shift Selector

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.

NOTICE

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 show **N** when neutral is selected. It is not necessary to press neutral before starting the vehicle. The electronic control unit (ECU) or TCM 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 the driver 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.

NOTICE

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 show the selected 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

Drivetrain

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 de-

fault 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.

Drive Axles, Detroit™ and Meritor™

For additional information regarding Meritor axles, visit the Meritor website at www.arvinmeritor.com.

Drive Axles With Differential Lock

The optional driver-controlled differential lock should only be used under adverse road conditions where greater traction is needed. With the differential lock on, the turning radius is increased and vehicle handling is affected. The red differential lock indicator light illuminates on the dash message center when the differential lock is engaged.

A 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. Do not exceed 25 mph (40 km/h) when the differential lock is engaged.

Under normal traction conditions, do not use the differential lock feature.

Differential Lock Switch

NOTICE

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

A two-position guarded rocker switch controls the differential lock. See [Fig. 9.3](#). To lock the wheels together, momentarily press the upper half of the switch. To unlock the wheels, press the upper half of the switch again.

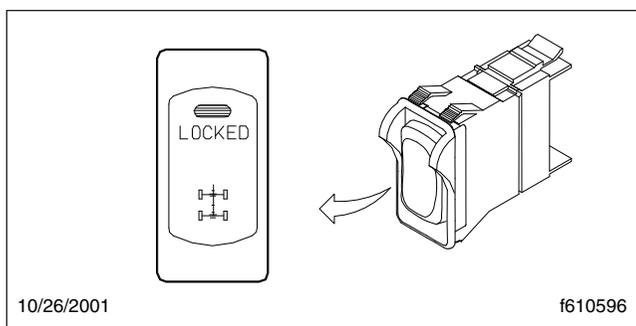


Fig. 9.3, Differential Lock Switch, Optional

IMPORTANT: The differential lock rocker switch is guarded to prevent unintentional switch activation. If the light emitting diode (LED) in the switch begins to blink during normal operation, when the switch has not been activated, an error condition exists. 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 remains illuminated constantly. 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 remains illuminated when the differential lock is engaged.

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.

NOTICE

The differential lock should be engaged when the vehicle is stopped or moving at a low, constant speed and the wheels are not spinning, slipping, or losing traction. Engagement at high speed or power can damage the axle(s).

Do not permit rear wheels to spin freely for more than ten seconds when traction is lost. Shift into lock to prevent damage to interaxle and main differentials.

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.

Drivetrain

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. 9.4](#). Drive cautiously and do not exceed 25 mph (40 km/h).

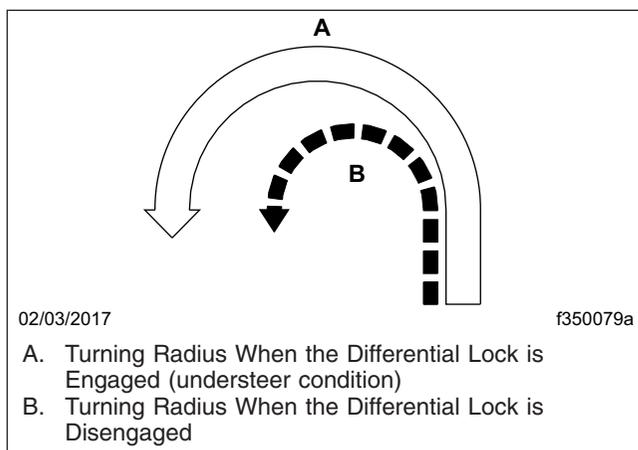


Fig. 9.4, Turning Radii

To disengage the differential lock after leaving poor road conditions, press the upper half of the switch, 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.

10

Hydraulic and Air Brake Systems

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Hydraulic and Air Brake Systems

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 one air system, the air compressor will operate, but the air supply in the leaking system will not be replenished. There will be enough air in the working 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. 10.1](#).

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.

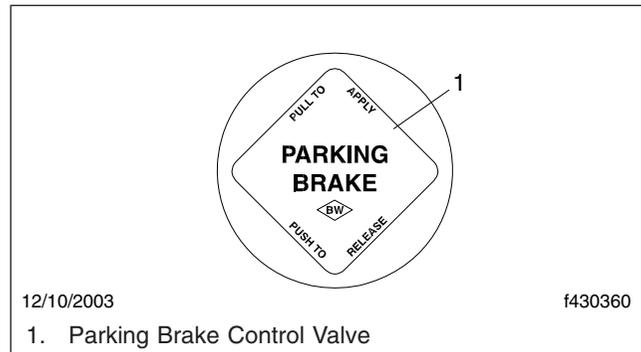


Fig. 10.1, Parking Brake Control Valve

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

NOTICE

Do not continually push down on the parking brake control valve 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.

Parking Brake Interlock Release

1. Depress the brake pedal.
2. Push the parking brake control valve in.

Parking Brake and Ignition Key Release

1. Turn the ignition key to the ON position.
2. Depress the brake pedal.
3. Push the parking brake control valve in.

Parking 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.

Hydraulic and Air Brake Systems

4. Depress the brake pedal.
5. Push the parking brake control valve in.

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. Depress 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, follow the steps below 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 the 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 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, shift the transmission to neutral. Apply the parking brakes, if the vehicle is to be parked.

NOTICE

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.

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.

Hydraulic and Air Brake Systems

Bosch Hydraulic 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 slip-pers.

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 bus 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 brake 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 bottom of the fill-neck. See **Fig. 10.2**. Use only DOT 3 brake fluid in the Bosch hydraulic pin slide brake system.

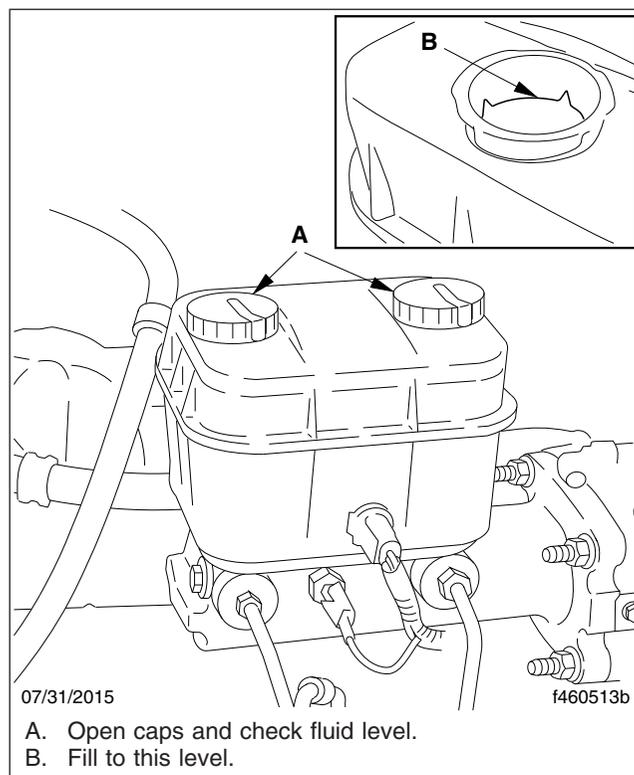


Fig. 10.2, Master Cylinder Reservoir

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.

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 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 will control all wheels to provide steering control and a reduced braking distance.

Although the ABS 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 cannot prevent an accident if the driver is speeding or following too closely on slippery road surfaces.

Even if the ABS 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.

Automatic Slack Adjusters

NOTICE

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.

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.

Automatic Traction Control

Vehicles with electronic engines and ABS may have Automatic Traction Control (ATC). On these vehicles, the ATC system automatically limits wheel spin during reduced-traction situations. In normal braking applications, the standard air brake system is in effect.

During reduced-traction situations, the ATC solenoid valve controls air pressure to the modulator valves and they in turn increase, hold, or reduce pressure to the appropriate brake chambers to provide better traction whenever wheel spin occurs.

When the ATC system is in the NORMAL mode, it will apply gentle braking to the spinning wheel, to improve power to the wheel(s) with better traction. If both wheels are spinning, the system will signal the engine to reduce power.

Hydraulic and Air Brake Systems

ATC may include a deep snow and mud option to increase available traction on extra soft surfaces like snow, mud, or gravel. If so equipped, a momentary contact rocker switch labeled ATC will be located on the dash. Pressing the switch will temporarily allow more wheel spin. The activation of the deep snow and mud option is indicated by a flashing WHEEL SPIN lamp. Pressing the switch again will cycle the system back to normal operation.

NOTICE

The deep snow and mud option is intended to be used under specific slippery conditions that require momentary increased wheel spin. Using this option for an extended period of time may damage the vehicle brake system.

After the ignition switch is turned on, the ABS indicator light and the WHEEL SPIN indicator light illuminate for about three seconds. After three seconds, the warning lights go out if all of the ABS components are working.

During vehicle operation, solid illumination of the ABS light indicates a problem with the vehicle ABS. Repair the ABS immediately to ensure full braking capability.

If equipped with ATC, an amber WHEEL SPIN indicator light illuminates if one of the drive wheels spins during acceleration. When the light illuminates, partially release the throttle pedal to stop the spinning wheel. 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.

NOTICE

Do not turn the differential lock switch on while the WHEEL SPIN indicator light is on. To do so could damage the rear axle.

Electronic Stability Control

Electronic Stability Control (ESC) automatically reduces engine power, applies the engine brake (if so equipped), and/or applies the brakes when the acceleration sensor detects that the vehicle is at risk of rolling over. In addition, ESC offers the added capability of complete directional stability (yaw control) in oversteer and understeer conditions to reduce the likelihood of drift-out. The system determines where

the driver is attempting to steer the vehicle and how much brake demand is required in order to more precisely control the vehicle in an emergency situation.

ESC works by constantly comparing the driver's intention with the vehicle's actual behavior. The system does this by monitoring systems such as wheel speed, steering angle, yaw rate, lateral acceleration, throttle position, and brake application. A central microcomputer analyzes the collected data and triggers a response to keep the vehicle on course when an unstable condition is detected.

The roll stability control system automatically reduces engine power, applies the engine brake (if so equipped), and/or applies the brakes when the acceleration sensor detects that the vehicle is at risk of rolling over. The control can intervene even before an advisory message is displayed.

When the system detects that the vehicle is at risk of oversteering or understeering, it applies individual wheel end brakes, activates the engine brake (if so equipped), and/or cuts engine power, depending on the severity. As a result, the driver has full control over the vehicle until the system detects a potential risk and intervenes accordingly. ESC operates automatically; the driver does not monitor or activate the system. When ESC activates, an indicator lamp illuminates on the instrument panel. See [Fig. 10.3](#) for the indicator lamp used on the ICU3 instrument panel and [Fig. 10.4](#) for the indicator lamp used on the Ametek instrument panel.



Fig. 10.3, ESC Indicator Lamp, ICU3 Panel



Fig. 10.4, ESC Indicator Lamp, Ametek Panel

Exhaust Brake

General Information

An exhaust brake is an optional auxiliary braking system that assists, but does not replace, the service brake system. The driver can use the exhaust brake, in combination with the accelerator and clutch pedal (if so equipped), to make maximum use of the exhaust brake in off-highway and mountain driving as well as in traffic or high-speed highway driving.

The exhaust brake is controlled by a dash-mounted rocker switch, shown in **Fig. 10.5**, to help slow the vehicle when the accelerator is released.

To turn the exhaust brake on, press on the upper part of the rocker switch. When the exhaust brake switch is on, an amber light emitting diode (LED) illuminates inside the switch. When the panel lights are on, the EXHST BRK legend is backlit in green.

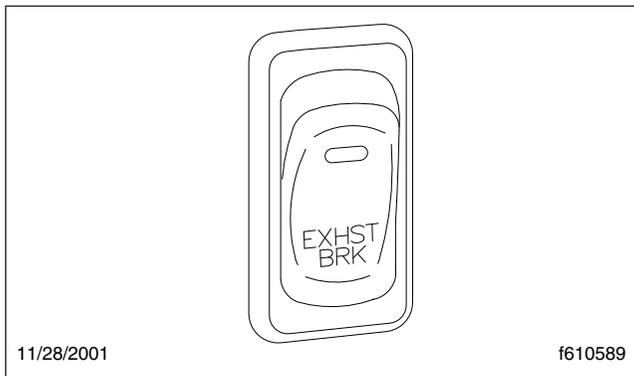


Fig. 10.5, Exhaust Brake Switch

The exhaust brake is only active when engine speed is between 1100 and 2700 rpm. Depressing the accelerator 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 foot from the accelerator, and the upper half of the exhaust brake switch is pressed in with the amber LED 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 as 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, the driver 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,

Hydraulic and Air Brake Systems

with the amber LED 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 switch is turned off before shutting down the engine.

Brake Burnishing (new vehicle)

IMPORTANT: Check the brake system and ensure that it is in proper operating condition before attempting the brake burnishing procedure.

1. In a safe area, make 10 sharp brake applications or "snubs," slowing the vehicle from 40 to 20 mph (64 to 32 km/h) using light (approximately 10 to 20 psi [69 to 138 kPa]) brake pressure.
2. Make 10 stops from 20 mph (32 km/h) using moderate (20 to 30 psi [138 to 207 kPa]) brake pressure.
3. Make 2 stops from 20 mph (32 km/h) using hard (full application of air pressure) brake applications.

NOTE: After the hard brake applications, it is normal to notice a hot brake odor.

4. Drive the vehicle 5 to 7 miles (8 to 11 km) allowing the brakes to cool, and then come to a stop.

NOTE: After performing the burnishing procedure, there should be no brake noise and the brakes should have good stopping ability.

5. If the brakes pull the vehicle to one side or grab after the burnishing procedure, contact a Freightliner dealer for assistance.

Pre- and Post-Trip Checklists

Pretrip and Post-Trip Inspection General Information	11.1
Daily Pretrip Inspection and Maintenance Checklist	11.2
Weekly Post-Trip Inspection and Maintenance Checklist	11.2
Monthly Post-Trip Inspection and Maintenance Checklist	11.3

Pre- and Post-Trip Checklists

Pretrip and Post-Trip Inspection General Information

Regulations in Canada and the U.S. clearly indicate that it is the driver's responsibility to perform an inspection, and ensure the complete road-worthiness of a vehicle, before placing it into service. Commercial vehicles may be subject to inspection by authorized inspectors, and an unsafe vehicle can be taken out of service until the driver or owner repairs it.

Use the following checklists to ensure that vehicle components are in good working condition before each trip. Careful inspections eliminate stops later to fix overlooked or forgotten items.

Numbers within each of the checklists reference the corresponding detailed instructions found under the daily, weekly, or monthly inspection and maintenance 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 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.

Pre- and Post-Trip Checklists

Daily Pretrip Inspection and Maintenance Checklist

See [Table 11.1](#) for a checklist of the procedures that should be performed daily, before the first trip.

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
_____	drain manually drained air reservoirs (that are not equipped with automatic drain valves)	1
Check _____	surge tank coolant level	2
Inspect _____	radiator and charge air cooler	3
Inspect _____	engine for fuel, oil, or coolant leaks	4
Check _____	intake-air restriction indicator and air intake system	5
Check _____	engine oil level	6
Check _____	automatic transmission fluid level, if equipped	7
Check _____	fuel/water separator, if equipped	8
Inspect _____	fuel tank(s), fuel lines, and connections	9
Check _____	fuel level	10
Check _____	clean diesel engine fuel cap vent area	10
Check _____	front and rear suspension components	11
Check _____	reset dash-mounted air intake restriction indicator	12
Check _____	air-pressure warning system	13
Check _____	horn	14
Check _____	backup alarm, if equipped	–
Check _____	exterior lights	15
Inspect _____	air brake chambers and pushrods	16
Inspect _____	slack adjusters	17
Check _____	tire pressure	18
Inspect _____	tire condition	19
Check _____	rims and wheels	20
Check _____	air brake system	21
Check _____	parking brake	22
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 , if equipped	23
Inspect _____	engine and chassis wiring	24
Inspector _____ Date _____		

Table 11.1, Daily Pretrip Inspection and Maintenance Checklist

Weekly Post-Trip Inspection and Maintenance Checklist

See [Table 11.2](#) for a checklist of the procedures that should be performed weekly, post-trip.

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

Pre- and Post-Trip Checklists

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	1
Check _____	wheel bearing lubricant level	2
Inspect _____	steering components	3
Check _____	drive belt conditions	4
Check _____	air restriction indicator	5
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

See [Table 11.3](#) for a checklist of the procedures that should be performed monthly, post-trip.

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.

Procedure Performed (check off)	Monthly Post-Trip Inspections/Checks	Procedure Reference
_____	clean the battery terminals	1
Check _____	fluid level in the hydraulic brake reservoir, if equipped	2
Check _____	steering wheel play	3
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	4
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	5
_____	clean the bus undercarriage	6
Inspector _____ Date _____		

Table 11.3, Monthly Post-Trip Inspection and Maintenance Checklist

12

Pre- and Post-Trip Inspections and Maintenance

Safety Precautions	12.1
Daily Pretrip Inspection and Maintenance Procedures	12.1
Weekly Post-Trip Inspection and Maintenance Procedures	12.9
Monthly Post-Trip Inspection and Maintenance Procedures	12.10

Pre- and Post-Trip Inspections and Maintenance

Safety Precautions

! DANGER

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

Daily Pretrip Inspection and Maintenance Procedures

IMPORTANT: If any system or component does not pass this inspection, it must be corrected before operating the vehicle. Whenever equipment requires adjustment, replacement, and/or repair, see the *Saf-T-Liner C2 School Bus Workshop Manual* for procedures and specifications.

Complete the following inspection and maintenance procedures to ensure that vehicle components are in good working condition before each trip. A driver who 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 daily, weekly, and monthly inspection and maintenance procedures should be performed before the trip.

IMPORTANT: The pre- and post-trip checklists, inspections, and maintenance procedures detailed in this chapter are **not all-inclusive**. Refer to other component and body manufacturers' instructions for specific inspection and maintenance instructions, as well as local, state, and federal guidelines.

1. Drain the brake system air reservoirs (reservoirs without automatic drain valves only).

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 bottom of the remaining air reservoirs. Block the valves open.

NOTICE

Coolant must be filled to the COLD MAX line of the surge tank. Low coolant could result in engine overheating, which could cause engine damage.

2. Check the engine coolant level in the radiator surge tank.

See [Fig. 12.1](#). If the coolant is low, add a 50/50 mixture of water and antifreeze. Refer to the engine manufacturer's service literature for approved coolants. Fill the surge tank with coolant to the COLD MAX line when the tank is cool. If the surge tank was empty, start the engine after refilling and check the level again when the engine is at operating temperature.

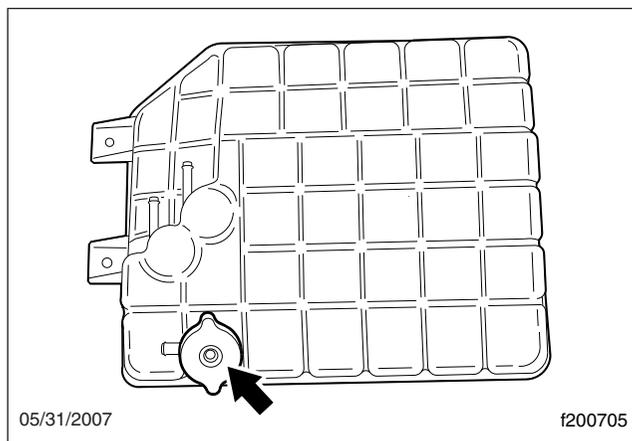


Fig. 12.1, Surge Tank Fill Cap

3. Inspect the radiator and charge air cooler, including the radiator and heater hoses, clamps and support brackets.

Pre- and Post-Trip Inspections and Maintenance

- 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 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. See **Group 20** of the *Saf-T-Liner C2 School Bus Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer for assistance.
- 3.5 Make sure the radiator inlet and outlet hoses are pliable and are not cracking or ballooning.
- 3.6 Make sure the heater hoses are pliable and are not cracking or ballooning.
- 3.7 Tighten hose clamps as necessary.

IMPORTANT: Do not overtighten hose clamps, as hose life can be adversely affected.

- 3.8 Ensure hose support brackets are securely fastened. Make sure hoses are not located near sources of wear, abrasion, or high heat.

IMPORTANT: When replacing hoses, install service-type knitted or braided yarn-reinforced neoprene hose. Extended-service-life silicone hoses may also be used. See the Alliance Parts Catalog at www.alliance-brandparts.com or contact a Freightliner dealer.

4. *Check the ground underneath the engine for fuel, oil, or coolant leaks. Correct any leaks found.*
5. *Inspect the air intake system for leaks or damage.*

NOTICE

Failure to maintain a sealed air intake system could allow the entry of dirt and contaminants into the engine. This could adversely affect engine performance and result in engine damage.

- 5.1 Push the reset button on the air intake restriction indicator located on the air cleaner, if equipped.
- 5.2 Check the air intake duct from the air cleaner to the engine intake. Make sure the duct components are secure and airtight.

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.

IMPORTANT: On engines that comply with EPA07 or newer regulations, use CJ-4 engine oil with less than 1% sulfated ash. Failure to use CJ-4 oil may void the warranty on emission aftertreatment components.

6. *Check the engine oil level.*

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.

- 6.1 Park the vehicle on a level surface. Allow several minutes for the oil to drain back into the oil pan to ensure an accurate reading.

NOTE: For diesel engines, follow the engine manufacturer's guidelines for engine shut-down time requirements prior to checking the oil level.

- 6.2 Pull out the dipstick and clean it with a paper towel or cloth, then push the dipstick back in all the way. Remove it again, keeping the tip down, and check the oil level.

Pre- and Post-Trip Inspections and Maintenance

- 6.3 If the oil is below the cross-hatched area, or the add mark, at the tip of the dipstick, add at least one quart (liter) of the recommended oil. See [Fig. 12.2](#) for diesel engines and [Fig. 12.3](#) for propane engines.

For diesel engines that comply with EPA07 or newer regulations, use CJ-4 engine oil with less than 1% sulfated ash.

For liquid propane gas (LPG) engines, use SAE 5W-30 oil that meets GM standard GM6094M and has the American Petroleum Institute (API) symbol. **Do not use** SAE 10W-40 or 20W-50.

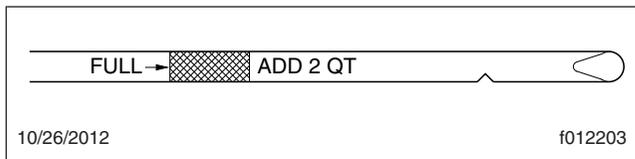


Fig. 12.2, Oil Dipstick (diesel engine)

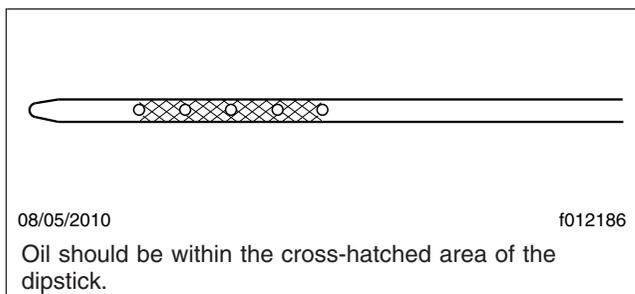


Fig. 12.3, Oil Dipstick (propane engine)

NOTICE

Failure to use the recommended oil can result in engine or aftertreatment component damage and will void the warranty.

7. If the vehicle is equipped with an automatic transmission, check the automatic transmission fluid level.

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

- 7.1 Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.
- 7.2 With the parking brake applied, shift to Neutral (N). Let the engine run at idle.

- 7.3 Wipe the dipstick clean and check the fluid level. A safe operating level is any level within the HOT-run (upper) band on the dipstick. See [Fig. 12.4](#).
- 7.4 If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT-run band.

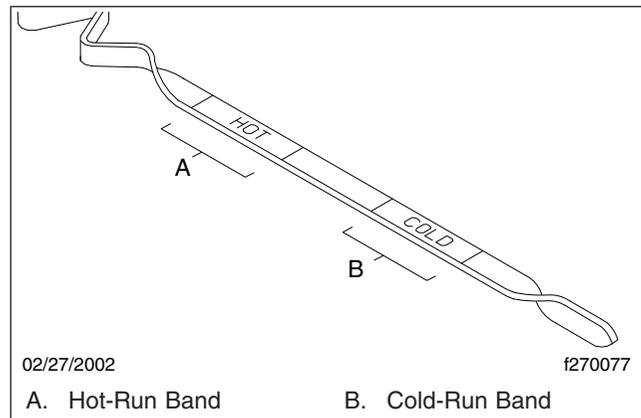


Fig. 12.4, Automatic Transmission Dipstick Markings

8. Check for water in the fuel/water separator, if equipped.

IMPORTANT: When draining fluid from a fuel/water separator, drain the fluid into an appropriate container and dispose of it properly. Many jurisdictions now issue fines for draining fuel/water separators onto the ground.

- 8.1 Place a suitable container under the fuel/water separator.

NOTE: A hose may be used to direct water into the container. Use a hose with a 1/2-inch pipe thread on DAVCO models.

- 8.2 If the engine is equipped with a built-in water separator, loosen the drain valve, and allow the water to run out. Close the drain valve, taking care not to overtighten it.
- 8.3 *Alliance/Racor Models:* Turn the drain plug counterclockwise to open it. See [Fig. 12.5](#).
DAVCO Models: Remove the vent cap and open the drain. See [Fig. 12.6](#).
- 8.4 Stop draining fluid when fuel begins to drain out.

Pre- and Post-Trip Inspections and Maintenance

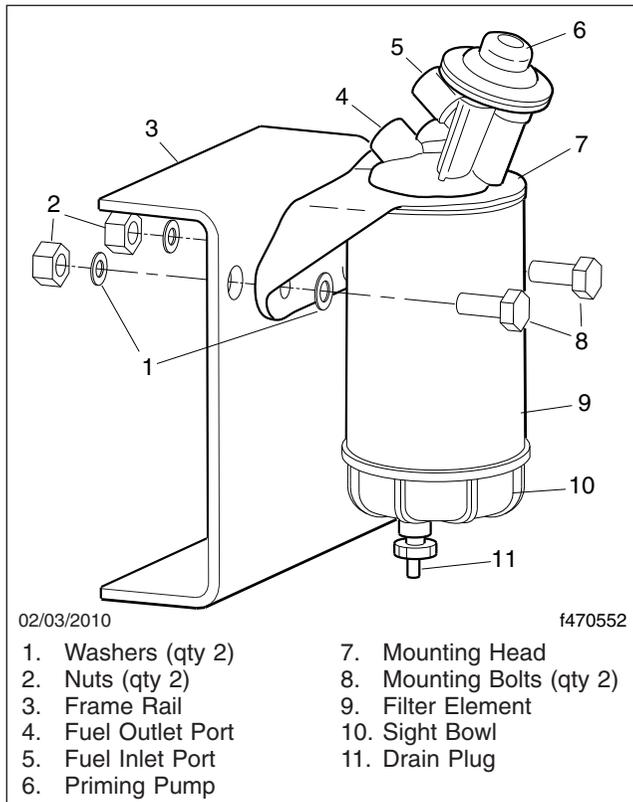


Fig. 12.5, Alliance Fuel/Water Separator Assembly and Installation

Alliance/Racor Models: Turn the drain plug clockwise to close it.

