



RECREATIONAL VEHICLE CHASSIS

Operator'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.

Freightliner chassis are equipped with various chassis and driver controls. The coverage in this manual applies to all recreational vehicle chassis in general and everything may not apply specifically to your vehicle, due to optional component offerings. Component coverage specific to the front-engine diesel chassis can be found in **Chapter 8**. If parts on your chassis differ from those shown, they may have been installed by the vehicle final-stage manufacturer.

The safety or performance of your vehicle could be adversely affected by the installation of nonstandard components. Note the limitations and specifications provided in the vehicle and chassis manuals, and consult Freightliner Custom Chassis Corporation before making any alterations to the chassis.

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. Freightliner Custom Chassis Corporation 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 *Recreational Vehicle Chassis 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

Foreword

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 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.

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, or breakdown coordination. Our people are knowledgeable, professional, and committed to keeping your vehicle moving.

Reporting Safety Defects

If you believe that your vehicle has a defect that 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 Freightliner Custom Chassis Corporation.

If the 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 Freightliner Custom Chassis Corporation.

To contact NHTSA, you may call the Vehicle Safety Hotline toll-free at 1-888-327-4236 (TTY:

1-800-424-9153); go to www.safercar.gov; or write to: Administrator, NHTSA, 1200 New Jersey Avenue, SE, Washington, DC 20590. You can also obtain other information about motor vehicle safety from www.safercar.gov.

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

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

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Vehicle Identification

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Vehicle Identification

Component Information Label

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

The component information label lists the manufacturer, month and year of manufacture, vehicle identification number (VIN), gross vehicle weight rating (GVWR), front and rear gross axle weight ratings (GAWR), and tire and wheel information. It also indicates if the vehicle has been certified as compliant with Federal Motor Vehicle Safety Standard (FMVSS). See [Fig. 1.1](#).

The image shows a rectangular label with a white background and a black border. At the top, it reads "INCOMPLETE VEHICLE IDENTIFICATION DATA". Below this is the Freightliner logo, which includes the word "FREIGHTLINER" in a stylized font and "A Subsidiary of FREIGHTLINER LLC" underneath. The main body of the label contains the following text: "INCOMPLETE VEHICLE MANUFACTURED BY: FREIGHTLINER CUSTOM CHASSIS CORPORATION GAFFNEY, SOUTH CAROLINA 29341", "INCOMPLETE VEHICLE DOM:", "VIN:", "GVWR/PNBV:", "GAWR/PNBE:", "FRONT =", "WITH TIRES RIMS (COLD)", "PRESSURE =", "FIRST INTMD =", "WITH TIRES RIMS (COLD)", "PRESSURE =", "REAR =", "WITH TIRES RIMS (COLD)", "PRESSURE =", "VEHICLE TYPE:", "MODEL:", "NOTE: ALL WEIGHTS LISTED IN kg (lb) PRESSURES LISTED IN kPa (psi)", and "OVERSPEEDING OR OVERLOADING WILL VOID WARRANTY. THE ABOVE DATA REPRESENTS ORIGINAL EQUIPMENT." At the bottom left, it says "09/11/2002" and at the bottom right, it says "f080123".

Fig. 1.1, Component Information Label

The tire and rim portion of the component information 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

tire and rim label, then the tires and rims determine the load limitations on each of the axles.

Incomplete chassis intended for service in the U.S. have an incomplete vehicle certification label attached by the final-stage manufacturer. 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.

Vehicle Identification Number

The chassis vehicle identification number (VIN) is stamped on a metal plate permanently attached to the vehicle, and the last six digits (designating the chassis serial number) are stamped into the metal frame. See [Fig. 1.2](#). A VIN label is also mounted by the body builder. Mounting locations vary, to include the glove box. See [Fig. 1.3](#).

The image shows a rectangular label with a white background and a black border. At the top, it reads "FREIGHTLINER CUSTOM CHASSIS CORPORATION". Below this is the VIN "4UZA4FVC0TC748531" in a large, bold font. Underneath the VIN is "GAFFNEY, SOUTH CAROLINA, USA". At the bottom left, it says "04/18/2005" and at the bottom right, it says "f080061a".

Fig. 1.2, Vehicle Identification Number, Typical

NOTE: Always include the chassis serial number (last six digits of the VIN) when communicating to Daimler Trucks North America.

Emissions Labels

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](#).

A reference label included with the driver's documentation package contains important warning indicators

Vehicle Identification

in the instrument cluster that pertain to the ATS. See **Fig. 1.4**.

It is a violation of U.S. federal law to alter exhaust plumbing, ATS, or other components in any way that

INCOMPLETE VEHICLE COMPONENT INFORMATION

INCOMPLETE VEHICLE MANUFACTURED BY:
FREIGHTLINER CUSTOM CHASSIS CORPORATION
GAFFNEY, SOUTH CAROLINA 29341
INCOMPLETE VEHICLE DOM:
VIN:

CHASSIS MODEL:
ENGINE MODEL:
TRANS MODEL:
FRONT AXLE MODEL:
REAR AXLE MODEL:

PAINT MFR:
PAINT NUMBER:



A Subsidiary of FREIGHTLINER LLC

USE VEHICLE ID NUMBER (VIN)
WHEN ORDERING PARTS.

WHEELBASE:
ENGINE NUMBER:
TRANS NUMBER:
FRT AXLE NUMBER:
REAR AXLE NUMBER:
REAR AXLE RATIO:

FOR COMPLETE PAINT INFORMATION
SEE VEHICLE SPECIFICATION SHEET.

FREIGHTLINER CUSTOM CHASSIS CORPORATION

GAFFNEY, SOUTH CAROLINA, USA

12/04/2001
f080122

Fig. 1.3, Vehicle Identification Number Label, Typical

EXHAUST AFTERTREATMENT SYSTEM INFORMATION					
INDICATOR LAMP(S)	 (Solid) Level 1	 (Flashing) Level 2	 (Flashing) CHECK Level 3	 Level 4	 WARNING
Indicator Lamp Message(s)	Filter Regeneration Recommended.	Filter Regeneration Necessary	Parked Regeneration Required – Engine Derate	Service Regeneration Required. Engine Derate To Idle Only.	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 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.					

02/20/2009
f080156

Fig. 1.4, ATS Indicators

Vehicle Identification

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). These vehicles are equipped with components that increase fuel efficiency and reduce GHG emissions. Components may include, but are not limited to, low-rolling resistance tires.

A Vehicle Emission Control Information Label indicates compliance with GHG14 regulations. See

Fig. 1.5. It is the owner's responsibility to maintain the vehicle so that it conforms to EPA and NHTSA regulations.

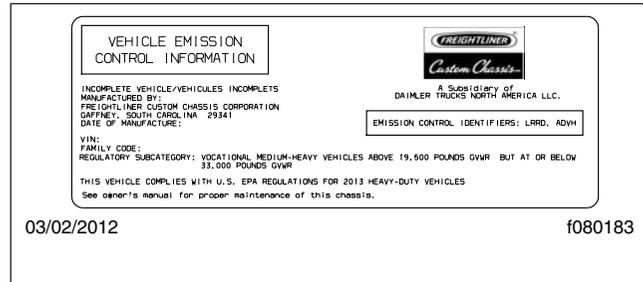


Fig. 1.5, Vehicle Emission Control Information Label

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	GHG14: Aerodynamic and fuel efficiency components including low-rolling resistance tires specifically designed to meet regulatory fuel efficiency and greenhouse gas emissions standards.

* 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

2

Instruments

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Instruments

Lightbar Control Unit (LBCU)

The lightbar control unit (LBCU) instrument cluster is a full-featured, individual-gauge cluster with an intelligent lightbar (ILB). The individual gauges have light emitting diode (LED) backlighting. The lightbar control unit receives inputs for the gauges. See [Fig. 2.1](#) and [Fig. 2.2](#) for a typical instrument gauge panel, and see [Fig. 2.3](#) and [Fig. 2.4](#) for the LBCU message center warning lights. See the other headings of this chapter for detailed information on warning indicator lights and other instruments.

IMPORTANT: The LBCU is capable of determining when input information is lost. The loss of input data will be noticeable to the operator by movement of the gauge to zero. The odometer value will not be driven to zero if total loss of vehicle distance data occurs. When data input is lost, hyphens (-) will replace the digits in the data field on the display screen.

NOTE: When the ignition is turned on, all of the indicator lights will illuminate for approximately three seconds to allow the operator to perform a bulb check.

IMPORTANT: If the warning system does not activate when the ignition switch is in the ON position, repair the system to provide proper warning protection.

Audible Alarms

During start-up, the LBCU will perform a self-test and an audible alarm will sound until the self-test is completed. If any faults are found during the self-test, ERROR will appear on the display screen. Acknowledge any alarms before proceeding to the pretrip checklist. The alarm will also sound if any of the following conditions occur:

- Air pressure falls below 65 psi (448 kPa).
- Anytime the low air warning light is activated. On the air system, the low air light/audible alarm will normally come on when the engine is first started, but will go off when the air pressure in the air tanks reaches approximately 65 to 76 psi (448 to 524 kPa). The parking brake will not disengage until the air pressure has reached 65 psi (448 kPa).
- Emergency engine shutdown is activated.

- The parking brake is applied and the transmission is not in neutral.
- The transmission is in neutral or the ignition is off, and the parking brake is not set and the service brake is not depressed.
- The turn indicator is active.
- Anytime the ignition is turned off when the panel lamps are still illuminated.

Emergency Shutdown

The LBCU will shut down if the voltage supply is not within the normal operating range of 9 to 16 volts for more than 10 milliseconds (msec). During emergency shutdown, the gauge pointers will freeze, the display will go blank, and the lamps will turn off. When the power is restored to within the normal operating range following an emergency shutdown, the needles will resynchronize to zero, and the self-test will be performed before resuming normal operation.

Information Center

The LBCU is an interactive graphical display that is capable of displaying text messages and graphics to communicate real-time information about the status and performance of the vehicle to the operator. This information is organized in a menu-structured format.

Power Initialization

When the ignition is turned on, the information center will illuminate with the Freightliner Custom Chassis logo. If there are no alarms detected from the self-test, the driver checklist is displayed.

Navigating the Menu Screen

Navigate the menu structure using the toggle switch, located in the driver's area. The "up" arrow of the toggle switch is yellow. See [Fig. 2.5](#).

Menu Structure

The menu structure is organized around three menu screens: the ignition off screen, the home screen, and the setup/maintenance/diagnostics screen. Each of these screens contains lists of the sub-menu screens that may be accessed by highlighting the desired sub-menu and clicking the right arrow on the toggle switch.

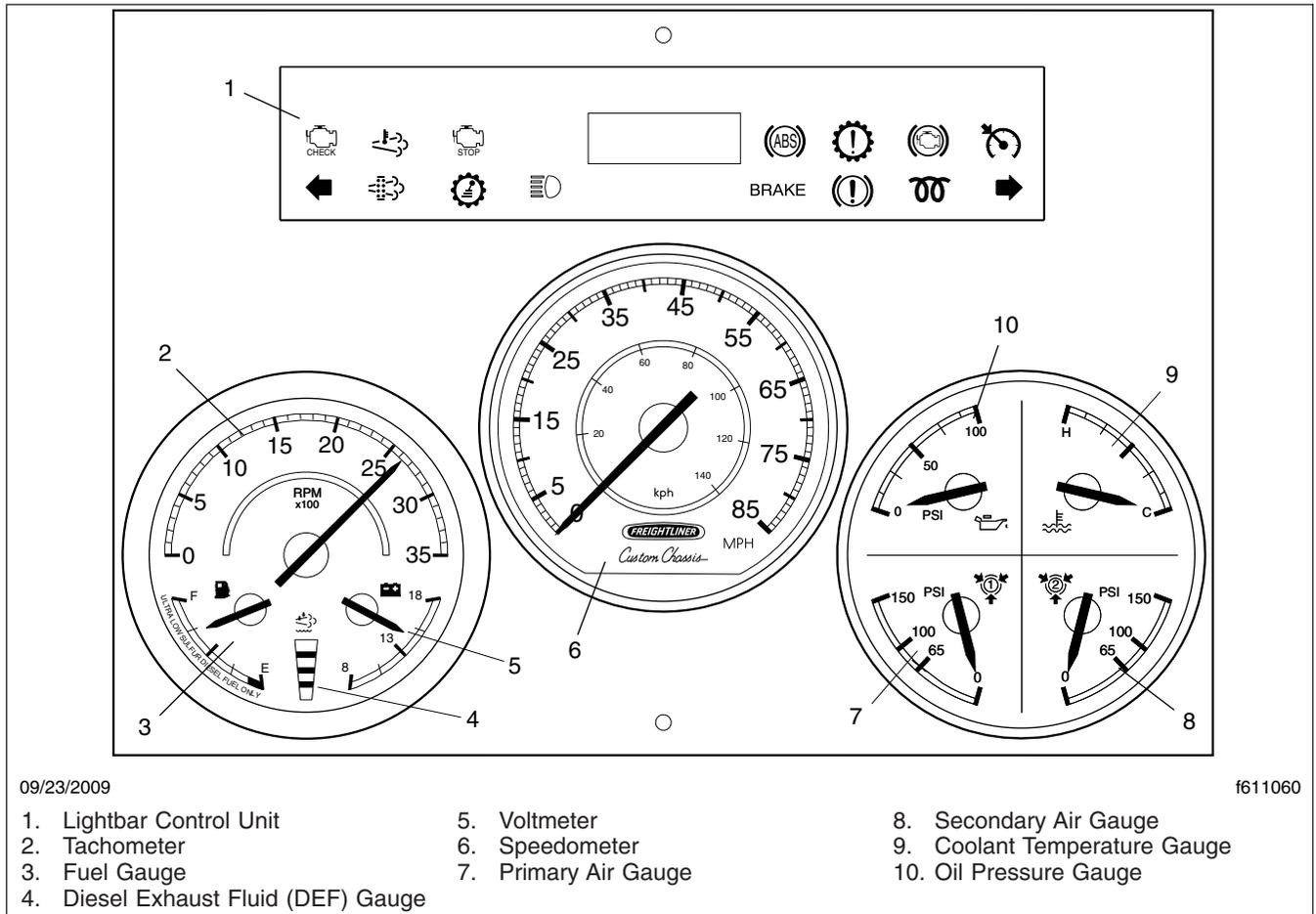


Fig. 2.1, Typical Instrument Panel, EPA10 and Newer Engines

Ignition Off Screen

When the ignition is OFF and the headlights are ON, the odometer is displayed. When the ignition is OFF and the generator is ON, the generator hours are displayed (if connected by the body builder).

Home Screen

NOTE: Alarm messages have priority over other display screens. If no alarms are present or all alarms have been acknowledged, the driver checklist will be displayed.

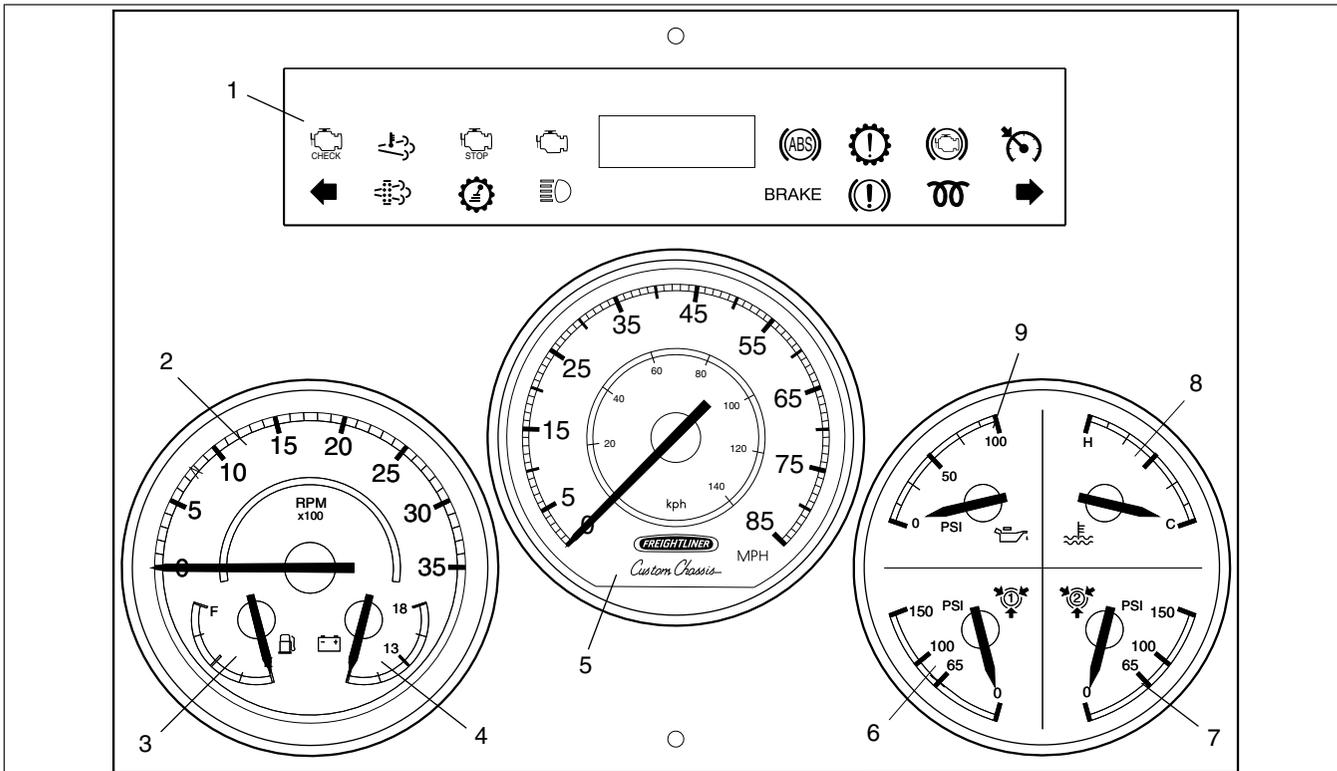
The following options are found in the menu and sub-menus of the home screen.

- A pretrip inspection checklist that includes 19 items and 10 driver-entered options. Once

each item has been reviewed, click the right arrow of the toggle switch to place a check by the item. Click the left arrow to exit the checklist.

- **Driver's Favorite Categories**—There are nine categories that the driver can select from; three can be viewed at one time. Select the category desired by using the up/down toggle switch. Then, click the right arrow of the toggle switch for three seconds to access the sub-menus within each category. Finally, click the left arrow of the toggle switch to exit.
- **Setup/Maintenance/Diagnostics** screen is actually three different categories for the driver to use. They are as follows:

Instruments

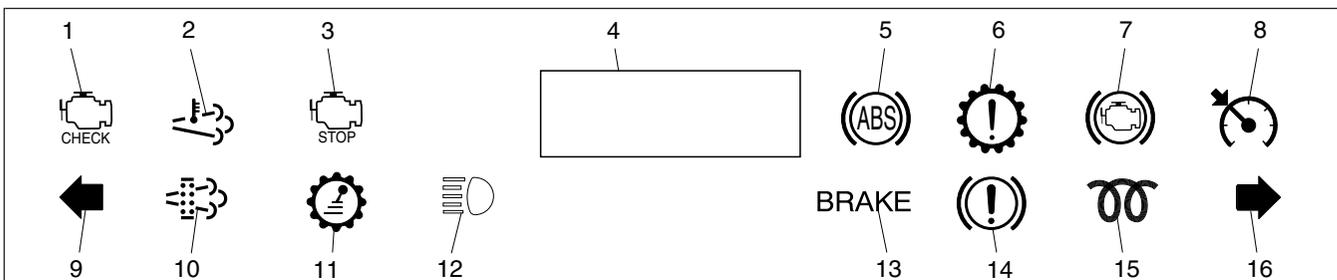


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- | | | |
|--------------------------|----------------------|------------------------------|
| 1. Lightbar Control Unit | 4. Voltmeter | 7. Secondary Air Gauge |
| 2. Tachometer | 5. Speedometer | 8. Coolant Temperature Gauge |
| 3. Fuel Gauge | 6. Primary Air Gauge | 9. Oil Pressure Gauge |

Fig. 2.2, Typical Instrument Panel, EPA07-Compliant



09/23/2009

f611067

- | | | |
|--|--|-----------------------------------|
| 1. Check Engine Indicator | 6. Check Transmission Indicator | 11. Shift Inhibit Indicator |
| 2. High Exhaust System Temperature (HEST) Lamp | 7. Engine Brake Engaged Indicator | 12. Headlight High-Beam Indicator |
| 3. Stop Engine Warning | 8. Cruise On Indicator | 13. Parking Brake Indicator |
| 4. Dash Driver Display Screen | 9. Left-Turn Signal Arrow | 14. Low Air Pressure Indicator |
| 5. ABS Indicator | 10. Diesel Particulate Filter (DPF) Lamp | 15. Wait to Start Indicator |
| | | 16. Right-Turn Signal Arrow |

Fig. 2.3, LBCU Message Center/Warning Lights, EPA10 and Newer Engines

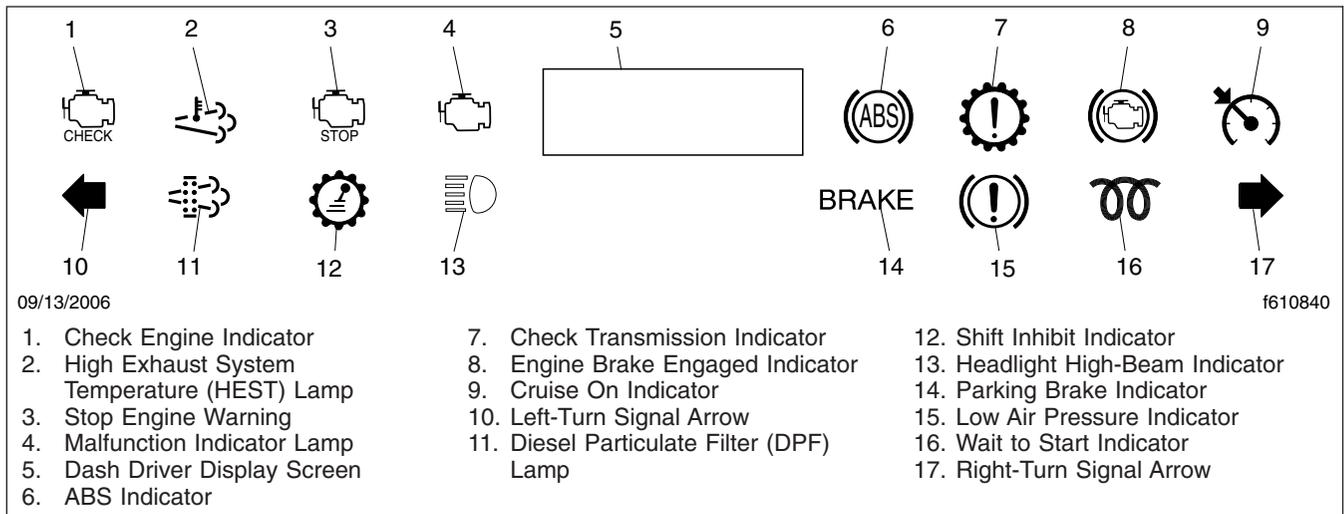


Fig. 2.4, LBCU Message Center/Warning Lights, EPA07-Compliant

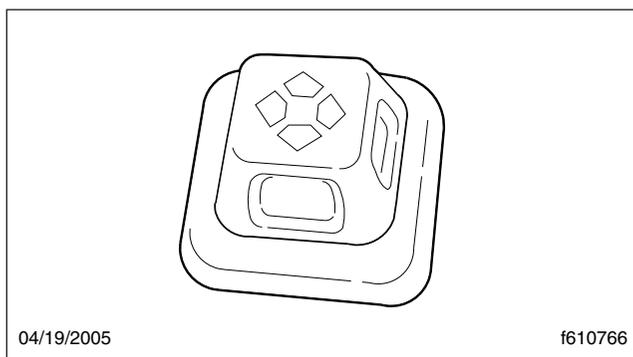


Fig. 2.5, Toggle Switch

1. Setup—Includes set time and date, configure checklist, select metric/english, set LCD properties.
2. Maintenance—Includes engine oil, engine air filter, engine fuel filter, transmission oil, generator oil, generator fuel filter, generator use time.
3. Diagnostics—Includes check gauges, check icons, check inputs, check outputs, engine diagnostics, ABS diagnostics, hardware/software version, and software debug display (this menu is used by the gauge manufacturer only).

The following steps are used to make changes within the various categories.

1. From the Driver's Favorite Category menu, hold down the right arrow of the toggle switch for five

seconds to select the setup/maintenance/diagnostics screen.

2. Press the down arrow on the toggle switch to select either setup, maintenance, or diagnostics.
3. Press the right arrow on the toggle switch to select the sub-category; "Set Time and Date" for example.
4. Use the left/right arrows on the toggle switch to change the information, and the up/down arrows to move within the sub-category.
5. Once all changes have been made, hold down the right arrow on the toggle switch.

Menu Structure

The menu structure road map is provided to illustrate the screens that are available in the information center and the path to specific screens. Refer to the road maps to set the time and date, view engine diagnostics, etc. See [Fig. 2.6](#), [Fig. 2.7](#), [Fig. 2.8](#), [Fig. 2.9](#), [Fig. 2.10](#), [Fig. 2.11](#), [Fig. 2.14](#), [Fig. 2.12](#), [Fig. 2.13](#), [Fig. 2.15](#), [Fig. 2.16](#), [Fig. 2.17](#), [Fig. 2.18](#), [Fig. 2.19](#), [Fig. 2.20](#), [Fig. 2.21](#), [Fig. 2.22](#), [Fig. 2.23](#), [Fig. 2.24](#), and [Fig. 2.25](#).