DAVCO Models: Close the drain valve. Install and hand-tighten the vent cap.

9. *Inspect the fuel tanks, fuel lines, and connections.*
 - 9.1 Ensure 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.

WARNING

Never operate the engine with the fuel tank shut-off 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.

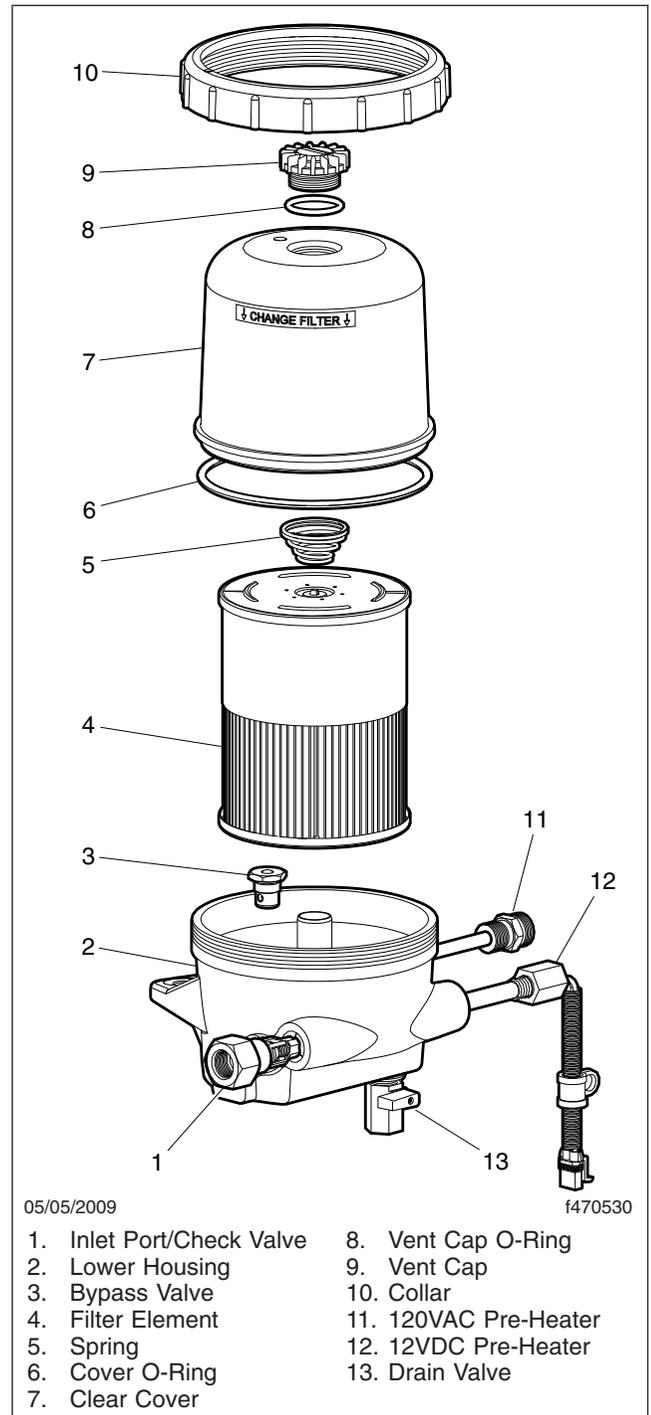


Fig. 12.6, DAVCO Fuel/Water Separator (Fuel Pro 482 shown)

- 9.4 If equipped with fuel tank shutoff valves, be sure the valves are fully open.

Pre- and Post-Trip Inspections and Maintenance

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.

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.

IMPORTANT: On engines that comply with EPA07 or newer regulations, use ultralow-sulfur diesel (ULSD) with 15 ppm sulfur content or less. Failure to use ULSD fuel may void the warranty on emission components.

10. Check the fuel level in the fuel tank(s). To keep condensation to a minimum, fuel tanks should be filled at the end of each day.

On vehicles equipped with a diesel engine, be sure that the fuel cap vent area is clean.

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. Push the reset button on the dash-mounted air intake restriction indicator, if equipped.
13. With the ignition switch in the OFF position, check the air-pressure warning system.
 - 13.1 If not previously drained, drain the air reservoirs using moderate brake applications until pressure in both reservoirs is less than 70 psi (483 kPa).
 - 13.2 Turn the ignition switch to the ON/RUN position. The ICU will complete a full gauge sweep and bulb check, and an audible warning will sound. Ensure the low air pressure lamp (BRAKE AIR) remains illuminated and an audible warning continues to sound after the gauge sweep is complete.
14. Make sure that the electric horn works.
15. Make sure all the exterior lights are working.

All exterior lights should be checked for proper operation. Clean the windshield, side, and rear windows (if equipped) with a long-handled or telescoping window cleaning device and standard cleaning solutions.

IMPORTANT: Stand only on the ground, on a stepladder, 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.

- 15.1 Turn the ignition switch to the ACCESSORY or ON/RUN position.
- 15.2 Make certain the service brake is not applied and the parking brake is set.
- 15.3 Press the pretrip inspection switch on the dash, shown in [Fig. 12.7](#), to begin the pretrip light inspection.

The instrument cluster will beep rapidly for five seconds, and then begin a 10-second countdown, followed by a 2-second beep. The 10-second countdown period allows

Pre- and Post-Trip Inspections and Maintenance

the operator to exit the bus before the pre-trip light inspection begins. After the 2-second beep, the following exterior lights will flash simultaneously:

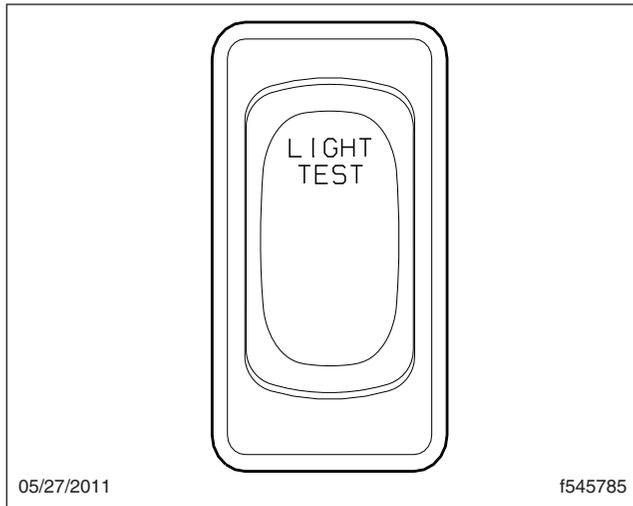


Fig. 12.7, Pretrip Light Inspection Switch

- amber warning lights (front and rear)
- red warning lights (front and rear)
- stop arm
- park lights (all)
- turn signals
- left and right headlights (low- and high-beam)
- crossing arm (may partially retract during flashing-off period)
- taillights
- brake lights
- back-up lights

15.4 The pretrip light inspection can be stopped by:

- turning the ignition switch to the OFF position;
- applying the service brake;
- releasing the parking brake.

16. *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. 12.8. 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*.

17. *Visually inspect slack adjuster components.*

Inspect the slack adjuster boot for cuts or tears. If the boot is damaged, have it replaced. See Fig. 12.9.

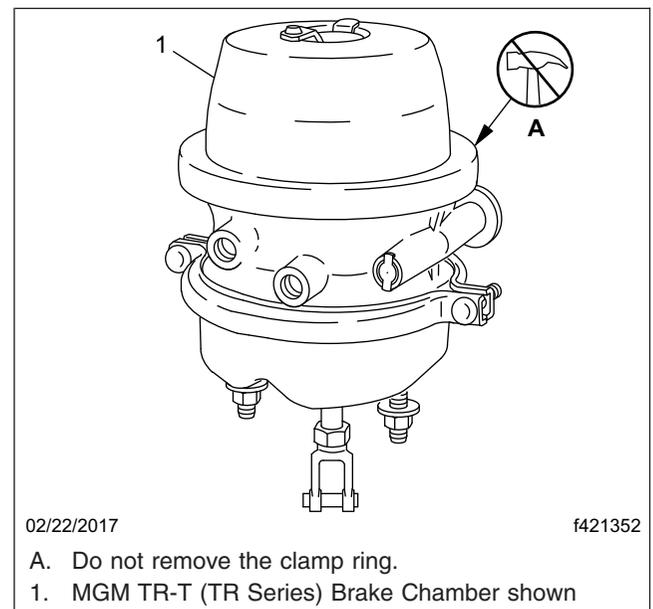


Fig. 12.8, Parking Brake Chamber Clamp

18. *Check tire inflation pressures.*

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

Pre- and Post-Trip Inspections and Maintenance

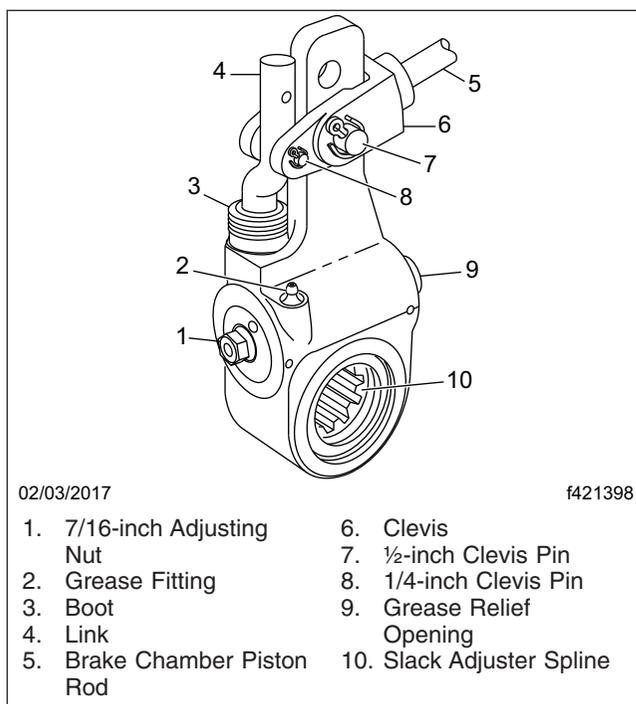


Fig. 12.9, Automatic Slack Adjuster (typical)

failure and loss of vehicle control, resulting in serious personal injury or death.

- 18.1 If a tire has been run flat or underinflated, check for possible wheel or tire damage before adding air.

Keep compressed air reservoirs and lines dry during tire inflation. Use well-maintained inline moisture traps and service them regularly.

NOTICE

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 by a qualified tire service facility.

- 18.2 Inflate the tires to the applicable pressures if needed.

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.

- 18.3 Be sure valve stem caps are on every tire and that they are screwed on finger-tight.

IMPORTANT: Low-rolling resistance (LRR) tires minimize wasted energy as a tire rolls, thereby decreasing rolling effort and improving fuel efficiency. If tire replacement is necessary, replacement tires must meet or exceed the rolling resistance of the originally installed tires in order to maintain compliance with greenhouse gas and fuel efficiency regulations (GHG14).

Contact your tire manufacturer/supplier to determine the rolling resistance of the originally installed tires. Visit www.epa.gov/smartway for additional information and resources.

19. *Inspect the condition of all tires.*

- 19.1 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.
- 19.2 Inspect each tire for bulges, cracks, cuts, and penetrations.
- 19.3 Inspect each tire for oil contamination (petroleum derivatives will soften the rubber and destroy the tire).

20. *Check the wheel nuts for indications of looseness. Examine each wheel component.*

- 20.1 Remove all dirt and debris from the assembly. Rust streaks or metal build-up around stud holes, or out-of-round or worn stud holes, may be caused by loose wheel nuts.
- 20.2 Examine the wheel components (including studs and nuts) for cracks or other damage.

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

Pre- and Post-Trip Inspections and Maintenance

occur, possibly resulting in serious personal injury or death.

NOTICE

Use the recommended torque values and follow the proper tightening sequence. Insufficient wheel nut torque can cause wheel shimmy, resulting in wheel damage, stud breakage, and extreme tire tread wear. Excessive wheel nut torque can break studs, damage threads, and crack discs in the stud hole area.

- 20.3 Make sure all wheel nuts are tightened. If tightening is necessary, use the tightening pattern in [Fig. 12.10](#) for 10-stud disc wheels and [Fig. 12.11](#) for 8-stud disc wheels to initially tighten the flange nuts to 50 to 100 lbf-ft (68 to 136 N-m). Then tighten the flange nuts to 450 to 500 lbf-ft (610 to 678 N-m).

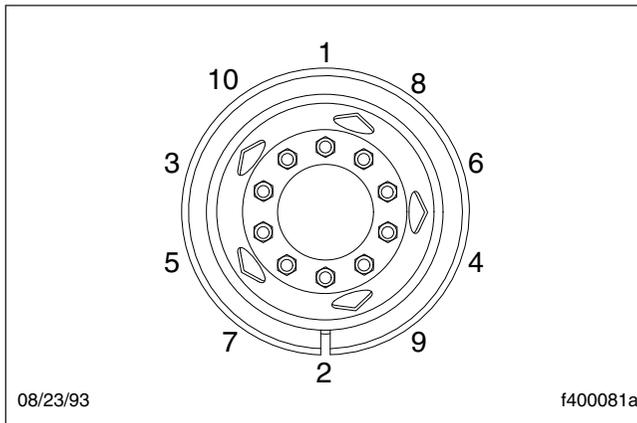


Fig. 12.10, Tightening Pattern, 10-Stud Disc Wheels

NOTE: Vehicles operating under severe or adverse conditions should be checked more frequently.

21. Check the air brake system for proper operation.

- 21.1 Check the air governor cut-in and cut-out pressures. Start the engine and ensure the BRAKE AIR lamp goes out and the buzzer silences when pressure reaches approximately 70 psi (483 kPa) in both air reservoirs. The air governor should cut out at approximately 120 psi (827 kPa). For vehicles with an optional dryer reservoir module (DRM), the cut-out pressure is approximately 130 psi (896 kPa).

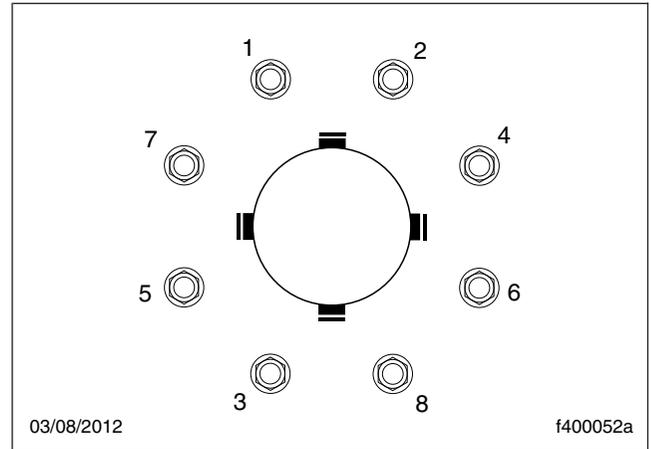


Fig. 12.11, Tightening Pattern, 8-Stud Disc Wheels

With the engine idling, apply the brake pedal several times. The air governor should cut in when pressure in the primary air reservoir (top air gauge) reaches approximately 100 psi (690 kPa).

21.2 Check the air pressure buildup time.

With the air system fully charged, make one full brake application and note the air pressure reading on the primary air gauge. Further reduce air pressure using moderate brake applications, then run the engine at governed rpm. Note the time that the pressure reaches the previously noted reading on the primary air gauge, then note the time that the air pressure reaches cut-out pressure.

If it takes longer than 30 seconds to reach cut-out pressure after the primary air gauge passes the previously noted pressure (noted after one full brake application), eliminate any leaks or replace the air compressor before operating the vehicle.

21.3 Check the air pressure reserve.

With the engine still off, make one full brake application and observe the pressure drop on the primary air gauge. If pressure drops more than 25 psi (172 kPa), eliminate any leaks before operating the vehicle.

21.4 Check the air leakage in the system.

With the parking brake applied, the transmission out of gear, and the air system fully charged, release the service brakes

Pre- and Post-Trip Inspections and Maintenance

and shut down the engine. Wait one minute and note the air pressure drop in psi (kPa) per minute from the primary air reservoir.

If leakage exceeds the limits shown in [Table 12.1](#), 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 12.1, Maximum Allowable Service Brake Leakage

22. Test the parking brake on a 20 percent grade.

Apply the hand brake with the vehicle on a 20 percent grade (or a steep grade that the vehicle may normally be parked on). If the parking brake does not hold the vehicle, repair the parking brake system.

23. Inspect the operation of the Hydro-Max® brake booster, as follows.

23.1 With the engine off, depress the brake pedal. The warning light and buzzer should come on, and the electric motor should run.

23.2 Start the engine and allow the gauges to sweep. Depress the brake pedal. No warning lights, buzzer, or electric motor should come on.

24. 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 clamps.

Weekly Post-Trip Inspection and Maintenance Procedures

1. Inspect the batteries and battery cables.



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. Inspect the outboard side of all wheel hubs and the hub oil seal area on the inboard side of each wheel for signs of oil leakage.

If any oil is found on wheel and tire or brake components, remove the vehicle from service until the leak has been fixed.

If needed, fill the hubs to the level indicated on the hub cap.

IMPORTANT: Before removing the fill plug, always clean the hub cap and plug.

3. Inspect the steering components.

3.1 Inspect tie rods, steering arms, and the drag link for signs of looseness (i.e., shiny spots or rust tracks). See [Fig. 12.12](#).

3.2 Check the steering gear mounting bolts and pitman arm nut, if equipped, for signs of looseness.

3.3 Check the drag link nuts for missing cotter pins.

3.4 Inspect the steering intermediate shaft and end yokes for excessive looseness or other damage.

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 it.

5. After resetting the air intake restriction indicator during the daily pretrip inspection, check the indicator again with the engine off.

5.1 Check an indicator with graduations to see

Pre- and Post-Trip Inspections and Maintenance

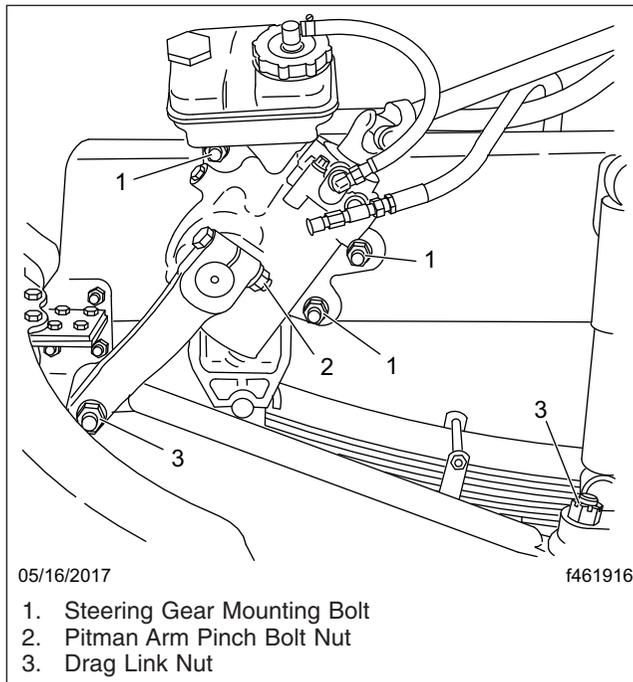


Fig. 12.12, Steering Gear Fasteners

if air restriction exceeds 25 inH₂O.

Check a go/no-go indicator without graduations to see if the colored bar shows through the clear window.

- 5.2 If air restriction exceeds the maximum allowable value, operate the vehicle for one more day, making sure not to run the engine over rated rpm. Refer to the engine operation manual for more information on rated rpm for your engine.
- 5.3 If air restriction exceeds the maximum value again, replace the air cleaner. For instructions, refer to **Group 09** of the *Saf-T-Liner C2 School Bus 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 per-

sonal 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. *Check the fluid level in the hydraulic brake reservoir, if equipped.*

If needed, fill the reservoir to the bottom of the fill-neck with DOT 3 heavy-duty brake fluid. See [Fig. 12.13](#).
 3. *Check the steering wheel for excessive play.*
 - 3.1 Start the engine. With the front tires straight ahead, turn the steering wheel until motion is observed at the front wheels.
 - 3.2 Align a reference mark on the steering wheel to a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels. See [Fig. 12.14](#).
 - 3.3 Measure the lash (free play) at the rim of the steering wheel. Excessive lash exists if steering wheel movement exceeds 2-1/2 inches (64 mm) with a 20-inch (508-mm) steering wheel, or 2-1/4 inches (57 mm) with an 18-inch (457-mm) steering wheel.
 - 3.4 If there is excessive lash, check the steering system for wear or incorrect adjustment before operating the vehicle.
 4. *Check the brake lining wear on vehicles equipped with air brakes.*

Pre- and Post-Trip Inspections and Maintenance

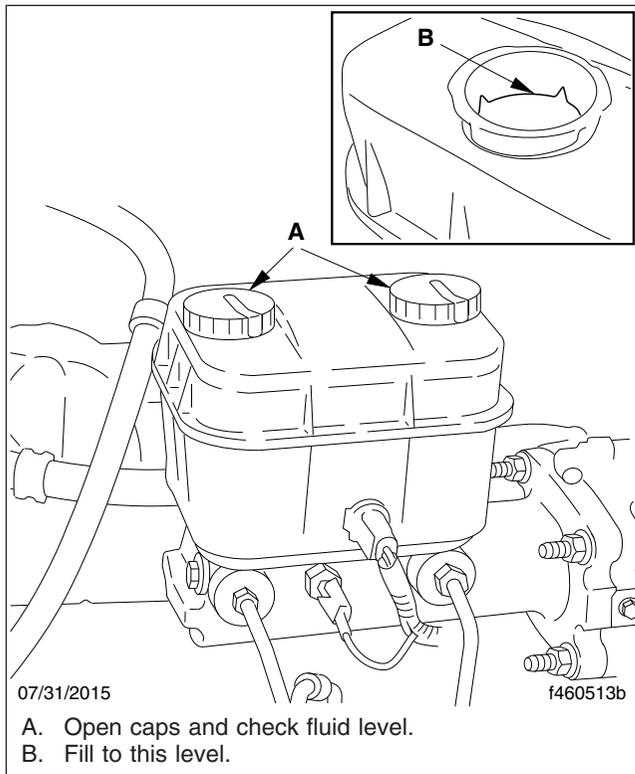


Fig. 12.13, Hydraulic Brake Reservoir

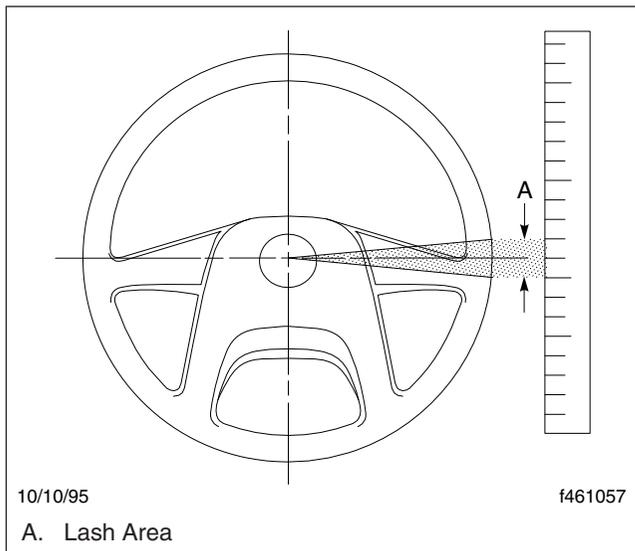


Fig. 12.14, Measuring Lash at the Steering Wheel

Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.

- 4.1 Apply the parking brakes, and chock the tires to prevent vehicle movement.

- 4.2 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.
- 4.3 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.
- 4.4 Install the inspection plugs in the dust shields or backing plates, if so equipped.

NOTE: The number and location of body mounting bolts and clips vary, depending on the options and wheelbase of each vehicle.

5. 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.

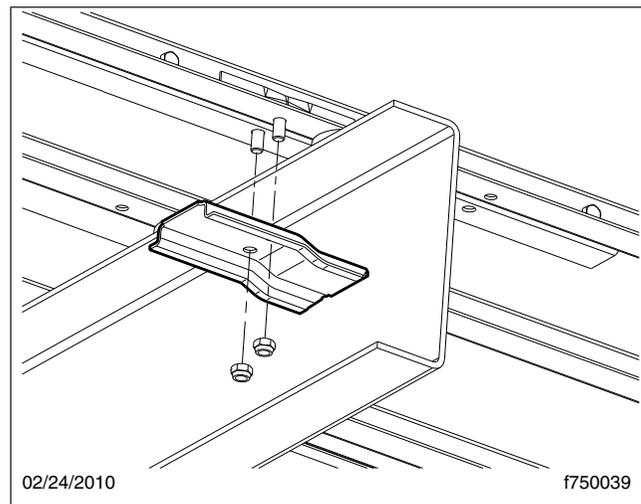


Fig. 12.15, Body Mounting Bolts and Clip (number and location vary)

NOTICE

When cleaning areas containing electrical components and connections, take care to protect these items from water intrusion. When using a

Pre- and Post-Trip Inspections and Maintenance

pressure washer to clean these areas, use the lowest possible pressure setting.

6. *Clean the undercarriage of the bus.*

Salt and de-icing material used on road surfaces in winter months deteriorates the metal of the vehicle. Use a high-pressure washer at the lowest setting to clean the undercarriage of the bus.

If corrosion or separation of the undercoat to body floor is visible, apply additional undercoating.

13

Cleaning and Care

Washing and Polishing	13.1
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Care of Chrome Parts	13.1
Dashboard and Instrument Panel Care	13.1
Vinyl Upholstery Cleaning	13.1
Floor Cleaning	13.2

Cleaning and Care

Washing and Polishing

To protect the new vehicle's finish, follow these guidelines carefully:

- During the first 30 days, rinse the 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 the vehicle. Brushes, chemicals, and cleaners may scratch the finish.
- During the first 120 days, do not wax the vehicle.

To extend the life of the vehicle's finish, follow these guidelines:

- Avoid washing the 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, remove oxidized paint using a cleaner specifically designed for this purpose before waxing. Remove all road tar and tree sap before waxing. Freightliner recommends the use of a high 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 the 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 and Instrument Panel Care

NOTICE

When cleaning the dashboard, instrument panel, or gauge lens covers, do not use Armor-All Protectant®, STP Son-of-a-Gun®, window cleaner, or other equivalent treatments. These cleaners contain vinyl plasticizers which can cause stress crazing in the interior plastic panels and can result in cracking of the panels. Some cleaners can also have an adverse effect on the clear plastic of instrument panels and gauge lens covers, resulting in a foggy or cloudy appearance. This type of damage is not covered by vehicle warranty.

To clean the dashboard, instrument panel, and gauge lens covers, use a cloth dampened with warm soapy water. Make certain to wring the cloth out well before cleaning, as excess water will damage the electrical components.

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 and 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 cloth dampened with 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.

Floor Cleaning

Dirt and other abrasive material that accumulates on the floor will shorten the life of the floor covering. Daily sweeping and cleaning should be performed to maintain the floor covering. **Do not** use any floor sweeping cleaner or solvent, as they may cause the floor covering to separate and lift from the floor. Begin at the front of the vehicle and sweep toward the rear and side emergency door(s). This will ensure a check of the emergency door's operation, as well as the removal of items that could keep the emergency door from sealing properly.