Ametek Instrument Panel

The following information describes a typical instrument panel manufactured by Ametek. See [Figure 2.26](#) and [Figure 2.27](#) for a typical instrument gauge

Instruments

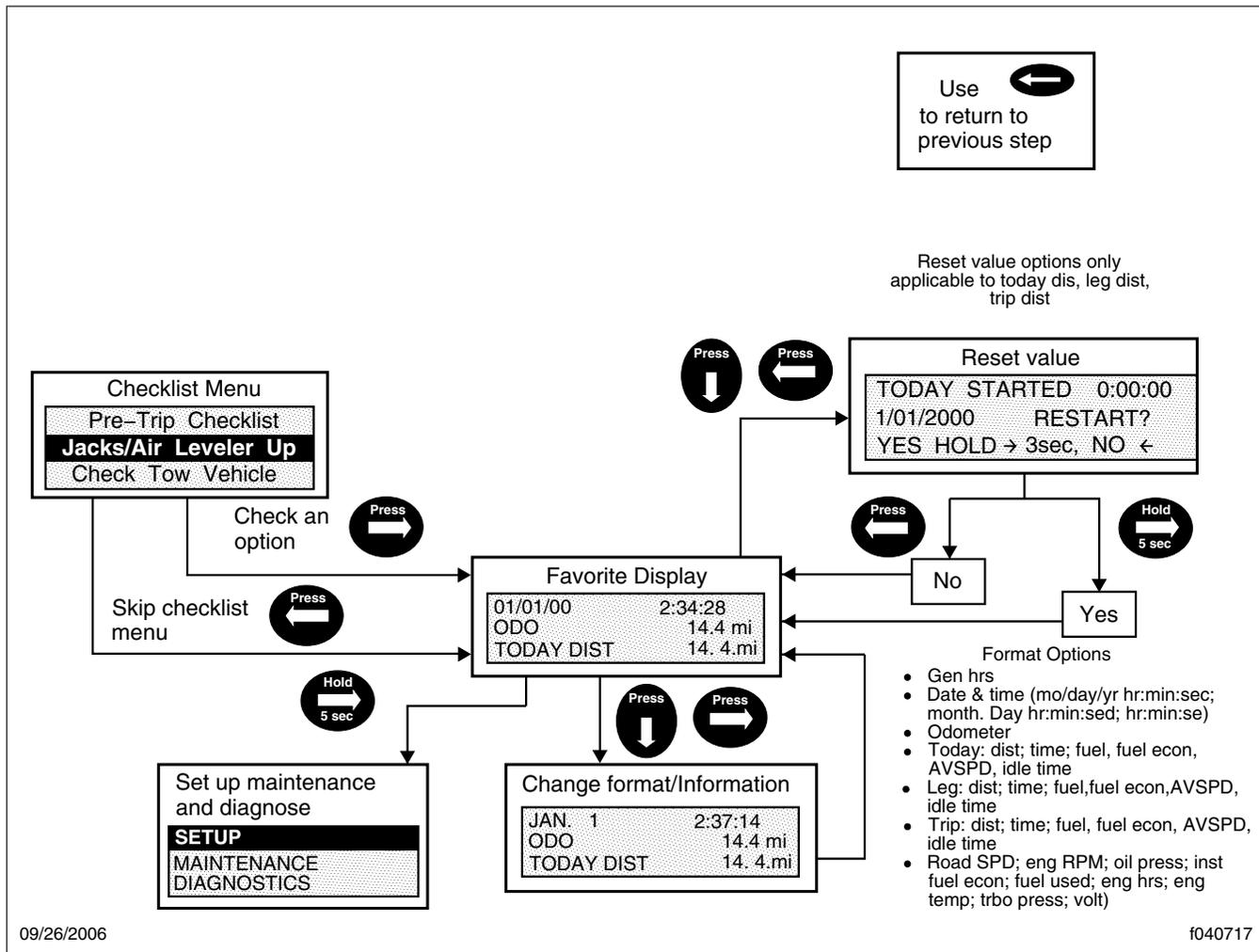


Fig. 2.6, Favorite Display

panel, and see [Figure 2.28](#) for the Ametek warning lights.

NOTE: These instrument panels are 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

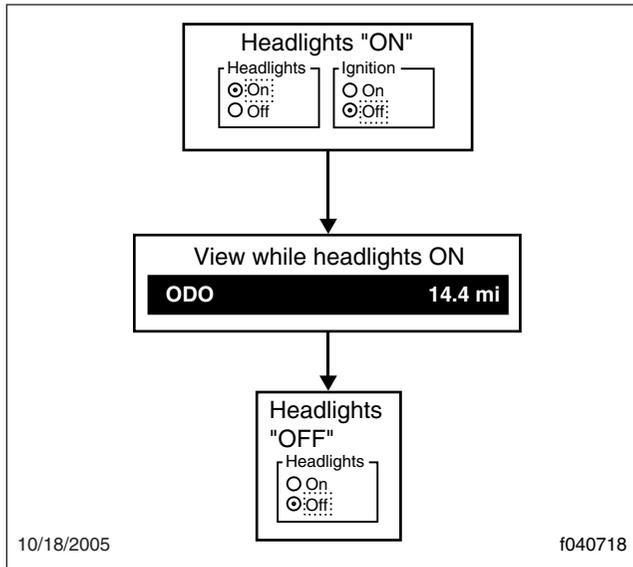


Fig. 2.7, View Odometer Value

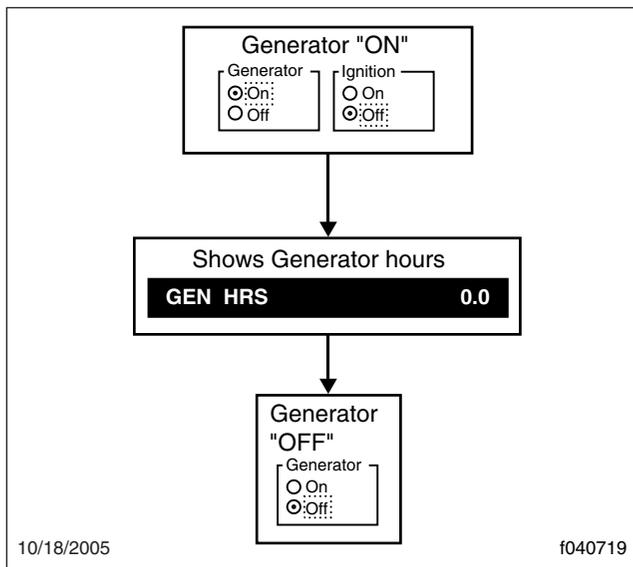


Fig. 2.8, View Generator Hours

- 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.

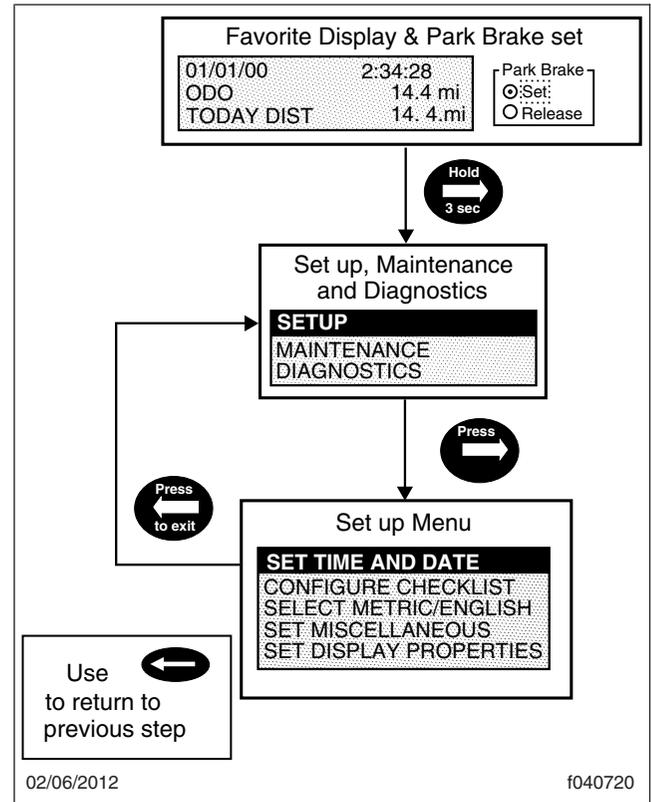


Fig. 2.9, Set Up Menu

Priority Messages

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

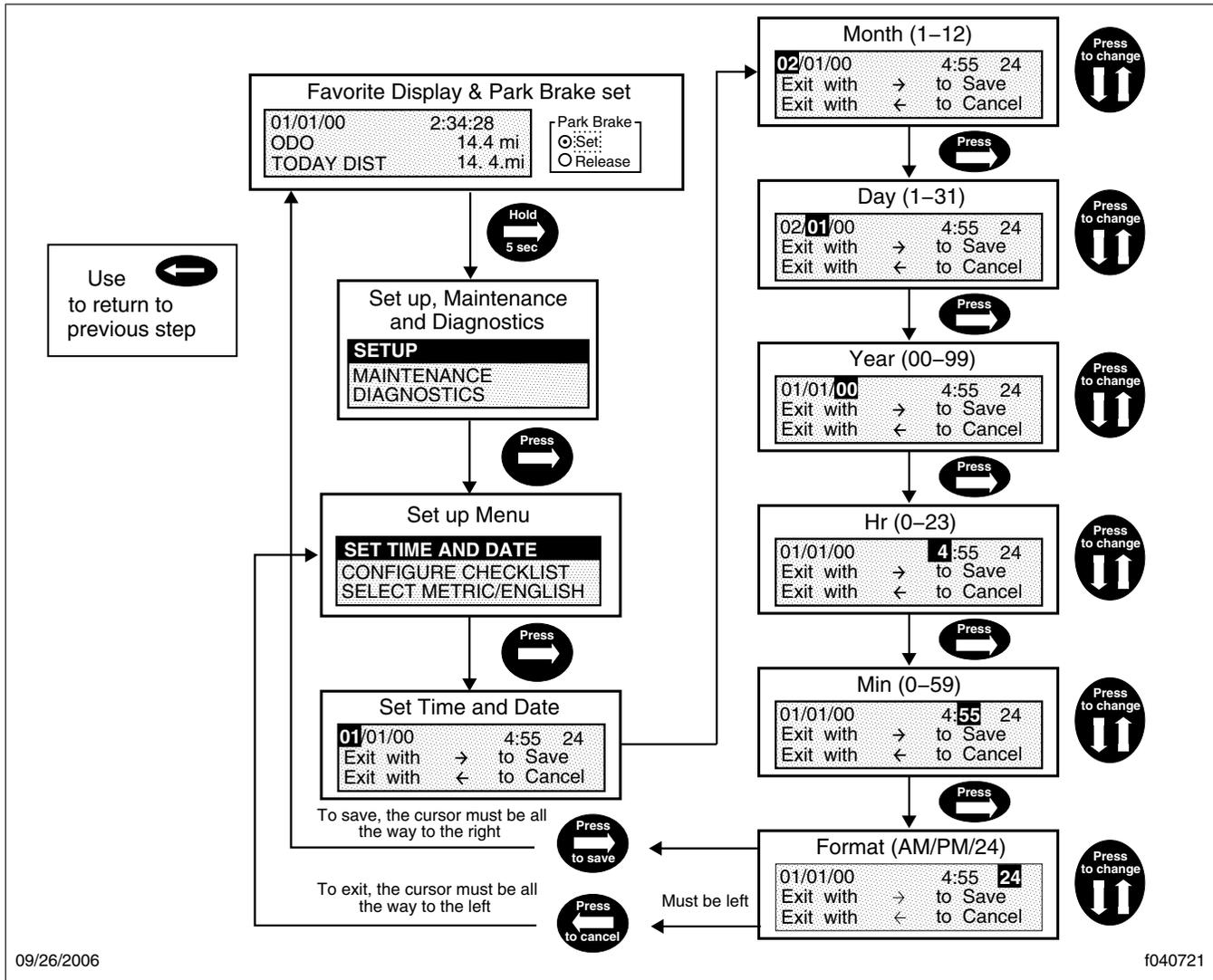


Fig. 2.10, Set Time and Date

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.

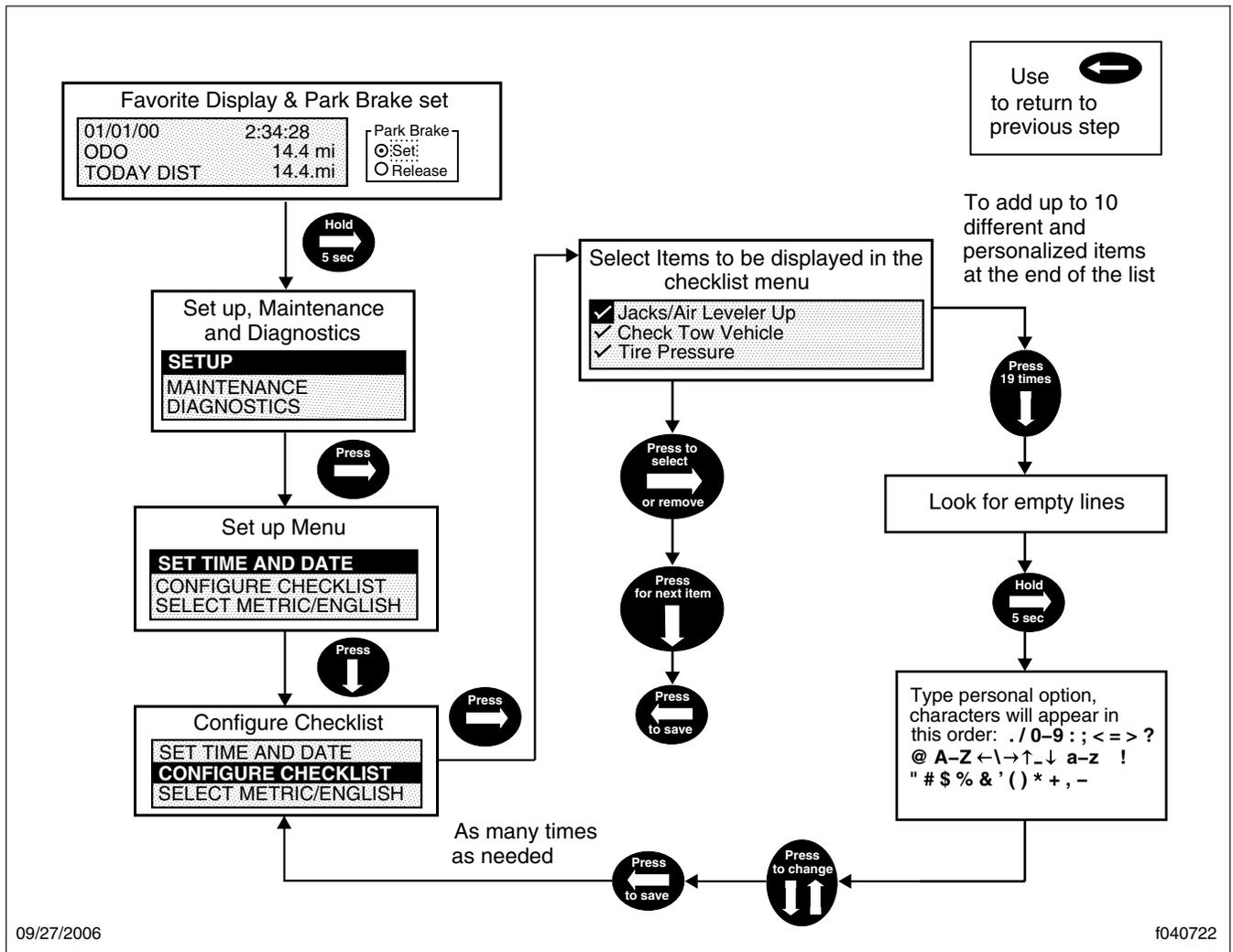


Fig. 2.11, Configure Checklist

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. 2.29, screens H, I, and J.

Startup Screen

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

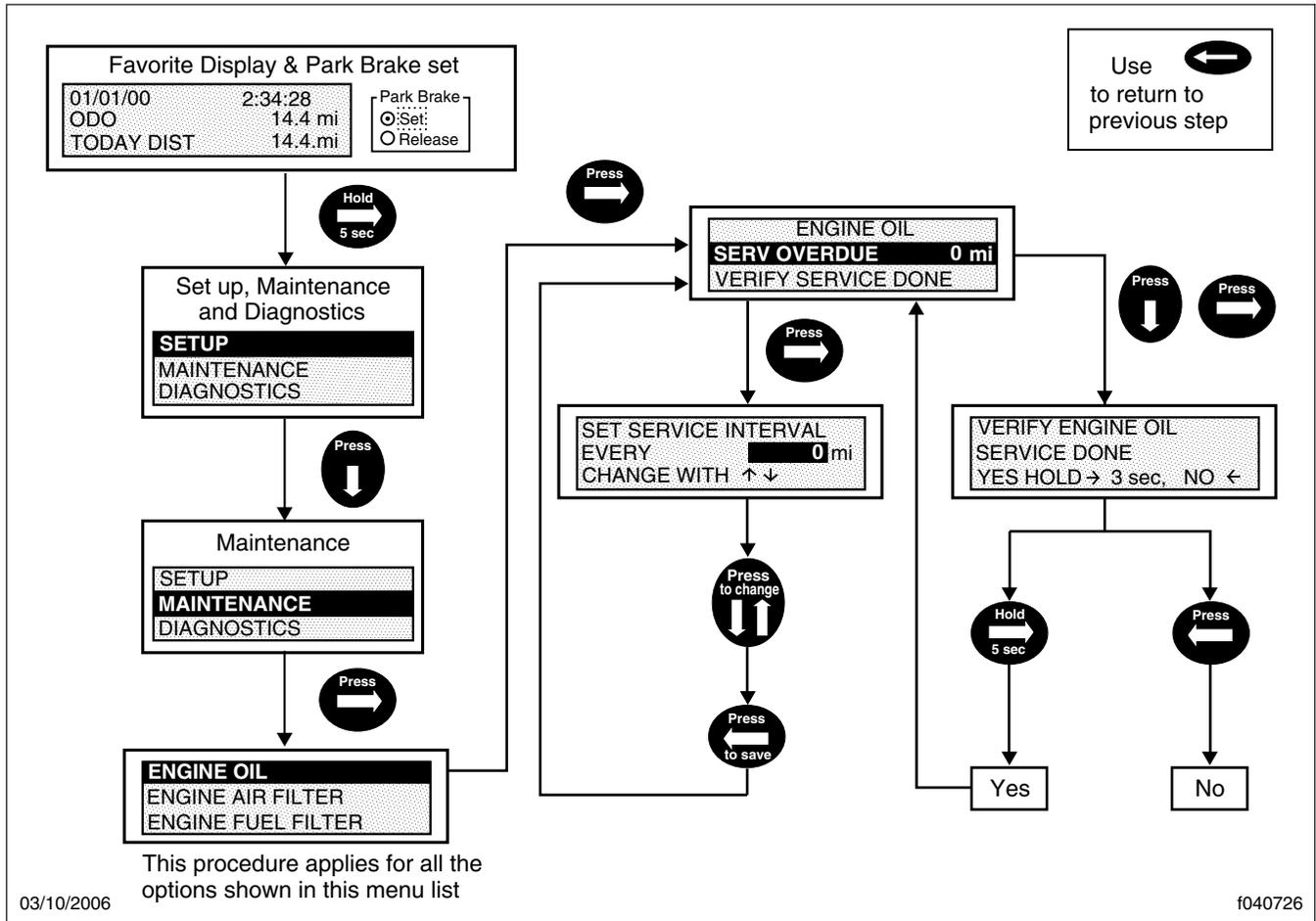


Fig. 2.13, Maintenance Menu

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.

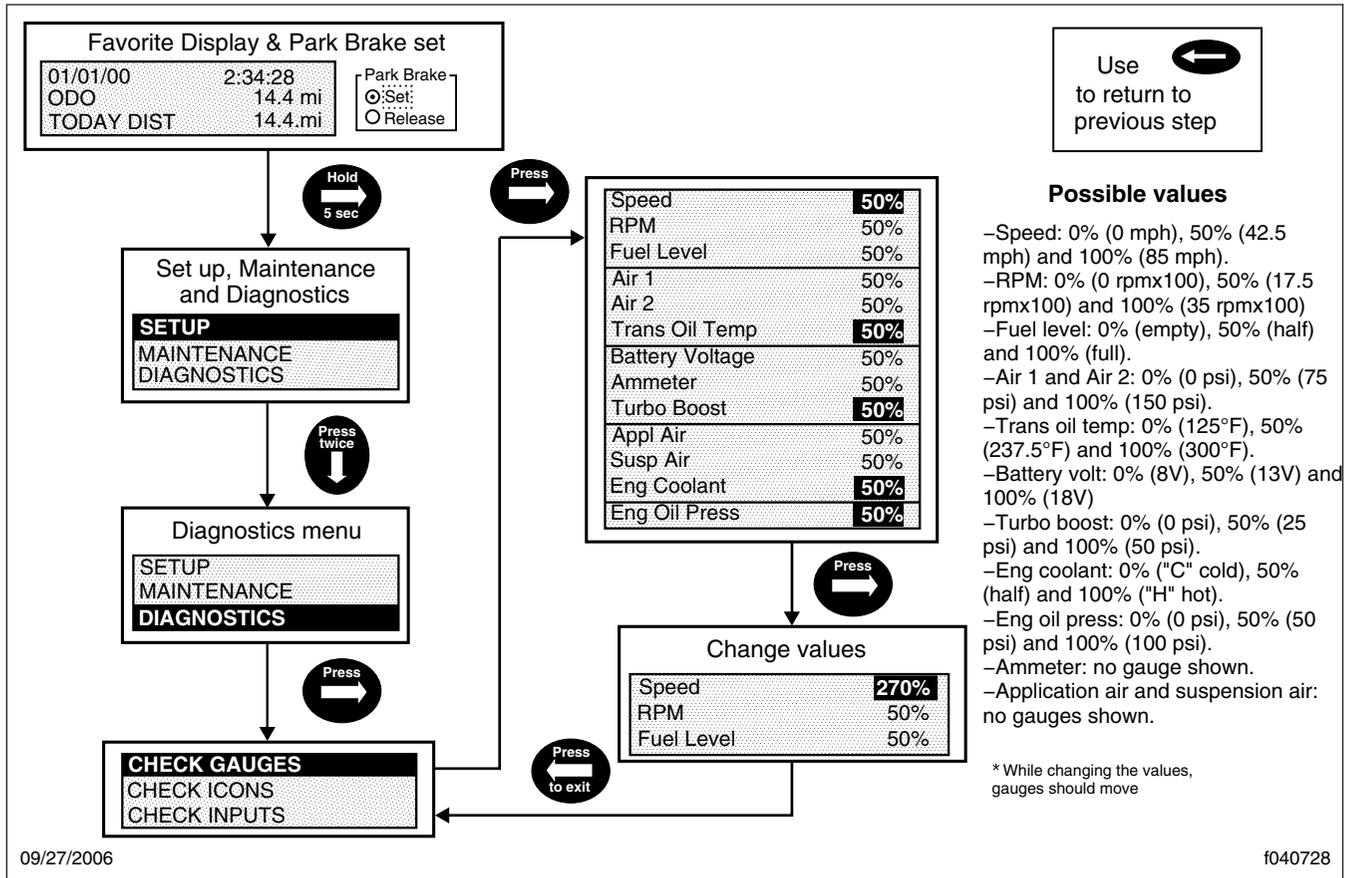


Fig. 2.16, Check Gauges and Change Values

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. 2.31](#), 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. 2.32](#), 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. 2.32](#), screen AL.

Menu Navigation

The menu navigation road maps are provided to illustrate the screens that are available in 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. Refer to the road maps to change items shown in lines one, two, and three of the display screen, view the setup screens, diagnostics, etc. See [Fig. 2.29](#), [Fig. 2.30](#), [Fig. 2.31](#), [Fig. 2.32](#), [Fig. 2.33](#), [Fig. 2.34](#), [Fig. 2.35](#), [Fig. 2.36](#), [Fig. 2.37](#), [Fig. 2.38](#), [Fig. 2.39](#), [Fig. 2.40](#), and [Fig. 2.41](#).

in the message display center.

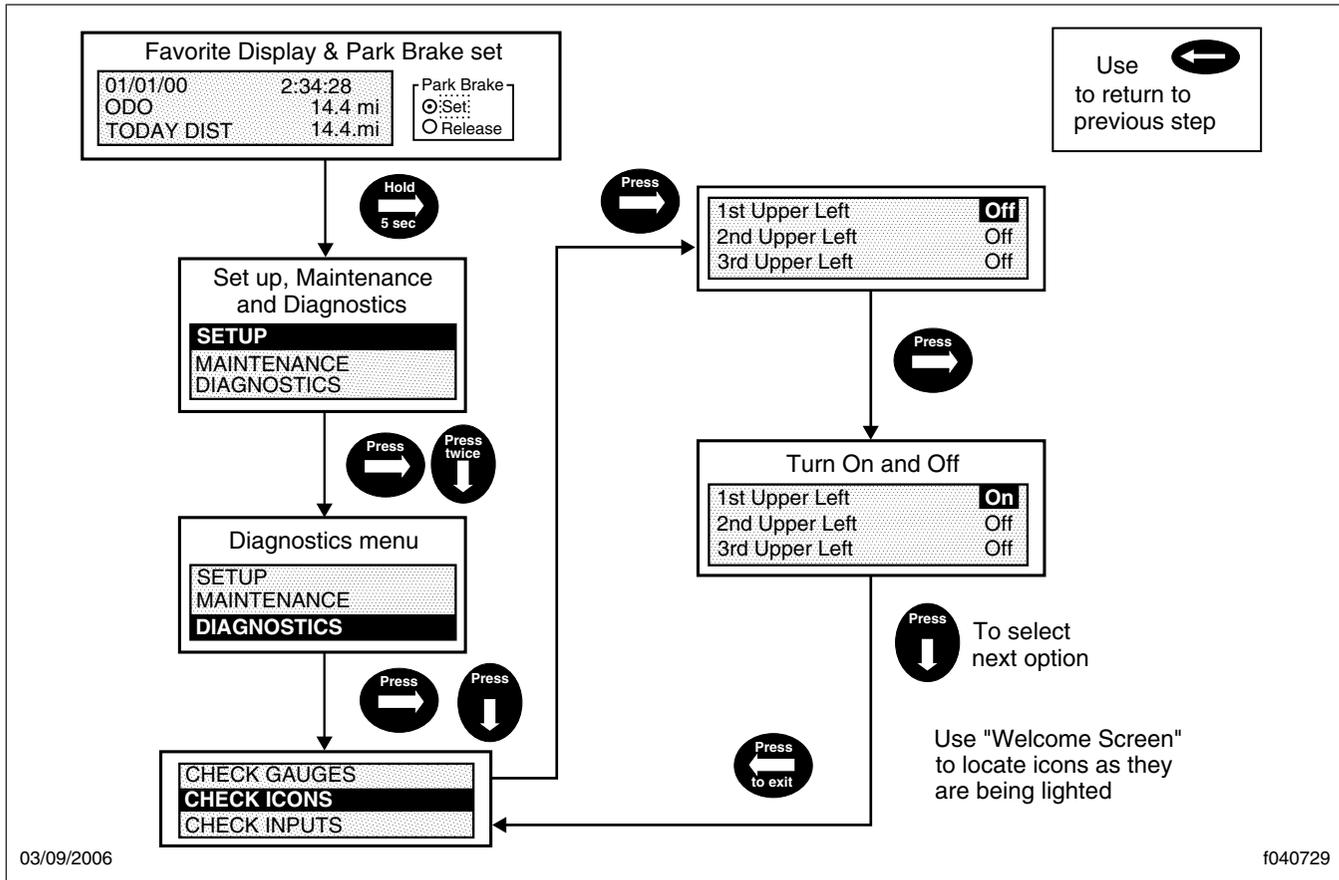


Fig. 2.17, Check Icons and Change Values

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. 2.35](#).

1. With the vehicle in park, turn the ignition to ON, 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. 2.35](#), 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

Warning and Indicator Lights

The following information describes the various warning and indicator lights found in the LBCU and Ametek instrument panels. See [Fig. 2.3](#) and [Fig. 2.4](#) for examples of the LBCU warning and indicator lights, and see [Fig. 2.28](#) for an example of the Ametek warning and indicator lights.

Check Engine Indicator

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

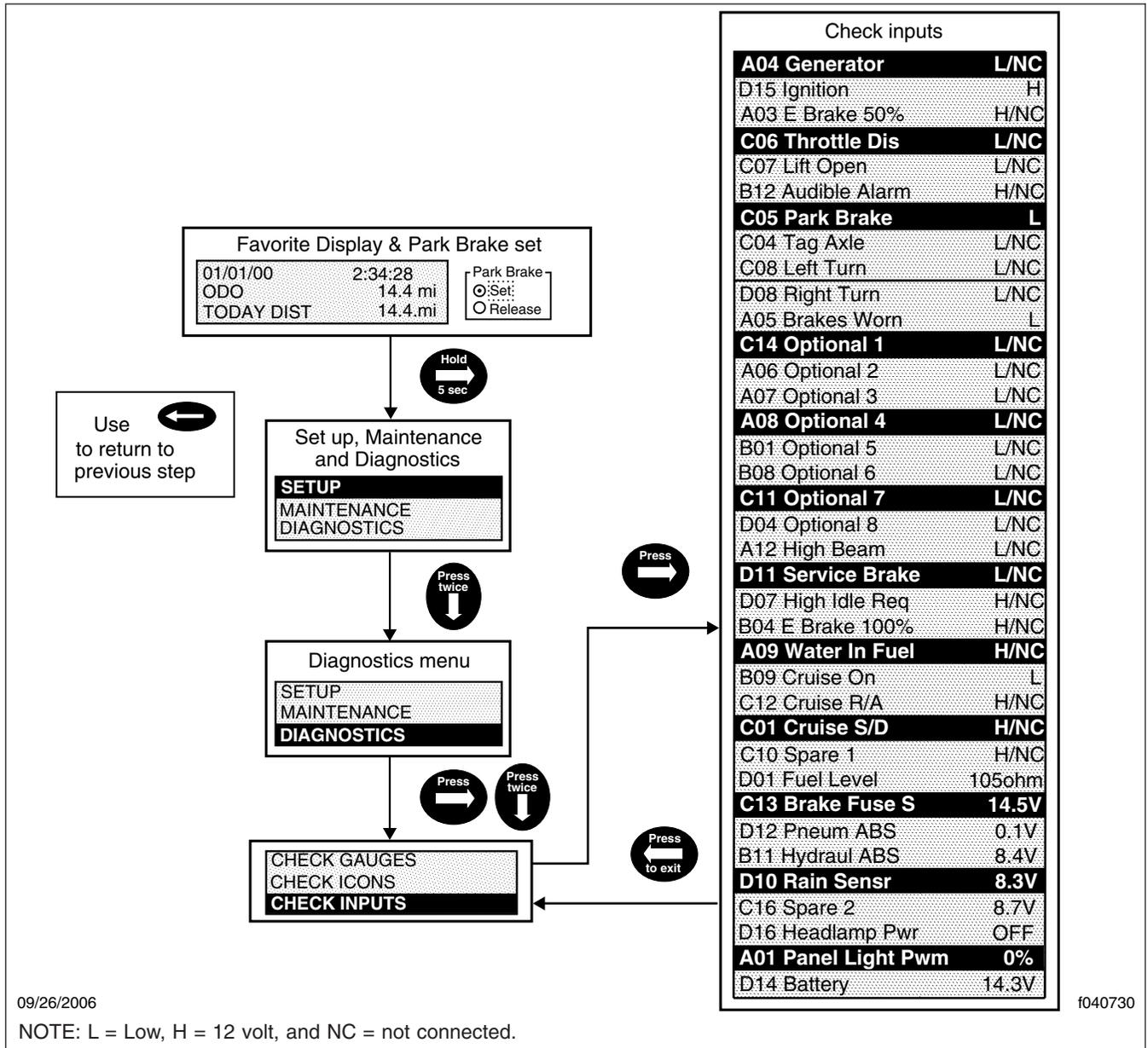


Fig. 2.18, Check Inputs

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

High Exhaust System Temperature (HEST) Lamp

The high exhaust system temperature light alerts the operator of high exhaust temperature during the regen process when the speed is below 5 mph (8 km/h), or during a manual regen. The HEST lamp does not signify the need for any kind of vehicle or

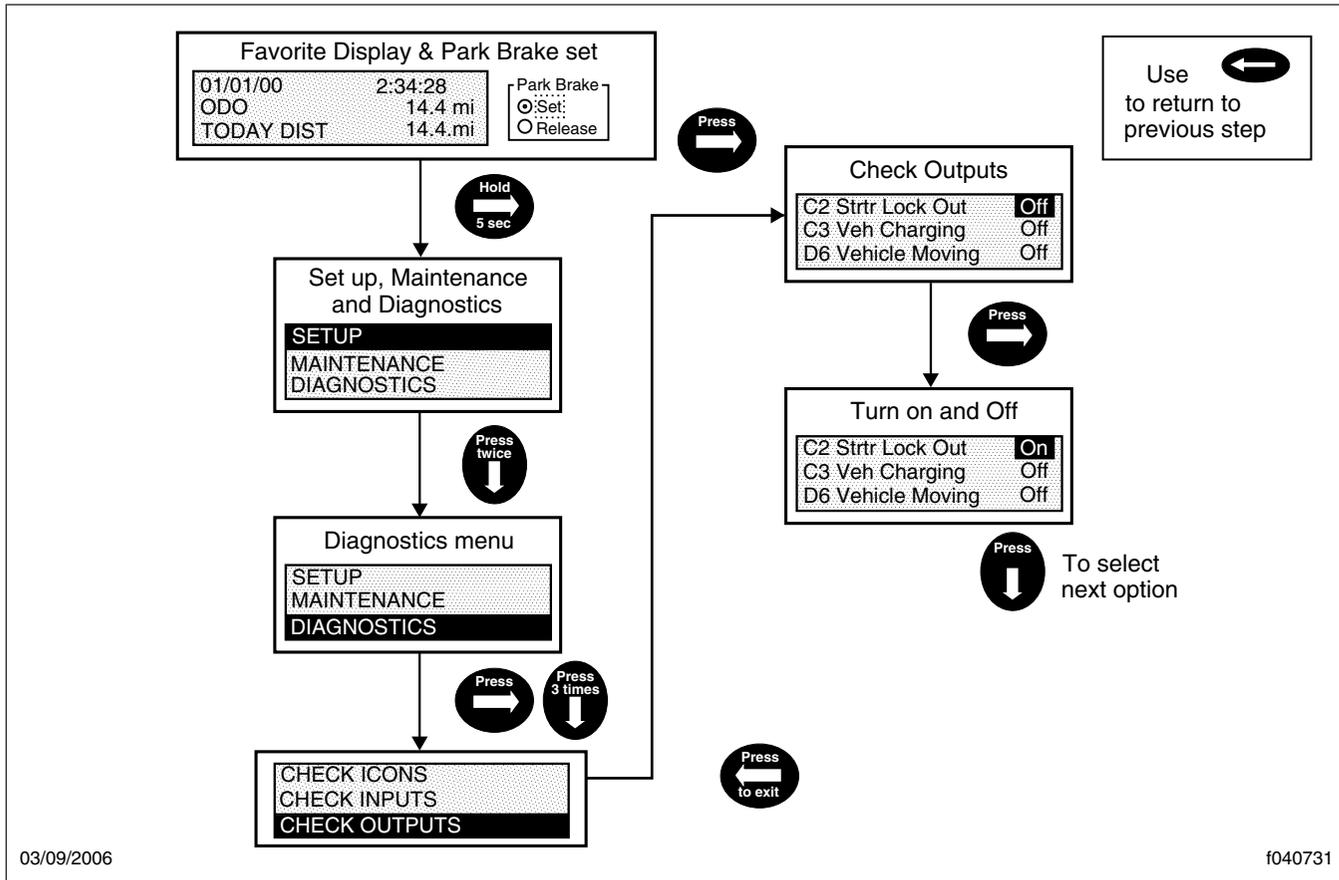


Fig. 2.19, Check Outputs

engine service; it only alerts the vehicle operator to high exhaust temperatures.

IMPORTANT: Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or explode.

Stop Engine Warning

The red stop engine (STOP) warning light illuminates if a malfunction that could cause engine damage occurs. In most cases, the engine protection warning will illuminate before the stop engine warning. When the stop engine warning light illuminates, immediately park the vehicle in a safe location and shut down the engine. Continued operation with the stop engine warning illuminated will lead to automatic engine shutdown and possible engine damage.

Malfunction Indicator Lamp

A 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.

Dash Driver Display Screen

The LBCU's interactive graphical display communicates real-time information about the status and performance of the vehicle to the driver.

ABS Indicator

The ABS indicator illuminates when a problem is detected.

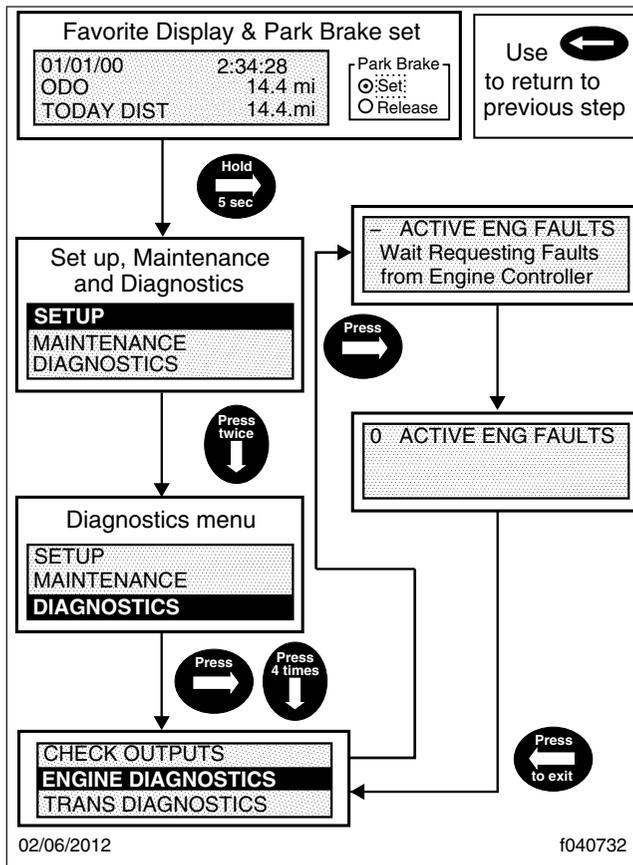


Fig. 2.20, Engine Diagnostics

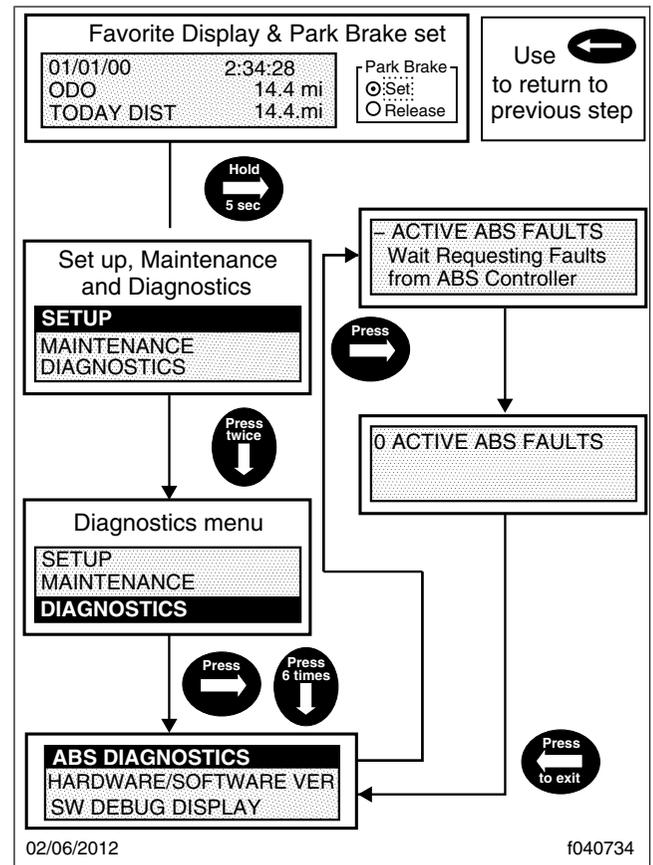


Fig. 2.21, ABS Diagnostics

WARNING

If the ABS warning lights come on while driving, repair the system immediately to ensure full antilock brake capability. Operating the vehicle when the ABS needs to be serviced could cause an accident, possibly resulting in personal injury or death, or property damage.

Check Transmission

A check transmission warning light will come on during vehicle operation (not during start-up) if the ECU (electronic control unit) has signalled a diagnostic code. Diagnostic codes indicate malfunctions in transmission operation. If this light stays on continuously during operation, have the transmission serviced as soon as possible.

Engine Brake Engaged Indicator

A green engine brake indicator illuminates when the engine brake is applied.

Cruise-On Indicator

A green indicator illuminates when the cruise control is on.

Left-Turn Signal Arrow

A green left-turn signal indicator light flashes on and off when the outside turn signals are flashing.

Diesel Particulate Filter (DPF) Lamp

A solid yellow Diesel Particulate Filter (DPF) lamp indicates that a manual regen is required soon, and should be scheduled for the earliest convenient time. A blinking yellow (DPF) lamp indicates that a manual

Instruments

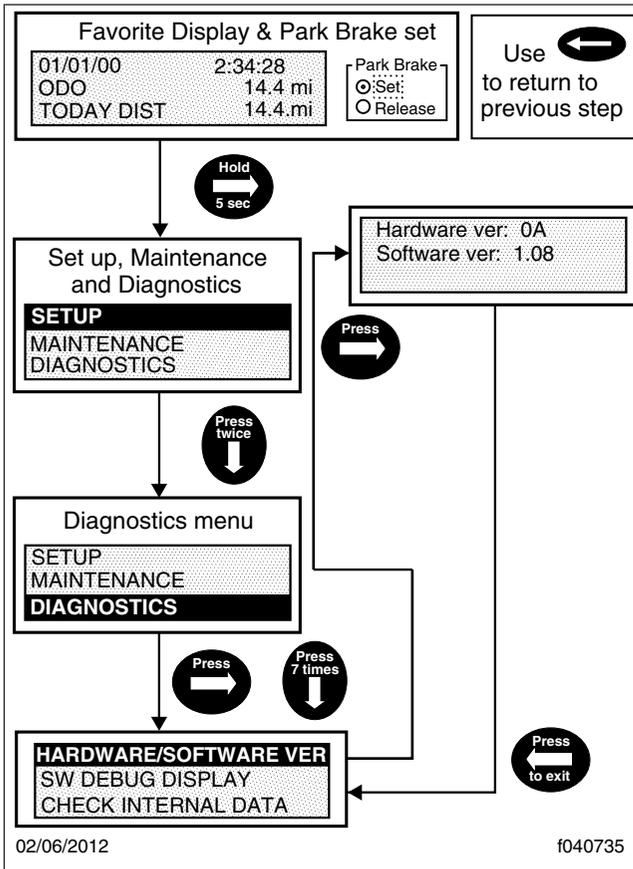
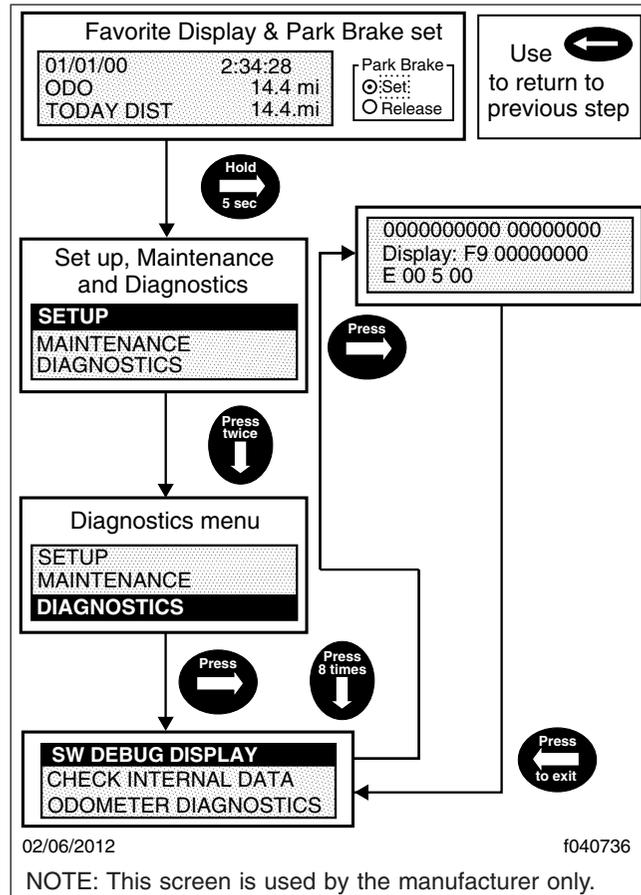


Fig. 2.22, Hardware/Software Menu



NOTE: This screen is used by the manufacturer only.

Fig. 2.23, Software Debug Display

regen is required immediately, or an engine derate may occur.

Shift Inhibit Indicator Lamp

A yellow shift inhibit indicator illuminates when the transmission ECU is prohibiting shifting.

Headlight High-Beam Indicator Lamp

A blue high-beam indicator light illuminates when the headlights are on high beam.

Parking Brake Indicator

A red parking brake light indicates when the parking brake is activated and the ignition switch is in the ON position.

Low Air Pressure Indicator

A red low air warning light normally illuminates when the air pressure in the air tanks falls below 65 psi (448 kPa). The light will normally come on when the engine is first started, but goes off when the air pressure in the air tanks reaches approximately 65 to 76 psi (448 to 524 kPa).

Wait to Start Indicator

A yellow wait-to-start indicator light illuminates when the intake heater is active. Wait until the indicator light goes off to start the engine.

Right-Turn Signal Arrow

A green right-turn signal indicator light flashes on and off when the outside turn signals are flashing.

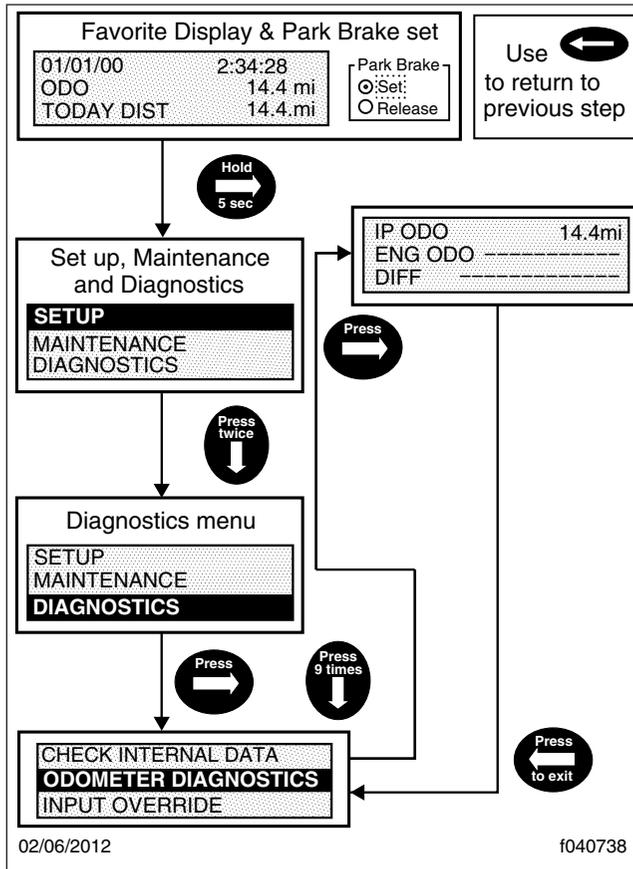


Fig. 2.24, Odometer Diagnostics

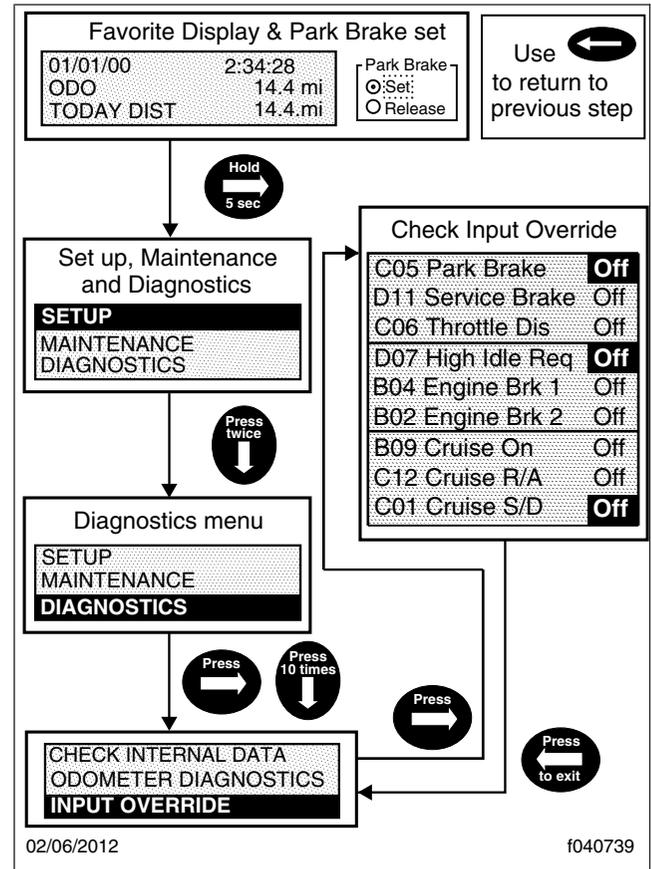


Fig. 2.25, Check Input Override

Maintenance Warning Light (Ametek only)

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.

Fasten Seat Belt Warning

The red fasten seat belt warning light (seat belt icon) illuminates for 30 seconds after the ignition switch is turned on.

Hydraulic Brake System Warning (Ametek only)

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.

Air Brake Indicator (Ametek only)

The red air brake indicator activates if the pneumatic brake system air is low, or if the air suspension is low.

Auto-Idle

The auto-idle feature will automatically increase the engine rpm when a low system voltage is detected under the following conditions:

- The transmission is in Park or Neutral.

Instruments

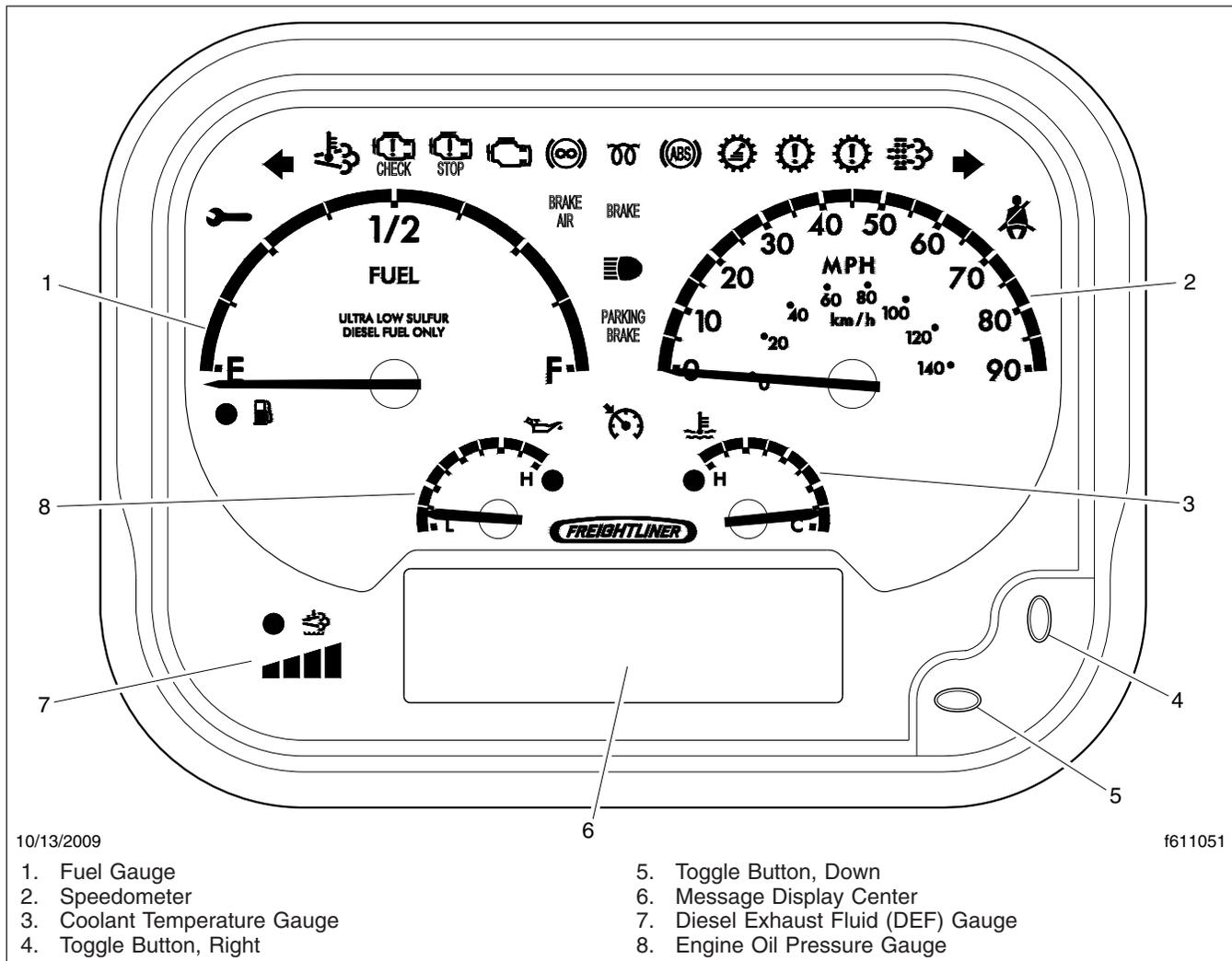


Fig. 2.26, Typical Ametek Instrument Panel, EPA10 and Newer Engines

- The parking brake is set.

The dash driver display screen will first display AUTO IDLE, meaning the system voltage has dropped below 12.2 volts, and the service brake is not on. See [Fig. 2.42](#). The ICU will increase the idle speed until the battery voltage reaches 13.4 volts. Acknowledge the Auto Idle message by pressing the left arrow button once on the toggle switch.

After the Auto Idle message is acknowledged the BATTERY LOW VOLTAGE message will display. See [Fig. 2.43](#). Perform any of the following functions to return the engine to normal operation:

- Press the service brake pedal.

- Shift the transmission out of Park or Neutral.
- Release the parking brake.

Speedometer and Tachometer

Speedometer

The speedometer indicates vehicle speed in miles per hour (mph) or kilometers per hour (km/h). See [Fig. 2.44](#).