Oil and grease deteriorate the floor covering quickly and should be removed as soon as possible. **Do not** use harsh detergents or excessive amounts of water to remove these items. Instead, mop with a mild soap solution and remove any excess water.

To maintain the floor covering appearance, occasionally wax it with a non-skid floor wax.

Over time, the floor covering may appear dull. If this should occur, mop the floor with a 10% bleach to 90% water solution.

14

In an Emergency

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In an Emergency

Hazard Warning Lights

The hazard warning light switch is part of the multi-function turn signal switch. It is a red rocker switch located on the top of the multifunction switch module. See [Fig. 14.1](#).

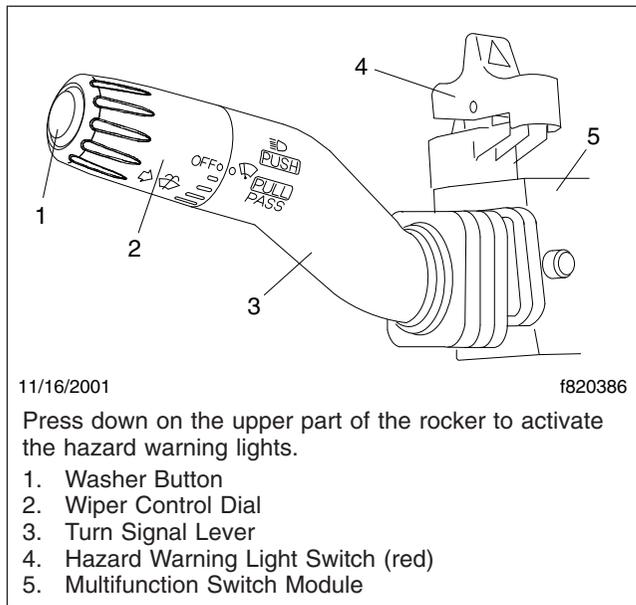


Fig. 14.1, Multifunction Turn Signal Switch

To activate the hazard warning lights, press down on the upper part of the rocker switch (towards the dash). To cancel the hazard warning lights, press down on the lower part of the rocker switch (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

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, and 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.

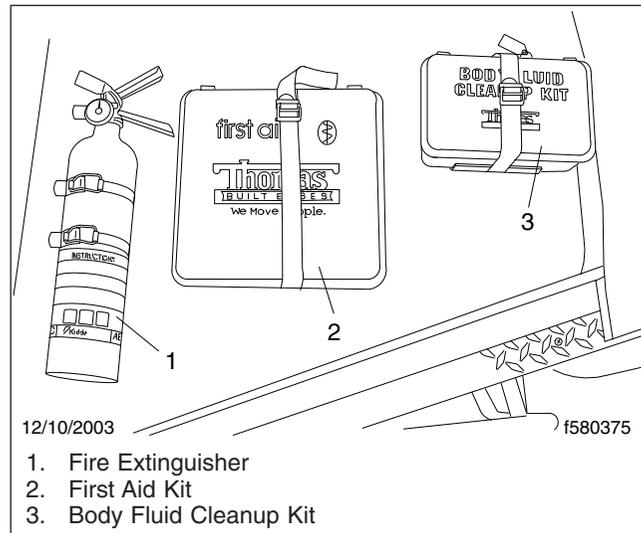


Fig. 14.2, Emergency Equipment

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

NOTE: Jumpstarting vehicles equipped with the Eaton® Hybrid System is identical to non-hybrid vehicles, which use the vehicle 12-volt battery system.

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 that both starting systems are the same voltage. Electronic devices on both vehicles can be damaged when connected to a vehicle with a different operating voltage.

1. Apply the parking brakes and turn off all lights and other electrical devices.

IMPORTANT: Do not attempt to jump start a damaged battery.

2. Open the battery door to access the batteries. Pull both pull-pin spring latches and slide the battery tray out. See [Fig. 14.3](#).

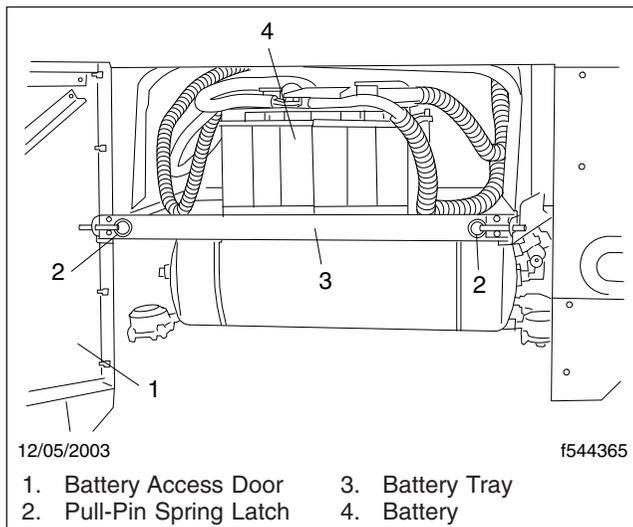


Fig. 14.3, Battery Access

NOTICE

Always connect the batteries and jumper cables correctly (positive-to-positive and negative-to-negative). Connecting a charging device backwards (positive-to-negative) can severely damage the vehicle electrical content and cause non-warrantable failures.

3. Connect the positive (+) jumper cable to the positive terminal on the discharged battery. See [Fig. 14.4](#).
4. Connect the other end of the positive jumper cable to the positive terminal on the booster battery providing the charge.

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 or acid burns.

5. Connect the negative (-) jumper cable to the negative terminal on the booster battery.
6. Connect the other end of the negative jumper cable to the negative ground stud on the vehicle requiring the jump start.
7. Start the engine of the vehicle providing the jump start and let the engine run for a few minutes to charge the batteries of the other vehicle.

NOTICE

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

8. Attempt to start the engine of the vehicle with the batteries receiving the charge.
9. When the engine starts, let it idle for 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 or acid burns.

10. Disconnect the negative jumper cable from the negative cable stud on the jump started vehicle.
11. Disconnect the negative jumper cable from the booster battery.
12. Disconnect the positive cable from the booster battery.
13. Disconnect the other end of the positive jumper cable from the jump started vehicle.

In an Emergency

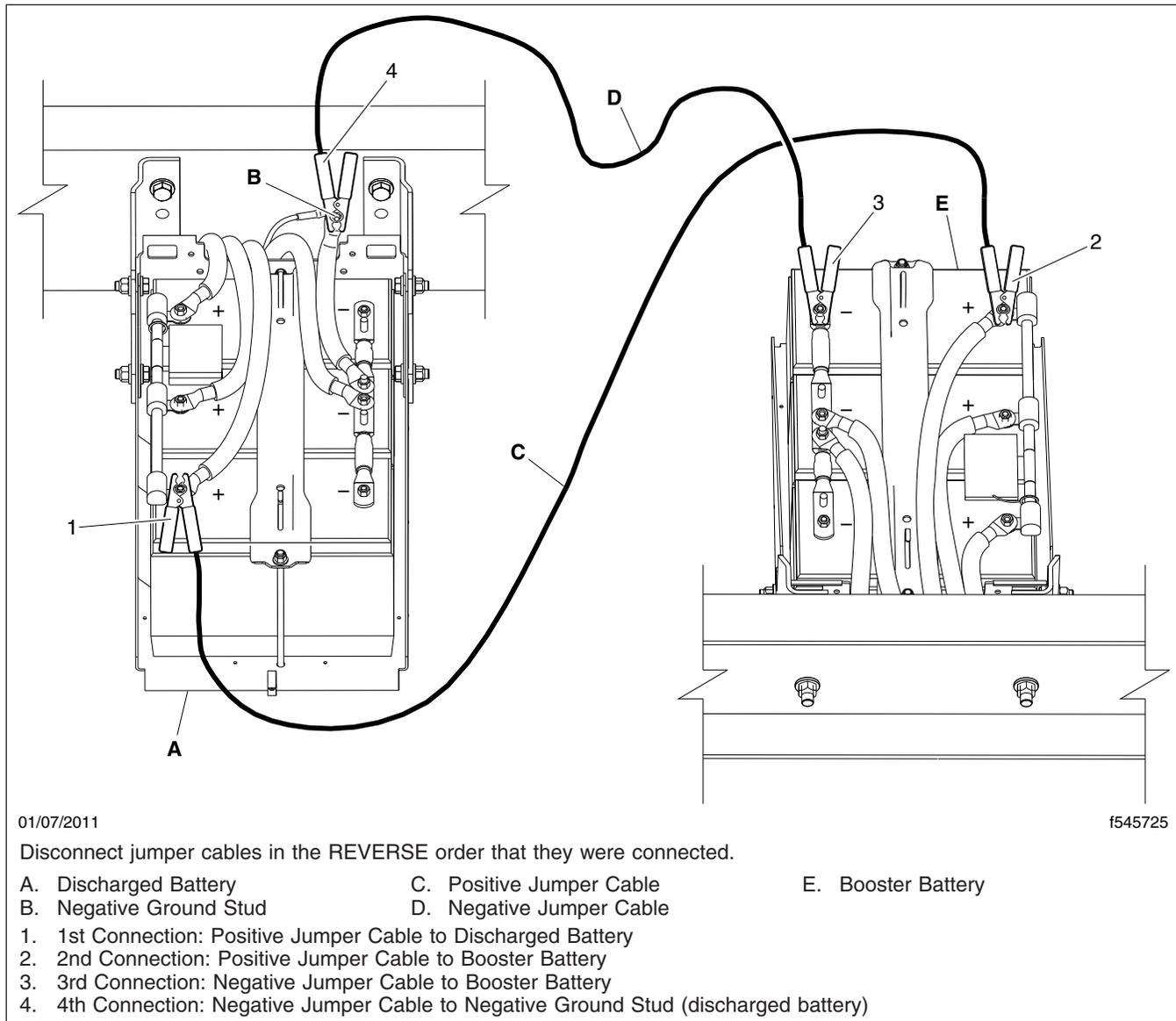


Fig. 14.4, Jumper Connections (three battery system shown for clarity)

14. Pull both pull-pin spring latches and slide the battery tray back into position. Release the pull-pin spring latches to lock the battery tray, then close the battery door.

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.

Towing



Do not tow an unbraked vehicle if the combined weight of both vehicles is more than the sum of

NOTICE

When towing or pushing the vehicle, regardless of the distance or speed traveled, either disconnect the driveshaft at the rear axle and support it as necessary, or remove the axle shafts. Failure to do this when towing the vehicle with the rear wheels on the ground could result in damage to the transmission and other parts.

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.
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

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.

In an Emergency

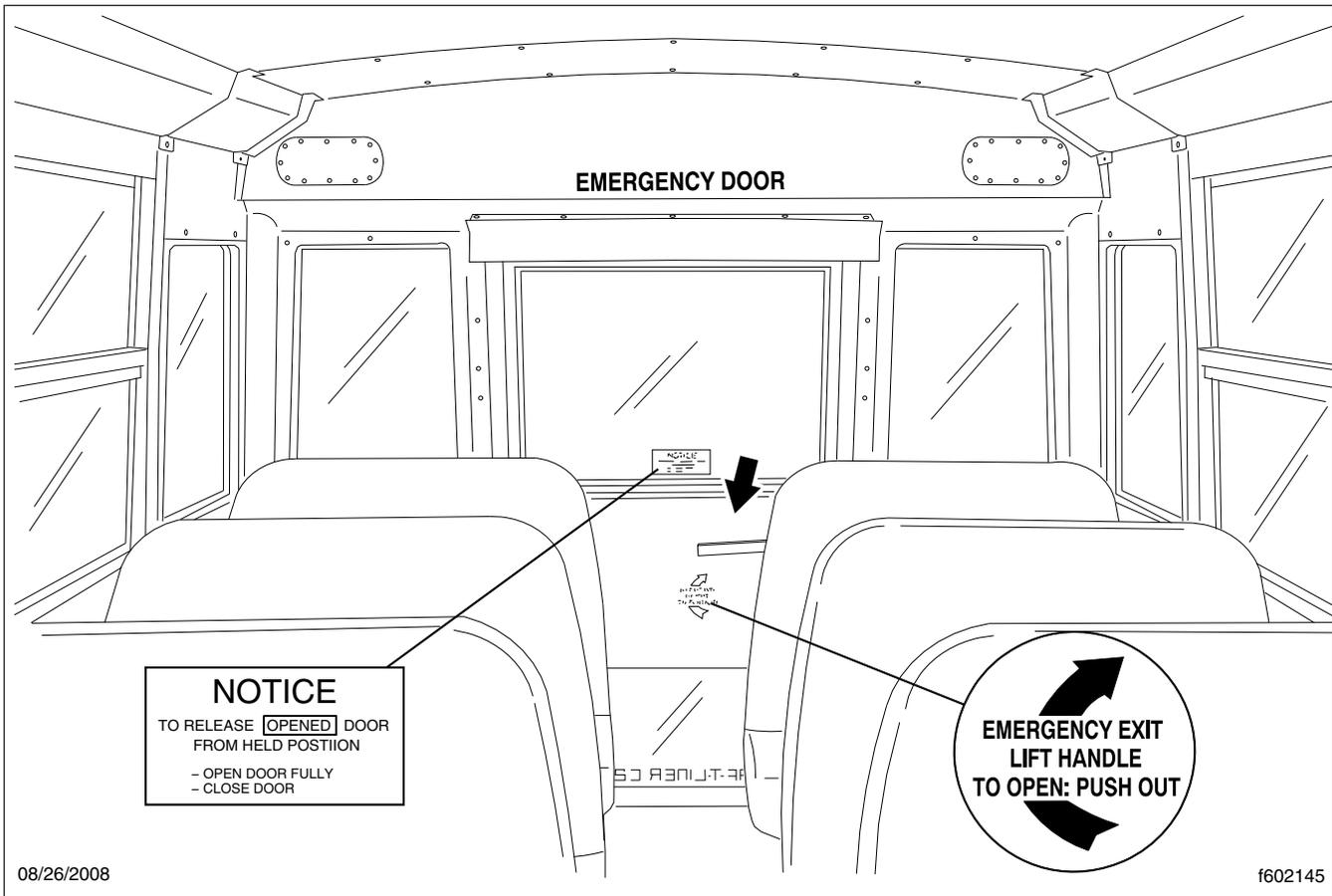


Fig. 14.5, Emergency Door

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 allow fuel to fill the fuel filter.

3. Prime the engine. See the engine manufacturer's manual for instructions to prime the fuel system. If further assistance is needed, call the Freightliner Customer Assistance Center at 1-800-385-4357 or 1-800-FTL-HELP.
4. Add fuel to the fuel tank.

If the vehicle is equipped with a propane engine, add at least 9 to 10 gallons (34 to 38 L) of liquid propane.

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.

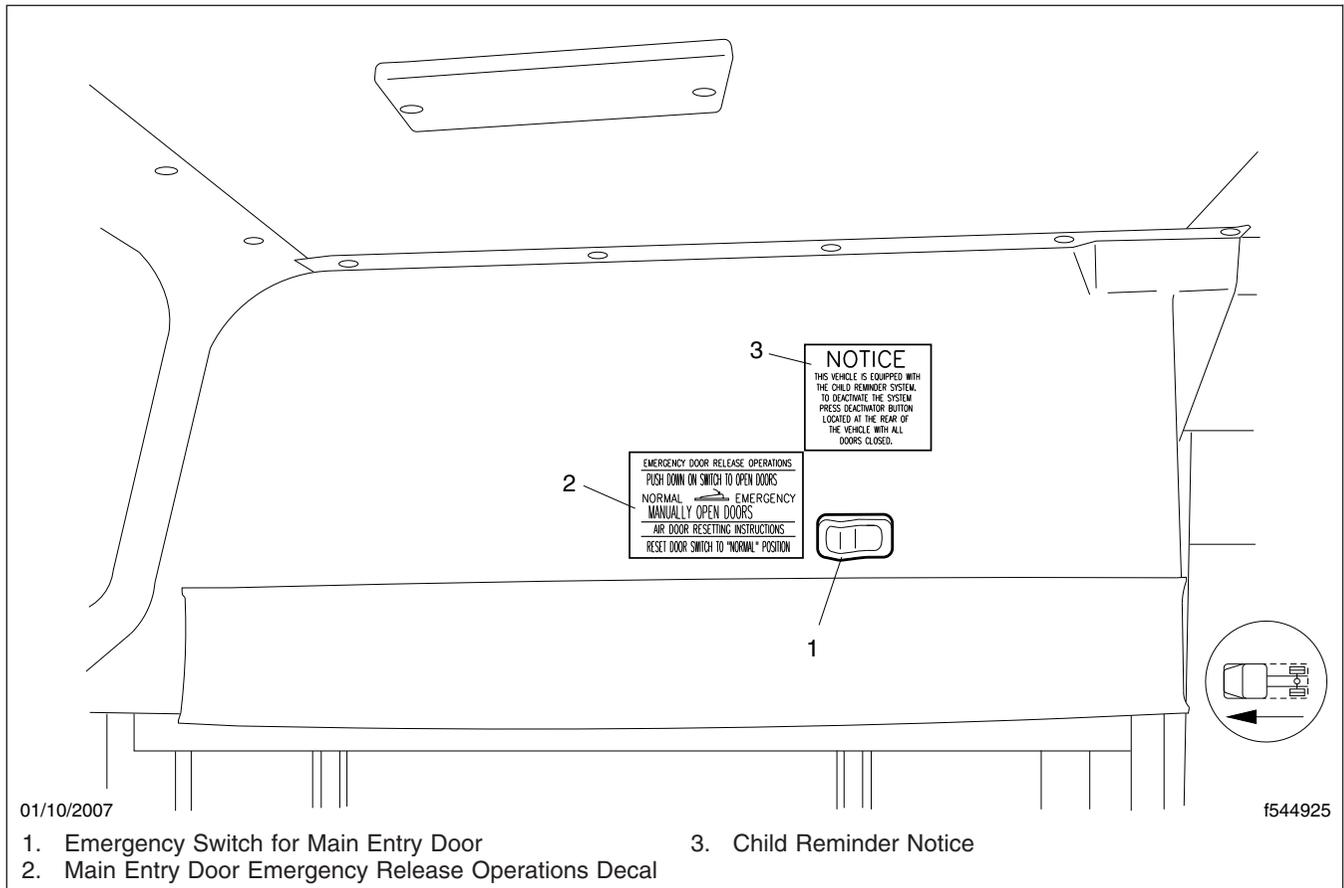


Fig. 14.6, Emergency Switch for Main Entry Door

- 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

! DANGER

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

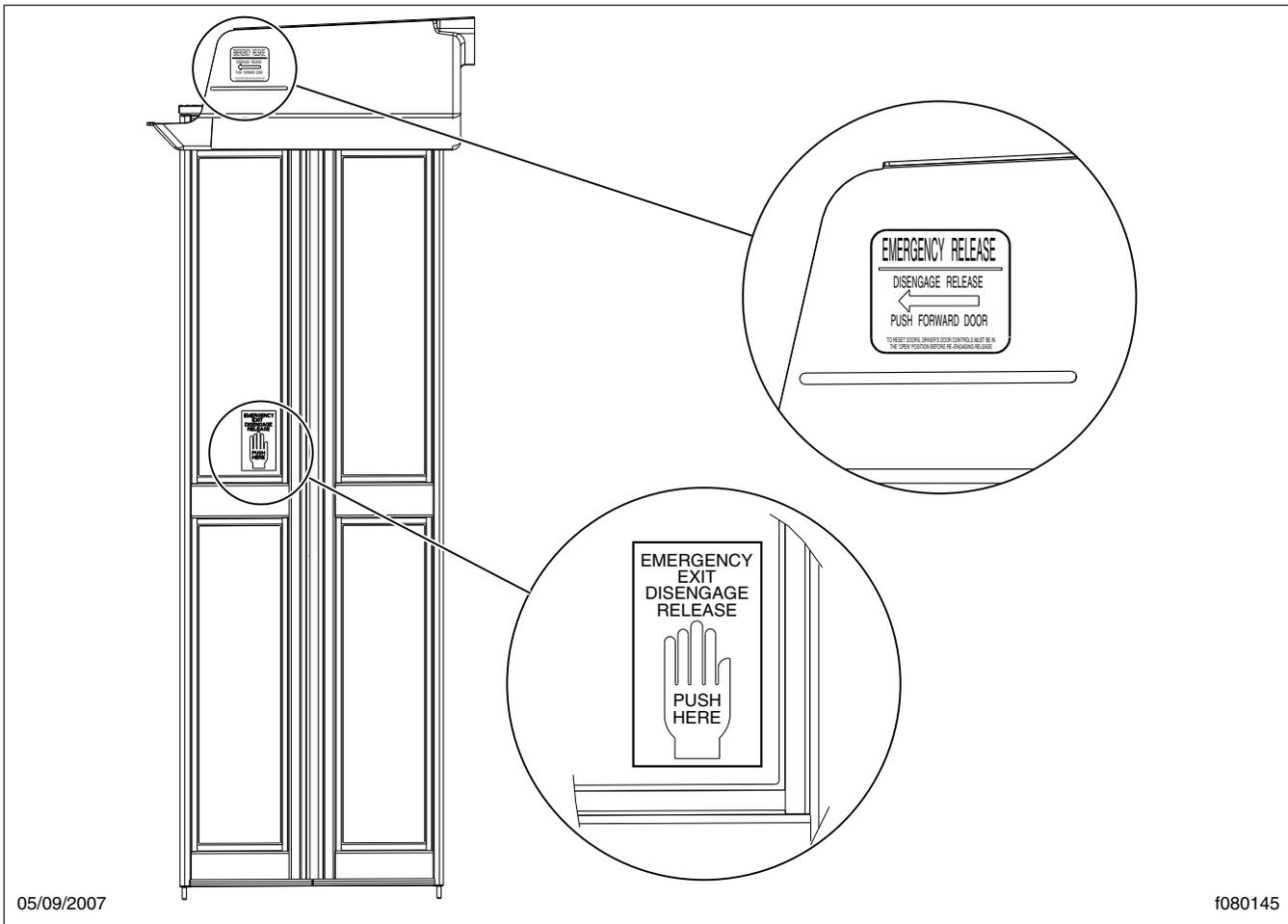
! WARNING

Wheel lug nut torque is very high and the wheel/tire assemblies are very heavy. Changing a tire could result in back injury. If possible, call a qualified service facility to change 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.

- Stop the vehicle on a level surface, away from traffic.
- Apply the parking brake, place the transmission in neutral (N), and shut down the engine.
- Turn on the hazard warning lights.
- Block the wheel diagonally opposite the wheel being changed.

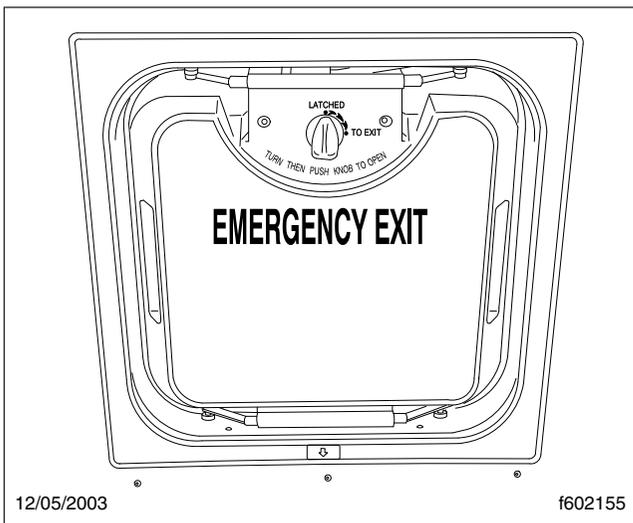
In an Emergency



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Fig. 14.7, Disengaging the Main Entry Door in an Emergency



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Fig. 14.8, Emergency Roof Escape Hatch

5. Remove the spare wheel, jack, jack handle, and lug wrench from storage.

WARNING

This vehicle is very heavy. Jacking this vehicle should be done with extreme caution. The vehicle could slip, causing personal injury or death.

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. When jacking the front bumper, the jacking point(s) must be

centered and within the bottom surface of the bumper support as shown in **Fig. 14.9**. Do not position the jack under the dropped frame rails in the center section of the bus.

- 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.

vehicle until the wheel touches the ground. Tighten the nuts.

- Finish lowering the vehicle to the ground, then remove the jack.
- Remove the block, then stow the jack, jack handle, and lug wrench.
- After operating the vehicle for 50 to 100 miles

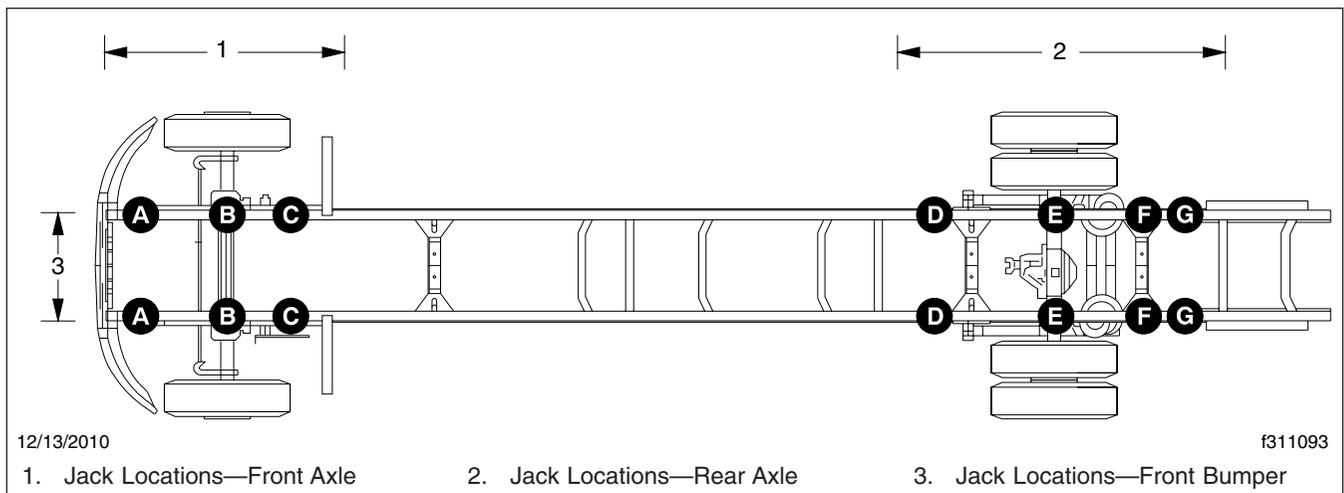


Fig. 14.9, Jack Placement

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.

- Raise the vehicle until the wheel is off of the ground. Remove the lug nuts and the wheel.
- 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.

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.

- 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

(80 to 161 km), retighten the wheel nuts to the specified torque values.

15

Headlight Aiming

Preliminary Checks	15.1
Checking Headlight Aim	15.1
Adjusting Headlight Aim	15.1

Headlight Aiming

Preliminary Checks

Before checking or adjusting the headlight aim, do the following:

- Check that the hood is closed and latched.
- Check the suspension for proper functioning of the leveling mechanism. On buses with air suspensions, make sure that the height is properly adjusted.
- Remove any large amounts of mud or ice from the underside of the fenders.
- Check the springs for sagging or broken leaves.
- Check for damage to the hood and hinge assembly. Repair as necessary.
- Clean the headlight lenses. Use a soft cloth with mild, non-caustic soap or detergent, and water.
- 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) away from, and perpendicular to, a vertical screen or wall. Shut down the engine and set the parking brake. Chock the tires.
2. Each headlight has a height adjusting dot. See [Fig. 15.1](#). Measure the distance from the ground to the height adjusting dot on each headlight. Note those distances. See [Fig. 15.2](#), Ref. A.