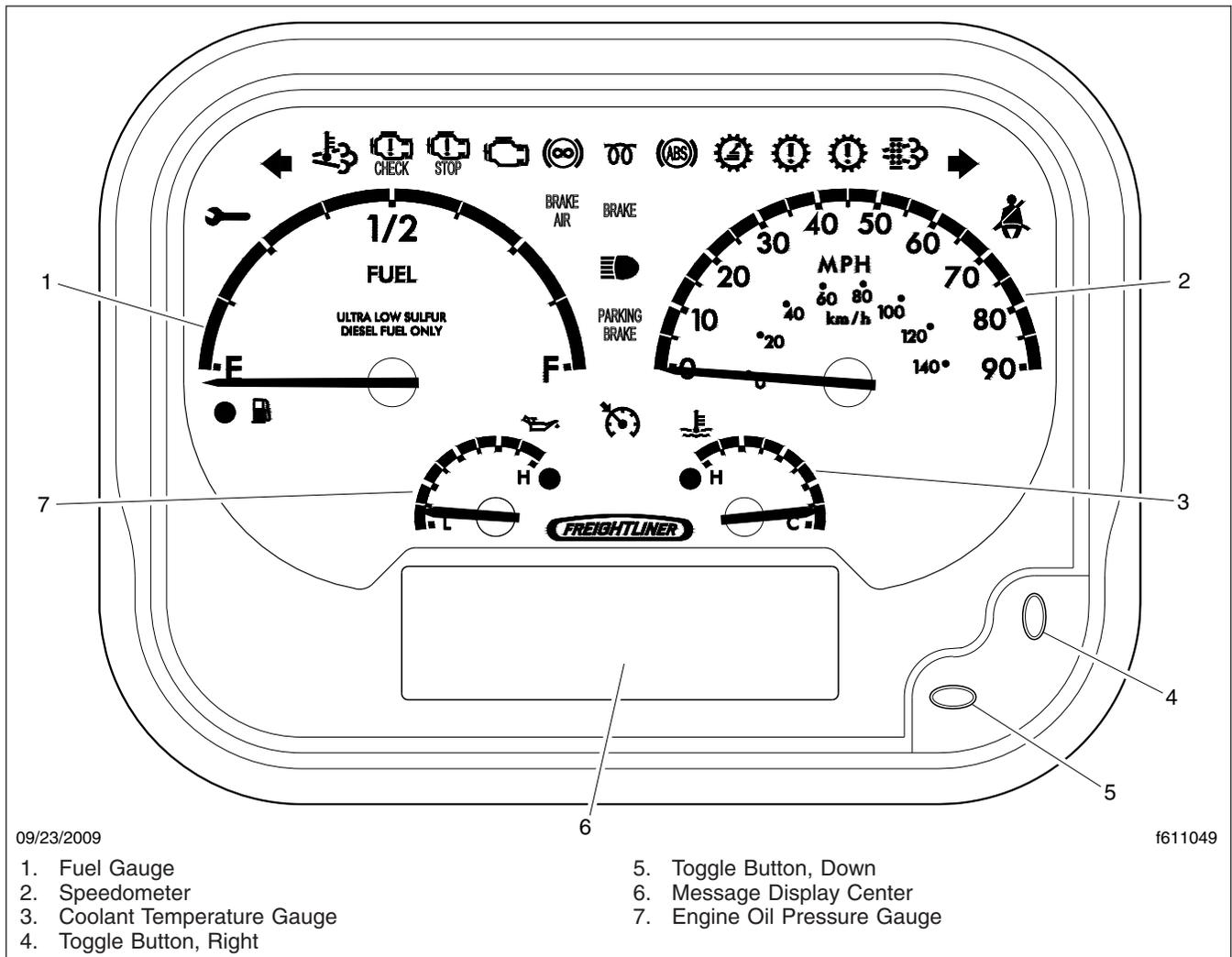


Fig. 2.27, Typical Ametek Instrument Panel, EPA07-Compliant

Tachometer (Three-in-One Gauge)

This gauge serves three functions as follows. See [Fig. 2.45](#).

- Tachometer; indicates the revolutions per minute (rpm) of the engine.
- Fuel Gauge; indicates the amount of fuel in the fuel tank.
- Voltmeter; indicates the vehicle charging system voltage when the engine is running, and battery voltage when the engine is stopped. By monitoring the voltmeter, the driver can be aware of potential charging system problems

and have them repaired before the batteries discharge enough to create starting difficulties.

The voltmeter shows the voltage of the battery when the engine is running. The voltage of a fully charged battery is 12.7 to 12.8 volts when the engine is stopped. A completely discharged battery will produce only about 12.0 volts. The voltmeter will indicate lower voltage as the vehicle is being started or when electrical devices in the vehicle are being used.

If the voltmeter shows an undercharged or overcharged condition for an extended period,

Instruments

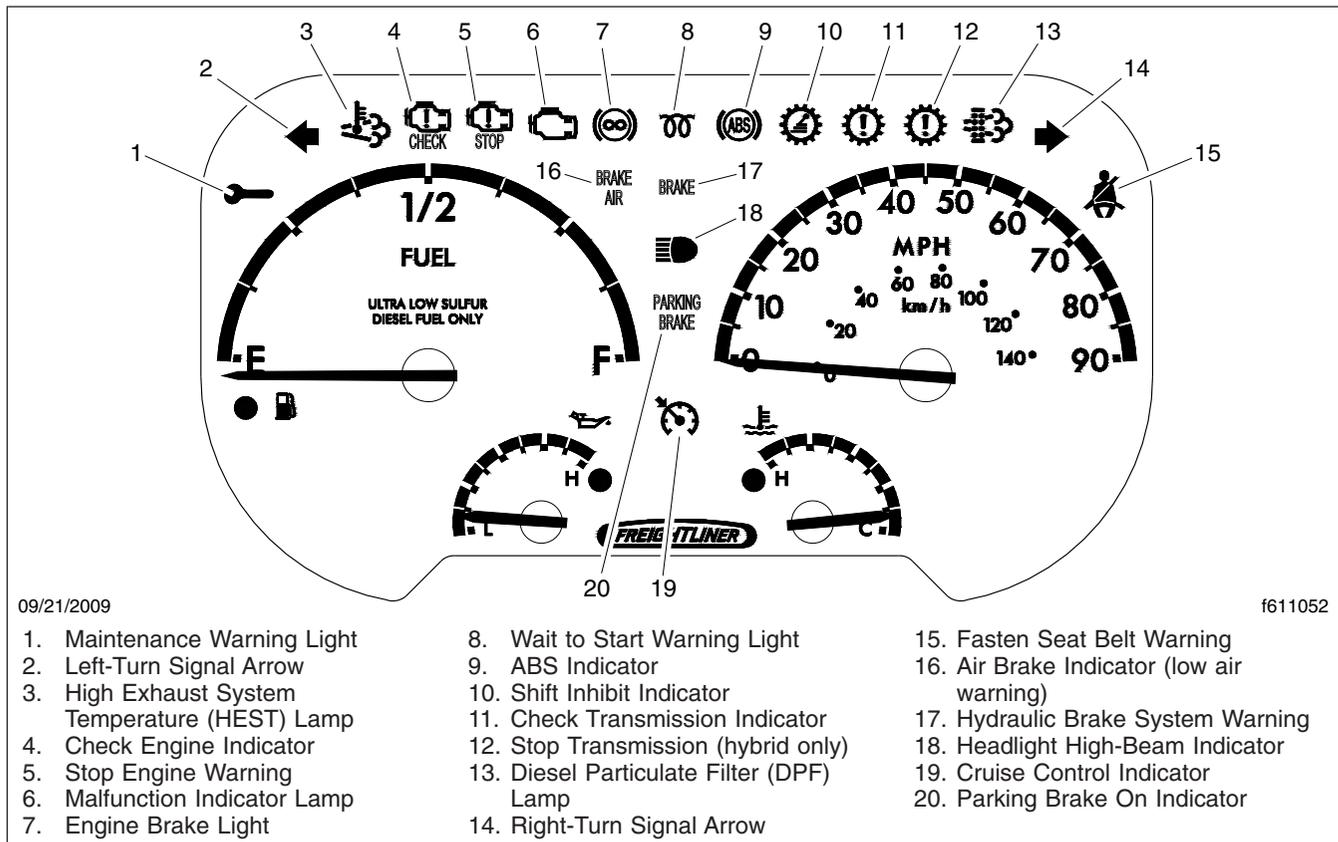


Fig. 2.28, Ametek Warning Lights

have the charging system and batteries checked at a repair facility.

NOTE: Some vehicles may be equipped (by the body builder) with a battery isolator system and a gel cell battery. On these vehicles, the voltmeter measures the average voltage of all the batteries when the engine is running. When the engine is stopped, the voltmeter shows the voltage of the engine-starting batteries.

Gauges

See Fig. 2.46 for an example of the pressure/temperature gauges found in the instrument panel.

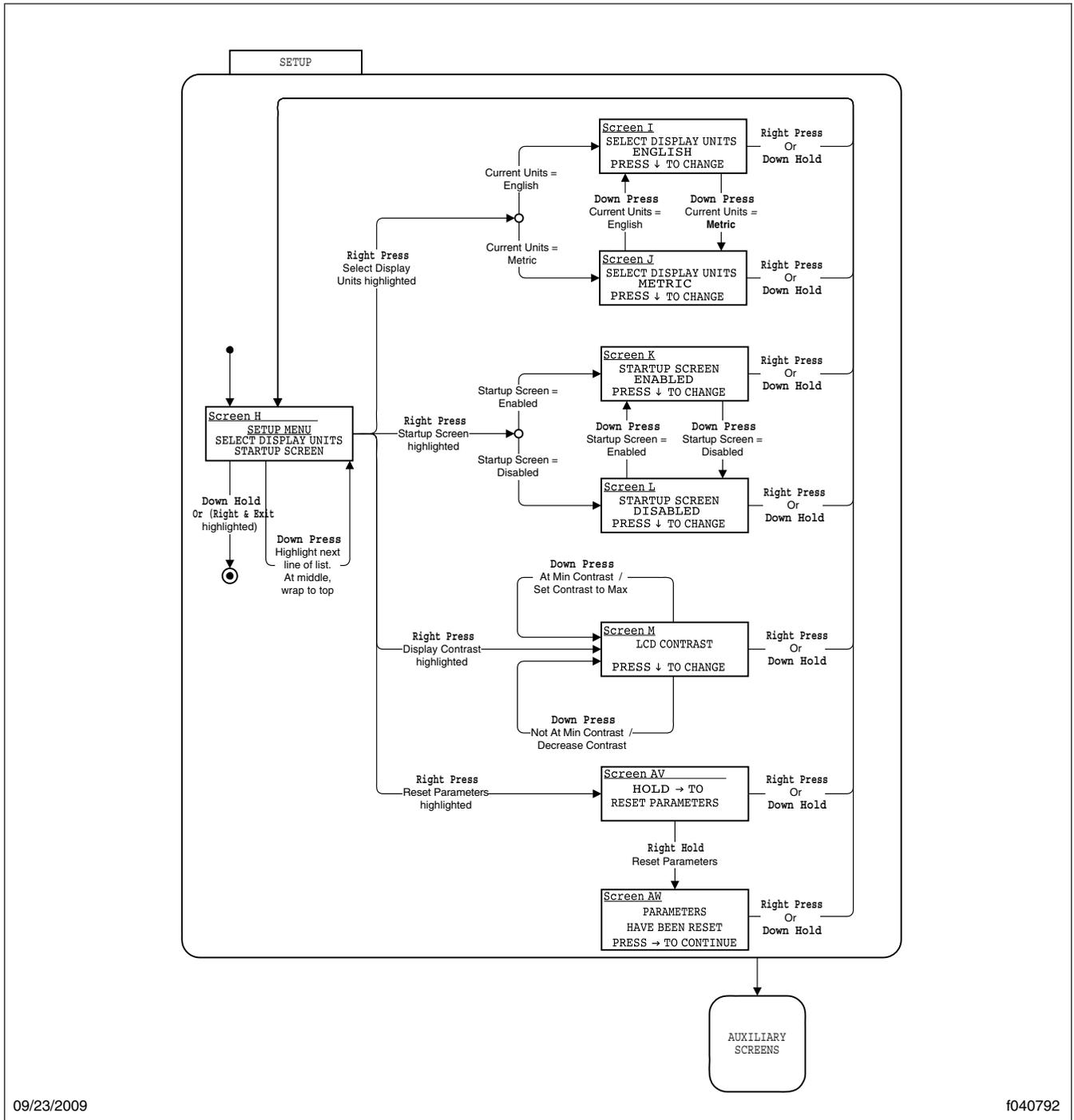
Pressure/Temperature Gauges (Four-in-One Gauge)

Engine Oil Pressure Gauge

The oil pressure gauge should read in the normal range, from 2 to 80 psi (14 to 552 kPa).

NOTICE

A sudden decrease or absence of engine 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.



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Fig. 2.29, Setup Menu Screens

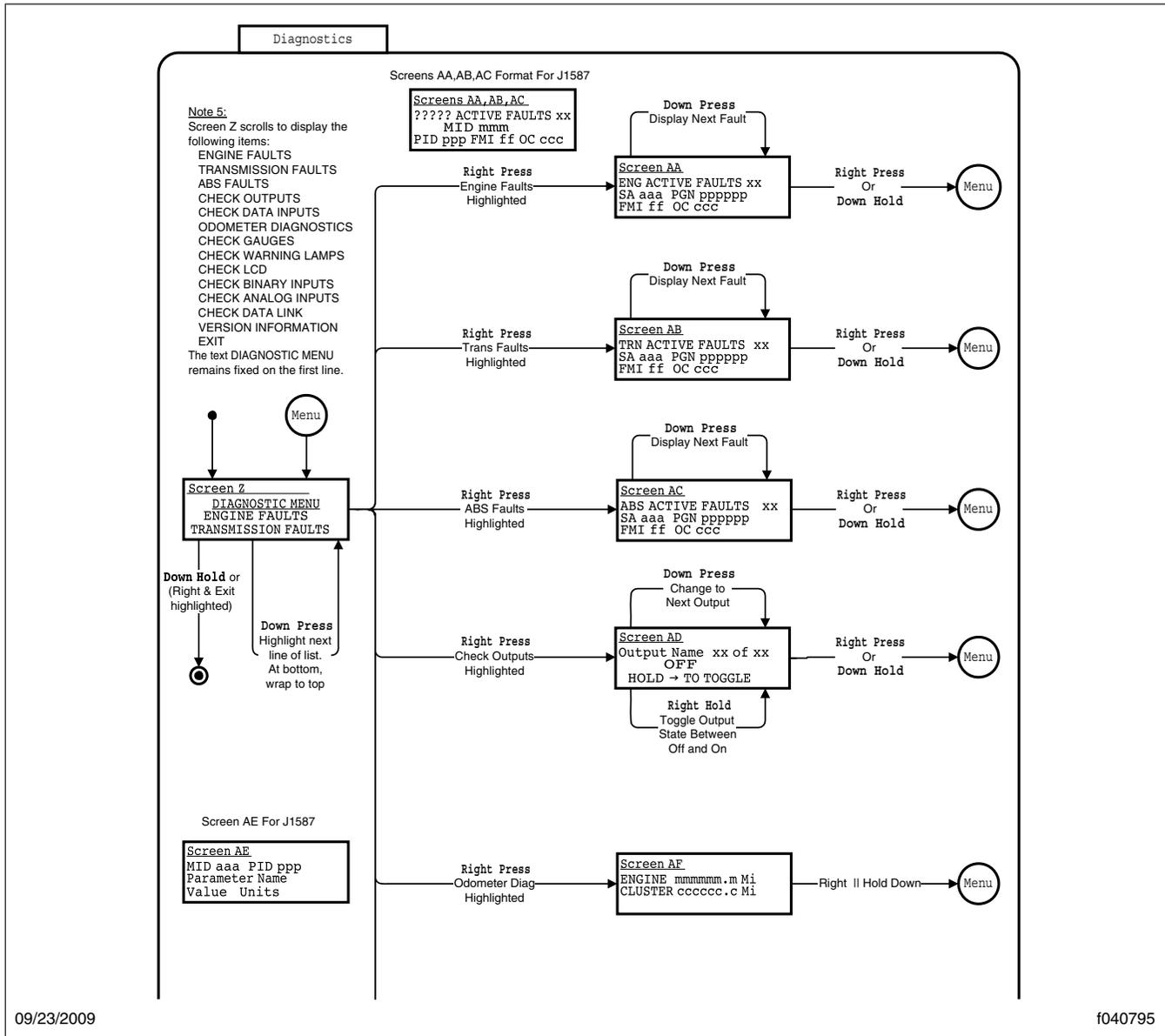


Fig. 2.30, Diagnostic Menu Screens, Screen 1

Coolant Temperature Gauge

During normal engine operation, the coolant temperature gauge should read in the normal range between cold and hot. If the temperature remains below or exceeds the normal range, inspect the cooling system to determine the cause.

Primary and Secondary Air Pressure Gauges

IMPORTANT: Two separate air pressure gauges indicate air pressure in the primary and secondary air systems. Build air pressure in both systems to 95 to 120 psi (620 to 827 kPa) before moving. It is normal to observe fluctuation in these gauges during operation of the vehicle. An

Instruments

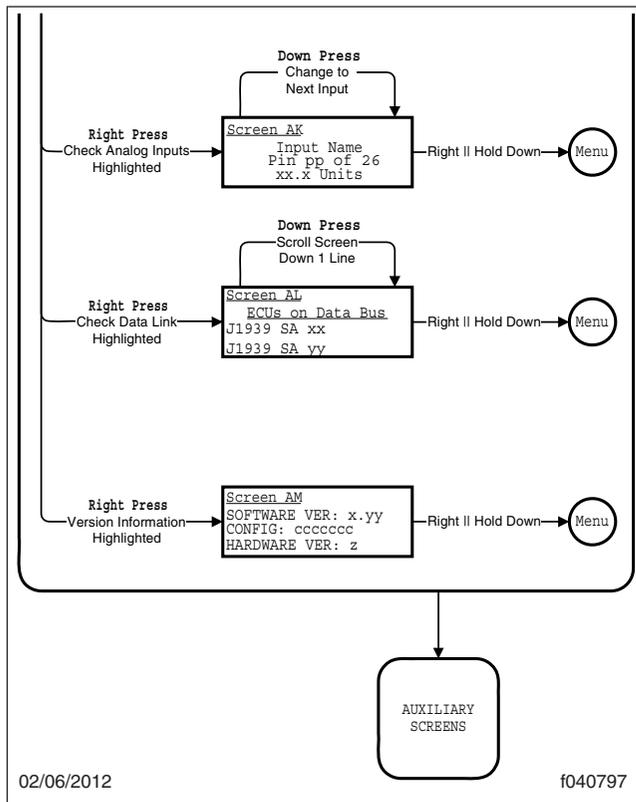


Fig. 2.32, Diagnostic Menu Screens, Screen 3

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.

Turbo Boost Gauge

The turbo boost gauge indicates the boost pressure at the turbocharger, from 0 to 50 psi (0 to 345 kPa). See the **Cummins Operation and Maintenance Manual** for more information.

Transmission Temperature Gauge

The transmission temperature gauge indicates the temperature of the transmission oil.

NOTICE

If the transmission continues to overheat during normal operation, have it checked and repaired.

Continued operation may cause damage to the transmission.

Tire Pressure Monitoring System (TPMS)

IMPORTANT: The use of temporary resealing or reinflation products containing internal sealers or propellants in any tire/wheel assembly, may adversely affect the operation of the tire sensor(s) and void the warranty.

The Tire Pressure Monitoring System (TPMS) constantly monitors the pressure and temperature of each tire on the vehicle, and provides tire status information to warn the driver about a tire-related problem before it becomes dangerous. Tire sensors mounted on each wheel measure tire pressure and temperature every 12 seconds and transmit data every 3 to 5 minutes. If a temperature change or tire pressure change of 3 psi (21 kPa) or greater is detected, the sensor breaks its regular schedule and transmits tire data immediately.

For further information on the TPMS, including operation, TPMS warnings, and proper tire removal/installation, see the SmarTire TPMS Owner's Manual.

Collision Warning System, Eaton VORAD VS-400 (Stand Alone)

The Eaton VORAD VS-400 is a computerized collision warning system (CWS) that uses forward-looking radar (FLR) to monitor objects ahead, and optional side-mounted sensors to monitor objects alongside the vehicle.

The system performs in fog, rain, snow, dust, smoke, and darkness. To be detected, objects must be within the radar beam field of view and provide a surface area that can reflect back the radar beam.

The front-looking antenna assembly transmits radar signals to, and receives them back from, objects ahead of the vehicle. This allows the determination of the distance, speed, and angle of the target ahead. The system uses this information to warn the driver of potentially dangerous situations.

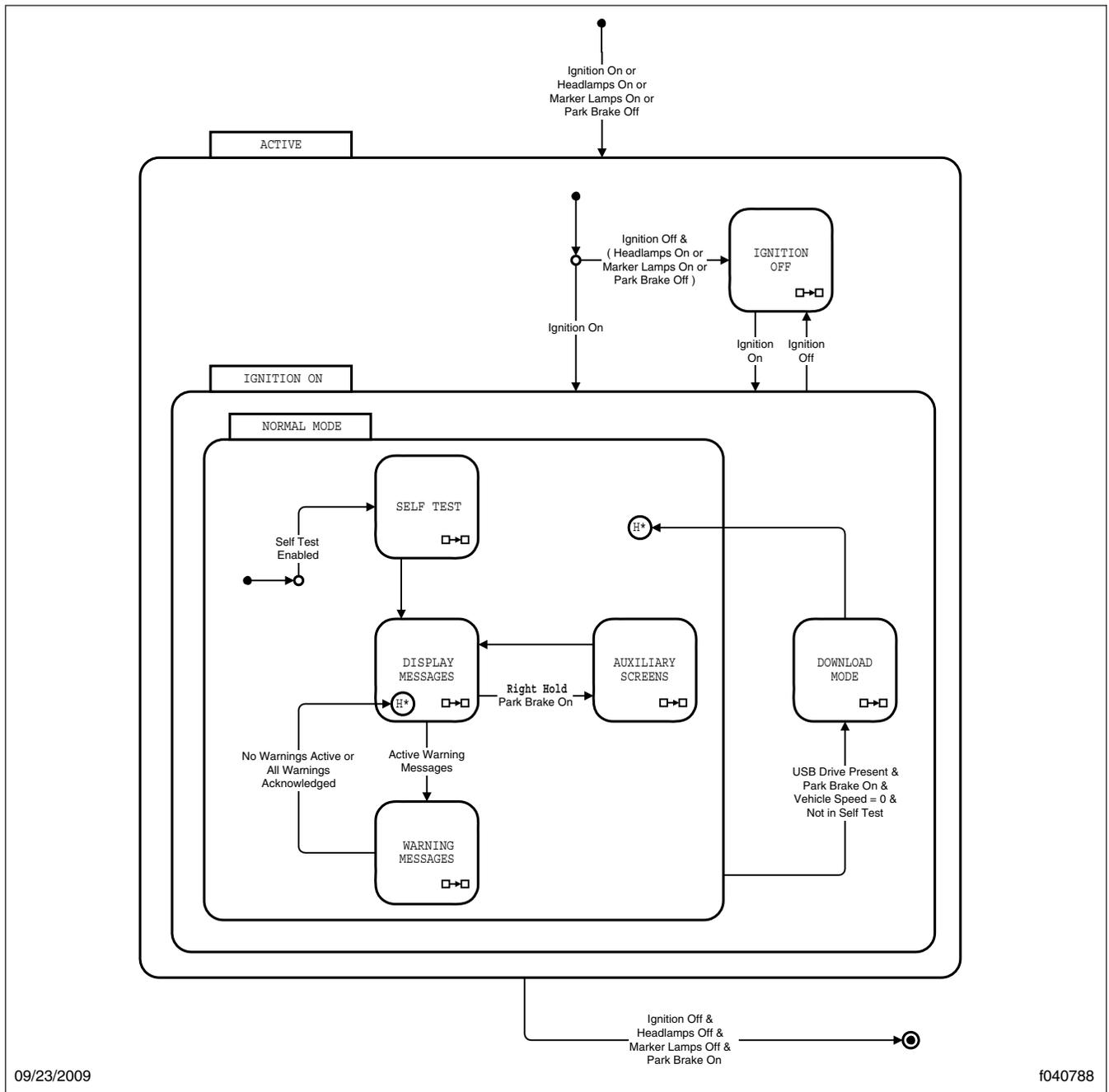


Fig. 2.33, Ignition On, Normal Mode

Optional side sensors also transmit and receive radar signals, for a distance of 2 to 10 feet (0.5 to 3 meters) alongside the vehicle. The side sensor can detect unseen objects, moving or stationary, adjacent to the vehicle.

WARNING

The Eaton VORAD VS-400 Collision Warning System (CWS) is intended solely as an aid for an

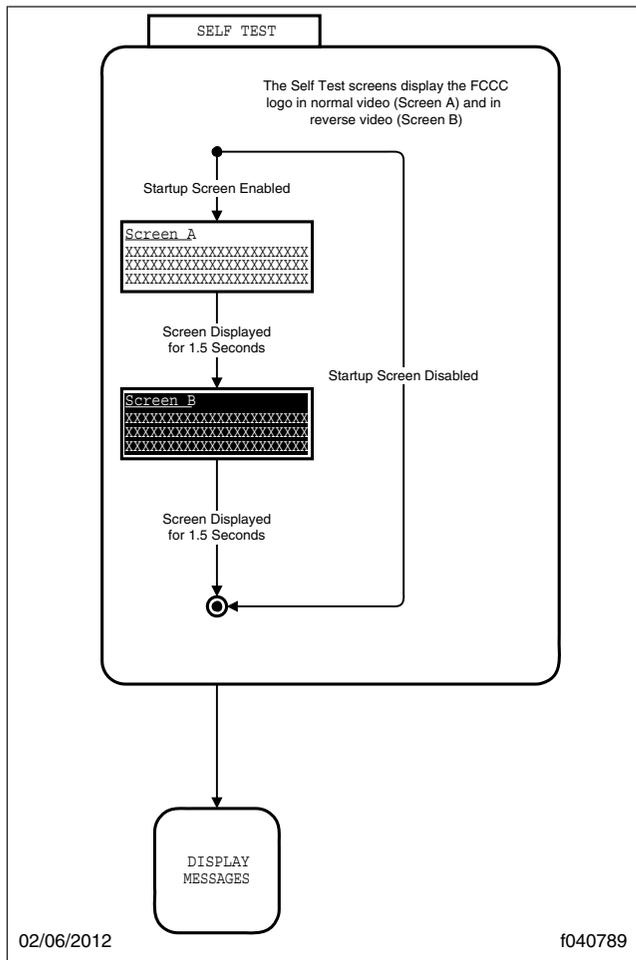


Fig. 2.34, Self Test

alert and conscientious driver. It is not intended to be used or relied upon to operate a vehicle. Use the system in conjunction with rearview mirrors and other instrumentation to safely operate the vehicle. Operate this vehicle, equipped with the VS-400 Collision Warning System, in the same safe manner as if the VS-400 Collision Warning System were not present.

The VS-400 Collision Warning System is not a substitute for safe, normal driving procedures, nor will it compensate for any driver impairment such as drugs, alcohol, or fatigue.

The VS-400 Collision Warning System may provide little or no warning of hazards such as pedestrians, animals, oncoming vehicles, or cross traffic.

Failure to drive safely and use the system properly could result in personal injury and/or death and severe property damage.

Driver Display Unit

The VORAD system controls are located in the driver interface unit (DIU). The DIU provides visual and audio warnings and messages. Menu selections are made by pressing the up, down, and OK buttons. See [Fig. 2.48](#).

The DIU has the following features:

- An internal speaker for audio warnings.
- Graphic display for visual warnings, menus, and other information.
- User interface keypad for scrolling up, scrolling down, and selection.
- Ambient light sensor, for auto illumination adjustment for daytime or night-time display.
- Programmable for driver ID with use of a PIN.

The following lights illuminate on the DIU to indicate a message:

- Red LED—illuminates with the collision alert display.
- Yellow LED—illuminates with headway alert display.
- Orange LED—illuminates when a system failure occurs.
- Blue LED—illuminates when information is available.

Immediately after each battery power-on cycle, the DIU initializes by executing self-test routines. During the initialization time, the screen shown in [Fig. 2.49](#) is displayed and all the LED lamps are activated (power-on bulb check) for approximately 3 seconds, along with a power-up tone.

When initialization is complete, the DIU displays the VS-400 system configuration screen. [Figure 2.50](#) shows the screens for the VS-400 configured for Collision Warning System (CWS) and SmartCruise™, and for CWS only.

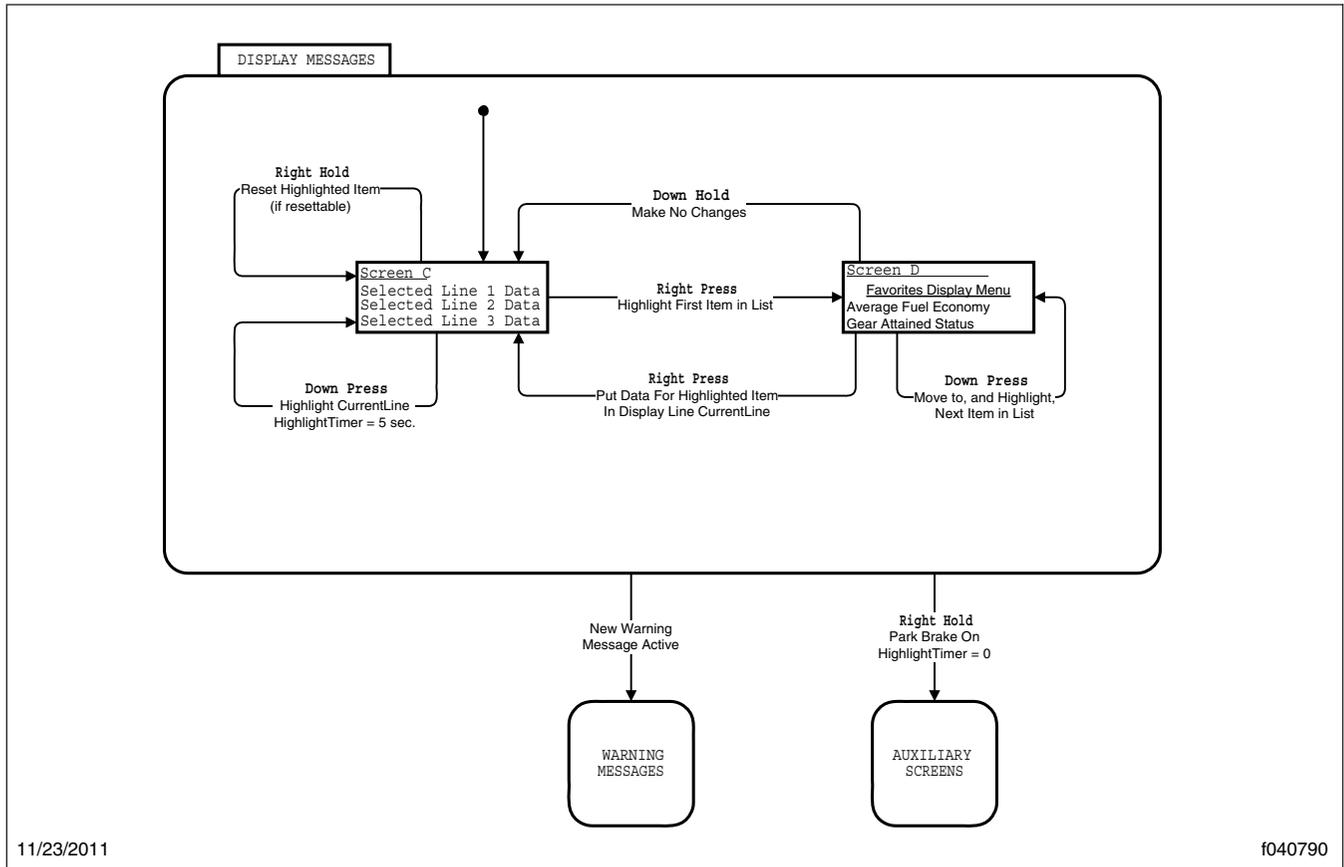


Fig. 2.35, Display Messages

Menu Selections

IMPORTANT: The display of any menu item is overridden whenever conditions require an alert warning, or collision warning, to be displayed.

After initialization, the menu screen is displayed. In this screen, the driver may scroll to the desired item by pressing an arrow button, then pressing the OK button to select the item. See Fig. 2.51. If the driver does not make a selection within 30 seconds, or the vehicle begins to move, the DIU changes to the system status display.

The DIU displays menu items when the menu mode is selected. The display of any menu item is overridden whenever conditions require an alert warning or collision warning to be displayed. The menu items are listed below.

System Status Screen

System status is displayed under normal operating conditions by scrolling to the "System Status" item and then pressing the "OK" button. This screen shows the status of each system, indicating if the system can operate normally. If a system cannot operate normally, the system displays "Failed" beside the system name rather than "OK". "Failed" means a fault is preventing the system from operating and it can not be used until the fault is corrected or acknowledged.

Depending on the VS-400 system installed, one of the following screens will appear unless a system fault is active. Pressing OK exits this menu. See Fig. 2.53.

Instruments

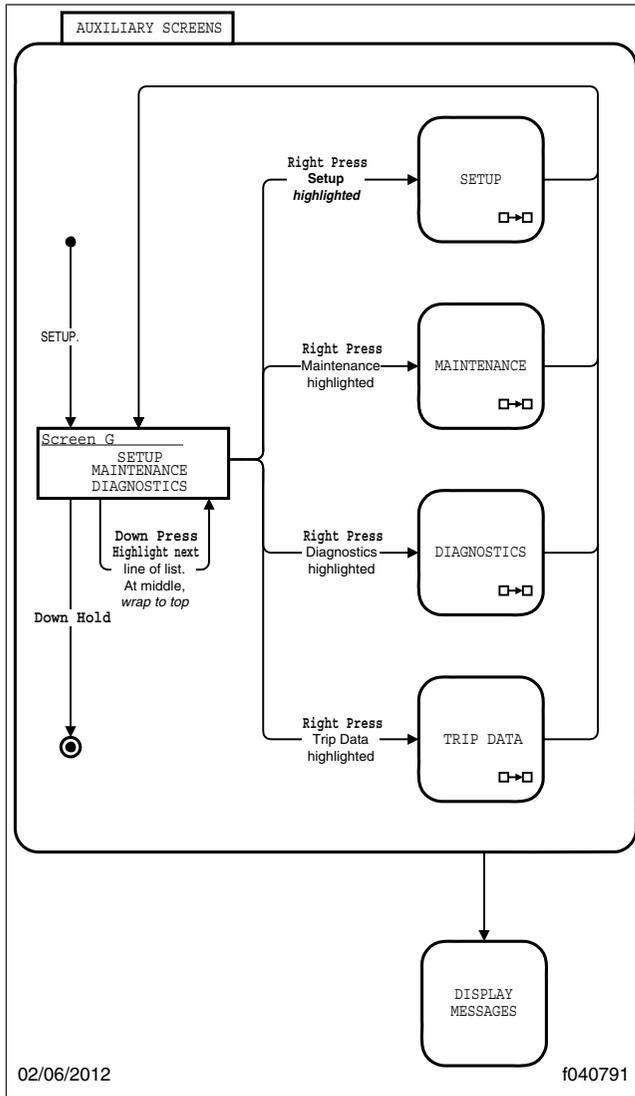


Fig. 2.36, Auxiliary Screens

Demo (vehicle must be stationary)

When the vehicle is stationary, and the demo mode is selected, the DIU will demonstrate the meaning of all LED and screen displays, including alert messages and sound warnings. The demo screens are scrolled through by pressing the down arrow. Pressing any other key exits the mode.

Volume

For configurations with adjustable volume, the minimum adjustable volume configuration is 50% of the

maximum volume. If the DIU volume is not adjustable, the display screen shows a grayed bar graph whenever volume adjustment is selected. After each ignition switch cycle, the volume will default to 100%.

One of the screens in Fig. 2.52 is displayed when volume is selected, if conditions do not require the display of headway alerts or warnings.

NOTE: Headway alert tones (yellow LED), and collision alert tones (red LED), may be suppressed when the brake is applied, if the parameter is configured to do so.

Brightness

The up and down arrows are used to change the brightness. This adjustment changes the warning LEDs and graphic display backlight brightness. Pressing the OK button exits this screen. See Fig. 2.54.

The ambient light sensor reading determines if the DIU is in daytime or nighttime mode. Menu-adjusted brightness is applied only to the mode the DIU is in at the time of adjustment. The previous brightness settings are repeated after each ignition cycle. However, the graphic display and the warning LED brightness range are constrained such that they are always visible regardless of how low the brightness is adjusted in all driving conditions. Pressing the OK button exits the menu.

SmartCruise® Headway Range

Headway range adjustment is only available in the CWS with SmartCruise version of the VS-400 system, with headway range adjustment enabled. Headway range adjustment is selected from the main menu with the scroll arrow, followed by pressing the OK key to select the screen. Headway range is adjustable between 3.25 and 2.25 seconds, in 0.25 second increments, by pressing the up or down arrows. The headway range setting will default to 3.25 seconds, after each ignition power cycle.

If the headway adjust screen is selected and headway range is not enabled, then only the "3.25 sec" screen is displayed. See Fig. 2.55 for the various headway range screens.

Pressing OK exits the menu.

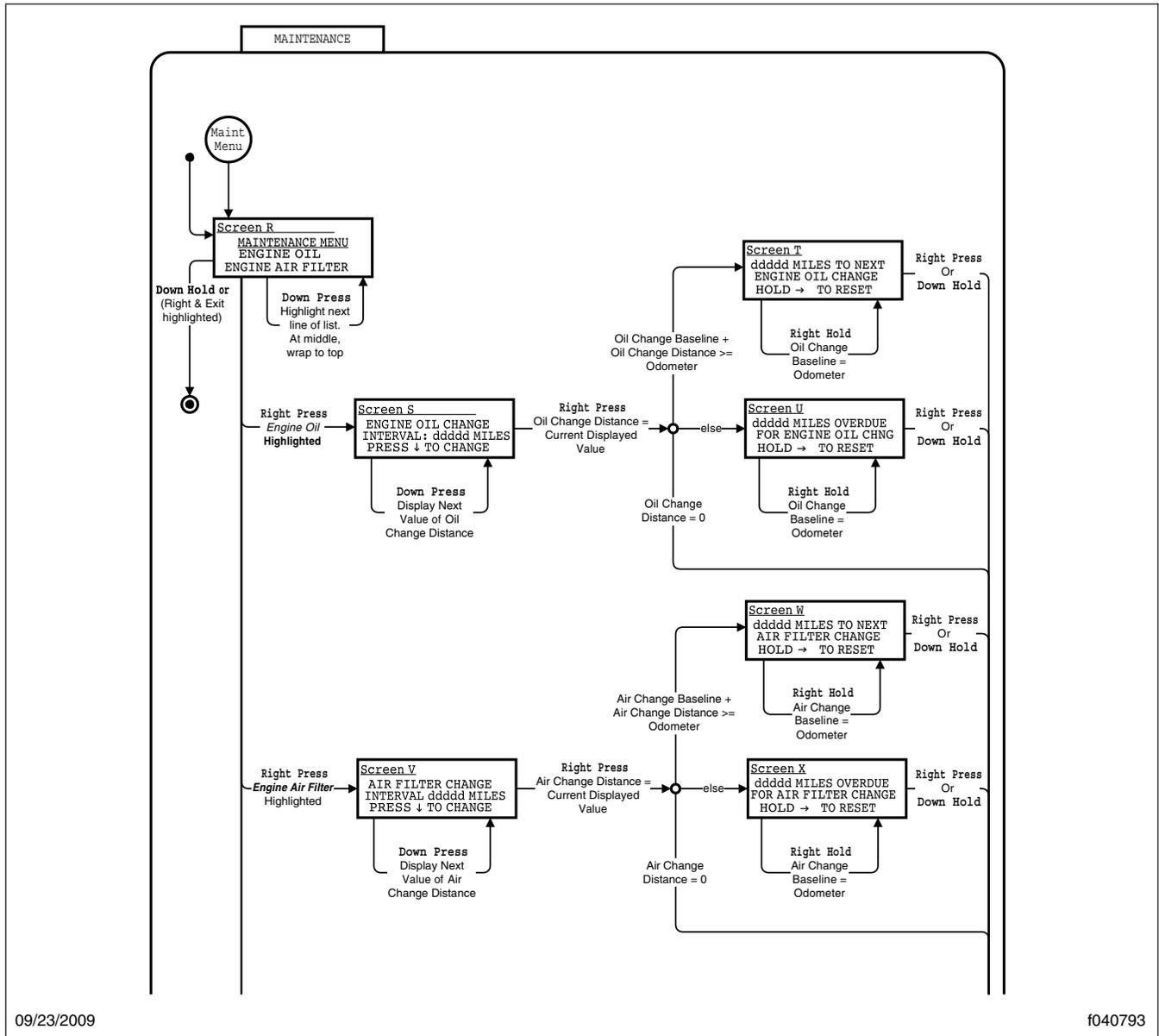


Fig. 2.37, Maintenance Menu Screens, Screen 1

If the headway range is adjusted to 3 seconds or below, and SmartCruise is active, the 3 second collision warning headway alert will not display. All other alerts are not suppressed.

KM/H MPH Screen

The up and down arrows are used to select either km/h or mph units for display of SmartCruise set

speed. The previous km/h or mph setting is displayed at the next ignition cycle. See Fig. 2.56.

Pressing OK exits this menu.

Diagnostics

The DIU displays fault codes currently active when this screen is selected. See Fig. 2.57. The vehicle must be stationary for the fault codes to display.

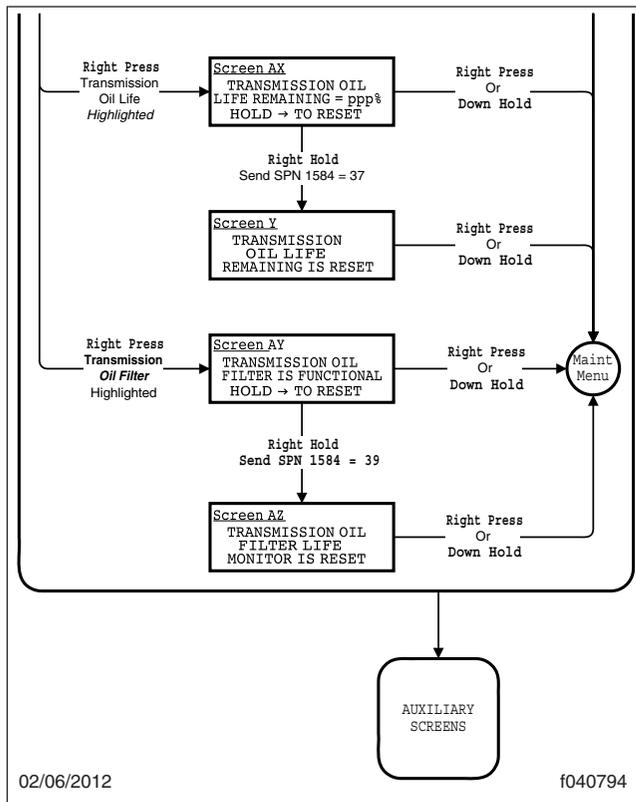


Fig. 2.38, Maintenance Menu Screens, Screen 2

Contact an authorized Freightliner dealer if fault codes display.

Forward-Looking-Radar (FLR) Warning System

If the VS-400 reads any vehicle speed before the forward-looking-radar has time to warm up, a single tone will sound, and one of the following screens will display. See [Fig. 2.58](#). The FLR may require a warm-up period of up to 5 minutes in extreme cold outside temperature conditions.

The VS-400 FLR identifies and tracks the nearest object in the lane of travel. This object is classified by the range, and assigned one of the messages shown in [Fig. 2.59](#), [Fig. 2.60](#), [Fig. 2.61](#), [Fig. 2.62](#), and [Fig. 2.63](#), and described under the following seven headings.

The alerts given by the VS-400 system are based on the “headway” to the object ahead, whenever vehicle speed is 10 mph (16 km/h) or greater.

Object Detected

When an object is in the lane of travel, the VS-400 system displays the following message and tone. See [Fig. 2.59](#).

- information message: OBJECT DETECTED
- tone sequence: none

3-Second Headway Alert

When a moving object is in the lane of travel, and the headway is greater than 2 seconds, up to and including 3 seconds, the DIU displays the following message. See [Fig. 2.60](#).

- information message: 3 seconds
- tone sequence: none

2-Second Headway Alert

When the vehicle is closing on a moving object in the lane of travel, and the headway is greater than 1 second, up to and including 2 seconds, the DIU displays the following message and tones. See [Fig. 2.61](#).

- information message: 2 seconds
- tone sequence: "2-Second closing headway alert" tones are sounded. (Note: This tone sequence is not sounded if the brakes are applied.)

1-Second Headway Alert

When the vehicle is closing on a moving object in the lane of travel, and the headway is greater than 0.5 seconds, up to and including 1 second, the DIU displays the following message and tones. See [Fig. 2.62](#).

- information message: 1 second
- tone sequence: "1-Second closing headway alert" tones are sounded. (Note: This tone sequence is not sounded if the brakes are applied.)

Collision Alert: 1/2-Second Headway

When the vehicle is closing on a moving object in the lane of travel, and the headway is 0.5 second or less, the DIU displays the following message and tones. See [Fig. 2.63](#).

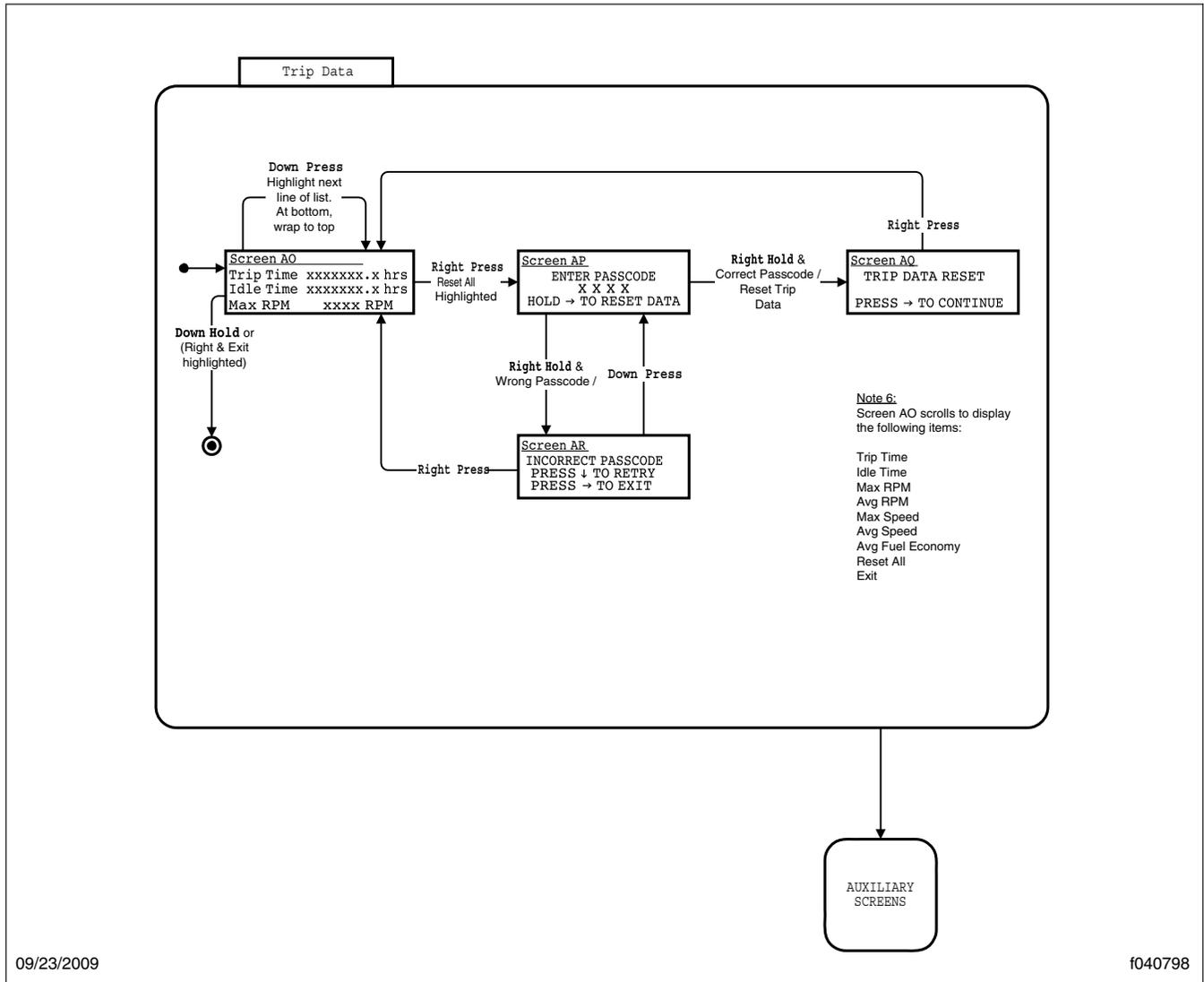


Fig. 2.39, Trip Data

- information message: COLLISION ALERT
- tone sequence: "1/2-Second closing alert" tones are sounded continuously.

Collision Alert: Slow Moving Object

See [Fig. 2.63](#). If the headway to a slow moving object is 3 seconds or less and the vehicle turn radius is 750 feet or more, the collision alert message is displayed and the "slow moving object tone" is sounded, provided:

- the vehicle speed is greater than 35 mph (56 km/h);
- the speed of the object is greater than 5 ft (1-1/2 m) per second;
- the object is in the lane of travel, and within 220 feet (67 meters) of the vehicle;
- the object speed is less than 80% of the host vehicle speed.

Instruments

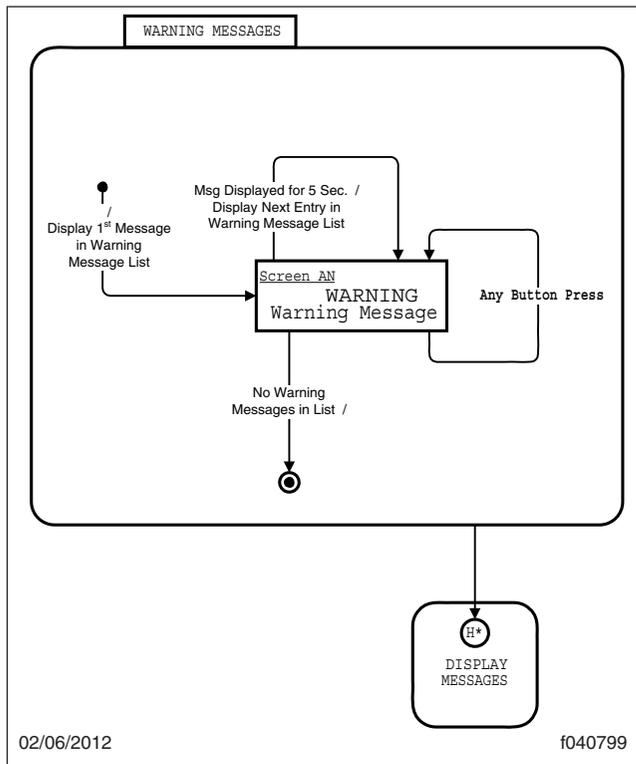


Fig. 2.40, Warning Messages

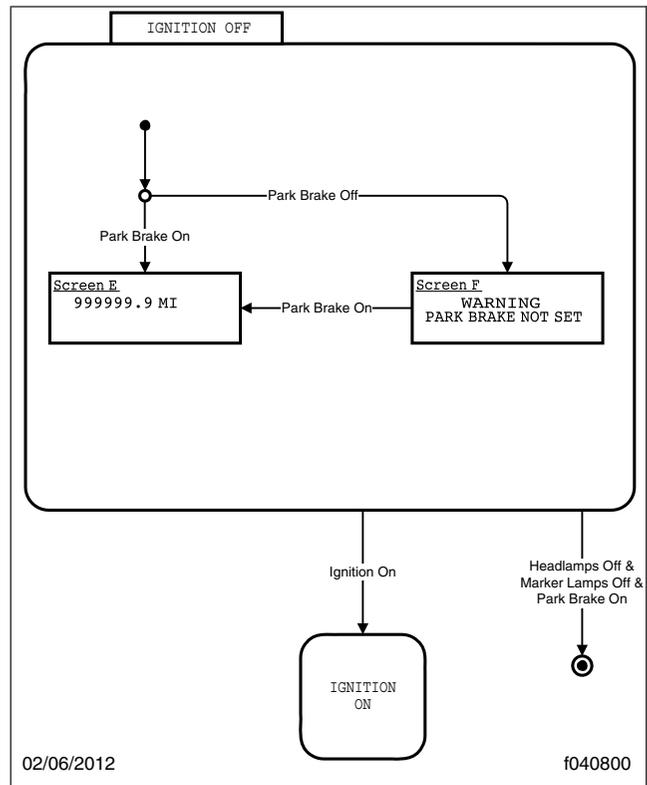


Fig. 2.41, Ignition Off (shown when ignition is keyed OFF)

Collision Alert: Stationary Object

See Fig. 2.63. If the headway to a stationary object is 3 seconds or less, and the vehicle turn radius is 750 feet (229 meters) or more, the collision alert message is displayed and the "stationary object tone" is sounded, provided the object is in the lane of travel, and within 220 feet (67 meters) of the vehicle.

Side Sensor Display

The side sensor display is mounted on the A-pillar. See Fig. 2.64. The following lights illuminate.

- The red LED illuminates when an object is detected.
- The red LED illuminates and a triple tone is sounded, when objects are detected and the turn signal is activated.
- The ambient light sensor determines if the side sensor display is in daytime or nighttime mode. The display brightness is automatically adjusted for daytime or nighttime operation.