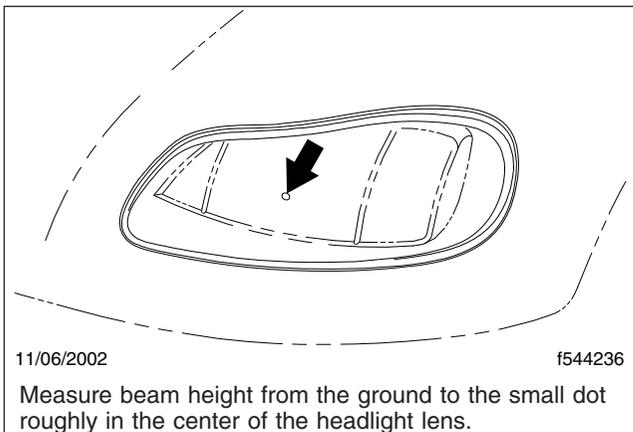


Fig. 15.1, Headlight Beam Height Adjusting Dot

3. Mark the vertical distances found in step 2 on the screen or wall, directly in front of the headlights. These marks represent the desired locations of each headlight bulb center in the following steps. See [Fig. 15.2](#), Items 2 and 3.
4. Turn on the low-beam headlights.
5. Identify the center of each beam projection by marking the area of brightest intensity on the wall. The area of brightest intensity should fall on or very near the marks made during step 3. See [Fig. 15.3](#).
6. Use [Table 15.1](#) to determine the maximum vertical distance allowable between the marks made in step 3 and the marks made in step 5. If the vertical distance between the marks made in steps 3 and 5 is greater than the maximum distance given in [Table 15.1](#), adjust the vertical positioning of that headlight.

Adjusting Headlight Aim

NOTE: Because of the various headlight assembly options offered, the location of adjustment screws on the vehicle's headlight assembly may vary from what is shown here.

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](#).
2. If necessary, adjust the horizontal positioning of the headlights so that each projection points directly forward.
3. Turn the vertical adjustment knob to adjust the headlight beam to meet the desired height. See [Table 15.1](#). Turn the knob clockwise to raise the beam; turn the knob counterclockwise to lower it.
4. Adjust the other headlight.

Headlight Aiming

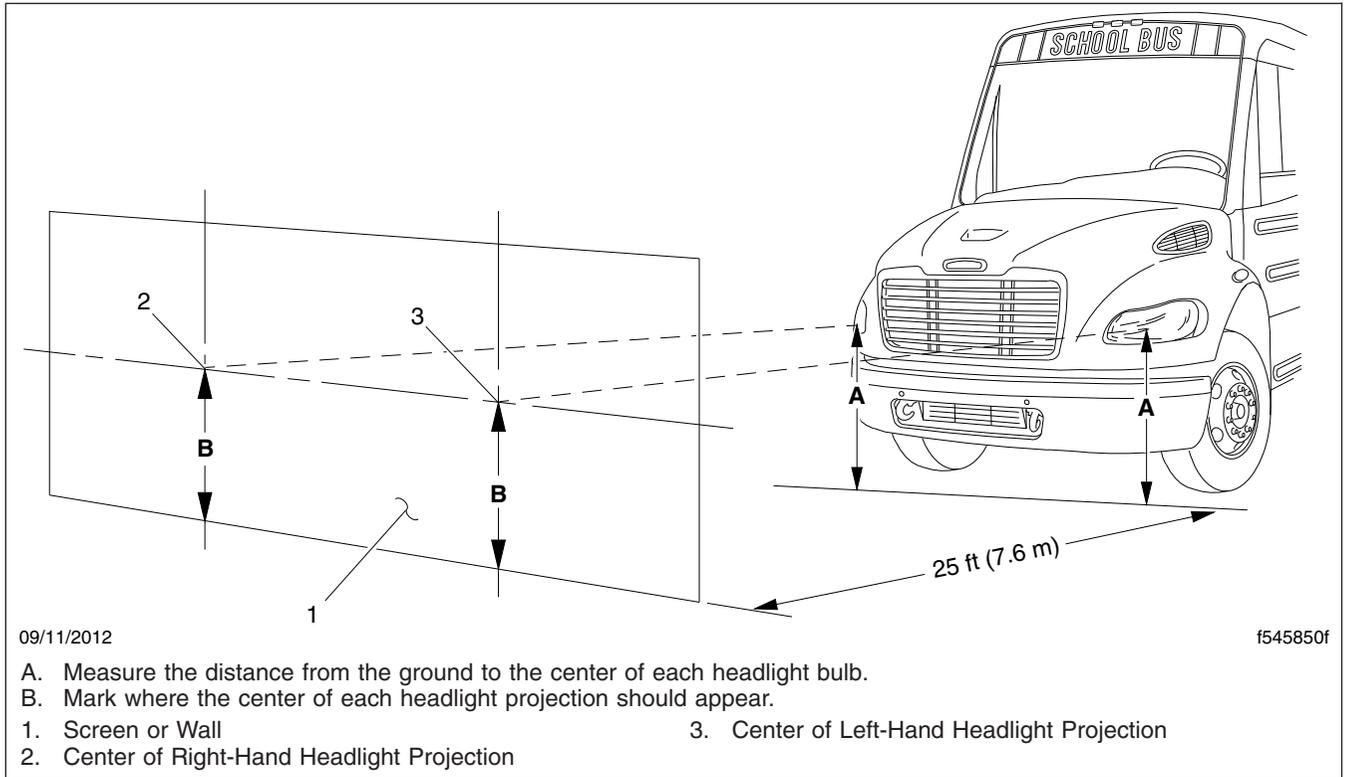


Fig. 15.2, Headlight Aiming Screen/Wall

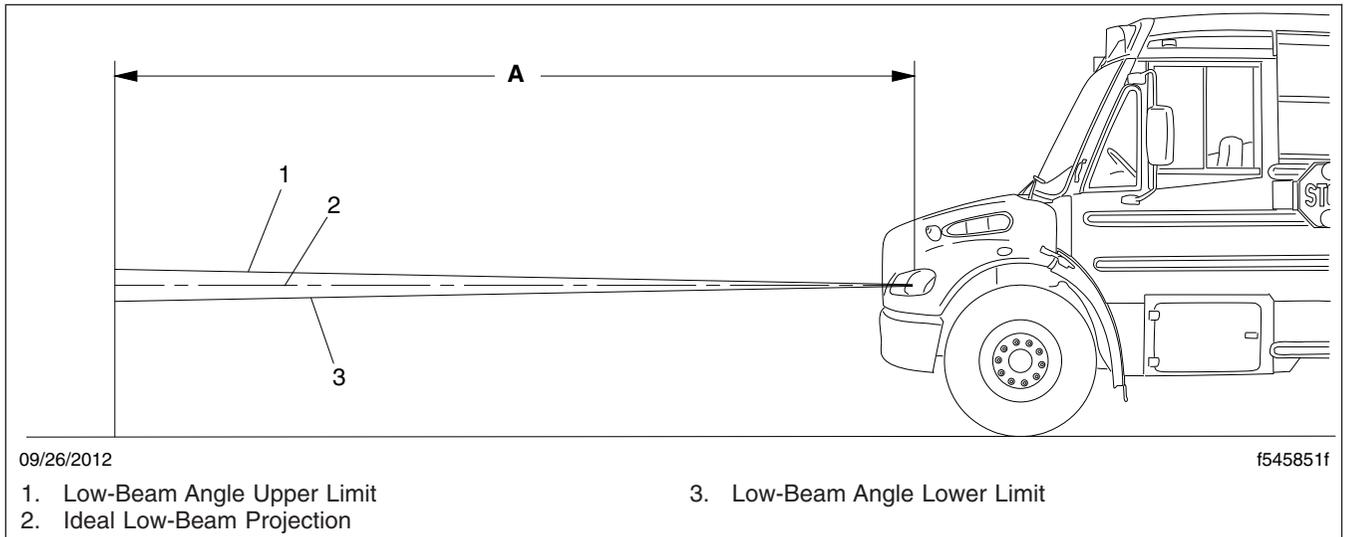


Fig. 15.3, Vertical Low-Beam Headlight Variation Limits

Headlight Aiming

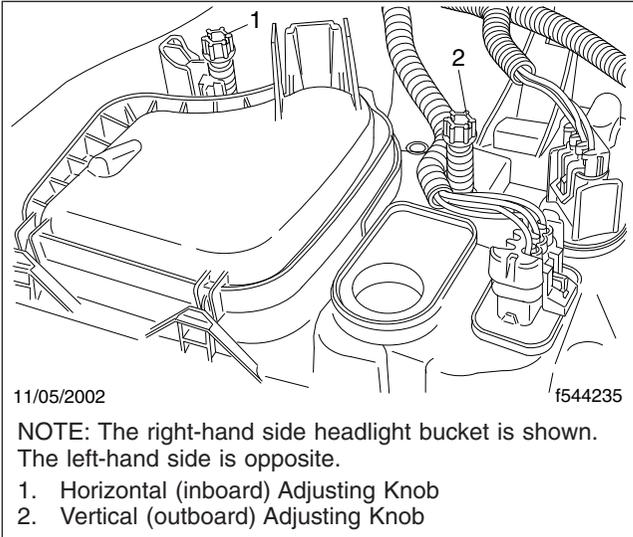


Fig. 15.4, Headlight Adjusting Knobs

Vertical Low-Beam Headlight Variation Limits			
Distance Between Ground and Headlight: in (mm)	Desired Variation (Fig. 15.3, Item 2): in (mm)	Upper Limit (Fig. 15.3, Item 1): in (mm) up	Lower Limit (Fig. 15.3, Item 3): in (mm) down
22–36 (560–900)	0	3.9 (100)	3.9 (100)
36–48 (900–1200)	2 (50) down	2 (50)	6 (150)
48–54 (1200–1400)	2.5 (64) down	1.6 (40)	6.5 (165)

Table 15.1, Vertical Low-Beam Headlight Variation Limits

16

Hybrid Electric Vehicle

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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 (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 antilock brake system (ABS) 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 pressure to the brake pedal.

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 the driver does not apply pressure to the brake pedal.

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](#).

IMPORTANT: The service switch on the PEC should only be used for an emergency shut-down, or when the service manual or troubleshooting guide calls for work on the high-voltage



Fig. 16.2, High Voltage Cables Warning Label

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 emergency shutdown information, see "In Case of an Emergency" in this chapter.

Cooling System

The HEV requires a liquid cooling system for the HDU, inverter, and 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 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.

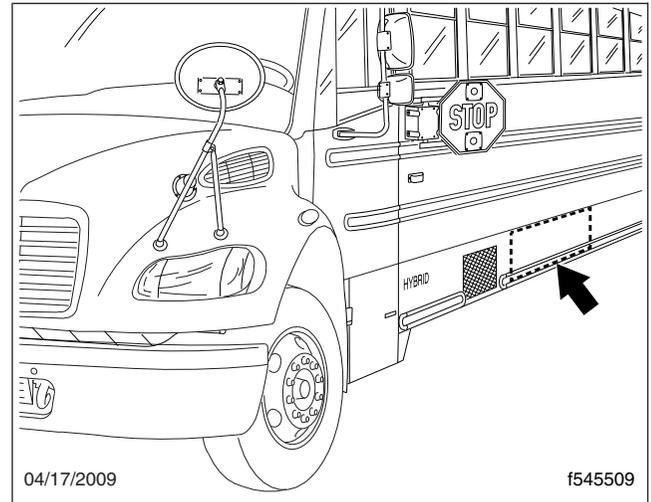


Fig. 16.3, High Voltage Cables and Power Electronics Carrier (PEC) Location



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. 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. Turn the ignition switch to the ON position.
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. Make sure that the transmission shift control is in the Neutral (N) or Park (P) position.

Hybrid Electric Vehicle

WARNING

Never start the engine unless the parking brake is applied. Accidental movement of the vehicle could result in property damage, personal injury, or death.

NOTE: The vehicle will crank after a brief delay.

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. 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 in gear, then 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

IMPORTANT: The transmission must be in neutral for proper shutdown.

1. With the vehicle stopped, place the transmission in Neutral (N).
2. Set the parking brake.
3. Shut down the engine by turning the ignition switch 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.

Eaton Automated Transmission

The Hybrid Saf-T-Liner C2 School Bus is equipped with an Eaton automated transmission. A T-handle

shift control is used by the driver to select the transmission ranges. See [Fig. 16.4](#).

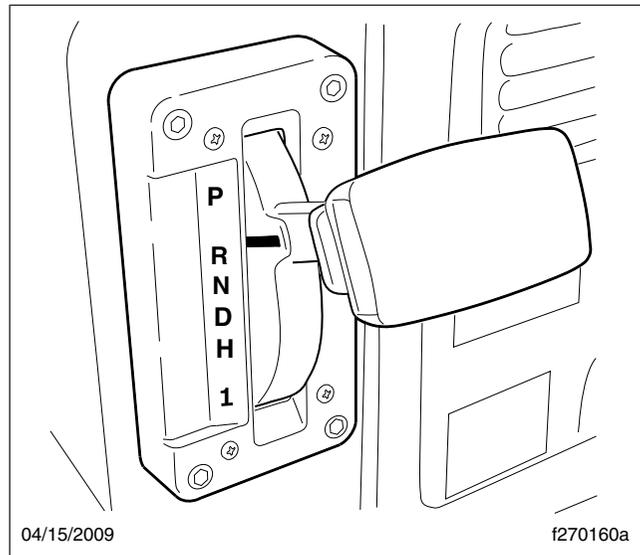


Fig. 16.4, T-Handle Shift Control (hybrid vehicle)

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)

The 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 Thomas Built Bus 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.

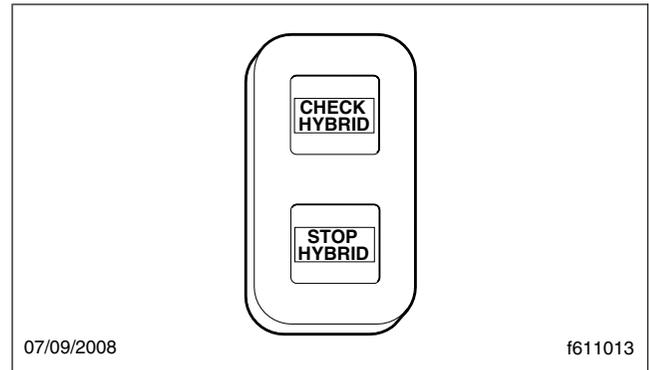


Fig. 16.5, Hybrid System Fault Lamps

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, dash lights, and 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 and HEV system will shut down.
- The HEV batteries are still active, but are isolated in the PEC.

Option 3

Push in the service switch on the PEC and shut down the engine.

Hybrid Electric Vehicle

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**.
- The hybrid system will be disabled.
- The HEV batteries are still "live" but are isolated in the PEC.

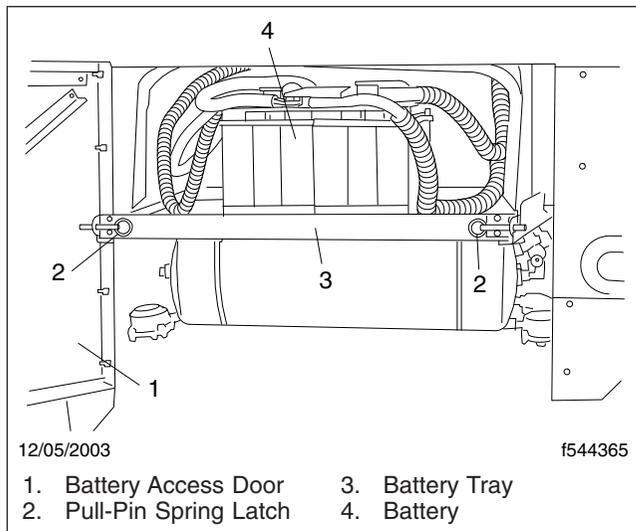


Fig. 16.6, Battery Access

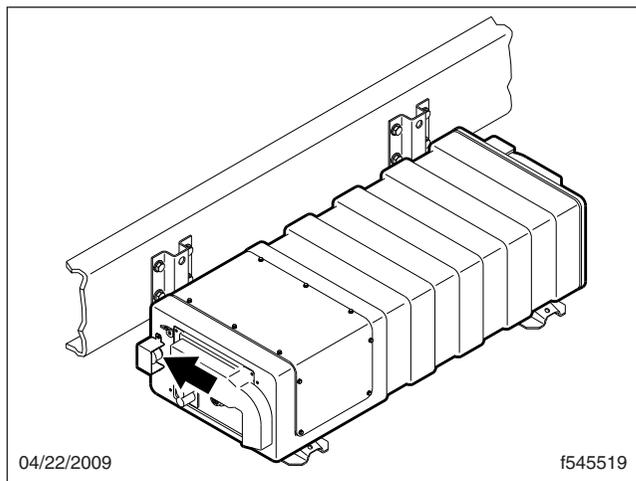


Fig. 16.7, Service Switch

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 (PEC). In any case, the engine, dash lights, and hybrid electrical system will shut down. The high-voltage batteries in the 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. 16.3** for the location of the high-voltage cables and PEC.

Jumpstarting

Jumpstarting vehicles equipped with the Eaton® Hybrid System is identical to non-hybrid vehicles, which use the vehicle 12-volt battery system. See **Chapter 14** for jumpstarting instructions.

Towing

NOTICE

When towing or pushing the vehicle, regardless of the distance or speed traveled, either disconnect the driveshaft at the rear axle and support it as necessary, or remove the axle shafts. Failure to do this when towing the vehicle with the rear wheels on the ground could result in damage to the transmission and other parts.

For instructions, see "Towing" in [Chapter 14](#).

Propane Fuel System

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Propane Fuel System

General Information

CAUTION

The propane fuel system requires special tools to make repairs. Service and repair of the propane fuel system should only be performed by trained propane service technicians. To prevent personal injury or damage to the fuel system, do not attempt repairs yourself.

DANGER

Never cut or weld on the propane storage tank. Severe bodily injury or fire could result.

Propane is highly flammable. Keep sparks and open flames away from propane. Do not smoke when refueling the vehicle. Failure to observe these safety precautions could cause serious bodily injury or death.

The information provided in this chapter is specific to the propane engine, however, other chapters in this manual pertain to the propane operated vehicle. These include, but are not limited to, the controls and pretrip inspection and daily maintenance chapters.

IMPORTANT: For assistance with propane engine related questions, contact Powertrain Integration at 1-877-336-6308.

NOTE: Oil consumption is normal during operation of the propane engine. The rate of consumption is highly dependent on vehicle loading and duty cycles. New engines may experience higher oil consumption during the engine break-in period. For further information, refer to the engine manufacturer's manual or contact Powertrain Integration.

NOTICE

If the ignition switch is in the RUN position for more than 15 seconds and the fuel tank is empty, the fuel pump must be unplugged. Failure to follow this procedure will result in damage to the fuel pump. Refer to the propane engine manual for instructions on how to unplug the fuel pump.

HD5 grade propane is recommended for propane engines. HD5 is a heavy duty engine grade propane with a minimum of 90% propane and a maximum of 5% propylene. This grade of propane is 100 plus oc-

tane and provides proper performance and emissions control, which the fuel system is designed to deliver.

The engine is designed to operate properly on a wide variety of liquid propane gas (LPG) blends which can fall in the category of HD5, and is not affected by "heavy ends" or other waxy hydrocarbons that have traditionally affected other systems.

NOTICE

LPG should be free of contaminants including, but not limited to, rust, dirt, sand, water, salt, and brine. These contaminants can cause engine damage that is not covered by the engine warranty.

WARNING

The propane fuel system operates at pressures up to 312 psi (2151 kPa). A sudden release of propane can cause serious injuries if it contacts the skin or eyes. Always wear protective gloves and eye protection when handling propane.

LPG has no color. A distinctive odorant, similar to sulfur or rotten eggs, is added to LPG to alert anyone nearby in the event of a leak.

Body Heater Loop Valve

The body heater loop valve circulates hot coolant to the body heaters, thereby providing heat inside the vehicle.

NOTICE

The body heater loop valve must be closed before operating the vehicle in temperatures of 100°F (38°C) or higher. Failure to do so could result in the loss of engine coolant, and cause engine damage over time. See [Fig. 17.1](#).

Ignition Switch and Key

The ignition switch has four positions: ACCESSORY, OFF, RUN, and START. See [Fig. 17.2](#).

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): low beam headlights, taillights, brake lights, road lights, clearance lights, turn signals, hazard warning lights, horn, CB radio, clock, and electric oil pan heater.

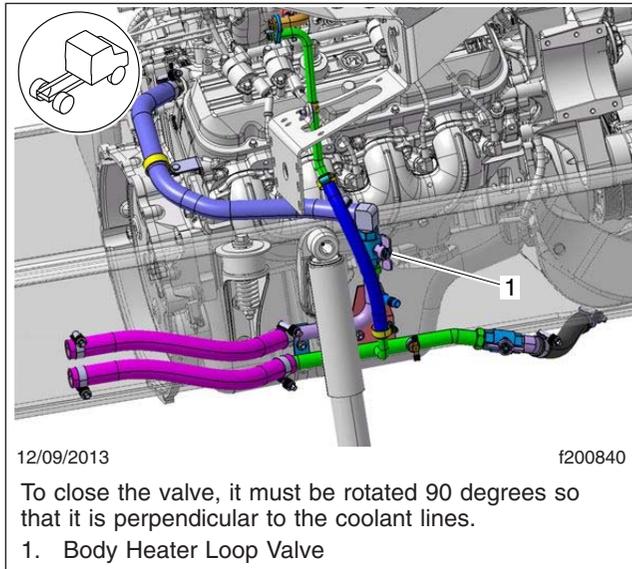


Fig. 17.1, Body Heater Loop Valve

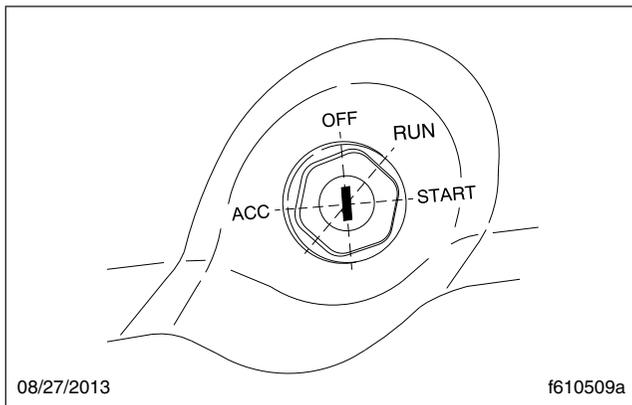


Fig. 17.2, Ignition Switch Positions

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

All electrical systems are operable in the RUN position. The warning lights and the buzzer for low air pressure and low oil pressure operate until minimum pressures are built up.

IMPORTANT: The propane engine is equipped with an amber wait to start indicator. The indicator light illuminates when the ignition is in the RUN position prior to engine start-up. Do not crank the engine until the wait to start indicator light goes out. See the "Ametek Panel" informa-

tion in this chapter for the location of the wait to start indicator.

NOTE: Some vehicles are equipped with a fuel door interlock option. When the fuel door is open, the vehicle will not start.

Turn the key fully clockwise to the START position to start the engine. When the engine starts, release the key.

Engine Operation

General Information

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

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

NOTICE

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.

Engine Starting

1. Set the parking brake.
2. Turn the ignition switch to the RUN position.

The amber wait to start indicator light illuminates when the ignition is in the RUN position prior to engine start-up. Do not crank the engine until the wait to start indicator light goes out.
3. Make sure that the transmission shift control is in Neutral (N), or if so equipped, the Park (P) position.

Propane Fuel System

WARNING

Never start the engine unless the parking brake is applied. Accidental movement of the vehicle could result in property damage, personal injury, or death.

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.

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.
1. With the vehicle stopped, place the transmission in Neutral (N), or if so equipped, the Park (P) position.
 2. Set the parking brake.
 3. Idle the engine for two to three minutes before shutting it down. This allows the lubricating oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, etc.

NOTE: Long periods of idling are not needed or recommended.

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

T-Handle Shifter

The propane Saf-T-Liner C2 School Bus is equipped with an Allison 2300 or 2350 Series transmission. A T-handle shift control is used by the driver to select the transmission ranges. See [Fig. 17.3](#). Refer to www.allisontransmission.com for additional information.

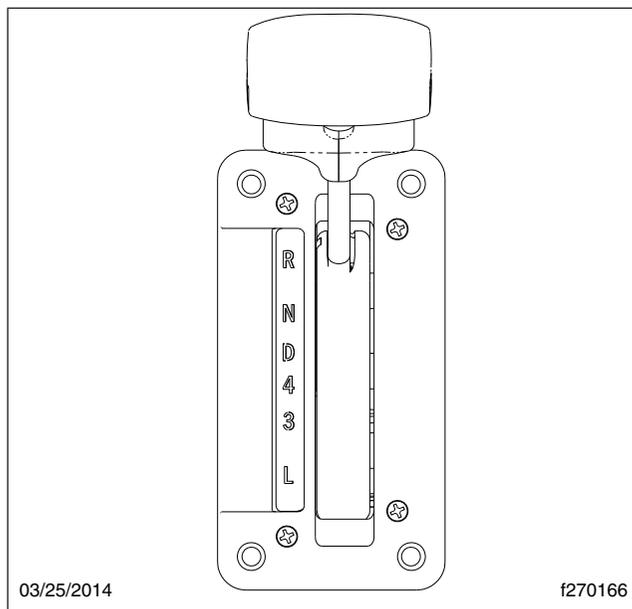


Fig. 17.3, T-Handle Shift Control

P (Park)

Use park, if so equipped, 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 is standard on the 2350 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, if so equipped, places the transmission in neutral and engages the park pawl.

PB (Auto-Apply Parking Brake, optional on 2300 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. When time at idle exceeds 5 minutes, select **N** (neutral), or if so equipped, **P** (park) or **PB** (auto-apply parking brake).

NOTE: The shift into reverse may not succeed if a range inhibitor is active. Check the driver display screen in the instrument panel for a RANGE INHIBIT message.

N (Neutral)

The neutral position places the transmission in neutral. 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.

This position is used when starting the engine and for stationary operation. It is also used to shut down the vehicle when **P** (park) or **PB** (auto-apply parking brake) are not available on the shifter. In this case, the parking brake must be applied.

Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and the driver 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 fifth or sixth 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 the driver display screen in the instrument panel for a RANGE INHIBIT message.

4 and 3 (Fourth and Third Ranges)

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

L (Low Range)

Use low range when pulling through mud or deep snow, when maneuvering in tight spaces, or when driving up or down very steep grades. Low 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).

Propane Refueling

CleanFuel USA recommends that the Liquid Propane Injection® (LPI) vehicle be refilled with fuel at stations that are specifically designed for vehicle refueling. For assistance locating LPG fuel stations, contact CleanFuel USA at www.cleanfuelusa.com or at 1-512-864-0300.