Fig. 2.42, Auto Idle Message

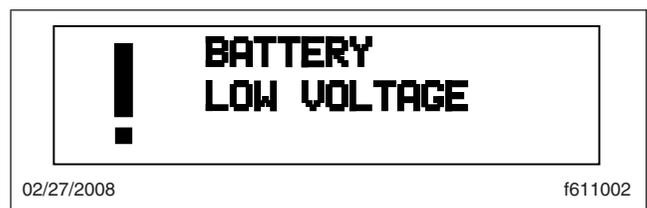


Fig. 2.43, Low Voltage Message

- The yellow LED illuminates when no objects are detected.

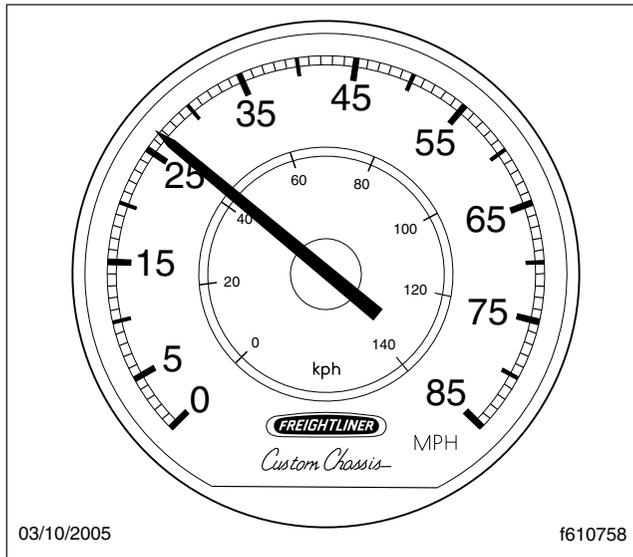


Fig. 2.44, Speedometer

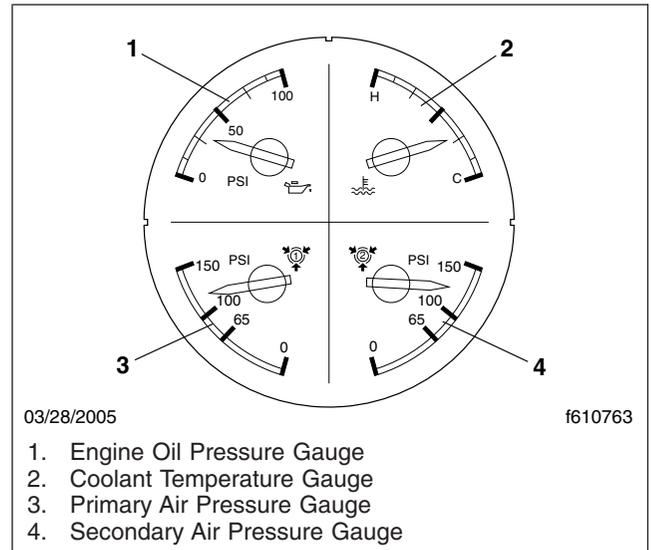


Fig. 2.46, Pressure/Temperature Gauges

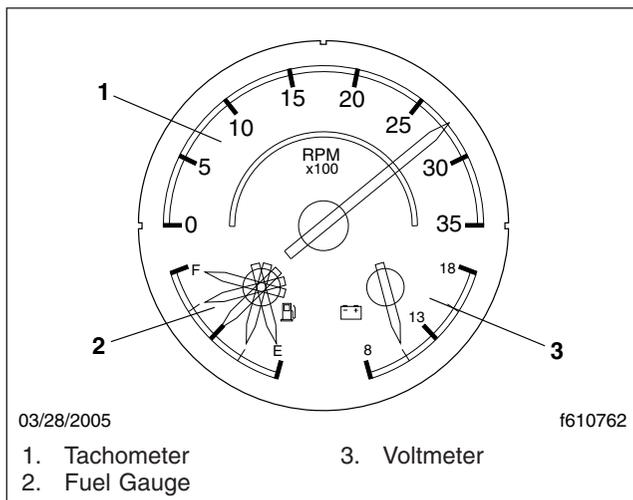


Fig. 2.45, Tachometer (Three-In-One Gauge)

- The red and yellow LEDs illuminate together when there is a fault condition.

Special Road Situations

Certain special road situations may affect the system's ability to detect objects. These situations include the effects of curves, dips, and hills which can provide an unexpected result.

NOTE: A warning may sound when an object is detected in front of the vehicle even though the

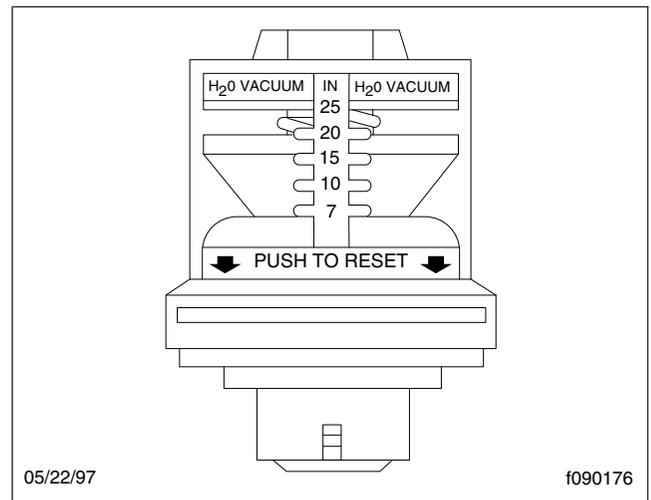


Fig. 2.47, Air Intake Restriction Indicator

driver intends to turn away or stop before reaching the object as follows:

- When an object is detected in a very sharp right- or left-hand turn, the audible alarm will not sound.
- When approaching a curve, alarms may sound and lights illuminate, because of an object off the road directly in line with your vehicle. This will not occur when the brakes are applied.

Instruments

- Elevated obstacles such as overpasses and overhead signs may be detected, when approaching a roadway descending to a lower elevation.
- Vehicles cannot be detected on the other side of a hill. An alarm will not sound until the object is within the antenna assembly's field of view.
- On approaching a steep hill, objects above the beam cannot be detected. Generally, the beam hitting the road surface does not cause an alarm.
- The side sensor only detects objects within its field of view, next to the tractor. A vehicle farther back behind the field of view, will not be detected.
- The side sensor range is set to detect average sized vehicles 2 to 10 feet (0.5 to 3 meters) away in the adjacent lane.
- The radar beam will detect near range cut-ins of approximately 30 feet (9 meters) or less, depending on the angle of entrance into the lane in front of your vehicle.


WARNING

Heavy rain or water spray at the side sensor may cause both the yellow and red lights on the side sensor display to illuminate at the same time. Under these conditions the system is temporarily unable to provide adequate warnings.

Failure to drive safely and use the system properly could result in personal injury and/or death and severe property damage.

NOTE: A continuous fixed object on the right side of the vehicle such as a guard rail, wall,

tunnel, or bridge may cause the side sensor alert light to stay on.

Maintenance

Keep the antenna assembly and side sensor(s) free of buildup of mud, dirt, ice, or other debris that might reduce the system's range.

Failure Display Mode/Fault Codes

The VS-400 performs internal diagnostics at power-up, then continuously monitors system components thereafter.

If a failure is detected, depending on what features are affected, the DIU displays a screen similar to [Fig. 2.65](#), blinks the orange fault light, and sounds a tone. Press the OK button to acknowledge the fault.

After the fault has been acknowledged by the driver pressing the OK button, the DIU will attempt to return to normal operations. The orange LED is continuously illuminated while the fault persists. If the fault disappears, the VS-400 transmits a message to indicate that the fault status has changed to a previously active fault.

In the event the FLR antennae becomes blocked while the vehicle is moving (e.g., snow, mud, ice, tampering, etc.), the system sounds a tone and displays the fault screen shown in [Fig. 2.66](#).

Previously active fault codes can be reviewed, tested, and cleared using the Eaton Service Ranger diagnostic tool. Contact an authorized Freightliner dealer to review and clear previously active fault codes. See [Table 2.1](#) for common fault codes.

VORAD Fault Codes				
Device	SPN	FMI	Description	Notes
DIU/FLR	639	2	One or more required messages missing from datalink	—
DIU/FLR	639	9	No message being received from datalink	—
DIU/FLR	639	13	Device cannot claim source address on datalink	—
DIU/FLR	639	19	Messages received with incorrect data or marked as error	—
FLR	886	7	FLR misaligned	—
FLR	886	12	FLR internally defective	—
FLR	886	13	FLR not configured properly	—
FLR	886	14	FLR blocked	—
DIU	893	12	DIU internally defective	—

VORAD Fault Codes				
Device	SPN	FMI	Description	Notes
FLR	898	13	Engine not configured for SmartCruise operation	Tested only if SC configured
FLR	898	14	Engine not supported for SmartCruise operation	Tested only if SC configured
DIU/FLR	1563	13	VS-400 component detects incompatibility issue with other VS-400 devices	—
DIU	1703	3	External right speaker shorted high	Tested only if external right speaker configured
DIU	1703	4	External right speaker shorted low	Tested only if external right speaker configured
DIU	1703	5	External right speaker open	Tested only if external right speaker configured
DIU	1704	3	External left speaker shorted high	Tested only if external left speaker configured
DIU	1704	4	External left speaker shorted low	Tested only if external left speaker configured
DIU	1704	5	External left speaker open	Tested only if external left speaker configured

Table 2.1, VORAD Fault Codes

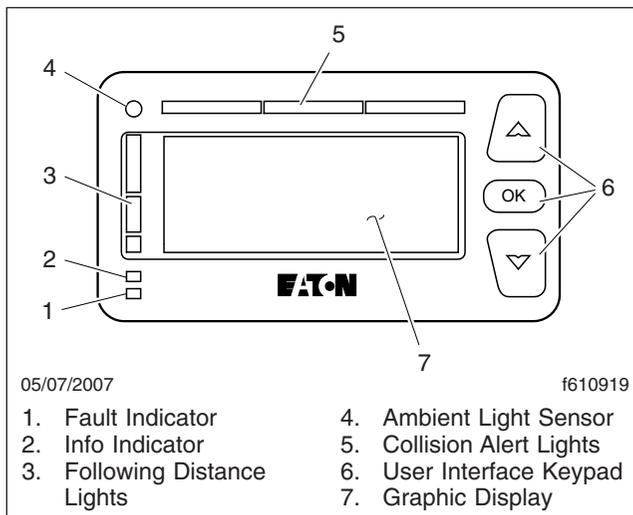


Fig. 2.48, Driver Interface Unit (DIU)

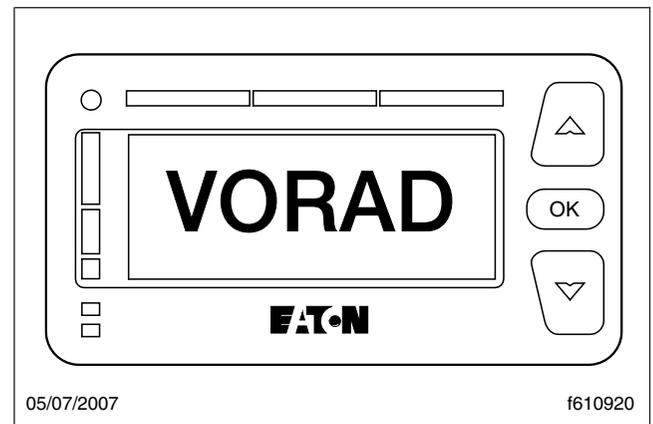


Fig. 2.49, Initialization Screen

Instruments

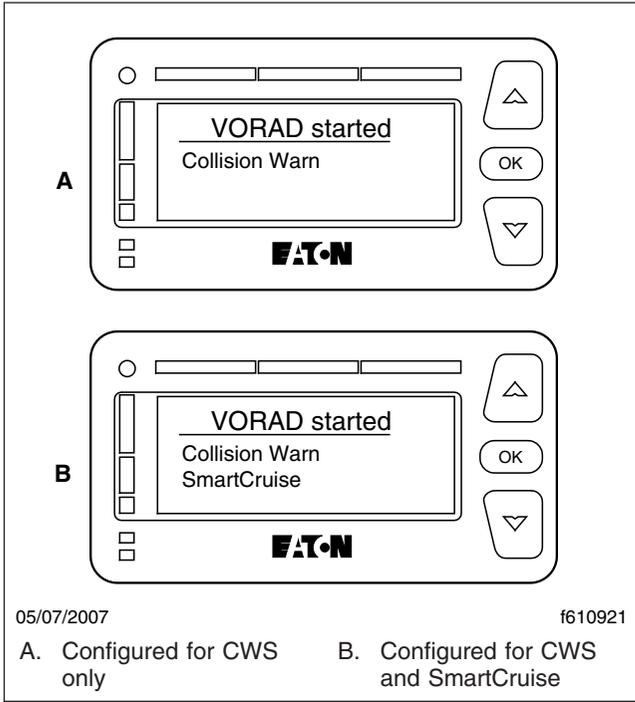


Fig. 2.50, System Configuration Screens

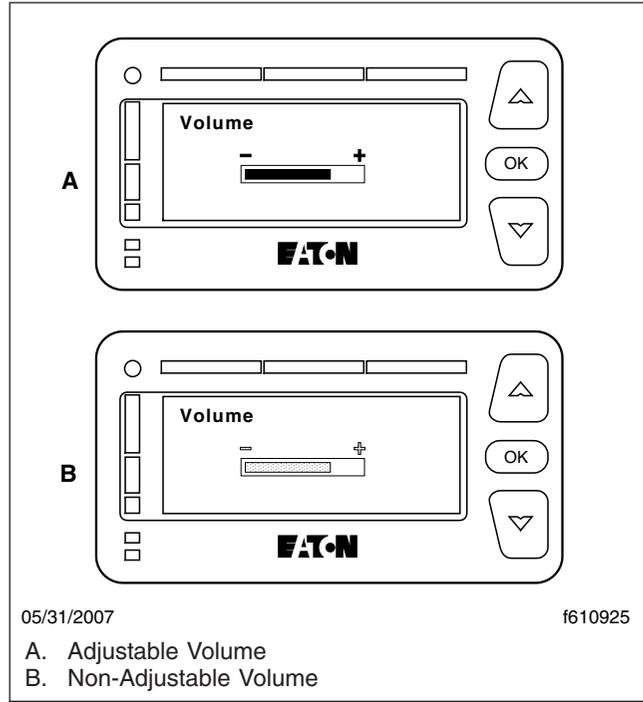


Fig. 2.52, Volume Display

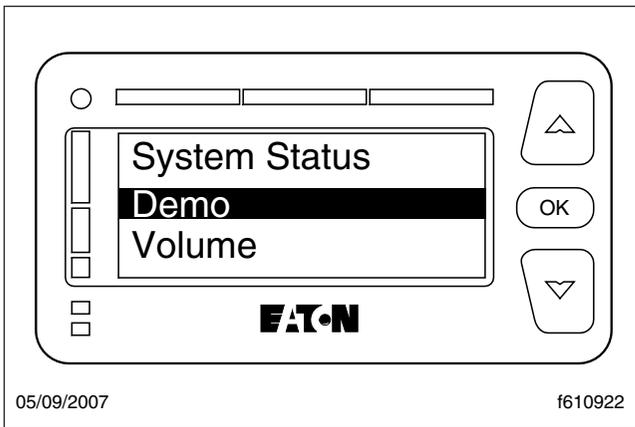


Fig. 2.51, Menu Screen

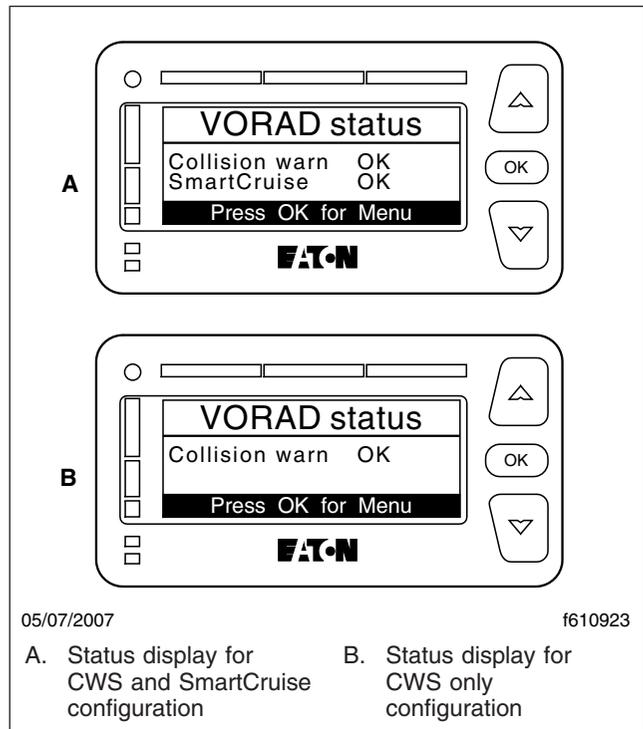


Fig. 2.53, System Status Screens

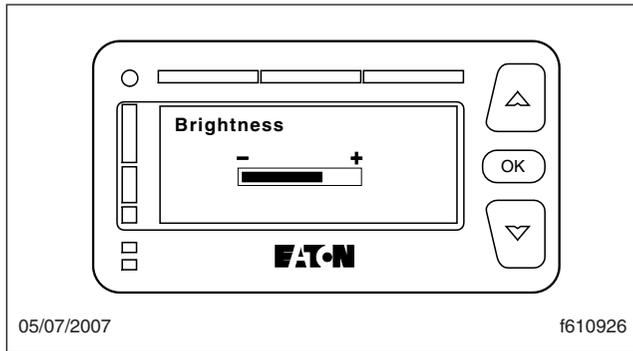


Fig. 2.54, Brightness Screen

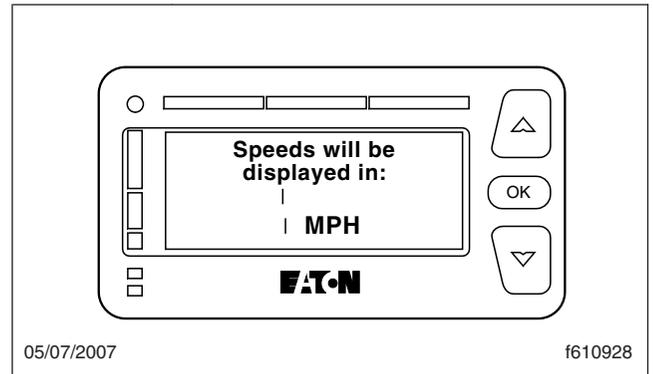


Fig. 2.56, KM/H MPH Selection Display

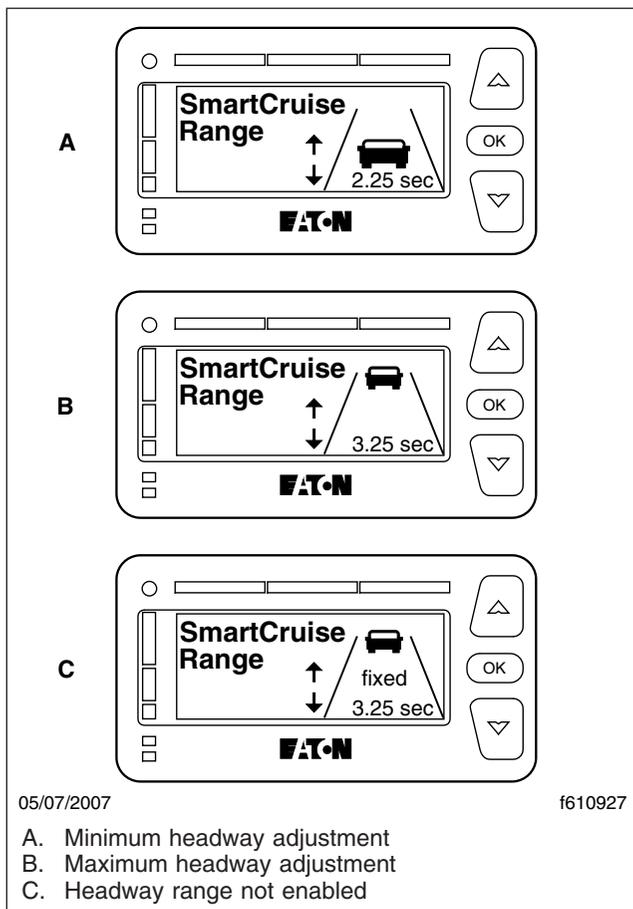


Fig. 2.55, Headway Range Display

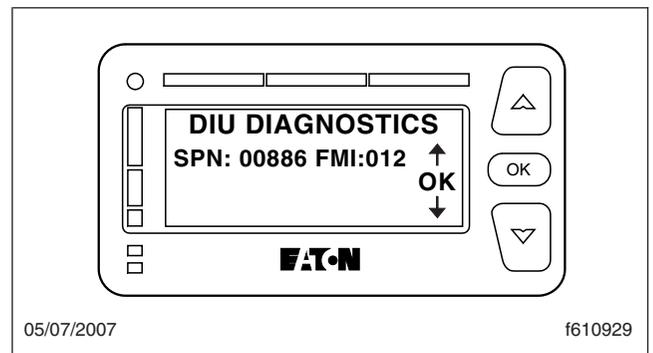


Fig. 2.57, DIU Diagnostic Display

Instruments

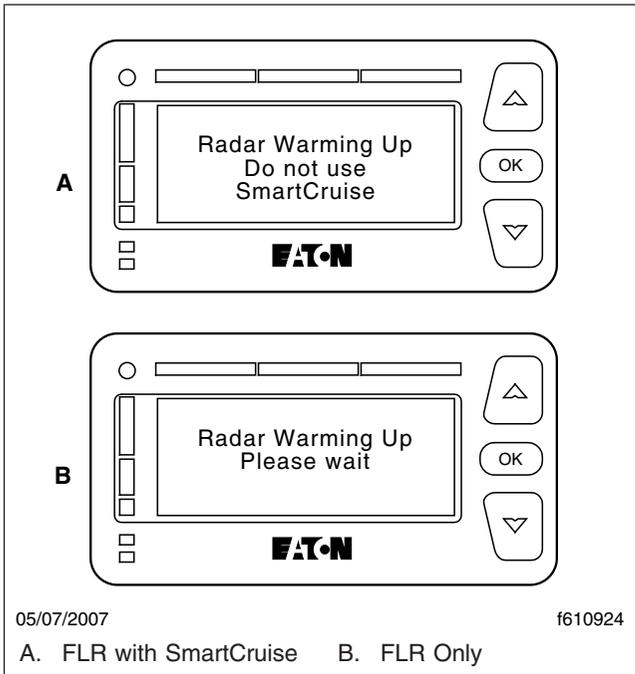


Fig. 2.58, FLR Warm-Up Screens

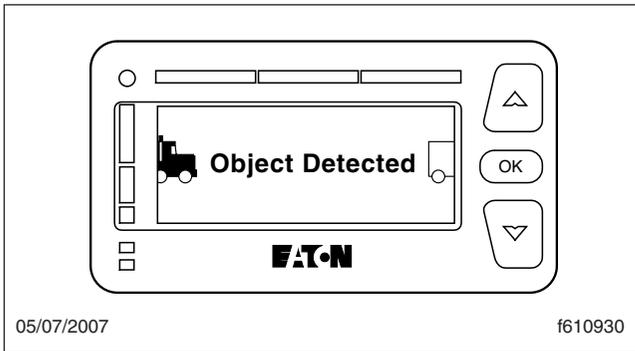


Fig. 2.59, Object Detected Alert

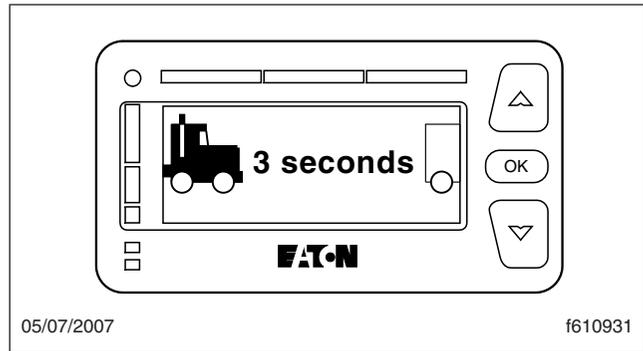


Fig. 2.60, 3-Second Alert

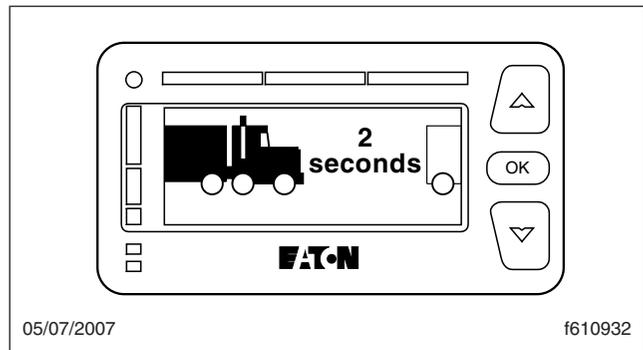


Fig. 2.61, 2-Second Alert

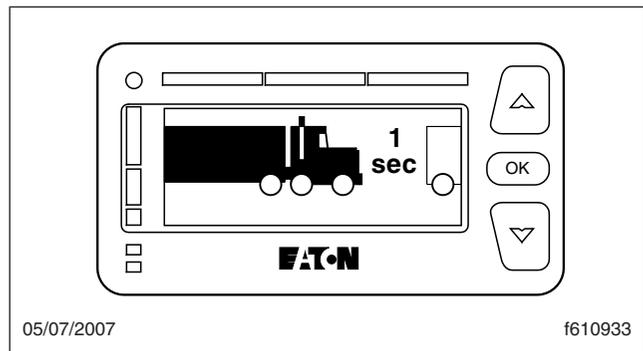


Fig. 2.62, 1-Second Alert

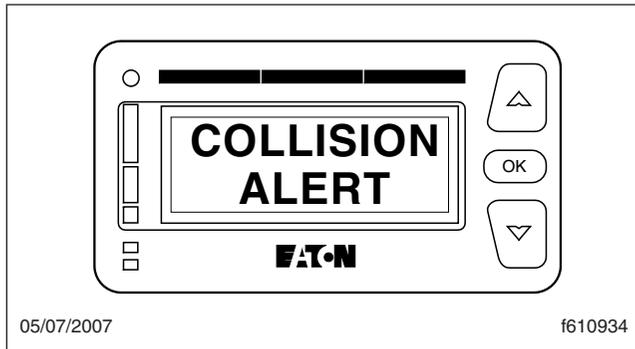


Fig. 2.63, Collision Alert

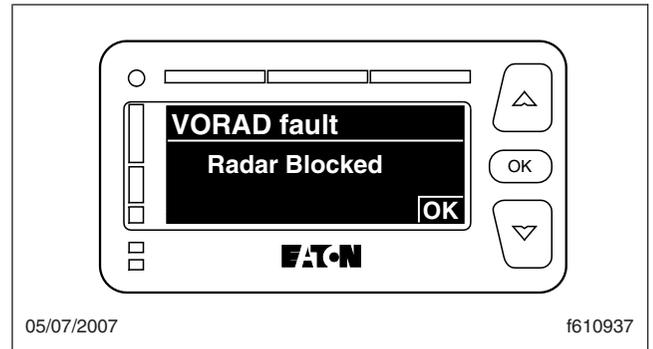


Fig. 2.66, Antennae Blocked Display

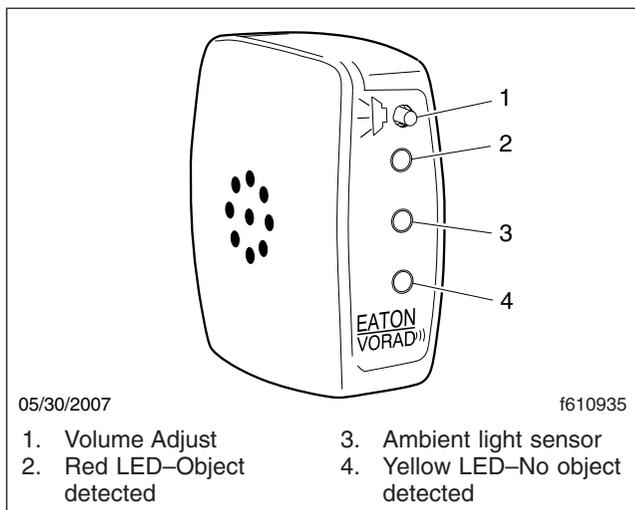


Fig. 2.64, Side Sensor Display

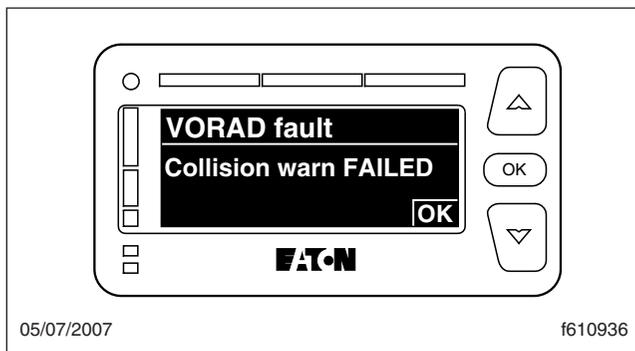


Fig. 2.65, VORAD Fault Display

3

Driver Controls

Ignition Switch and Key	3.1
Electrical System Controls	3.1
Lighting Controls	3.1
Windshield Wiper Controls	3.3
Cruise Control	3.4
Horn Control	3.5
Powertrain Controls	3.5
Braking Control	3.7
Steering Control	3.7

Driver Controls

Ignition Switch and Key

The ignition switch can be turned to four positions: ACCESSORY, OFF, ON, and START. See [Fig. 3.1](#).

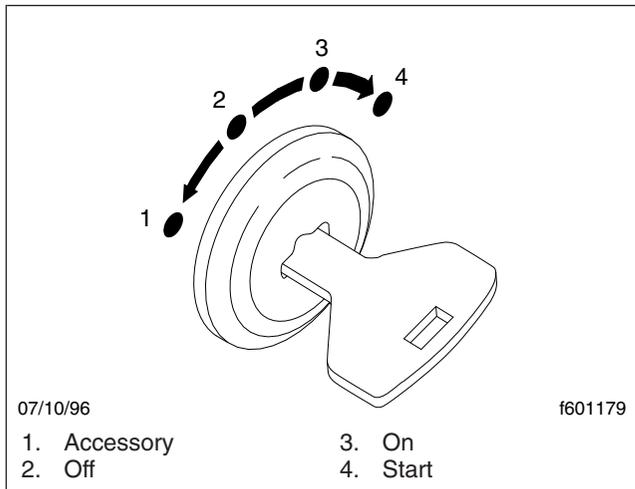


Fig. 3.1, Ignition Switch

The key can be inserted and removed only in the OFF position. The headlights (low beams), brake lights, fog lights, dome lights, clearance lights, turn signals, hazard warning lights, and parking lights operate with the ignition switch in the OFF position, regardless of whether the key is inserted.

All of the components that are operable in the OFF position are operable in the ACCESSORY position. The electric gauges will not operate when the key is in the ACCESSORY position.

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

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.

Electrical System Controls

Servicing the electrical system requires special skills and equipment, and should only be performed by a qualified technician. Take the vehicle to an authorized Freightliner 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.

Battery Disconnect Switch

IMPORTANT: When the batteries are disconnected (disconnect switch is turned to OFF), the cable to the starter is still hot, as it is not connected through the disconnect switch.

Some chassis may be equipped with a battery disconnect switch that can be used to prevent unwanted drain from the vehicle battery when the vehicle is not in use or is in storage. It can also rapidly disconnect the power supply in the event of an emergency. Mounting locations vary. See [Fig. 3.2](#).

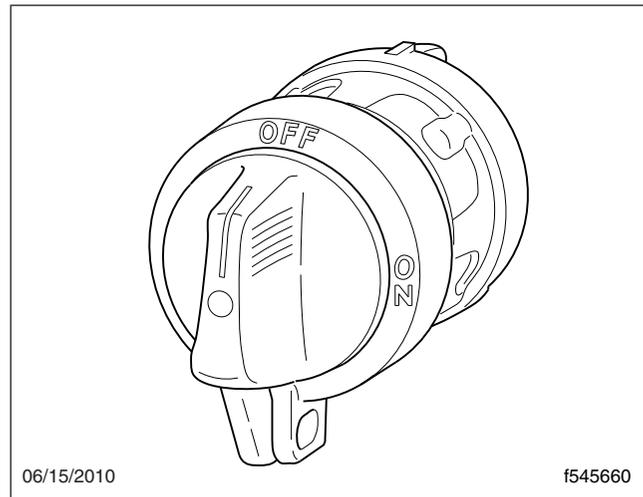


Fig. 3.2, Battery Disconnect Switch

Lighting Controls

Headlight Switches and Panel Lights

The control knob for the headlights, side marker lights, taillights, parking lights, license plate lights, and panel lights is located on the dash panel. See [Fig. 3.3](#). The headlight control knob operates as follows:

- Left Position: All lights off.

- Middle Position: All lights on except headlights and fog lights.
- Right Position: All lights on, except fog lights.
- Middle and Right Positions: All lights on, including the fog lights when the knob is pushed in.

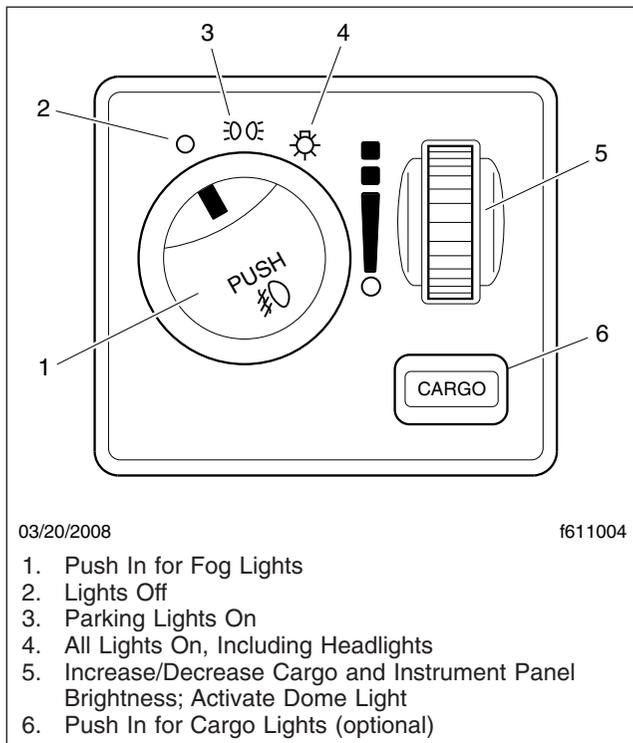


Fig. 3.3, Light Control

A separate dash panel dimmer control adjusts dash panel brightness. Turn the knob up to increase the panel brightness, and down to dim the light.

The dimmer control also turns the dome light on when the control is turned to the uppermost point. See [Fig. 3.3](#).

High-Beam Headlights

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

To activate the high-beam headlights, pull the multifunction turn signal lever up until a "clicking" sound is heard. See [Fig. 3.4](#). Pull the lever up until it clicks again to turn the high-beam headlights off. The low beams remain on during high beam operation.

When the high-beam headlights are on, a blue light illuminates on the instrument panel. For vehicles built for domicile in the United States, the road lights turn off when the high beams are activated.

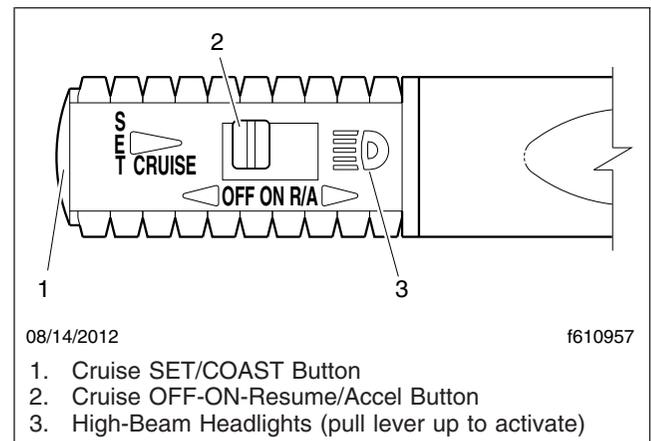


Fig. 3.4, Multifunction Turn Signal Switch

To flash the high beams momentarily, pull the lever up, and release it just before the lever clicks.

Headlight Interrupt (SmartWheel only)

To turn the headlights off briefly, press and hold the headlight interrupt switch on the left switch panel of the SmartWheel. See [Fig. 3.5](#) and [Fig. 3.6](#). The headlights will remain off only as long as the switch is pressed.

Marker Lamp Interrupt (SmartWheel only)

To flash the marker lamps on or off, press and hold the marker lamp interrupt switch on the right switch panel of the SmartWheel. See [Fig. 3.5](#) and [Fig. 3.6](#). The marker lamps will remain on or off only as long as the switch is pressed.

Turn Signals

Moving the multifunction turn signal lever down activates the left turn signal lights; moving it up activates the right turn signal lights. See [Fig. 3.4](#) for an example of the multifunction turn signal lever.

When a turn signal is activated, a green indicator arrow flashes at the far left or far right of the instrument panel.

Driver Controls

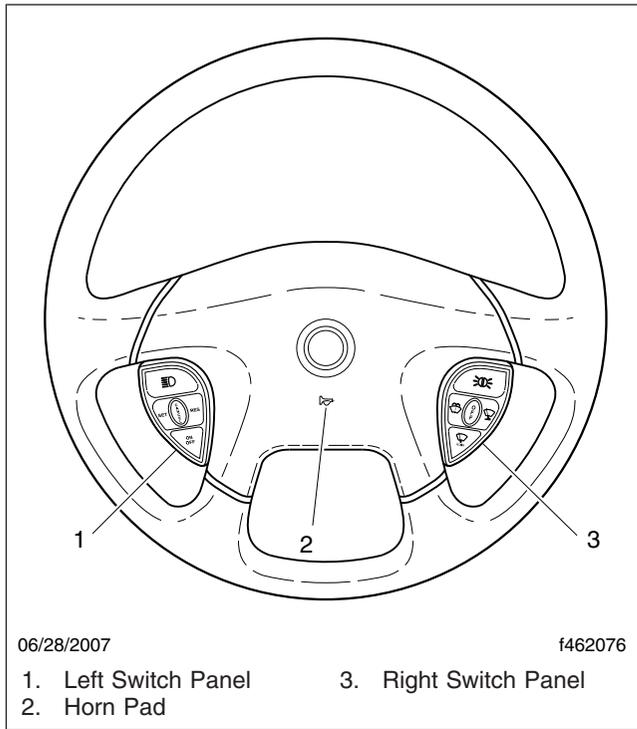


Fig. 3.5, SmartWheel

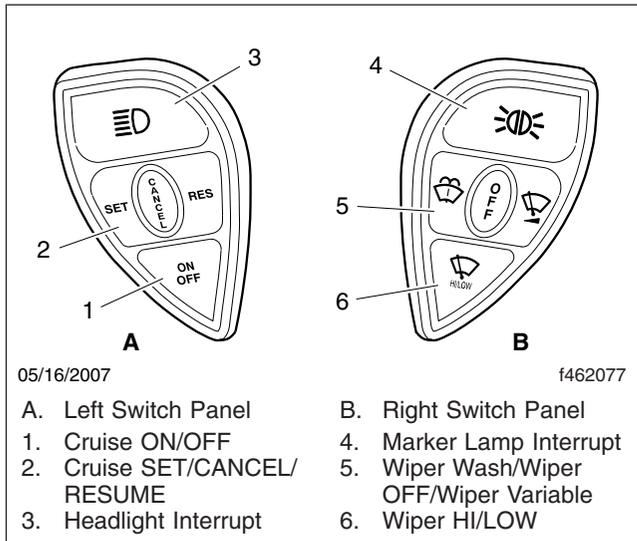


Fig. 3.6, SmartWheel Switch Panels

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.

Hazard Warning Lights

To activate the hazard warning lights, pull out the hazard warning light switch located under the multi-function turn signal switch. See **Fig. 3.7**. When the switch is pulled out, all of the turn control lights will flash. To cancel the hazard warning lights, move the turn signal switch up or down.

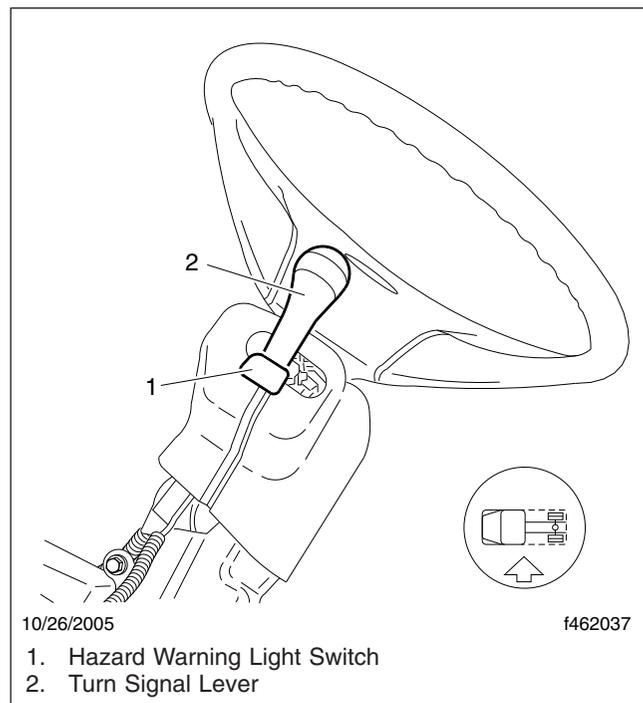


Fig. 3.7, Hazard Warning Light Switch Location

Windshield Wiper Controls

Standard Wiper Controls

On vehicles equipped with a standard steering wheel, the windshield wiper control is mounted on the dash by the body builder. Check with the body builder for operating instructions.

SmartWheel Wiper Controls

NOTE: SmartWheel wiper controls are located on the right switch panel. See **Fig. 3.5** and **Fig. 3.6**. Activating any wiper switch causes the

headlights to come on. To turn the headlights off, turn the ignition off.

Wiper Wash

Press and hold the wiper wash switch, shown in [Fig. 3.6](#), to activate the wiper wash pump. Depending on whether the HI/LOW or variable switch was selected, the wipers will continue to run in that mode when the switch is released.

Wiper HI/LOW

Press the wiper HI/LOW switch, shown in [Fig. 3.6](#), to activate the wipers at low speed. Press the switch again to activate the high speed. Continue pressing the switch to toggle between high and low speed.

Wiper Variable

Press the wiper variable switch, shown in [Fig. 3.6](#), to activate the wipers for one low-speed wipe. Press the switch again within approximately 30 seconds and a second low-speed wipe will occur. The wiper interval is set by the timing between the last two presses of the switch. Additional presses of the switch will shorten the interval. The variable mode will cancel if another wiper mode is selected.

Wiper OFF

Press the wiper OFF switch, shown in [Fig. 3.6](#), to cancel all wiper operation. Turning the ignition switch to the OFF position has the same effect.

Cruise Control

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

Cruise control allows the driver to automatically control the speed of the vehicle above 32 mph (51 km/h). The switches that operate the cruise control system are located either on the turn signal lever or on the left switch panel of a SmartWheel steering wheel.

See [Fig. 3.4](#) for turn signal-mounted cruise control switches. The OFF-ON-R/A (resume/accelerate) switch allows the driver to turn cruise control on and off, accelerate while in cruise control, or resume cruise speed. The SET/COAST switch allows the driver to select the cruise speed or temporarily disable the cruise control.

See [Fig. 3.5](#) and [Fig. 3.6](#) for SmartWheel-mounted cruise control switches. The ON/OFF switch turns cruise control on and off. The SET/CANCEL/RES switch is used to set cruise control speed, accelerate while in cruise control, temporarily disengage cruise control, or resume cruise speed.

Turn Signal-Mounted Cruise Control

WARNING

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.

NOTICE

Do not shift to neutral (N) when using cruise control. This will cause the engine to overspeed, which can damage the engine.

1. To cruise at a particular speed:
 - 1.1 Move the slide switch on the turn signal lever to the ON position.
 - 1.2 Hold the accelerator pedal down until the vehicle reaches the desired speed.
 - 1.3 Press and release the SET/COAST button at the end of the turn signal lever.
2. To increase the set speed, move the slide switch on the turn signal lever to the R/A (resume/accelerate) position.

To decrease the set speed, press and hold the SET/COAST button until the desired speed is reached.
3. To disengage the cruise control:
 - 3.1 Depress the brake pedal, *or*
 - 3.2 Move the slide switch on the turn signal lever to the OFF position.
4. If the brake pedal was used to disengage the cruise control, then move the slide switch to the R/A (resume/accelerate) position to resume the previously set speed.

Driver Controls

NOTE: When pulling a heavy load, climbing a very steep hill, or driving into a strong wind, bring the vehicle up to speed with the accelerator pedal and then let the cruise control take over.

If actual vehicle speed decreases 5 mph (8 km/h) or more below the set speed, the cruise control will automatically disengage.

5. To operate at high idle using the cruise control:
 - 5.1 Place the shift lever in neutral (N).
 - 5.2 Turn the cruise control on and accelerate to the desired rpm. Press and release the SET button on the turn signal switch.
 - 5.3 Disengage by depressing the brake pedal or turning the cruise control off at the turn signal switch.

SmartWheel-Mounted Cruise Control

NOTICE

Do not shift to neutral (N) when using cruise control. This will cause the engine to overspeed, which can damage the engine.

1. To cruise at a particular speed:
 - 1.1 Press the ON button on the steering wheel.
 - 1.2 Hold the accelerator pedal down until the vehicle reaches the desired speed.
 - 1.3 Press the SET button on the steering wheel.
2. To increase the set speed, accelerate to the desired speed, then press the SET button on the steering wheel.
To decrease the set speed, press and hold the SET button on the steering wheel until the desired speed is reached.
3. To disengage the cruise control:
 - 3.1 Depress the brake pedal, *or*
 - 3.2 Press the OFF button on the steering wheel.
4. If the brake pedal was used to disengage the cruise control, press the RES button on the

steering wheel to resume the previously set speed.

NOTE: When pulling a heavy load, climbing a very steep hill, or driving into a strong wind, bring the vehicle up to speed with the accelerator pedal and then let the cruise control take over.

If actual vehicle speed decreases 5 mph (8 km/h) or more below the set speed, the cruise control will automatically disengage.

5. To operate at high idle using the cruise control:
 - 5.1 Place the shift lever in neutral (N).
 - 5.2 Turn the cruise control on and accelerate to the desired rpm. Press and release the SET button on the steering wheel.
 - 5.3 Disengage by depressing the brake pedal or pressing the OFF button on the steering wheel.

Horn Control

The button for the horn is located in the center of steering wheel. To sound the horn, press the center of the steering wheel pad. See [Fig. 3.8](#).

Powertrain Controls

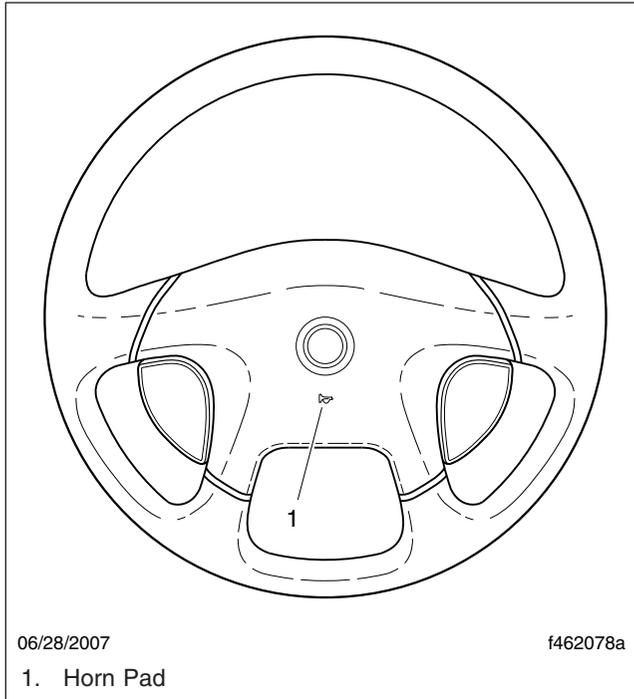
Allison Automatic Transmissions

Allison automatic transmissions are controlled by an electronic control unit (ECU). See [Fig. 3.9](#) and [Fig. 3.10](#). See [Chapter 7](#) for complete transmission operating instructions.

Tag-Axle Suspension Dump Switch

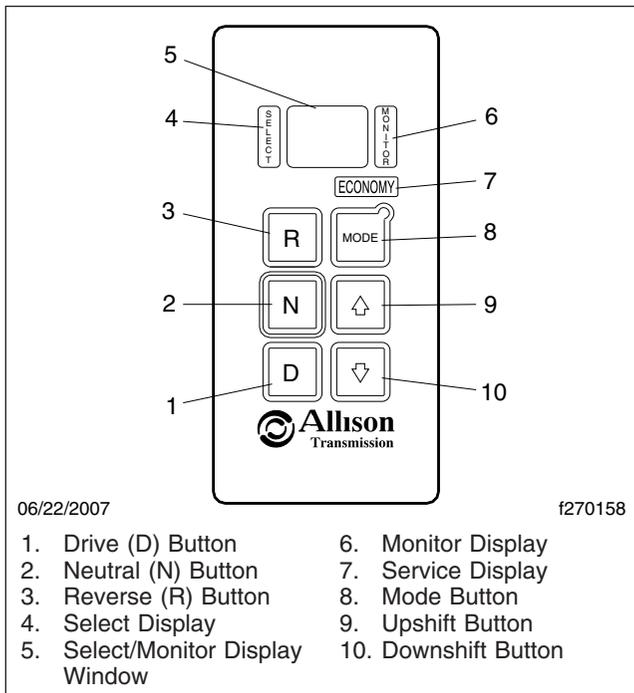
The optional tag-axle suspension is a non-liftable, full-time suspension designed to increase the Gross Vehicle Weight Rating (GVWR). It is used when the rear suspension/axle will be loaded to a weight greater than 20,000 lb (9072 kg). Under certain conditions, air can be exhausted from the air springs to improve maneuverability or traction on the drive axle via the tag-axle suspension dump switch.

The tag-axle suspension dump switch is operated by a three-position, dash-mounted rocker switch. See [Fig. 3.11](#). The manual TAG DUMP mode is activated by pressing the top of the rocker switch. The AUTO



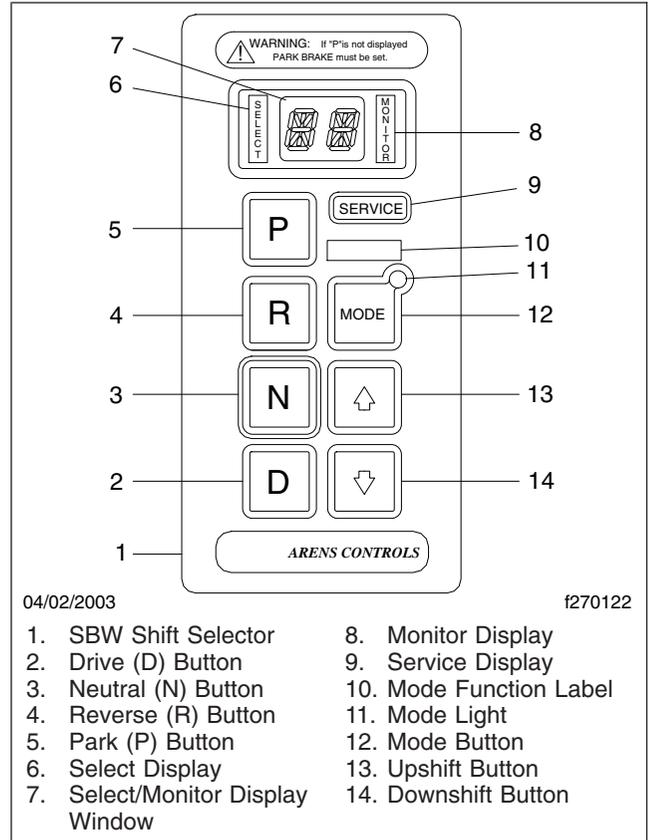
1. Horn Pad

Fig. 3.8, Horn Control, Standard Steering Wheel



1. Drive (D) Button	6. Monitor Display
2. Neutral (N) Button	7. Service Display
3. Reverse (R) Button	8. Mode Button
4. Select Display	9. Upshift Button
5. Select/Monitor Display Window	10. Downshift Button

Fig. 3.9, GEN IV Shift Selector



1. SBW Shift Selector	8. Monitor Display
2. Drive (D) Button	9. Service Display
3. Neutral (N) Button	10. Mode Function Label
4. Reverse (R) Button	11. Mode Light
5. Park (P) Button	12. Mode Button
6. Select Display	13. Upshift Button
7. Select/Monitor Display Window	14. Downshift Button

Fig. 3.10, Shift-By-Wire (SBW) Shift Selector

DUMP mode is activated automatically during reverse gear applications when the rocker switch is placed in the middle (level) position. When you depress the bottom of the rocker switch, the tag-axle suspension dump switch is placed in the OFF (down) position, and the TAG DUMP mode is inactive.

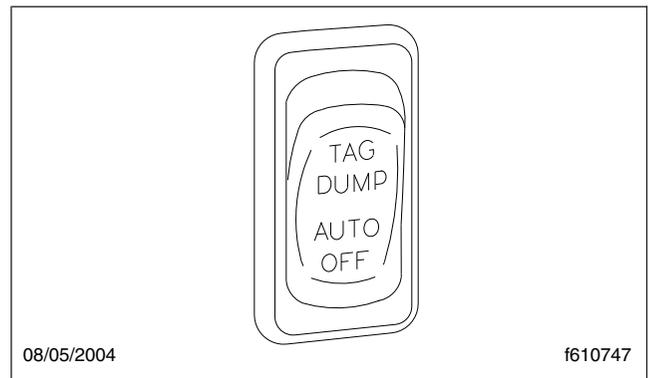


Fig. 3.11, Tag-Axle Suspension Dump Switch

Driver Controls

WARNING

If the vehicle is equipped with an air suspension system, do not move the vehicle with the air suspension deflated. Doing so could result in a loss of vehicle control, possibly causing personal injury and property damage.