The propane fuel system utilizes a closed system, with fuel supply and return lines. This requires more advanced refueling equipment due to variances in pressure. When refueling the vehicle at a station not specifically designed for dispensing propane (also referred to as autogas), the refueling process may be very slow or the tank may not fill at all. The vehicle propane tank is subjected to heat from the pavement and chassis components, which cause a normal increase in tank pressure. The station pump may not be able to produce pressure high enough to overcome that of the tank on the vehicle. It is recommended that the filling dispenser have a minimum of 90 psi (621 kPa) pump differential boost pressure over the storage tank pressure; most modern stations are designed to 130 psi (896 kPa) differential pressure. It is recommended to refuel the vehicle at a modern station to prevent any customer inconvenience.

Propane Fuel System

LPI fuel tanks are equipped with both an 80% fixed liquid level gauge, and an automatic overfill protection device (OPD). The LPI system is designed to be filled reliably and safely using only the OPD. Therefore, it is not recommended to use the 80% fixed liquid level gauge unless required by the filling station attendant, or for annual OPD verification. See the *CleanFuel USA Owners Manual Supplement* for instructions on how to perform the annual OPD verification test.

CAUTION

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

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

Propane is stored in the fuel tank under high pressure. Never fill a leaking or damaged tank, as this could result in serious injury. Have the vehicle fuel tank(s) and fuel system inspected for leaks by a trained technician annually.

Propane is a liquid under pressure and is stored in a pressure vessel unlike a gasoline or diesel tank. A propane tank must never be filled to more than 80% of its actual capacity, to allow room for expansion. 80% is considered "full" for all propane tanks. When the tank is filled to the correct 80% level, the fuel gauge should read full.

The following steps describe a typical refueling procedure. See [Fig. 17.4](#) for an example of the dual propane tank system.

1. Park the vehicle on level ground to ensure that the tank is properly filled.
2. Turn the vehicle ignition to OFF and set the parking brake. Chock the tires if required.
3. Ensure that there are no open flames or ignition sources in the area.
4. Open the fuel door and remove the fuel tank cap from the fuel fill valve.
5. Inspect the fill valve O-ring, making certain the O-ring is seated in the groove and is not damaged or missing.

CAUTION

Never connect the propane fill nozzle to the tank fill valve if the O-ring is damaged or missing, as this could result in serious injury. Replace the O-ring before connecting the propane fill nozzle.

6. Connect the propane fill nozzle to the tank fill valve.
7. Rotate the propane fill valve nozzle clockwise until it is firmly attached to the tank fill valve.
8. Close the fill nozzle vent valve if so equipped.
9. Open the 80% bleeder valve only if required. CleanFuel USA does not recommend using the bleeder valve. Use of the valve in a low emission fuel station is prohibited.
10. Open the valve on the refueling nozzle.
11. Turn the propane dispenser on to begin refueling.
12. When the OPD stops the flow of fuel into the tank, close the filling valve.
If use of the 80% bleeder valve is required, stop filling when liquid from the bleeder appears in the form of a white cloudy vapor.
13. Turn the propane dispenser off.

CAUTION

Never overfill the propane fuel tank. Overfilling the fuel tank can cause a dangerous condition, resulting in serious injury and damage to the vehicle.

After refueling, if a strong smell of propane persists or if a hissing sound is heard, notify the fuel station operator. Do not start the vehicle.

14. Disconnect the filling nozzle from the tank fill valve.
 - 14.1 If necessary, first open the vent valve on the nozzle, if so equipped, and release the pressure from the valve for safety.
 - 14.2 Rotate the filling nozzle connector counterclockwise and remove it. Then return it to the dispenser.

NOTE: Some vehicles are equipped with a fuel door interlock option. When the fuel door is open, the vehicle will not start.

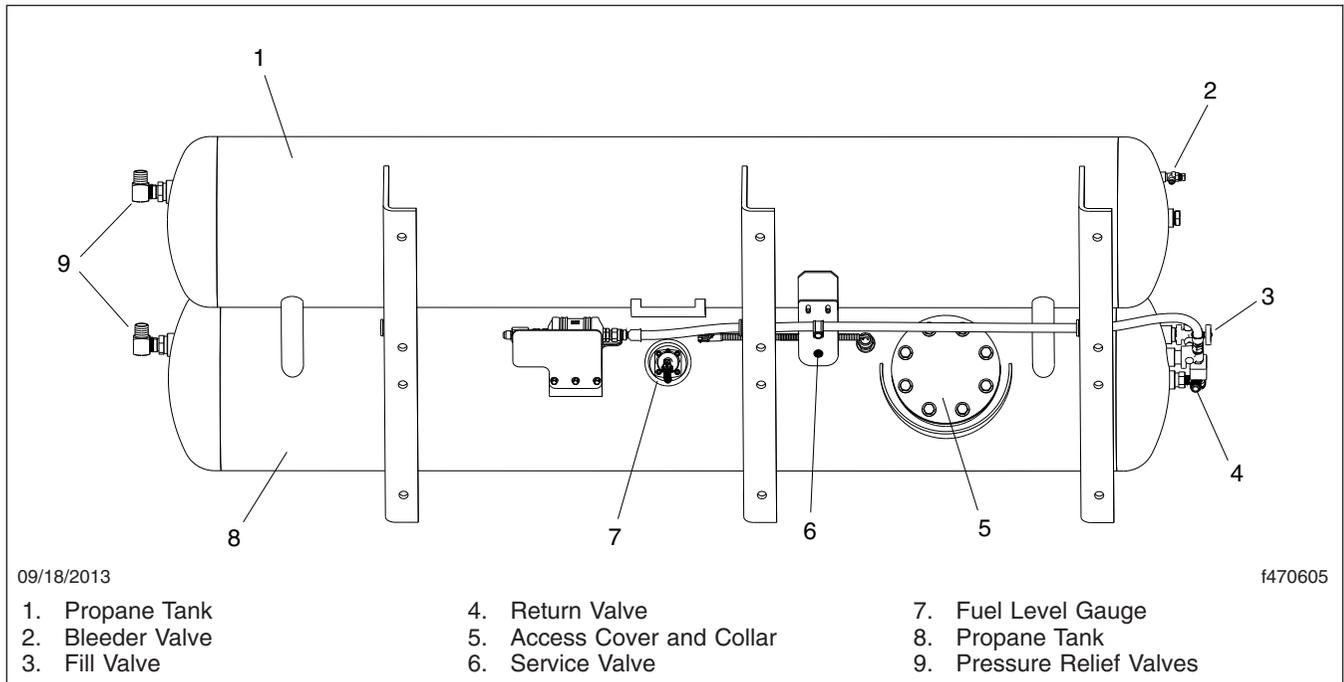


Fig. 17.4, Dual Propane Tank System

15. Install the fuel cap on the fuel fill valve and close the fuel door.
16. Check for leaks on the fill valve and connecting piping, and around the 80% bleeder valve.
17. Ensure that all of the fuel tank valves are in the fully-closed position.

Ametek Instrument Panel

The following information describes the Ametek instrument panel, used with liquid propane gas (LPG) engines. The instrument panel is shown in [Fig. 17.5](#).

NOTE: The instrument panel is shown with a standard U.S. speedometer, which shows miles per hour (mph) more prominently than kilometers per hour (km/h).

Message Display Center

The message display is a graphical, backlit, liquid crystal display (LCD) that relays information to the vehicle operator. The messages displayed include:

- Odometer
- Trip Odometer 1/Trip Odometer 2
- Chassis Battery Voltage

- Instantaneous Fuel Rate
- Average Fuel Rate
- Gear Attained Status
- Transmission Temperature
- Hour Meter
- Boost Pressure
- Engine Oil Pressure
- Coolant Temperature
- Fuel Level
- Percent Engine Load
- Engine RPM

During normal operation, the LCD displays the odometer value and chassis battery voltage on the top line, and driver selected parameters, such as the trip odometer and fuel rate, on the second and third lines.

Priority Messages

Priority messages (including warning messages) are displayed in the LCD due to various inputs or data

Propane Fuel System

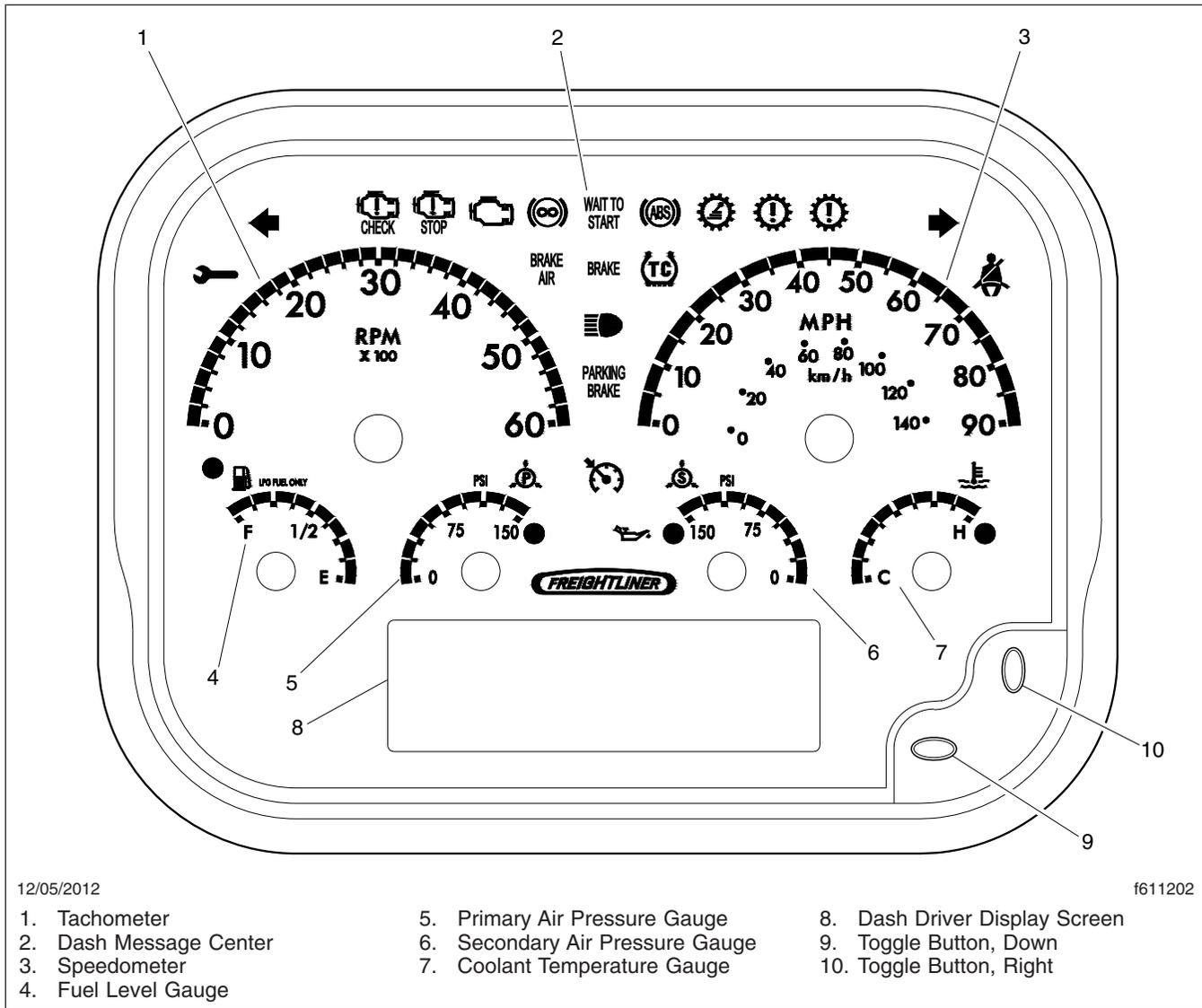


Fig. 17.5, Gauge Layout (typical, U.S.), LPG Engines

messages. Unless noted otherwise, the priority message will take over the whole screen, allowing multiple messages to be displayed in five second intervals.

Self-Test

When the ignition is turned on, a required self-test automatically begins. Gauge needles will reset to zero during the self-test, and then immediately move to the position dictated by the data received. During this time, the warning lights, alarm (buzzer), and driver display screen will also perform a self-test.

NOTE: The driver can activate or deactivate the start-up self-test by accessing the setup menu.

Menu System

The menu system is shown on the driver display screen once the self-test is finished. The menu system responds to input from the driver and remains active as long as the ignition is on. In order for the driver to operate the menu system, the ignition must be ON, and the park brake must be set (ON). The main features of the menu system are described below.

- **Setup**—this is used to set various parameters, which are saved when the ignition is turned off. Setup has select display units, startup screen, LCD contrast, and reset parameters.
- **Maintenance**—shows various maintenance intervals such as engine oil, air filter, etc.
- **Diagnostics**—this is used for setting and reading inputs and outputs and checking the gauges. It also shows the hardware and software version of the instrument panel, and has menus to retrieve active error codes from the engine, transmission, and ABS controllers.

NOTE: No lines can be highlighted in the menu system screen. To get to the sections that can be highlighted, press the right arrow toggle button and hold it for two seconds. The display screen will change and the options shown can then be highlighted. Once a selection has been chosen and changes are made, press the right arrow toggle button to go back to the main message display screen.

Setup Menu

Select Display Units

The set units screen allows the driver to choose between English or metric units of measurement for the displayed values. To navigate to the set units screen, see [Fig. 17.6](#), screens H, I, and J.

Startup Screen

The startup screen selection allows the driver to turn the startup screen on or off.

LCD Contrast

Select contrast from the menu to set the LCD contrast. Use the down toggle button to set the contrast to the desired level. To navigate to the contrast screen, see [Fig. 17.6](#), screen M.

Reset Parameters

The reset parameters screen is included with vehicles that have the Allison transmission prognostics feature.

Maintenance Menu

The maintenance menu has the following three sub menus:

- maintenance intervals

- transmission oil life remaining
- transmission oil filter life monitor

Maintenance Intervals

The maintenance intervals menu allows the driver to set the change intervals for engine oil and engine air filter. If the intervals are set to zero, the maintenance warnings must be disabled.

Transmission Oil Life Remaining

If transmission prognostics are enabled, this menu indicates how much useful oil life remains.

Transmission Oil Filter Life Monitor

If transmission prognostics are enabled, the transmission oil filter life monitor tells the driver if the transmission oil filter is clogged and in need of repair. A message will appear on the display screen as TRANS OIL FILTER FUNCTIONAL or TRANS OIL FILTER CLOGGED.

Diagnostic Menu

The diagnostic menu contains the following items:

- engine faults
- transmission faults
- ABS faults
- check outputs
- odometer diagnostics
- check gauges
- check indicators (warning lamps)
- check LCD
- check binary inputs
- check analog inputs
- check datalink
- hardware/software version

All of the items in the diagnostic menu can be accessed by using the toggle buttons and selecting the auxiliary screens. Then navigate to the diagnostic sub-menu. Some of the more frequently used diagnostic menus are described further below.

Engine Faults

This screen displays engine fault codes that are received from the engine electronic control unit (ECU).

Propane Fuel System

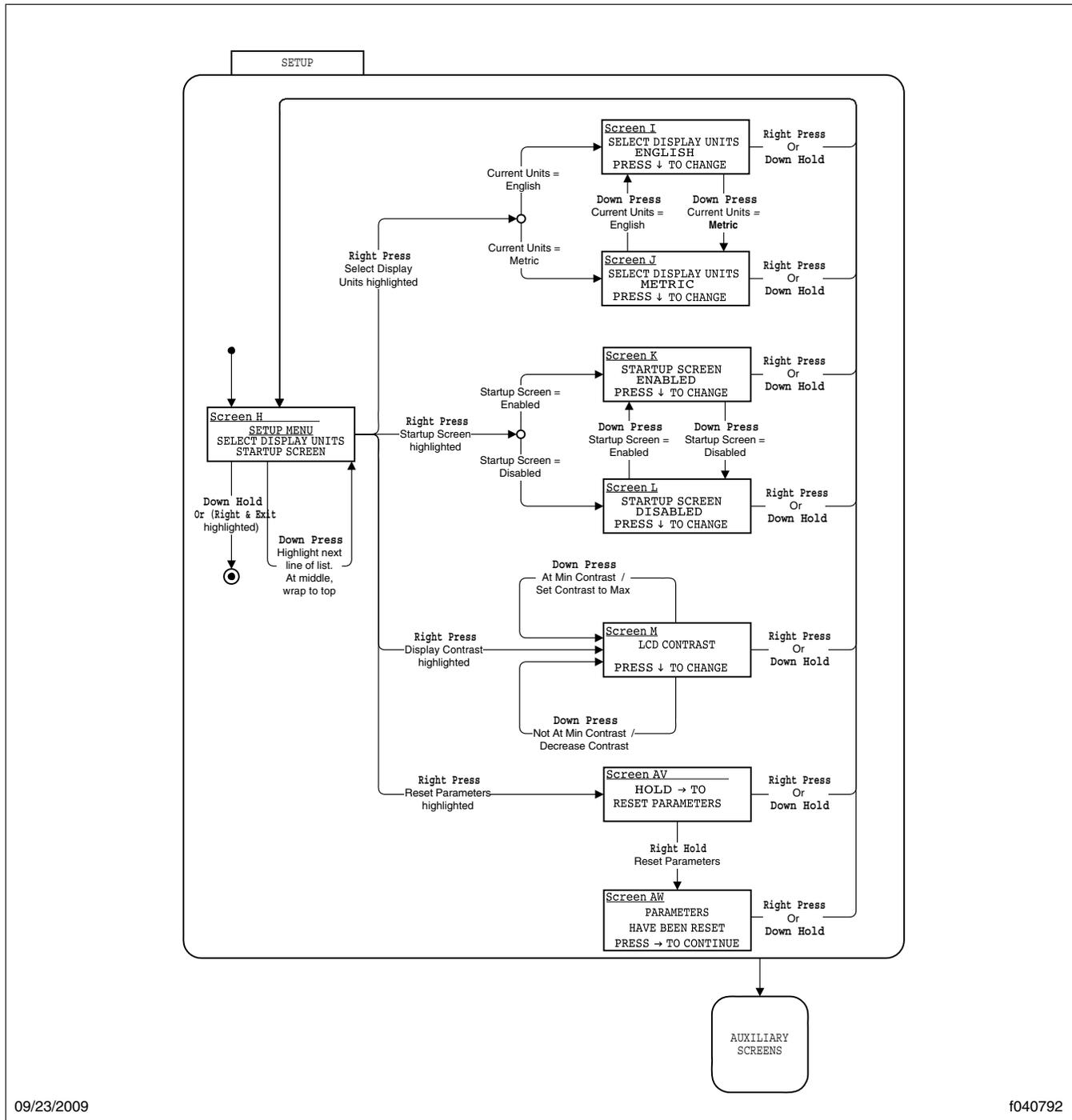


Fig. 17.6, Setup Menu Screens

To navigate to the engine fault screen, see [Fig. 17.7](#), screen AA.

Transmission Faults

This screen displays transmission fault codes that are received from the transmission ECU. To navigate

Propane Fuel System

off, displaying the lamp name and status in the LCD. To navigate to the warning lamp screen, see [Fig. 17.8](#), screen AH.

Check LCD

Selecting the check LCD screen displays the Freightliner Custom Chassis Corporation (FCCC) logo in normal and reverse video three times and then returns to the menu. To navigate to the check LCD screen, see [Fig. 17.8](#), screen AI.

Check Binary Inputs

The check binary inputs screen displays the pin number and status of each binary input. The toggle buttons allow the driver to select each binary input. This information is continuously updated to assist in troubleshooting. To navigate to the check binary inputs screen, see [Fig. 17.8](#), screen AJ.

Check Analog Inputs

The check analog inputs screen displays the pin number and actual value of each analog input defined in the system. The toggle buttons allow the driver to select each analog input. This information is continuously updated to assist in troubleshooting. To navigate to the check analog input screen, see [Fig. 17.9](#), screen AK.

Check Datalink

The check datalink screen allows the driver to view all devices that communicate on the J1939, J1587, and GMLAN datalinks. To navigate to the check datalink screen, see [Fig. 17.9](#), screen AL.

Menu Navigation

The menu navigation screens are provided to illustrate the menu system. The paths to specific screens are shown, along with instructions for using the toggle buttons to move from one screen to another. See [Fig. 17.6](#), [Fig. 17.7](#), [Fig. 17.8](#), [Fig. 17.9](#), [Fig. 17.10](#), [Fig. 17.11](#), [Fig. 17.12](#), [Fig. 17.13](#), [Fig. 17.14](#), [Fig. 17.15](#), [Fig. 17.16](#), [Fig. 17.17](#), and [Fig. 17.18](#).

IMPORTANT: Follow the steps below to change the three items (also known as favorites) shown in the message display center. The message display center is referred to as screen C in [Fig. 17.12](#).

NOTE: The driver can check the pressure of the propane in the fuel rail (pressure of the fuel in

both the tank and pump booster), and make this one of the three items shown in the message display center. Select the item with the fuel pump and psi reading, then follow the directions below to make it one of the favorites.

1. With the vehicle in park, turn the ignition to RUN, and allow the self test to complete.
2. Press the down toggle button to select an item to change. The selected item will now be highlighted.
3. Press the right toggle button once to enter the favorites display menu, shown in [Fig. 17.12](#), as screen D.
4. Use the down toggle button to scroll through the available items.
5. Highlight the new item, then press the right toggle button. The selected item will now appear in the message display center.

Warning and Indicator Lights

There are 19 warning and indicator lights (telltales) installed in the dash message center. See [Fig. 17.19](#). 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.

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

A description of the standard warning and indicator lights are listed below.

Maintenance Warning Light

When the amber maintenance warning light illuminates, the message display center will alert the driver as follows:

- Oil Change Required—alerts the driver that the engine has reached the recommended oil change interval.
- Air Filter Reminder—the air filter requires checking or replacement.
- Transmission Prognostics Warning—if the transmission has prognostics enabled.

Propane Fuel System

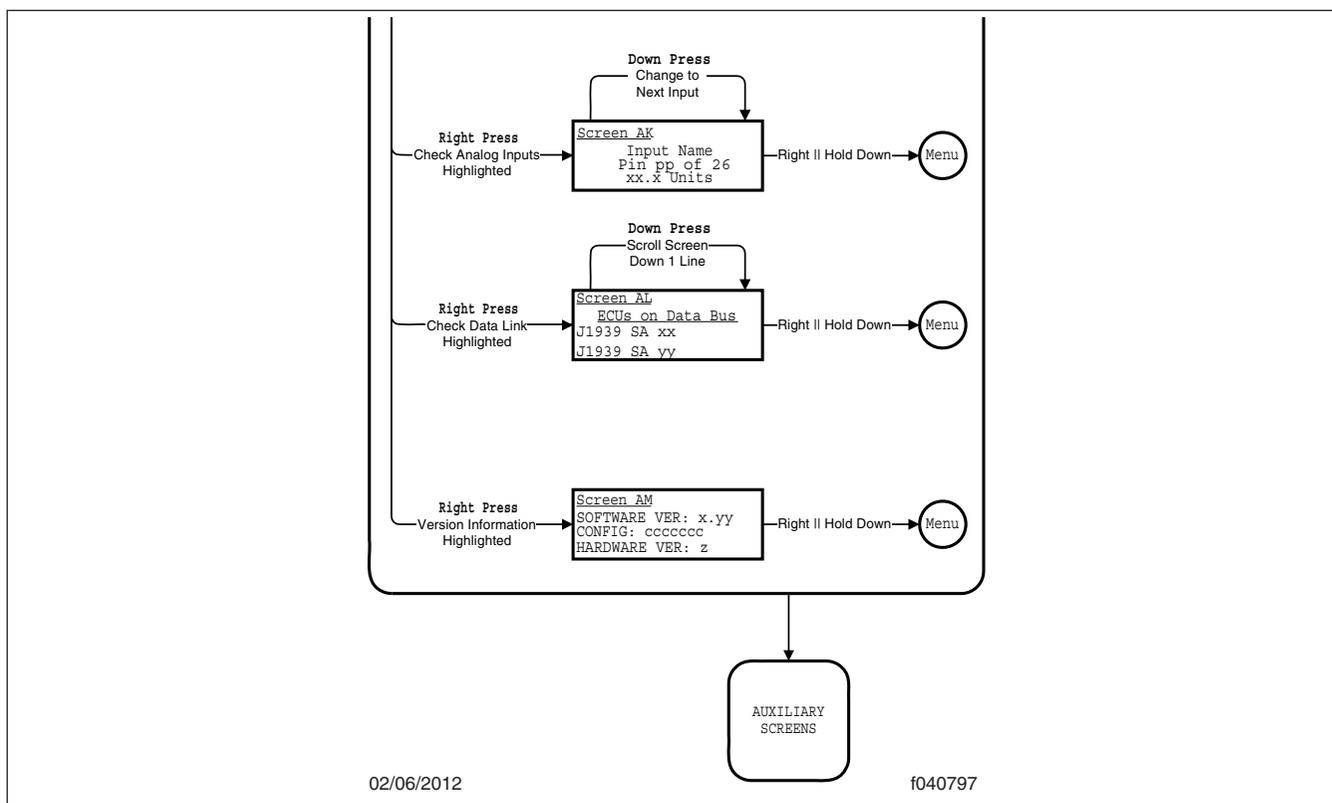


Fig. 17.9, Diagnostic Menu Screens, Screen 3

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 stop engine warning light illuminates to indicate that the protection system available for the engine has been activated. The engine ECU will derate the engine, allowing it to run, but at lower rpm and slower vehicle speed. The vehicle may be driven to a safe location.

NOTICE

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

If the engine is shut down while the vehicle is in service, a single restart attempt may be performed. Depending on the nature of the fault condition, a cool-down period may be required before restarting. If, upon restarting, the fault condition still exists the lamp will come on and the engine should be shut

down. At this point, the vehicle is unsafe to drive and should be transported to an authorized Freightliner service facility.

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.

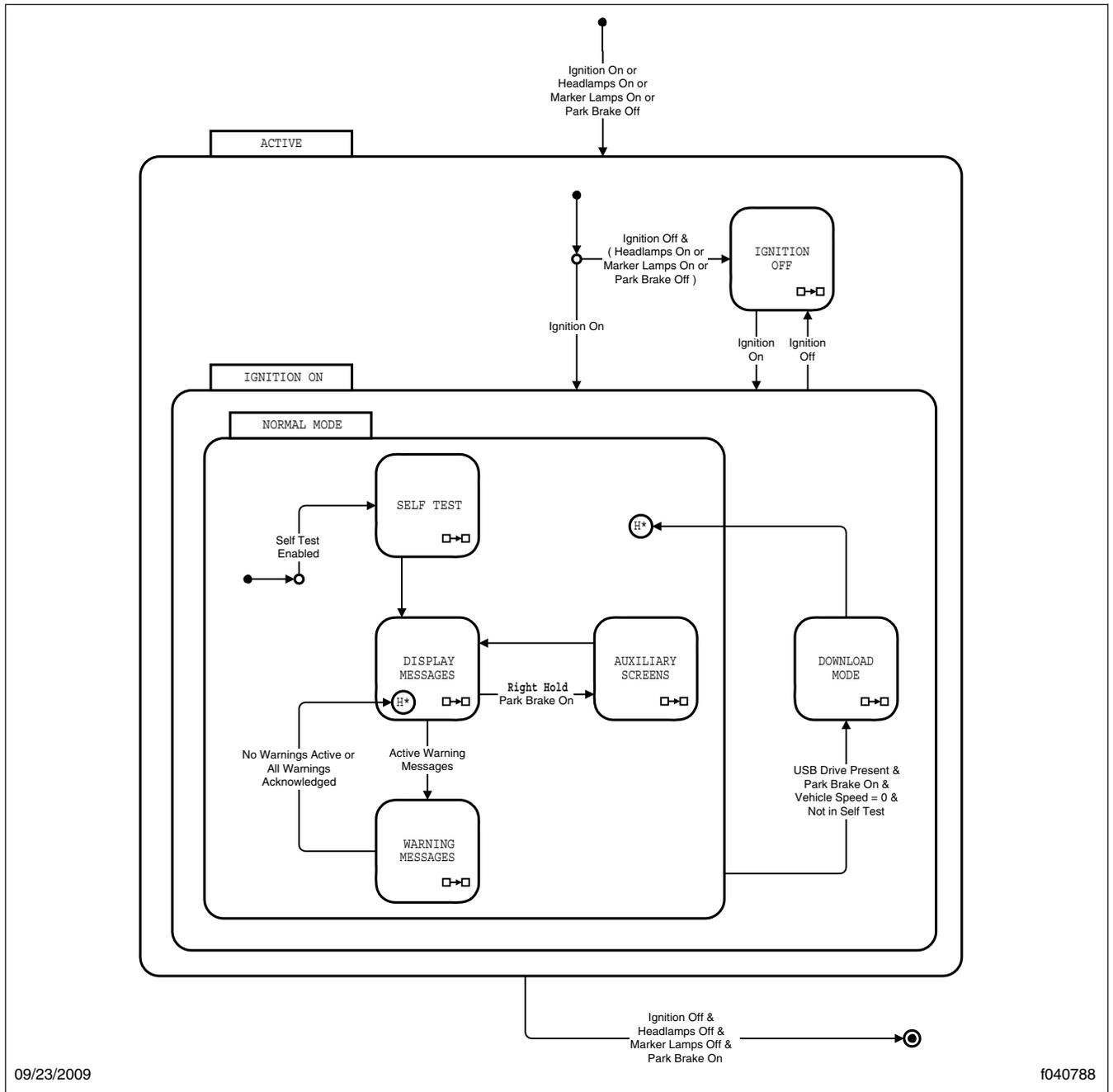
Malfunction Indicator Lamp (MIL)

Indicates an engine emissions-related fault. See the engine operation manual for details.

Low Air Pressure Warning

The red low air pressure warning light 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



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Fig. 17.10, Ignition On, Normal Mode

secondary air reservoir falls below 65 to 75 psi (448 to 517 kPa).

Headlight High-Beam Indicator

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

Propane Fuel System

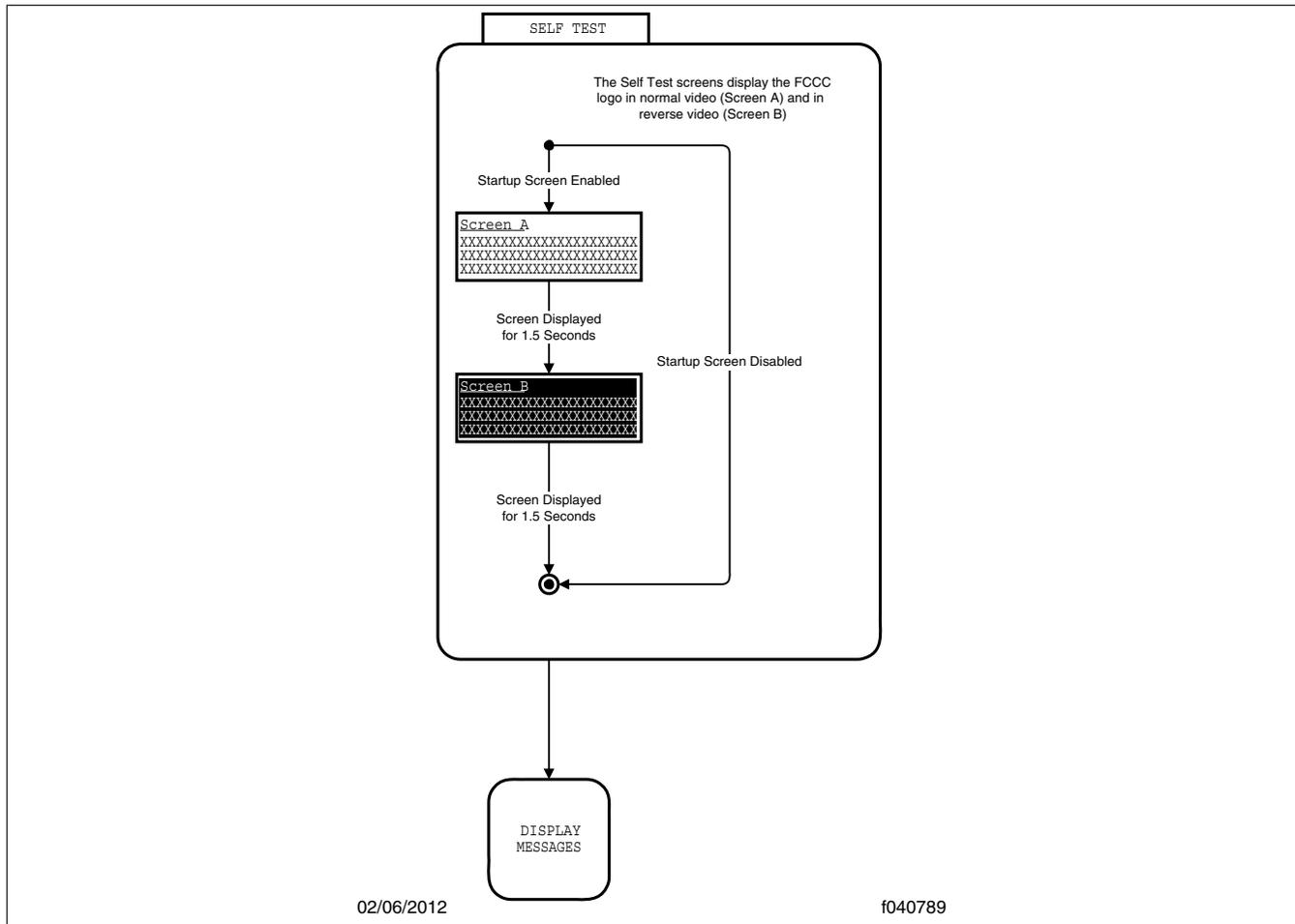


Fig. 17.11, Self Test

Wait to Start Indicator

The amber wait to start indicator light illuminates with the ignition switch in the ON position prior to engine start-up. Do not crank the engine until the wait to start indicator light goes out.

Hydraulic Brake System Warning

The red brake system warning illuminates if there is a hydraulic brake system failure, or if the vehicle is powered and the engine is not running.

ABS Indicator

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

NOTE: For more information about this light and the ABS system, see [Chapter 10](#).

Traction Control Indicator

The amber traction control indicator illuminates when the wheels lose traction.

Shift Inhibit Indicator

The amber shift inhibit indicator light illuminates whenever all conditions for safe transmission shifting have not been met.

Check Transmission Indicator

NOTE: The LPG check transmission indicator has a different icon (exclamation point), and illuminates when the transmission fluid temperature goes above a preset level.

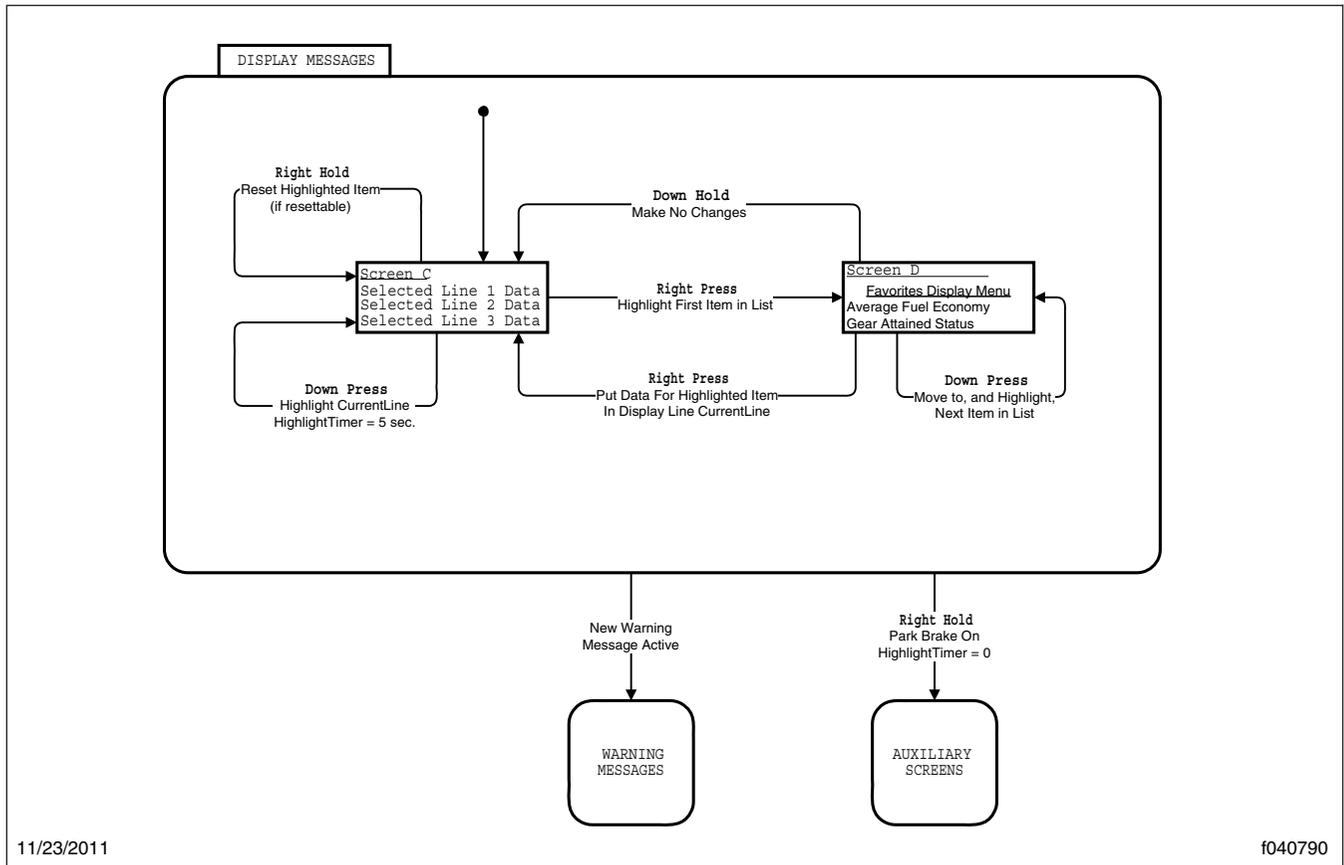


Fig. 17.12, Display Messages

The amber check transmission indicator 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.

Stop Transmission Indicator

The red warning light illuminates when the transmission control unit senses a malfunction.

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.

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.

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.

Propane Fuel System

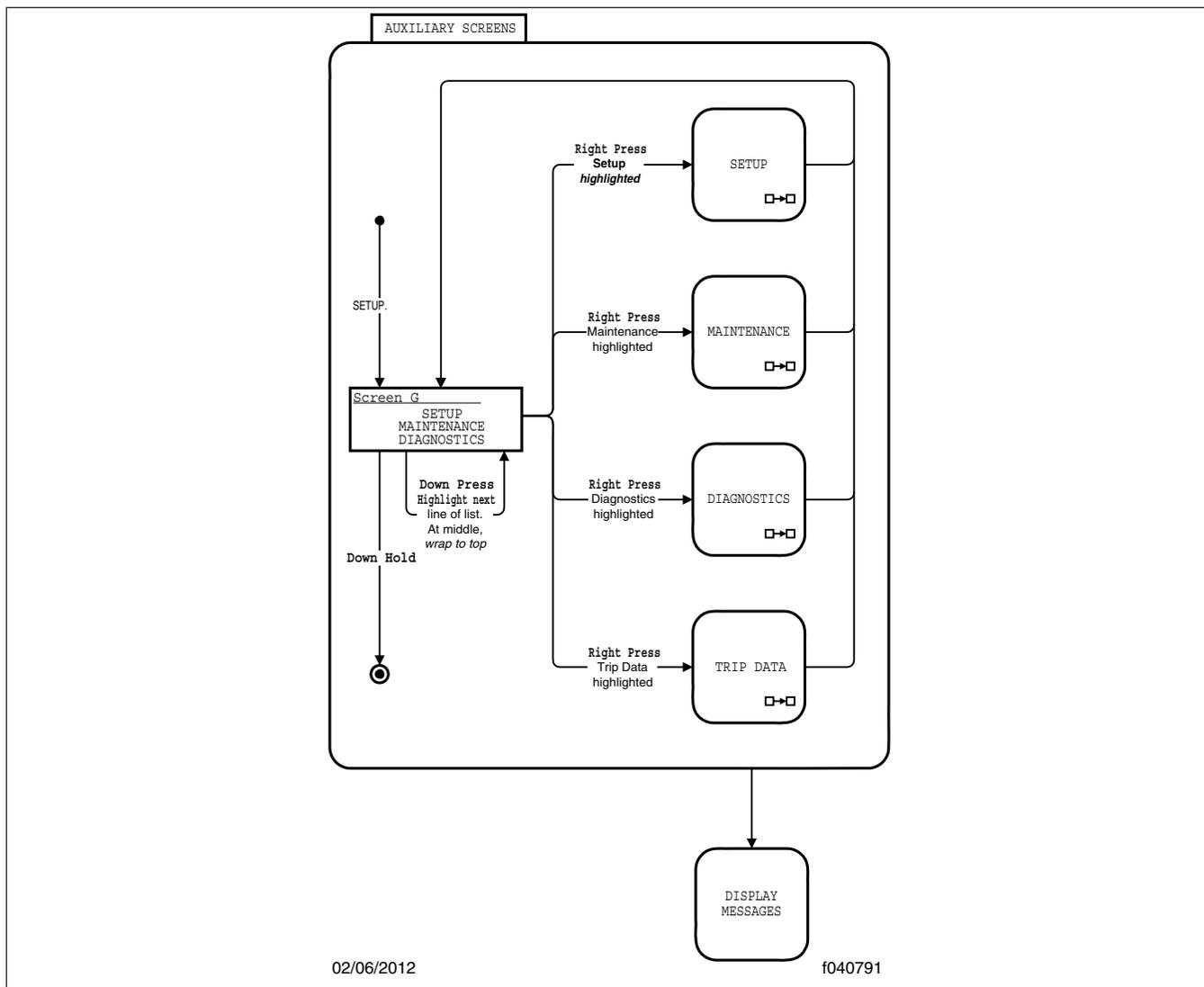


Fig. 17.13, Auxiliary Screens

Cruise Control Indicator

A green indicator illuminates when the cruise control is activated.

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 which is 6 psi (41 kPa) at 700 rpm, or 18 psi (124 kPa) at 4400 rpm.

- 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).
- The coolant temperature rises above 253°F (123°C) and the check engine and stop engine lights illuminate. When the coolant temperature falls below 244° (118°C) the emergency buzzer and stop engine light will turn off.

NOTE: The check engine light will remain on until the vehicle is inspected at an authorized Freightliner service facility.

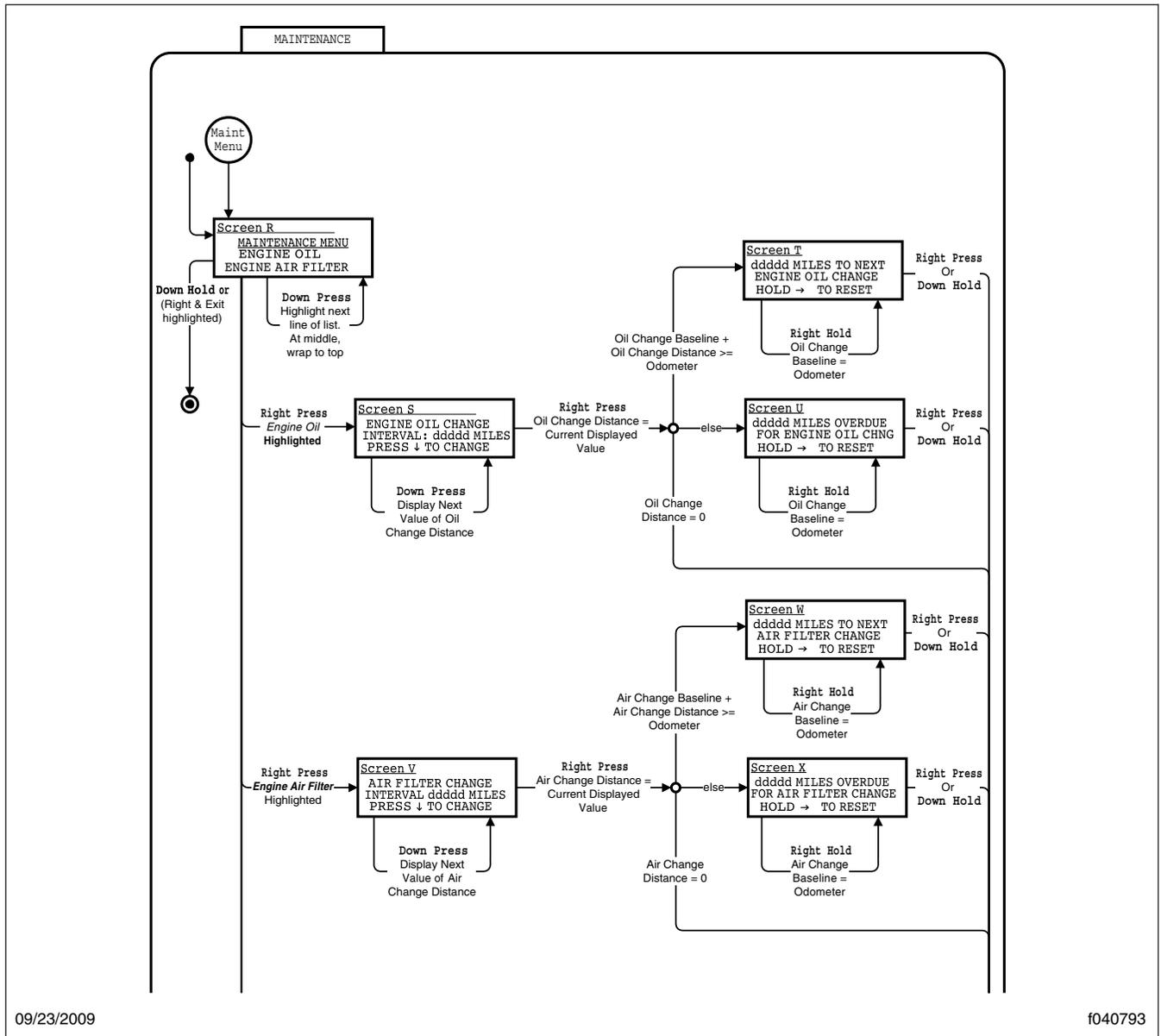


Fig. 17.14, Maintenance Menu Screens, Screen 1

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. 17.20](#).

The NAFTA version (not shown) of the speedometer face reverses this arrangement, with km/h in larger

numbers. The metric-only version (not shown) shows km/h exclusively.

Tachometer

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. 17.20](#).

Propane Fuel System

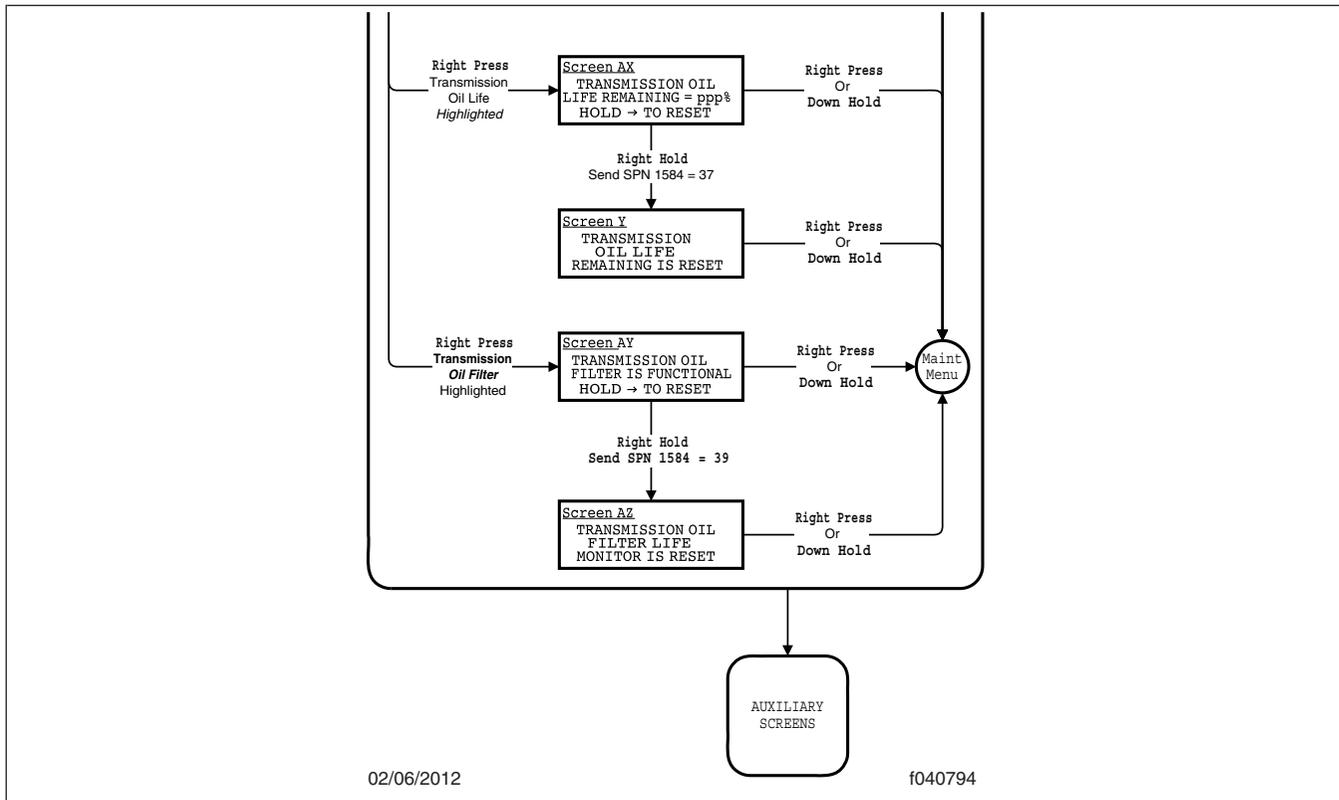


Fig. 17.15, Maintenance Menu Screens, Screen 2

Standard Instruments

Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tanks. See Fig. 17.21. A low-level warning light illuminates when the fuel level registers 1/8th of capacity.

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. 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 property damage, 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. 17.22.

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.

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.

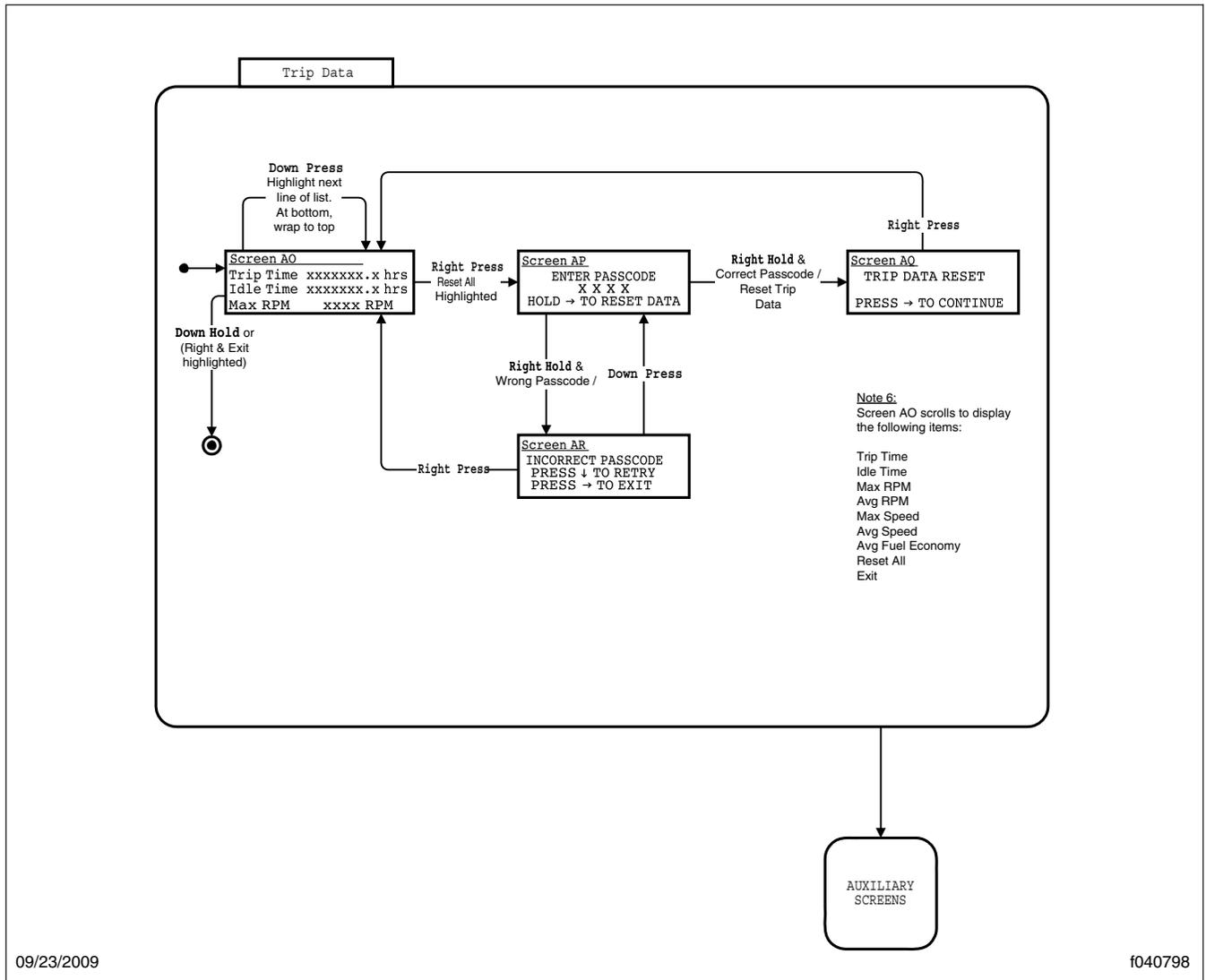


Fig. 17.16, Trip Data

During normal engine operation, the coolant temperature gauge should read 200 to 205°F (93 to 96°C). See Fig. 17.23. If the temperature remains below 160°F (71°C) or exceeds 235°F (113°C), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

The coolant temperature gauge is very important. See Fig. 17.23. If the coolant temperature rises above 253°F (123°C), the check engine and stop engine lights will illuminate, and the buzzer will sound. At this point, the engine will derate and idle speed will increase, to speed up the cooling fan and water pump to cool the engine.

Grade Brake

IMPORTANT: The grade brake is an optional auxiliary brake system that works through the transmission. It should not be confused with exhaust brake or engine brake. Furthermore, the grade brake should not be used in place of the service brakes to stop the vehicle.

Chassis equipped with a propane engine may have an optional grade brake. The grade brake is designed to downshift the transmission—when going downhill for example—without overspeeding the engine. Refer to the *Allison Operator's Manual* for proper operation of the grade brake. See Fig. 17.24

Propane Fuel System

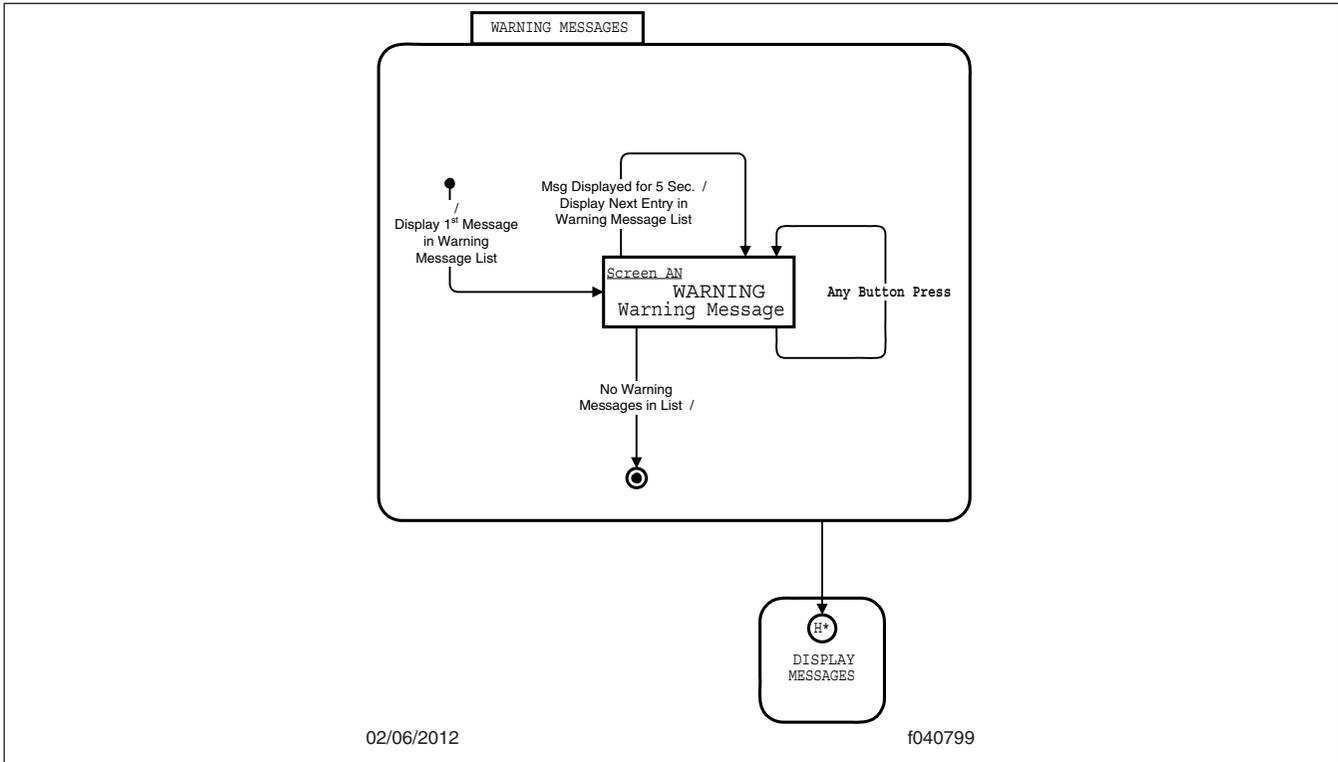


Fig. 17.17, Warning Messages

for an example of the grade brake switch. An amber light activates at the top of the switch when the grade brake is activated.

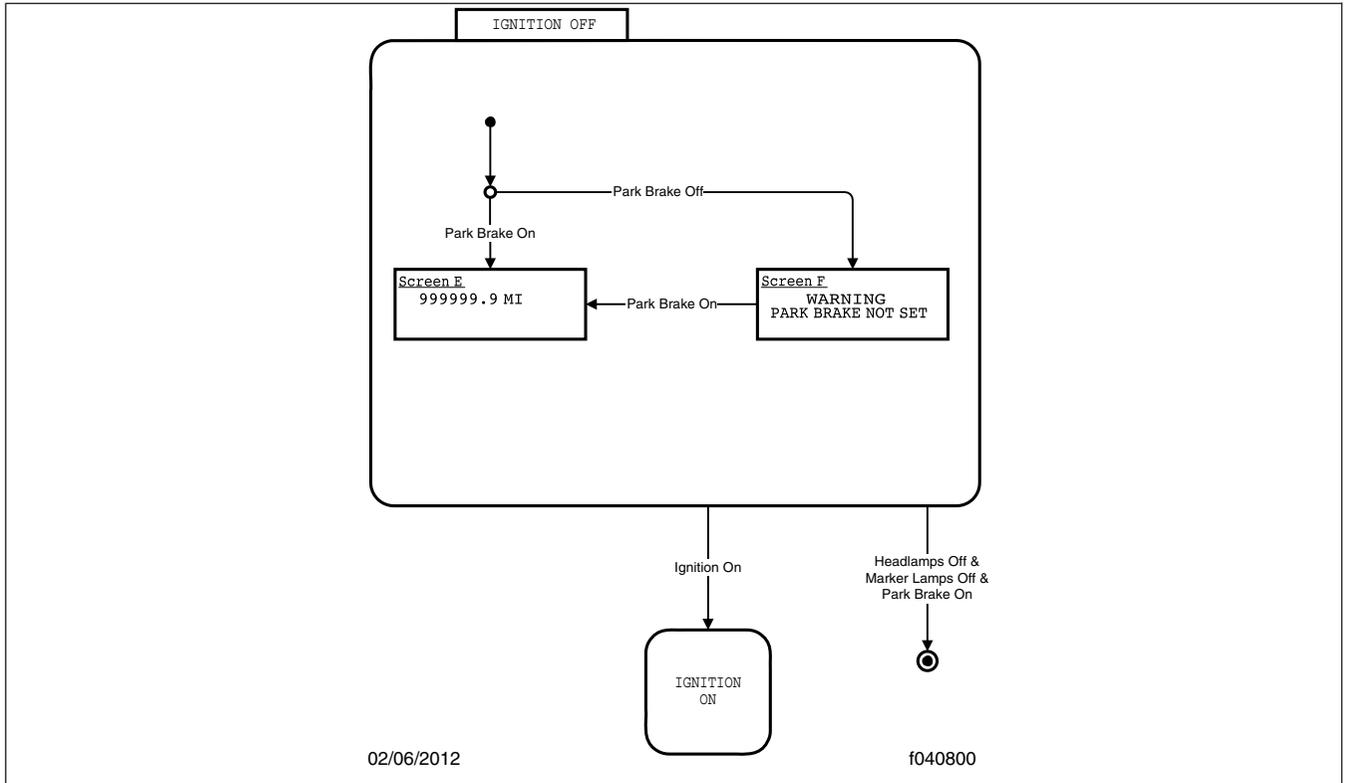


Fig. 17.18, Ignition Off (shown when ignition is keyed OFF)

Propane Fuel System

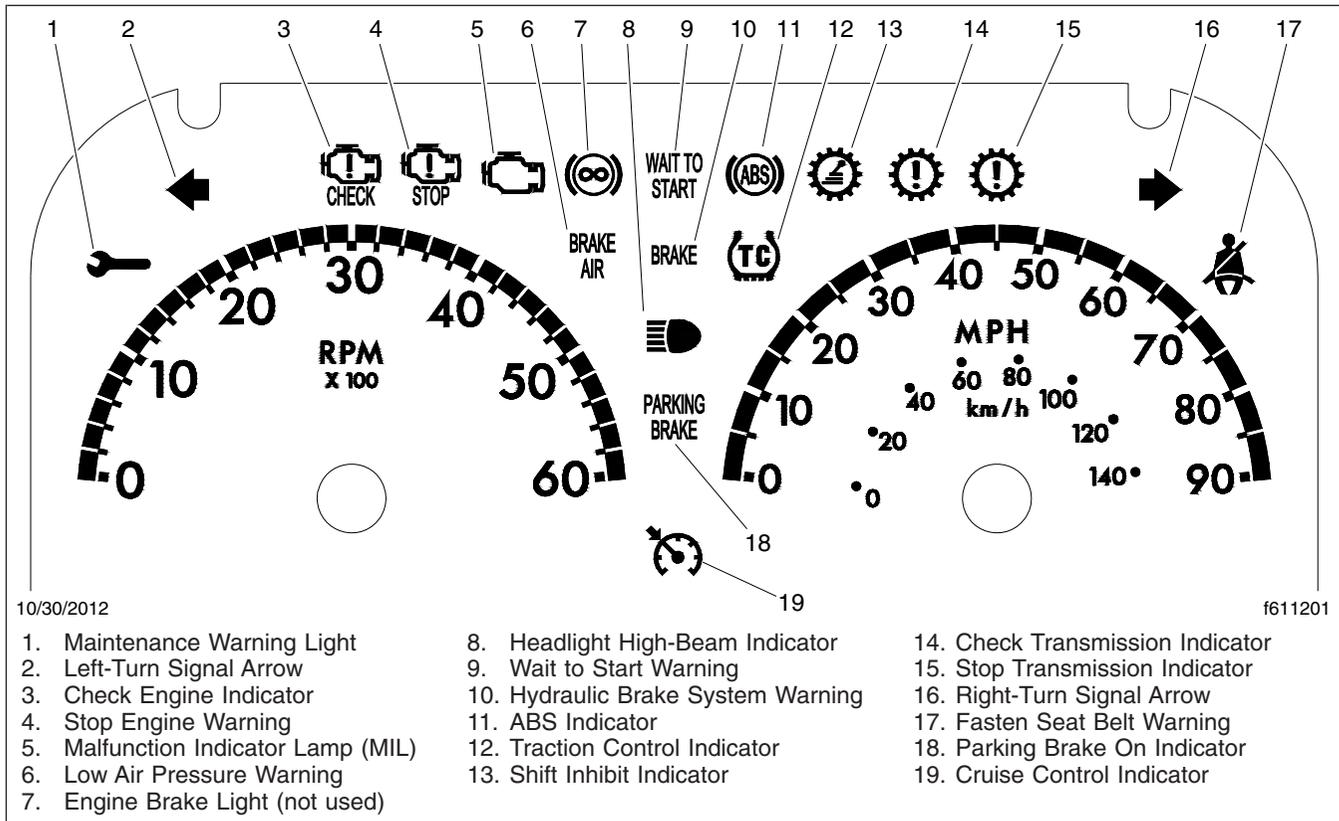


Fig. 17.19, LPG Engine Warning and Indicator Lights

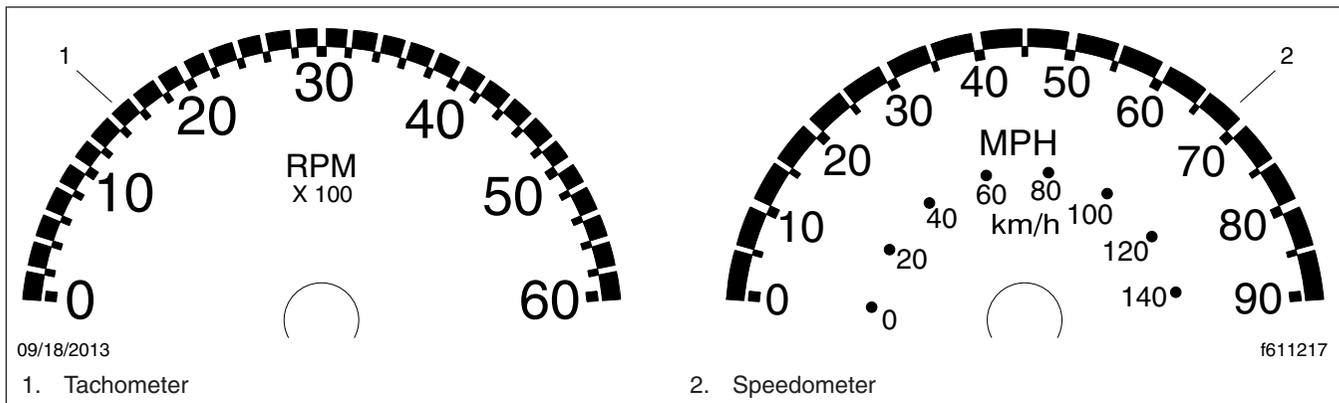


Fig. 17.20, Speedometer and Tachometer (U.S. version)

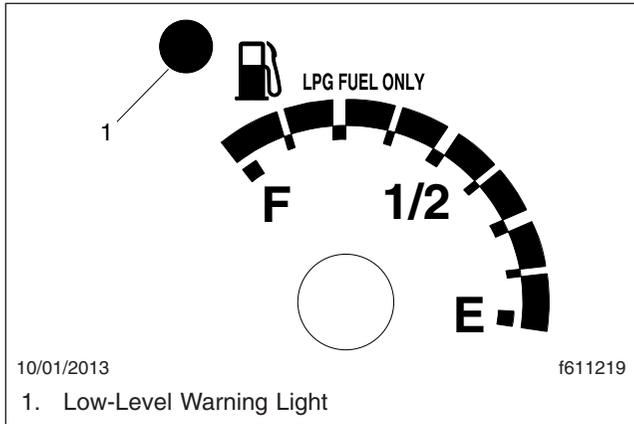


Fig. 17.21, Fuel Level Gauge

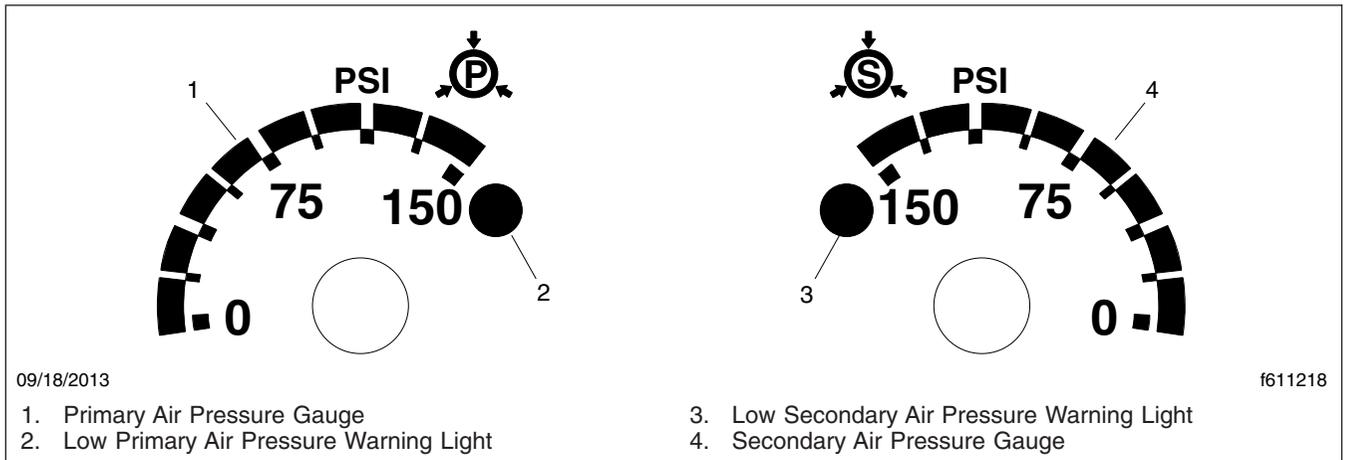


Fig. 17.22, Air Pressure Gauges

- 1. Primary Air Pressure Gauge
- 2. Low Primary Air Pressure Warning Light

- 3. Low Secondary Air Pressure Warning Light
- 4. Secondary Air Pressure Gauge

Propane Fuel System

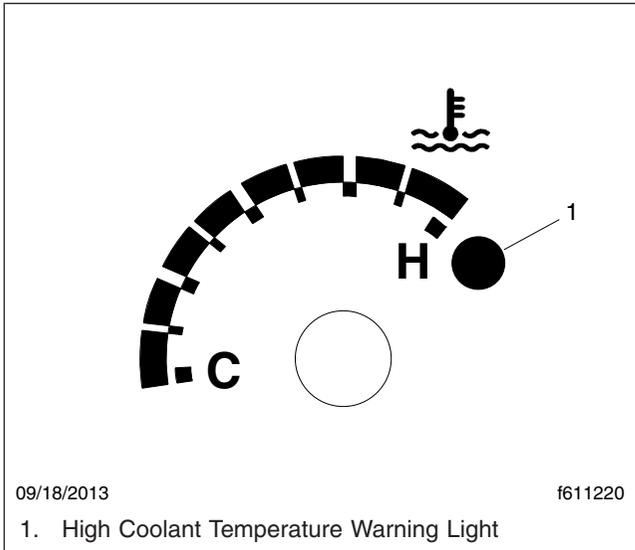


Fig. 17.23, Coolant Temperature Gauge

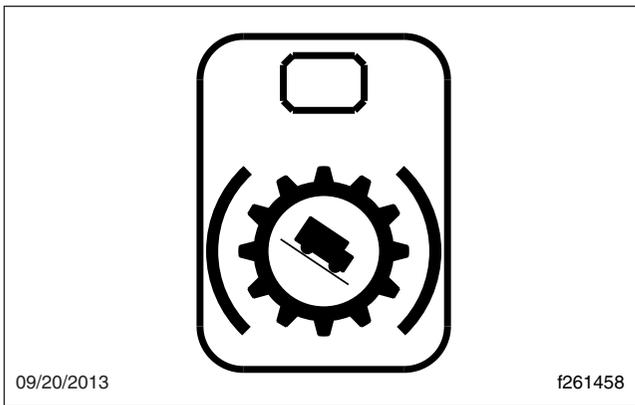


Fig. 17.24, Grade Brake Switch

18

Compressed Natural Gas Fuel System

General Information	18.1
Safety Precautions	18.1
Fuel Tank Filling Procedures	18.2
Engine Starting	18.4
Major Repair and Replacement of Compressed Natural Gas Components	18.5
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Speedometer and Tachometer	18.10
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Compressed Natural Gas Fuel System

General Information

CAUTION

Service and repair of the compressed natural gas (CNG) fuel system should only be performed by trained CNG service technicians. To prevent personal injury or damage to the fuel system, do not attempt repairs yourself.

NOTE: Information provided in this chapter is specific to the CNG engine, however, other chapters in this manual pertain to the CNG operated vehicle. These include, but are not limited to, the controls and pretrip inspection and daily maintenance chapters.

CNG is made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure. CNG often contains an odor-producing chemical.

When vaporized at ambient temperatures, natural gas is less dense than air, and it rises and disperses. Cold atmospheric conditions may prevent natural gas from dispersing quickly when released in large amounts.

Natural gas is nontoxic, but it can cause asphyxiation if present in very large concentrations.

For natural gas to burn, it must first vaporize, then mix with air in the proper proportions (flammable range is 5 to 15% by volume in air), and then be ignited.

A typical natural gas fuel system consists of:

- Fuel supply cylinders that store compressed gas at high pressure.
- Pressure relief and manual fuel shutoff valves.
- A filling connection with a check valve that prevents the gas from flowing back out of the fuel filling line.
- High-pressure and low-pressure fuel filters.
- A pressure control regulator that reduces the high fuel tank or cylinder pressure to the lower pressure needed for the engine.
- A fuel contents gauge that indicates the fuel supply in the tank or cylinders.

Safety Precautions

DANGER

Natural gas is highly flammable. Failure to observe the following safety precautions could lead to the ignition of the natural gas, which could cause serious bodily injury or death.

Follow these safety precautions when operating or repairing a natural gas vehicle.

- Do not start the engine if a natural gas leak is detected.
- Never cut or weld on the CNG fuel cylinders. Severe bodily injury or fire could result.
- Do not transfer CNG from one vehicle to another, as a buildup of static electricity could cause a spark and ignite the fuel.
- Do not attempt to cut any fuel supply piping components.
- CNG is highly flammable. Avoid open flames or sparks near a natural gas vehicle.
- Permit no smoking or other ignition sources within thirty feet of a natural gas vehicle.
- Have CO₂ fire extinguishers (ABC minimum) located in a highly visible and easily accessible location.
- Always purge the fuel lines before performing maintenance or repairs on a natural gas fuel system. To purge the lines, close the manual fuel shutoff valve, and start the engine. Let the vehicle idle until the fuel lines are empty and the engine stops.
- Always use a natural gas detector to test the system for leaks, whether an odor is present or not. Routinely inspect the fuel filtering and regulating mechanisms, and the fuel lines. A bubble solution can be used to pinpoint the exact location of leaks.
- Always tighten fasteners and fuel connections to the required torque specification. Overtightening or undertightening could cause leaks.
- Close the fuel shutoff valve(s) before performing maintenance and repairs.
- Do not bring a natural gas vehicle indoors unless the workshop is equipped with a methane detection and ventilation system. Do not store

Compressed Natural Gas Fuel System

a natural gas vehicle indoors for an extended period of time.

In Case of Emergency

If a vehicle has sustained damage or a leak has been discovered:

1. Turn the ignition switch off, set the parking brake, and disconnect the battery.
2. Remove all ignition sources from the area surrounding the vehicle.
3. If it is safe to do so, close all fuel shutoff valves.
4. Open the vehicle doors to introduce fresh air.
5. Use a natural gas detector to identify leaks in the fuel system.

Fuel Tank Filling Procedures

CNG is moved from the fuel station storage tanks to the vehicle cylinders through a metered dispenser. During fueling, as pressure inside of the vehicle cylinders increases, so does the temperature. The dispenser shuts off when it determines the CNG cylinders are full.

CNG fuel cylinders cannot be filled to their full capacity of 3600 psi (24 800 kPa) in cooler weather. Since temperature change causes gas to expand and contract, less pressure in the cylinders on a cold day is equal to the same amount of gas at a higher pressure on a warm day. The fuel station dispenser has a temperature-pressure compensating device, which accounts for ambient temperature during fueling. See **Table 18.1** for approximate full cylinder pressures at various temperatures.

CNG Temperature/Pressure Compensation Values		
Temperature: °F (°C)	Fill Station Pressure Set Point	
	3000 psi (20 684 kPa) Set Point	3600 psi (24 821 kPa) Set Point
100 (37.8)	3415 (23 546)	4086 (28 172)
90 (32.2)	3276 (22 587)	3909 (26 952)
80 (26.7)	3138 (21 636)	3754 (25 883)
70 (21.1)	3000 (20 684)	3600 (24 821)
60 (15.6)	2861 (19 726)	3445 (23 752)
50 (10)	2723 (18 774)	3288 (22 670)
40 (4.4)	2584 (17 816)	3131 (21 587)
30 (-1.1)	2446 (16 865)	2973 (20 498)
20 (-6.7)	2307 (15 906)	2814 (19 402)
10 (-12.2)	2169 (14 955)	2655 (18 306)
0 (-17.8)	2031 (14 003)	2495 (17 202)

CNG Temperature/Pressure Compensation Values		
Temperature: °F (°C)	Fill Station Pressure Set Point	
	3000 psi (20 684 kPa) Set Point	3600 psi (24 821 kPa) Set Point
-10 (-23.3)	1893 (13 052)	2336 (16 106)
-20 (-28.9)	1755 (12 100)	2180 (15 031)
-30 (-34.4)	1616 (11 142)	2024 (13 955)
-40 (-40)	1477 (10 184)	1868 (12 879)

Table 18.1, CNG Temperature/Pressure Compensation Values

Use the following steps to fuel a CNG vehicle.

CAUTION

Wear eye protection and cover exposed skin when working on a natural gas fuel system or fueling a natural gas vehicle. Failure to do so could result in personal injury.

1. Shut down the engine and apply the parking brake.

IMPORTANT: Close all windows and doors during the fueling process. Keeping windows and doors closed allows for easier leak detection inside the cab after fueling.

WARNING

Natural gas fuel tanks, lines, and valves are always pressurized. Always observe safety precautions. Failure to do so could lead to loss of control over a filling hose or to ignition of the natural gas, which could cause severe property damage, serious bodily injury, or death.

2. Ensure all fuel cylinder shutoff valves are open.
3. Ensure the vehicle fuel system manual shutoff valve is open. See **Fig. 18.1**.
4. Open the CNG fuel panel access door and remove the dust cap from the vehicle fuel fill port.
5. Ensure the O-ring is present inside the fuel fill port. If the O-ring has been dislodged or is missing, the station dispensing nozzle will not connect securely to the fill port.
6. Turn the selector knob on the service pump to the vent position, if equipped.
7. Connect the quick coupling on the dispensing nozzle securely to the vehicle fuel fill port.

Compressed Natural Gas Fuel System

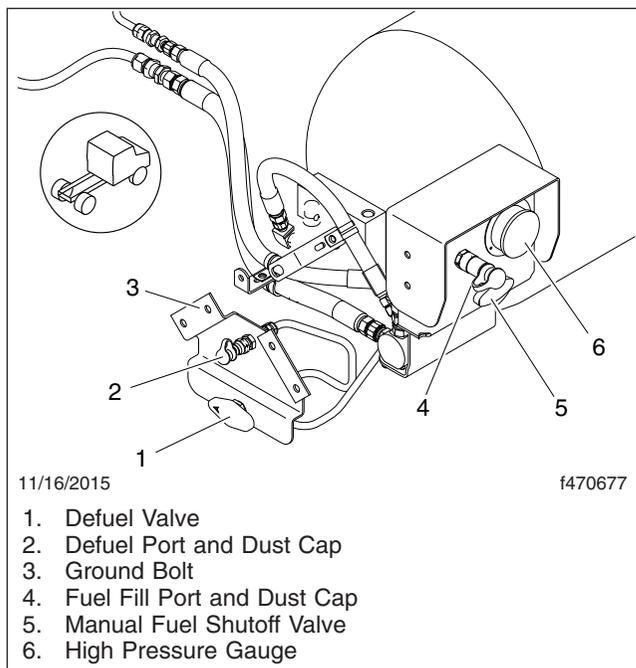


Fig. 18.1, CNG Fuel Panel

8. Turn the selector knob on the service pump to the fill position, if equipped.

WARNING

If at any time the service pump or vehicle begins to vent CNG uncontrollably, notify a station attendant or activate the service station emergency shut-off switch to cease the flow of CNG and avoid property damage and/or severe personal injury.

9. Switch on the service pump. A slight hissing noise may be heard as the fuel cylinders fill.
10. Watch the pressure gauge on the service pump. When the gauge reads approximately 3600 psi (24 800 kPa), or when the fill pressure stops climbing, the CNG cylinders are full. The service pump will shut itself down automatically. See [Table 18.1](#) for pressure compensation values based on ambient temperatures.
11. Move the selector knob on the service pump to the vent position, if equipped. A short hiss will be heard as a small amount of natural gas is vented into the hose.

WARNING

Do not attempt to remove the fill station nozzle from the tank fill fitting until venting of pressure is noted. If no venting occurs, ask for assistance from the station attendant. Removing an unvented coupling could result in an uncontrolled hose, which could lead to property damage or personal injury.

12. Remove the station dispensing nozzle from the vehicle fill port.
13. Install the dust cap on the vehicle fuel fill port and close the fuel panel access door.

Defueling CNG

Follow the instructions below for defueling, if the CNG cylinder(s) need to be emptied for any reason.

1. Prepare the vehicle for defueling.
 - 1.1 Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
 - 1.2 Turn the battery disconnect switch to the off position.
 - 1.3 Open the fuel access door.
 - 1.4 Note the fuel pressure on the high-pressure gauge (CNG tank pressure).
 - 1.5 Turn the three-way defueling valve to the vent position.
 - 1.6 Ground the CNG defueling hose to the ground bolt.
 - 1.7 Connect the CNG defueling hose to the vehicle by pulling back on the quick-connect collar on the hose and then push it on the vehicle coupler to make the connection.
2. Carefully attach the CNG defueling hose to the fuel connection on the empty storage tank and open the fuel valve on the nozzle, if so equipped.
3. CNG can be defueled from the vehicle to the empty storage tank. Slowly turn the three-way valve from the vent position to the defuel position on the vehicle.
4. Adjust the fuel flow to a steady flow rate. Too fast of a flow rate will cause the system to freeze up.

Compressed Natural Gas Fuel System

- When the gas stops flowing, look at the high-pressure gauge and verify the gas pressure. The CNG tank pressure gauge on the vehicle should be at or near zero.

WARNING

Fuel pressure in the hose will vent through the defuel valve on the vehicle. Natural gas fuel tanks, lines, and valves are always pressurized. Always observe safety precautions. Failure to do so could lead to loss of control over a filling hose or to ignition of the natural gas, which could cause serious bodily injury, death, or severe property damage.

- Turn the three-way valve on the vehicle from the defuel position to the vent position, and disconnect the hose from the fuel connection on the storage tank.
- Turn the three-way valve on the vehicle from the vent position to the off position.
- Disconnect the fuel hose from the vehicle. Pull back on the quick connect collar on the hose and pull the hose away from the vehicle coupler.
- Remove the defueling hose from the ground bolt.
- With the tires chocked, turn the battery disconnect switch to the on position and start the engine.
- Operate the engine at high idle until the engine stalls. Verify that the CNG tank pressure gauge reads zero after the engine stalls. Ensure that the engine will crank, but not start.

Engine Starting

NOTE: Before starting the engine, read [Chapter 4](#) for detailed information on how to read the optional instruments, [Chapter 5](#) for detailed information on how to operate the controls, and *Instrumentation Control Unit* in this chapter on how to read the instrument panel and gauges. Read the operating instructions in the engine manufacturer's operation manual before starting the engine.

- Before engine start-up, complete the engine pre-trip and post-trip inspections and maintenance procedures in [Chapter 12](#).
- Ensure the fuel shutoff valve is open.
- Set the parking brake.

- Ensure that the transmission shift control is in Neutral (N), Park (P), or the Park Brake (PB) position.
- Without starting the engine, turn the ignition switch to the ON position, shown in [Fig. 18.2](#). The electronic gauges on the instrumentation control unit (ICU) will complete a full sweep of their dials, the warning and indicator lights will illuminate, and the buzzer will sound for 3 seconds.

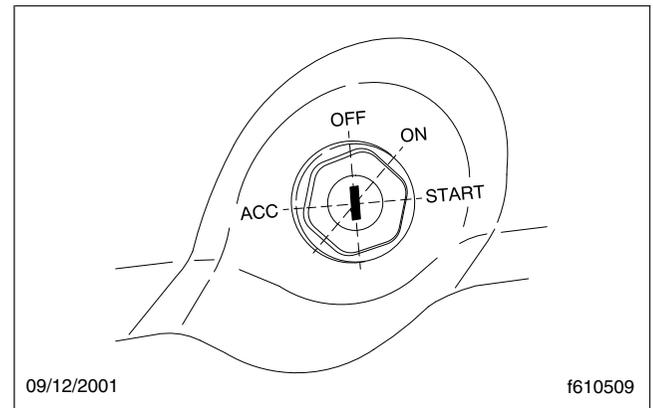


Fig. 18.2, Ignition Switch Positions

- Turn the ignition switch to the START position. Do not press down on the accelerator pedal. Release the key the moment the engine starts.
- Bring the engine up to operating speed gradually as it warms up and develops stable oil pressure. If the vehicle has not been operated previously in a 24-hour period, allow the vehicle to idle for five minutes.

NOTICE

Do not rev the engine if the oil pressure gauge indicates no oil pressure. Shut down the engine within approximately ten seconds to avoid engine damage.

- Check the oil pressure gauge for any drop in lubricating oil pressure or mechanical malfunction in the lubricating oil system.

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Major Repair and Replacement of Compressed Natural Gas Components

If a CNG-fueled vehicle is involved in an accident, remove the fuel cylinders from service and have them inspected by a qualified technician. Replace any leaking or damaged fuel cylinders and fuel lines; repair or replace leaking or damaged fittings. Install parts and components in accordance with the manufacturer's instructions.

Instrumentation Control Unit

The following information describes the instrumentation control unit (ICU3S) panel, used with compressed natural gas (CNG) engines. The instrument panel is shown in [Fig. 18.3](#).

NOTE: This instrument panel is shown with a standard U.S. speedometer, which shows miles per hour (mph) more prominently than kilometers per hour (km/h). Instruments and controls, and their locations, may vary from those shown.

The ICU3S instrument cluster receives information from the datalink and sensors installed on the vehicle, and sends 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.

Dash Message Center

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.

Ignition Sequence

When the ignition is turned on, all of the electronic gauges complete a full sweep of their dials, the warning and indicator lamps illuminate, 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 lamps illuminate during the ignition sequence:

- fasten seat belt warning
- 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 lamps, including check engine and stop engine
- all ABS indicator/warning lamps, including wheel spin, and tractor ABS (if installed)

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

When the ignition switch is turned on, the ICU3S 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
- Fourth line: SERVICE 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.

NOTE: If active faults are present, take the vehicle to an authorized Thomas Built Bus service facility as soon as possible.

If the fault requires immediate attention, the stop engine system will activate. In most cases, the check engine lamp will also illuminate.

Some examples include:

- high coolant temperature
- low air pressure

Compressed Natural Gas Fuel System

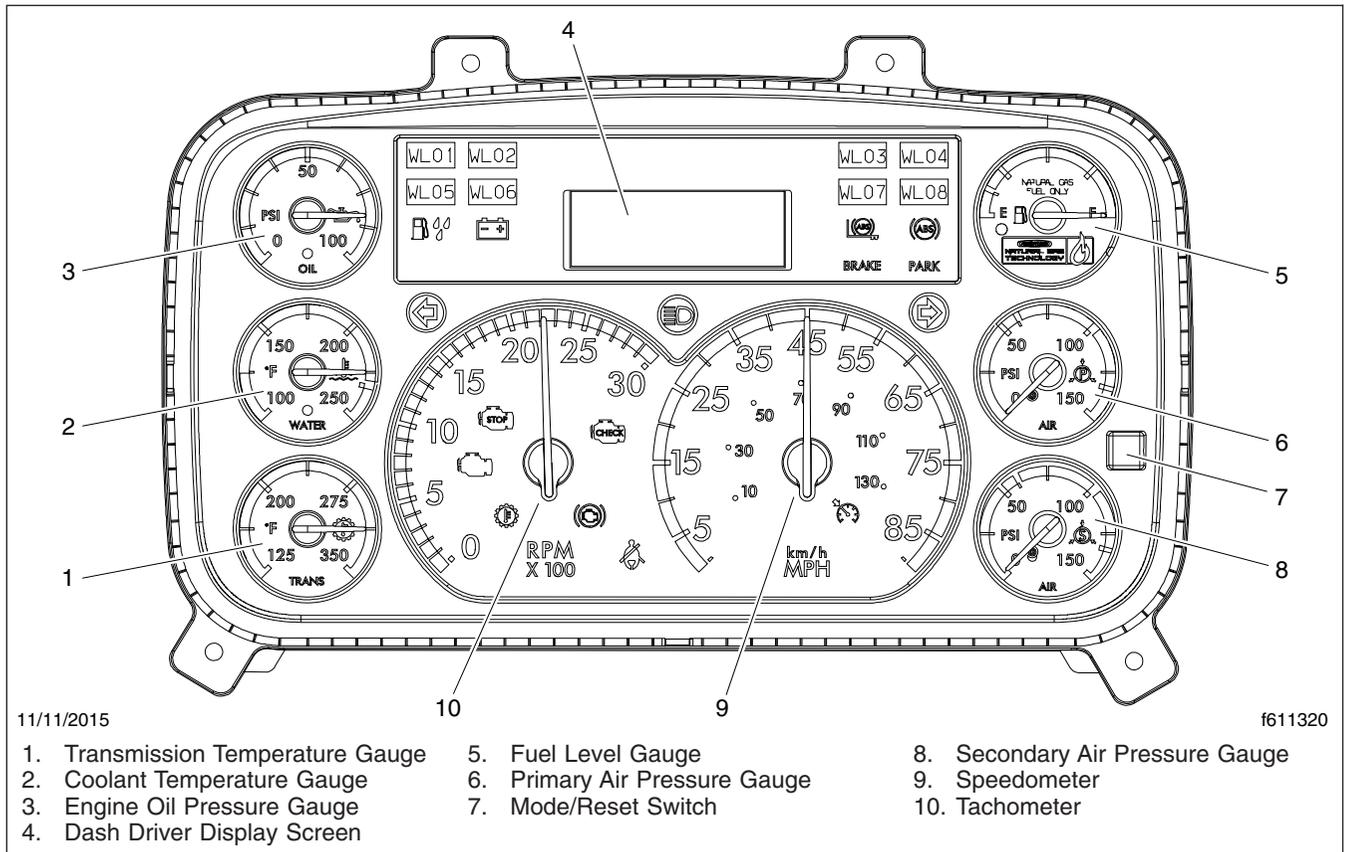


Fig. 18.3, Gauge Layout (typical, U.S.), EPA10 and Newer Engines

- low coolant level
- low engine oil pressure

NOTE: The check engine lamp 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.

IMPORTANT: If the legend SERVICE ENGINE appears on the driver display screen while operating the vehicle, bring the vehicle to an authorized Thomas Built Bus service facility when convenient.

Odometer

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 1,000,000, without the decimal point, and can continue up to 9,999,999. The odometer only displays significant figures (no leading zeros).

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.

Mode/Reset Switch

The mode/reset switch, shown in **Fig. 18.4**, 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.

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

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

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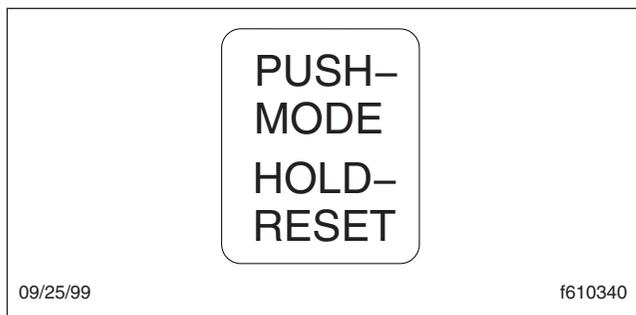


Fig. 18.4, Mode/Reset Switch

- 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 Lamps

There can be up to 24 warning and indicator lamps (telltales) installed in the dash message center. See [Fig. 18.5](#).

The instrument cluster has an emergency buzzer that sounds when serious conditions that require immediate attention occur.

A description of the standard warning and indicator lamps are listed below.

Left-Turn Indicator

The left-turn indicator flashes on and off when the left-turn signal lights are flashing.

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

Low Battery Voltage Warning

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

Low Air Pressure Warning

The low air pressure warning indicator (BRAKE 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.

ABS Warning

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

NOTE: For more information about this indicator and the ABS system, see [Chapter 10](#).

Parking Brake On Warning

The parking brake on indicator activates when 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.

Right-Turn Indicator

The right-turn indicator flashes on and off when the right-turn signal lights are flashing.

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

Headlight High-Beam Indicator

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

Cruise Control Indicator

The cruise control indicator illuminates when the cruise control is activated.

Fasten Seat Belt Warning

The fasten seat belt warning indicator (seat belt icon) illuminates for 3 seconds after the ignition switch is turned on.

When the engine is operating, if the driver's seat belt is unfastened and the park brake is not set, the seat belt warning indicator illuminates and a warning chime activates. The warning chime will remain active for 10 seconds. The warning indicator remains illuminated until the driver's seat belt is fastened.

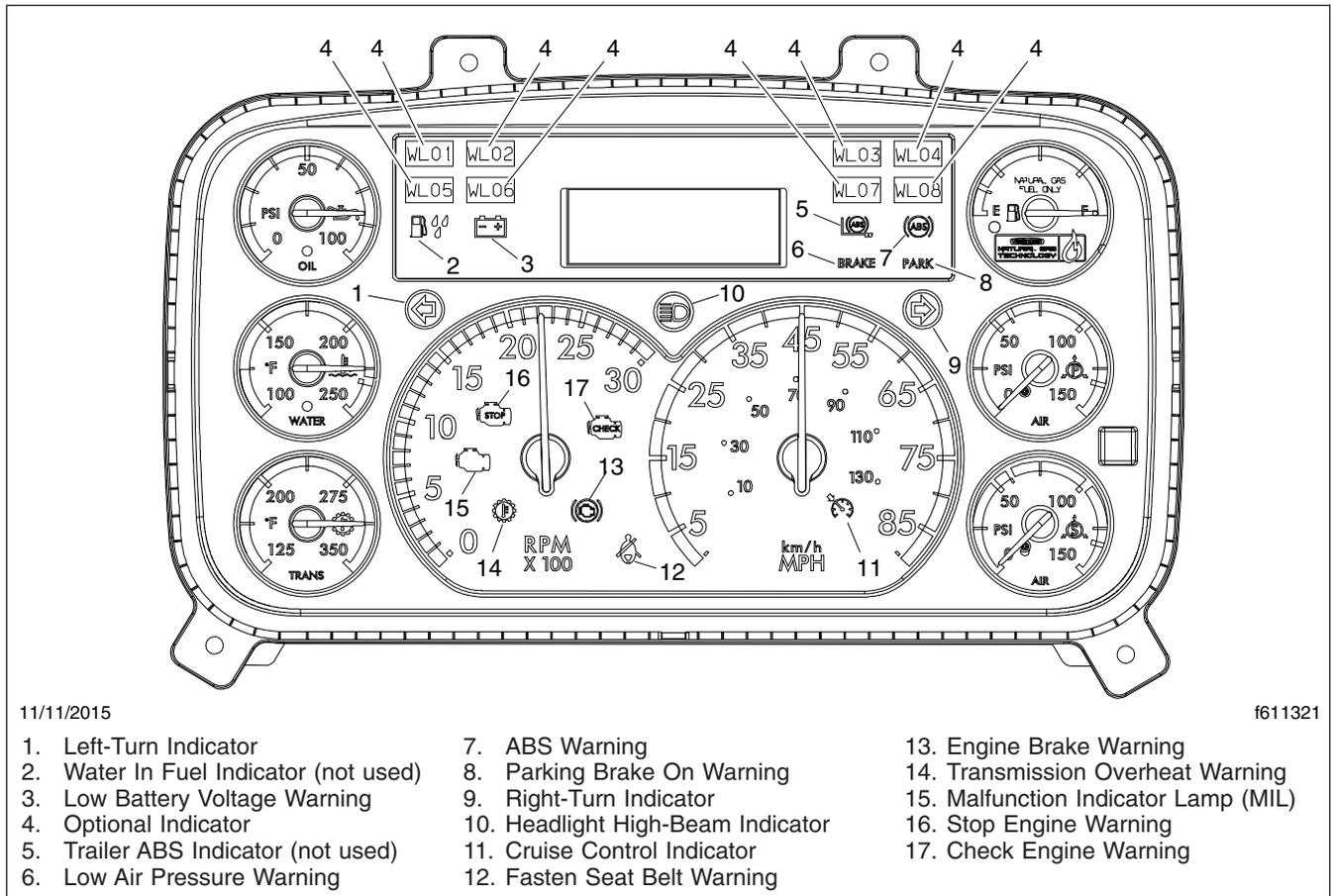


Fig. 18.5, ICU3S Warning and Indicator Lamps, EPA10 and Newer Engines

Engine Brake Warning

The engine brake warning indicator indicates the engine brake is enabled.

Transmission Overheat Warning

The transmission overheat indicator 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.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) indicates an engine emissions-related fault. See the engine operation manual for details.

Stop Engine Warning



When the red STOP engine lamp 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 stop engine warning indicator illuminates when the protection system available for the engine has been activated. On some engines, the engine electronic control unit (ECU) will derate the engine, allowing it to run, but at lower rpm and slower vehicle speed. The vehicle may be driven to a safe location.

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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 stop engine indicator 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.

Check Engine Warning

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

NOTE: If the check engine indicator illuminates during vehicle operation, take the vehicle directly to an authorized Thomas Built Bus service facility.

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 18.2](#).
- The coolant temperature rises above the preset level, which is 225°F (107°C).
- 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).

Oil Pressure Specifications*		
Engine Model	At Idle Speed: psi (kPa)	At Rated RPM: psi (kPa)
Cummins ISB	10 (69)	30 (207)

* Oil pressure is 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.

Table 18.2, Oil Pressure Specifications

Optional Warning and Indicator Lamps

A description of some commonly used optional warning and indicator lamps are listed below.

Air Filter Warning

The air filter warning indicator (AIR FILTER legend) illuminates when the air cleaner filter element is clogged, restricting the intake air flow below 25 inH₂O.

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

IMPORTANT: Never attempt to clean the air filter.

Check Transmission Warning

NOTE: Although it appears in the row of optional indicators, the check transmission indicator is a standard indicator.

The check transmission indicator, shown in [Fig. 18.6](#), notifies the driver of three things. Any of the following items could be the cause for activating the indicator:

- the oil needs to be changed
- the filter[s] need to be changed
- clutch maintenance is required

When the check transmission indicator illuminates, refer to the *Allison Operator's Manual* or contact customer support at Allison Transmission to determine the specific cause activating the indicator.

Low Fuel Pressure Warning

The low fuel pressure warning indicator, shown in [Fig. 18.7](#), notifies the driver that the CNG fuel cylinders need to be refilled.

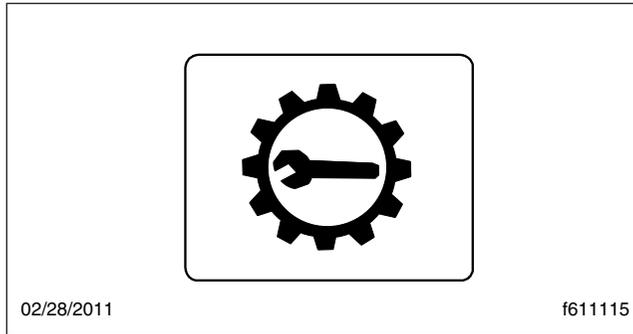


Fig. 18.6, Check Transmission Indicator

When the low fuel pressure indicator illuminates, there is less than 1/8th fuel capacity, which is approximately 260 psi (1793 kPa) in the fuel cylinders.

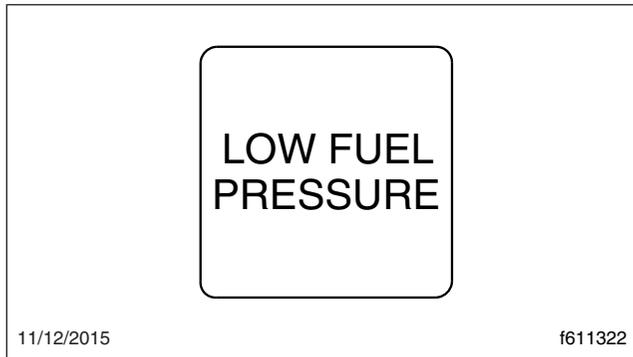


Fig. 18.7, Low Fuel Pressure Indicator

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. 18.8](#).

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

Tachometer

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. 18.8](#).

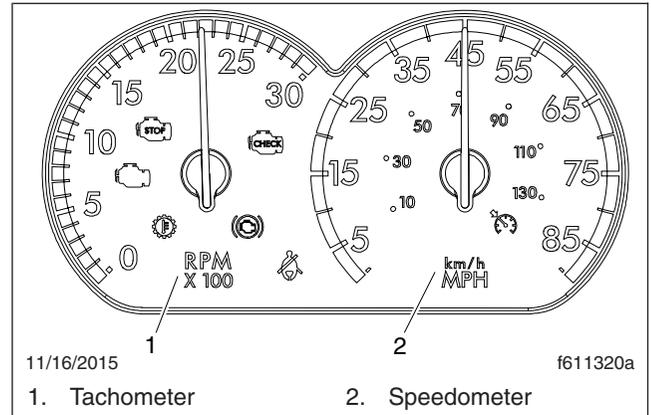


Fig. 18.8, Speedometer and Tachometer (U.S. version)

Standard Instruments

Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tanks. See [Fig. 18.9](#). A low-level warning lamp illuminates when the fuel level registers less than 1/8th fuel capacity, which is approximately 260 psi (1793 kPa) in the fuel cylinders.

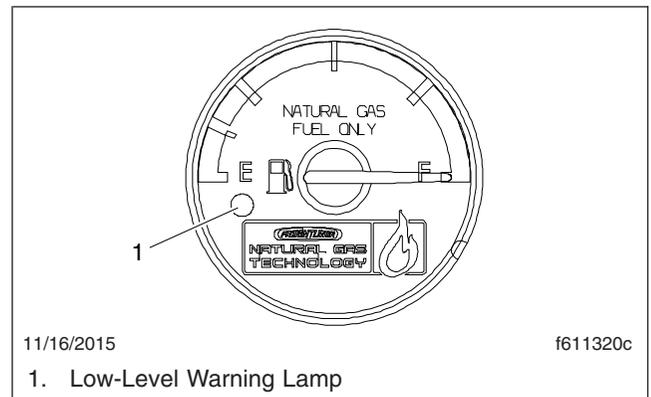


Fig. 18.9, Fuel Level Gauge

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. Do not attempt to move the vehicle until air pressure has risen above the minimum level. Moving a vehicle without adequate braking power could

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cause an accident resulting in property damage, 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. 18.10**.

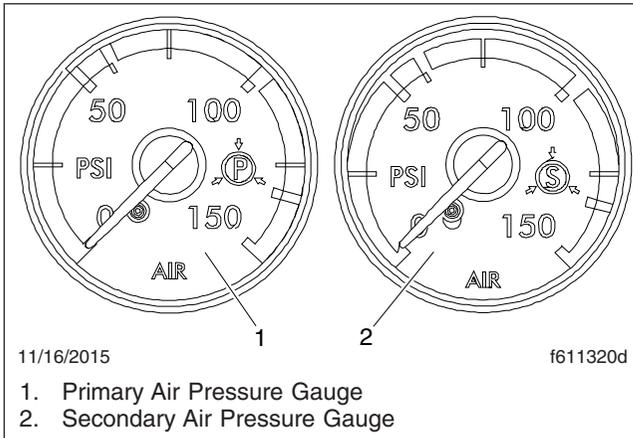


Fig. 18.10, Air Pressure Gauges

Air pressure gauges are required on all vehicles with air brakes. A low-air-pressure warning lamp 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 lamp and buzzer remain on until air pressure in both systems exceeds minimum pressure.

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 200 to 205°F (93 to 96°C). See **Fig. 18.11**. If the temperature remains below 160°F (71°C) or exceeds 235°F (113°C), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

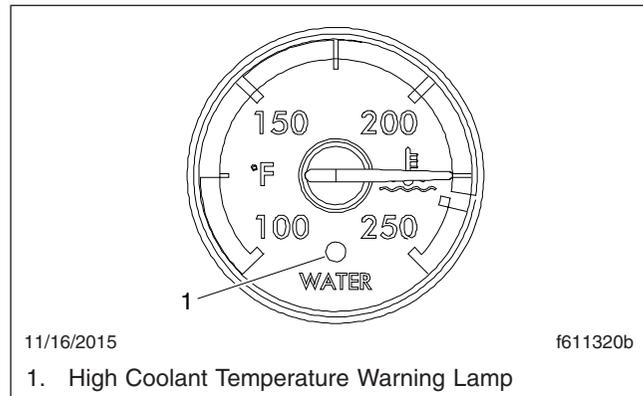


Fig. 18.11, Coolant Temperature Gauge

If the coolant temperature rises above 253°F (123°C), the check engine and stop engine lamps will illuminate, and the buzzer will sound. At this point, the engine will derate and idle speed will increase, to speed up the cooling fan and water pump to cool the engine.

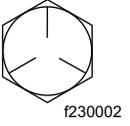
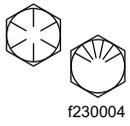
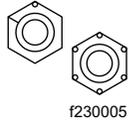
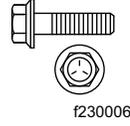
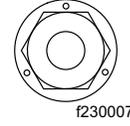
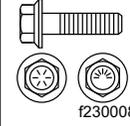
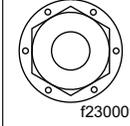
19

Specifications

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Replacement Light Bulbs	19.5

Specifications

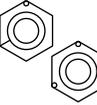
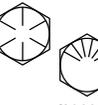
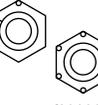
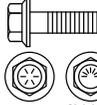
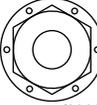
Torque Charts

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, Geomet 321XL coated, or waxed).

Table 19.1, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads

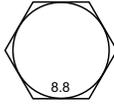
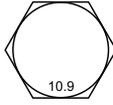
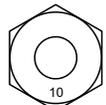
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter—Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)		Torque: 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 19.3](#). FCCC recommends that all plated and unplated fasteners be coated with oil before installation.

Table 19.2, 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, Geomet 321XL coated, or waxed).

Table 19.3, 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 19.4, 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)	degrees Celsius (°C)	1.8	32	degrees Fahrenheit (°F)

Table 19.5, Temperature Conversion

Specifications

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 HD5 Grade Propane Compressed Natural Gas (CNG)
Disc Brake Caliper Rails	FCCC No. 4JD623 Brake Caliper Slide Grease
Rear Axle Differential	See Manufacturer's Recommendations
Hydraulic System Reservoir	ATF must meet Dexron® III or TES-389 specifications
Engine Coolant	Refer to the engine manufacturer's service literature for approved coolant.

Table 19.6, Fluid and Lubricant Specifications

Fuse Information

Main PDM 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

Main PDM Fuse Identification		
CAV	Description	Fuse
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 19.7, Main PDM Fuse Identification

Replacement Light Bulbs

Replacement Light Bulbs	
Light Location	Lamp Trade Number
Warning Panel Lights	53 or LB-0108
Headlights MB and XB;	2A1
High Beam	1A1
Low Beam	2B1
Gauge Illumination	53, 194 or LB-0107

Replacement Light Bulbs	
Light Location	Lamp Trade Number
Automatic Transmission Gear Selector	53

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