NOTE: Chassis built with an air suspension dump option have an automatic feature that will not allow the suspension to be deflated unless the parking brakes are set. The suspension will automatically inflate when the parking brakes are released.

Tag-Axle Suspension—Dump Only

In the TAG DUMP mode, the axle air bags will deflate when **all** of the following conditions are met. If any of these conditions are not met, the tag-axle air bags will fill:

- The tag-axle suspension dump switch is momentarily pressed to toggle the tag-axle control module into the dump mode.
- The vehicle speed is less than 8 mph (13 km/h).
- The vehicle is in neutral or a forward gear.

If the vehicle exceeds a speed of 8 mph (13 km/h) while the switch is in the TAG DUMP position, the tag axle suspension dump switch control system will override the TAG DUMP mode and the tag suspension air bags will refill.

IMPORTANT: The tag-axle suspension dump switch feature must be cycled on and off of the TAG DUMP position if an override event occurs while the switch is in the TAG DUMP position.

In the AUTO DUMP mode, the axle air bags will deflate when **all** of the following conditions are met. If any of these conditions are not met, the tag-axle air bags will fill:

- The tag-axle suspension dump switch remains in the AUTO DUMP mode (reverse maintained position).
- The vehicle speed is less than 8 mph (13 km/h).
- The vehicle is in reverse.

Tag-Axle Suspension—Dump and Tag Wheel Steering

The tag-axle will be locked in an unsteerable position when **any** of the following conditions are met:

- The vehicle is in reverse.
- The vehicle speed exceeds 20 mph (32 km/h) while accelerating or exceeds 15 mph (24 km/h) while decelerating.

The tag-axle will be unlocked and steerable when **all** of the following conditions are met:

- The vehicle is in a forward gear.
- The vehicle speed is less than 20 mph (32 km/h) while accelerating or less than 15 mph (24 km/h) while decelerating.

Braking Control

Parking Brake Control Knob

All pneumatic-braked vehicles are equipped with a diamond-shaped parking brake control knob. See [Fig. 3.12](#). Pull the knob to apply the parking brake. In air brake systems, before the parking brake can be released, the air pressure in either brake system must be at least 65 psi (448 kPa). See [Chapter 5](#) for detailed operating instructions.

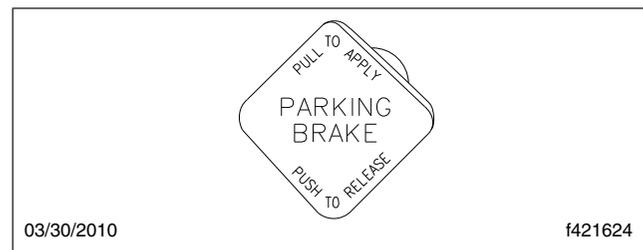


Fig. 3.12, Parking Brake Control Knob

Steering Control

TRW® ColumnDrive Adjustment Knob

WARNING

The ColumnDrive system will not steer the vehicle by itself. It is only intended to help assist the driver with steering. The driver must operate the vehicle the same way they would any other

vehicle that does not have this option. Attempting to let the ColumnDrive system operate the vehicle without the full attention of the driver to all road and traffic conditions, could result in property damage, severe personal injury, or death.

The optional TRW ColumnDrive assists the driver by keeping the vehicle centered in a variety of conditions, such as wind or bumpy sections of highway. Based on the driving conditions detected by the ColumnDrive sensors, the system helps provide torque to the steering wheel and avoid the need for sudden jerking motions from the driver.

Along with the automatic adjustments that ColumnDrive makes, the driver can also adjust the resistance of the steering wheel to their comfort level. The adjustment knob, shown in [Fig. 3.13](#), has six different settings. Turning the knob clockwise will increase the amount of resistance in the steering wheel.

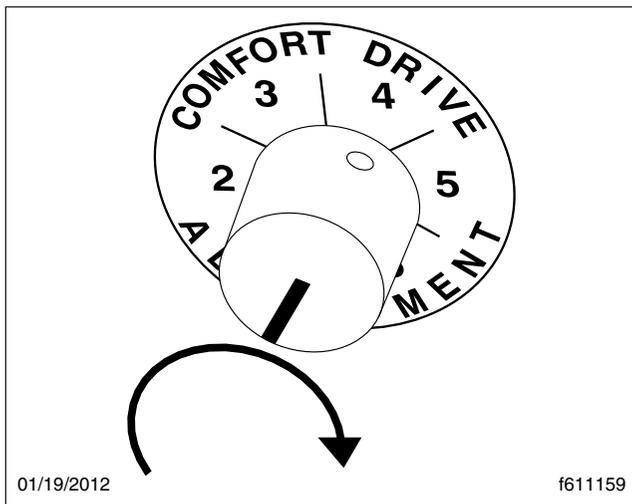


Fig. 3.13, ColumnDrive Adjustment Knob

4

Engines

Engine Starting	4.1
Engine Operation	4.2
Exhaust Brake	4.3
Exhaust Aftertreatment System (ATS)	4.3
Engine Shutdown	4.11

Engines

Engine Starting

This engine chapter is to serve as a guide for best practices only. Each make and model engine may have operating characteristics that are unique to that particular engine, and will be documented in the engine manufacturer's literature. Always refer to specific instructions and recommendations from the engine manufacturer.

NOTE: Before starting the engine, read [Chapter 2, Instruments](#), and [Chapter 3, Driver Controls](#). Read the operating instructions in the manufacturer's engine operation manual before starting the engine.

Normal Starting



Do not use any starting aid, such as ether, in engines with an air intake heater. This could cause an explosion and serious personal injury or death.

NOTE: Cummins and Detroit engines are run on a dynamometer before being shipped from the factory. They do not require a break-in period.

IMPORTANT: Special break-in oils are not recommended for new or rebuilt Cummins or Detroit engines.

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.

IMPORTANT: Ring gear and starter pinion damage caused by improper starting procedures is not warrantable.

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.

NOTICE

If the engine is equipped with a turbocharger, protect the turbocharger during start-up by not depressing the accelerator pedal until normal engine idle oil pressure registers on the gauge.

1. Before engine start-up, complete the pre- and post-trip inspections and maintenance procedures in [Chapter 10](#).
2. Set the parking brake.
3. Place the transmission in neutral.
4. Turn the key to the ON position and allow the gauge sweep to complete. The audible alert will sound for approximately four seconds.

During cold conditions, the WAIT TO START lamp may illuminate. Wait until the lamp goes out before turning the key to START.
5. After the gauge sweep has completed, turn the key to the START position.

NOTICE

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

6. Apply load gradually during the warm-up period.

NOTICE

If the oil pressure gauge indicates no oil pressure, shut down the engine within approximately ten seconds to avoid engine damage.

7. Check the oil pressure gauge for any drop in lubricating oil pressure or mechanical malfunction in the lubricating oil system. Minimum oil pressure at idle is 7 psi (50 kPa).

Cold-Weather Starting

See the engine manufacturer's operation manual for starting aids that are approved for specific engines.

If the unit is equipped with a block heater, start the block heater two to four hours before travel.

Starting After Extended Shutdown

Before engine start-up, complete the pretrip inspections and maintenance procedures in [Chapter 10](#).

NOTICE

Failure to eliminate water-diluted lubricating oil may lead to serious engine damage at startup.

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

Engine Operation

Normal Operation



Do not operate the engine in an area where flammable vapors such as gasoline or diesel fumes are present. Shut off 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.

Engines produce high horsepower and peak torque characteristics at low rpm. Because of this, it is not necessary to operate the engine at high rpm to deliver the required horsepower at the wheels. These characteristics may also result in less shifting and make shifting at lower rpm (to peak torque) more practical.

Depending on the vehicle gearing, the posted speed limit can sometimes allow operation in either of the

top two gears. However, for improved operating efficiency (fuel economy and engine life), operate in the top gear at reduced rpm, rather than in the next lower gear at the maximum rpm. Cruise at partial throttle whenever road conditions and speed requirements permit. This driving technique permits operating within the most economical power range of the engine.

When approaching a hill, accelerate smoothly to start the upgrade at full power (2000 rpm or higher is recommended), then shift down as desired to maintain the optimum vehicle speed.

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.

NOTICE

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

The engine is effective as a brake on downhill grades, but take care not to overspeed the engine going downhill. 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.

Cold-Weather Operation

Satisfactory performance of a diesel engine operating in low ambient temperatures requires modification of the engine, surrounding equipment, operating practices, and maintenance procedures. The lower the temperature, the greater the amount of modification required. See the engine manufacturer's operation manual for service products approved for use in cold weather engine operation.

If satisfactory engine temperature is not maintained, maintenance costs will increase due to greater engine wear. If the engine coolant gets too cold, raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil, causing all moving parts of the engine to suffer from poor lubrication.

If the engine is in good mechanical condition and the precautions necessary for cold-weather operation are taken, ordinary cold weather will not cause difficulty in starting or loss of efficiency.

Engines

The following points are important to observe when operating in cold weather.

- Check for cracks in the battery cases, for corrosion of the terminals, and for tightness of the cable clamps at the terminals.
- Charge the batteries to full capacity. Replace damaged batteries.
- If equipped, turn off the battery disconnect switch after the engine is shut down to prevent battery discharge.
- Have the alternator output checked at an authorized Freightliner dealer.
- Check the condition and tension of the drive belts.
- Refer to the engine manufacturer's operation manual for recommended heaters, low-viscosity lubricating oils, winter-grade fuels, and approved coolants.
- Periodically check the coolant mix ratio (concentration of antifreeze in the coolant). Add more if necessary.
- At temperatures below -4°F (-20°C), a coolant preheater is recommended.

High-Altitude Operation

Engines lose horsepower when operated at high altitude because the air is too thin to burn as much fuel as at sea level. Most turbocharged engines are rated for higher altitudes than naturally aspirated engines. An engine will have smoky exhaust at high altitudes unless a lower gear is used. Shift gears as needed to avoid excessive exhaust smoke.

Exhaust Brake

IMPORTANT: The exhaust brake is a vehicle slowing device, not a vehicle stopping device. It is not a substitute for the vehicle service brakes. Use of the exhaust brake for vehicle downhill control and slowing down on level terrain will allow the service brakes to remain cool and ready for an emergency.

WARNING

Do not use the exhaust brake if road surfaces are slippery. Using the exhaust brake on wet, icy, or snow-covered roads could result in loss of vehicle control, possibly causing personal injury or death, or property damage.

The exhaust brake is activated when the following conditions are satisfied.

1. The ON/OFF switch is in the ON position.
2. The accelerator pedal is not depressed.

The Allison transmission provides for optimum retarding by downshifting when the exhaust brake is selected. When the switch is turned ON and the driver's foot is removed from the accelerator pedal, the transmission will immediately preselect a lower gear. The transmission then starts to downshift through gears to reach the preselected gear. Downshifting occurs at a higher speed than is usual when the exhaust brake is not turned on. This allows the exhaust to provide the maximum retarding power.

Exhaust Aftertreatment System (ATS)

Vehicles and/or engines manufactured after December 31, 2006 and domiciled in the U.S. or Canada are required to meet all EPA and NHTSA regulations effective as of the vehicle build date. Engines manufactured between January 1, 2007 and December 31, 2009 meet EPA07 requirements. Engines manufactured between January 1, 2010 and December 31, 2012 meet EPA10 requirements.

Model year 2013 and later vehicles meet additional requirements as specified by NHTSA and EPA 2014 fuel efficiency and greenhouse gas emission standards (GHG14). 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.

NOTICE

Follow these guidelines for engines that comply with EPA07 or newer regulations, or damage may occur to the aftertreatment device (ATD) and the warranty may be compromised.

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

IMPORTANT: Using non-specification fuels or oils can lead to shortened diesel particulate filter (DPF) cleaning or replacement intervals. For example, using CJ-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.

EPA07 Engines

Engines built between January 1, 2007 and December 31, 2009 are required to meet EPA07 guidelines for reduced exhaust emissions of particulate matter and nitrogen oxides (NOx). NOx is limited to just over 1 gram per brake horsepower hour (g/bhp-hr), and particulate matter cannot exceed 0.01 g/bhp-hr.

The EPA07 ATS varies according to engine manufacturer and vehicle configuration, but the exhaust muffler is replaced by an aftertreatment device (ATD). Inside the ATD, the exhaust first passes over the diesel oxidation catalyst (DOC), then passes through the diesel particulate filter (DPF), which traps soot particles. The soot is burned to ash during a process called regeneration (regen).

EPA10 and Newer Engines

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 ATS that has, in addition to a DOC/DPF device like that used in an EPA07 ATD, a Selective Catalytic Reduction (SCR) device to reduce NOx downstream of the engine.

After exhaust gases 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. Passive regen occurs when the engine is running under load and regen occurs without input. 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 reduce 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.

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 diesel exhaust fluid (DEF) is injected into the exhaust stream, where heat converts it to ammonia (NH₃) gas. This mixture flows

Engines

through the SCR device, where the ammonia gas reacts with the NO_x in the exhaust, to produce harmless nitrogen (N₂) and water vapor (H₂O), 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. See [Fig. 4.1](#).

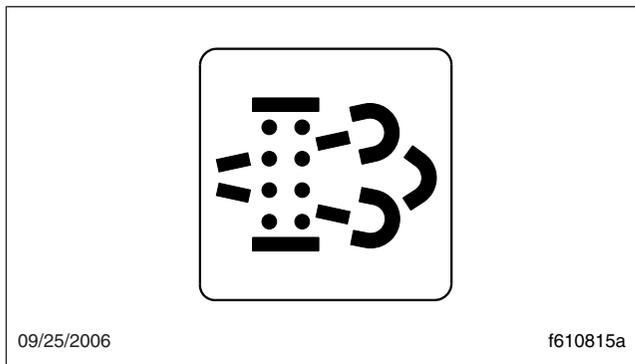


Fig. 4.1, Diesel Particulate Filter (DPF) Lamp

- A slow, 10-second flashing of the high exhaust system temperature (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. See [Fig. 4.2](#).

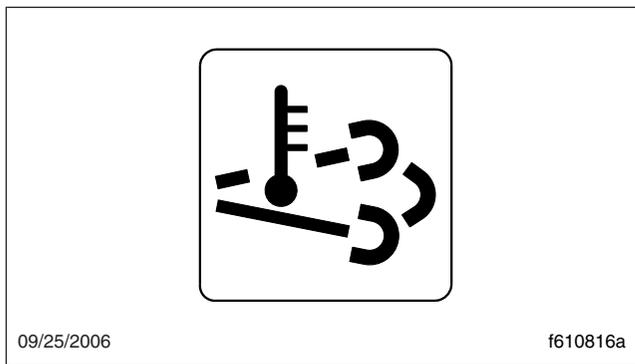


Fig. 4.2, High Exhaust System Temperature (HEST) Lamp

- A steadily illuminated HEST lamp alerts the operator of high exhaust temperatures when vehicle speed is below 5 mph (8 km/h) while it

is performing an automatic regen, and during a parked regen.

- An illuminated DEF warning lamp in the gauge, indicates that the DEF tank should be refilled at the next opportunity.

Parked Regen

DANGER

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

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

A reference label is included with the driver's documentation package initially in the glove box, that explains the ATS warnings, and actions required to avoid further engine protection sequences. See [Fig. 4.3](#).

IMPORTANT: The vehicle can have two different ways to initiate a parked regen, depending on the body builder. If there is not a regen switch on the dash, go to the *Shorting Plug* section.

The regen switch, located on the dash, is used to initiate a parked regen of the aftertreatment device. See [Fig. 4.4](#).

NOTE: The DPF lamp must be illuminated before the regen switch will initiate a parked regen.

To initiate a parked regeneration, perform the following steps.

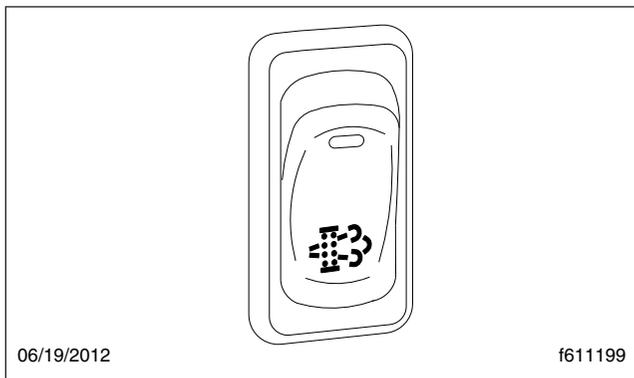
1. Park the vehicle away from all combustable and flammable materials. Chock the tires. Start and warm the engine until the coolant temperature is at least 150°F (66°C).
2. Set the parking brake. If the parking brake was already set, it must be released, then set again.
For manual transmissions, fully depress the clutch pedal, put the transmission in neutral, then release the pedal.

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>					

06/29/2009

f080147

Fig. 4.3, Exhaust-Aftertreatment Warnings Reference Label



06/19/2012

f611199

Fig. 4.4, Regen Switch

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. The regen cycle will finish after 20 to 60 minutes, at which time engine idle speed will drop to normal and the vehicle can be driven normally. The

HEST lamp may be illuminated, but will go out when the vehicle speed exceeds 5 mph (8 km/h), or the system has cooled to normal operating temperature.

5. To stop a parked regen at any time during the process, engage the clutch, brake, or accelerator pedal, or turn off the engine.

Shorting Plug

NOTE: The DPF lamp must be illuminated before the shorting plug will initiate a parked regen.

The shorting plug is used to initiate a parked regen of the ATD. The shorting plug is located under the dash, next to the steering column. Mounting locations vary. See [Fig. 4.5](#).

To initiate a parked regeneration, perform the following steps.

1. Park the vehicle away from all combustibile and flammable materials. Chock the tires. Start and warm the engine until the coolant temperature is at least 150°F (66°C).

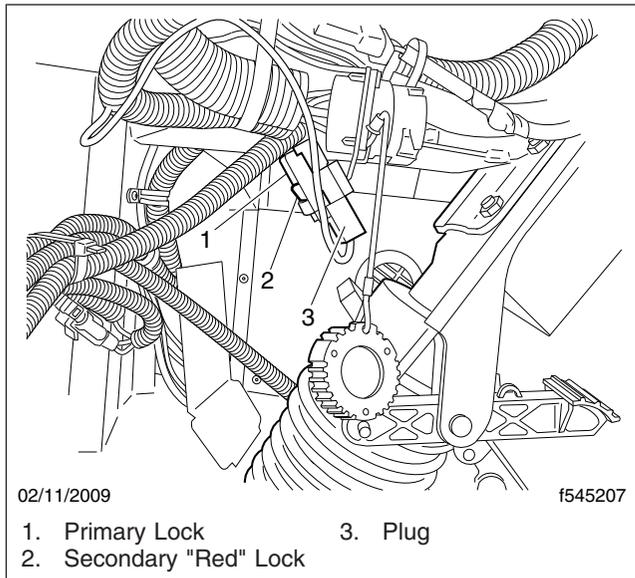


Fig. 4.5, Shorting Plug

2. Set the parking brake. If the parking brake was already set, it must be released, then set again.

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

If the vehicle has a two-pedal automated transmission, shift it into gear, then back to neutral.
- IMPORTANT:** The driver must remain with the vehicle during the entire regen cycle.
3. Disconnect the shorting plug, as follows.
 - 3.1 Slide the secondary red lock away from the white cover. See **Fig. 4.5**, Ref. 2.
 - 3.2 Push the primary lock in. See **Fig. 4.5**, Ref. 1.
 - 3.3 Pull the plug apart. See **Fig. 4.5**, Ref. 3.
 4. Wait four seconds.
 5. Connect the shorting plug.
 6. Engine rpm will rise, and initiate the regen process.
 7. The regen cycle will finish after 20 to 60 minutes, at which time engine idle speed will drop to normal and the vehicle can be driven normally. The HEST lamp may be illuminated, but will go out when the vehicle speed exceeds 5 mph (8 km/h),

or the system has cooled to normal operating temperature. The DPF light will shut off.

8. To stop a parked regen at any time during the process, engage the clutch, service brake, or accelerator 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 forward of the ATS. See [Fig. 4.6](#). 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.

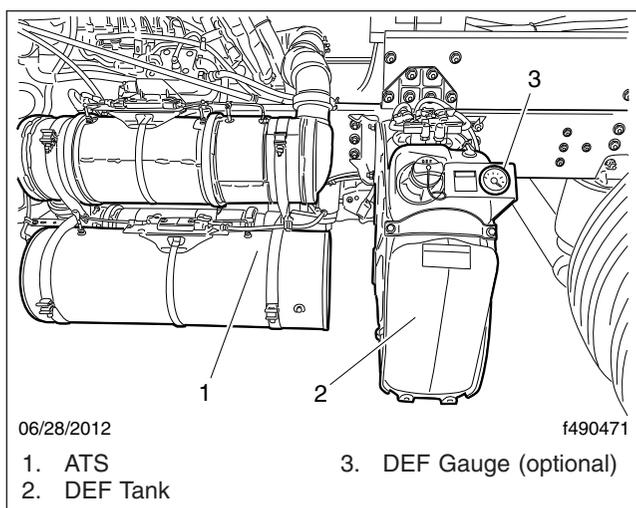


Fig. 4.6, DEF Tank With Optional DEF Gauge

The DEF tank will require filling a minimum of approximately every second diesel refuel depending on the DEF tank capacity. 6-, 13-, and 23-gallon tank capacities are available. 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. Vehicles equipped with a 23-gallon DEF tank should be able to travel over 6000 miles before needing a refill.

Fuel/DEF Gauge

The fuel and DEF levels are measured in a multipurpose fuel/DEF/voltmeter gauge. See [Fig. 4.7](#).

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 DEF lightbar 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 very low, refill DEF
- One bar flashing red—DEF empty, refill DEF

LBCU DEF Warnings and Engine Limits

IMPORTANT: Ignoring the DEF warning lights and not refilling the DEF tank will result in limited engine power with a speed limit of 5 mph (8 km/h) eventually being applied. See the engine manufacturer's operation and maintenance manual for further information.

DEF Level—Initial Warning

When the DEF level becomes low, the following warning strongly encourages the driver to refill the DEF tank. See [Fig. 4.8](#).

- One bar of the DEF-level lightbar illuminates amber.

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

DEF Low

When the DEF level reads low, the following warnings are activated. See [Fig. 4.9](#).

- A LOW DEF message appears on the LBCU driver display screen.
- One bar of the DEF-level lightbar flashes red.
- The CHECK engine lamp (amber) illuminates.

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

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

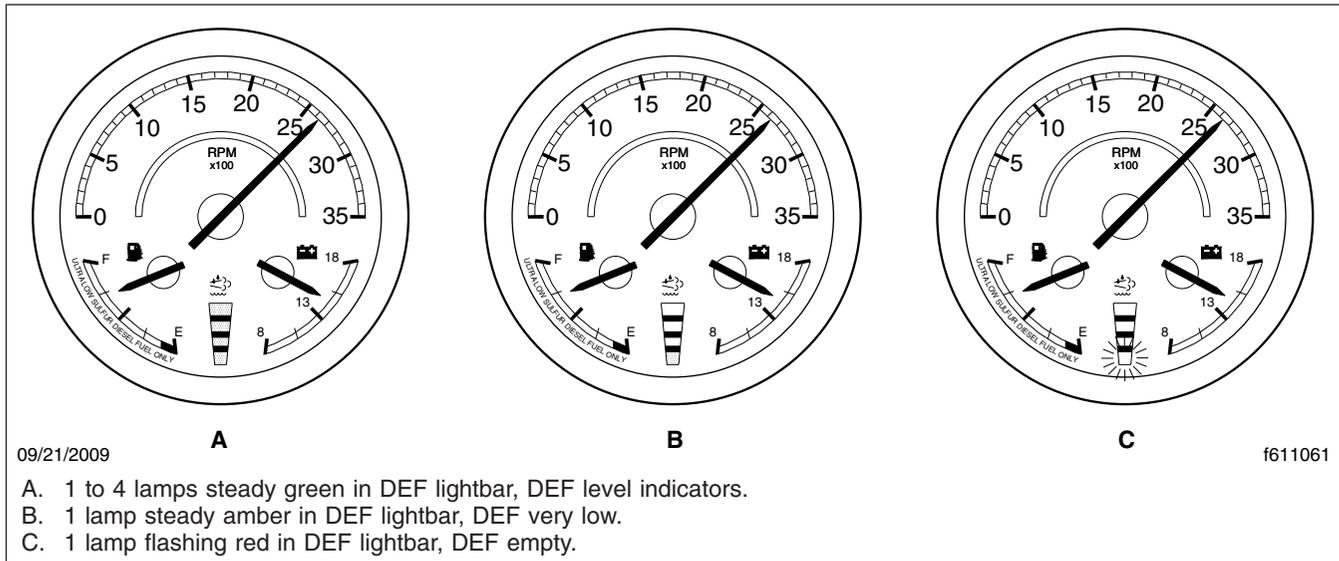


Fig. 4.7, Fuel/DEF/Voltmeter Gauge

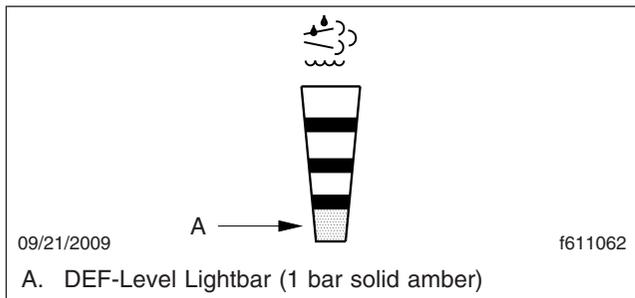


Fig. 4.8, DEF Level Initial Warning

- A VERY LOW DEF message appears on the LBCU driver display screen.
- One bar of the DEF-level lightbar flashes red.
- The CHECK engine lamp illuminates.

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

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

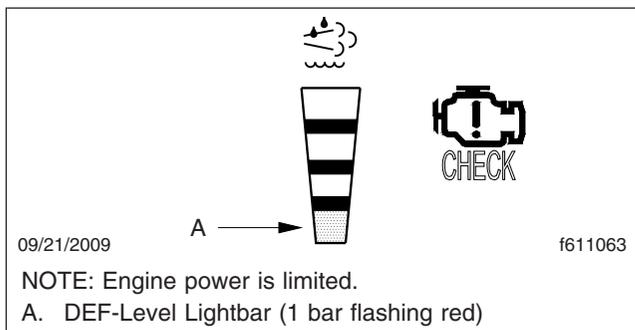


Fig. 4.9, DEF Level Low and Empty Warnings

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the red STOP engine lamp illuminates in addition to the CHECK engine warning lamp. A 5 mph (8 km/h) speed limit is applied after the next engine shutdown or while parked and idling. See [Fig. 4.10](#).

DEF Quality or SCR Tampering

NOTICE

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

DEF Empty

When the DEF tank registers empty, the following warnings are activated. See [Fig. 4.8](#).

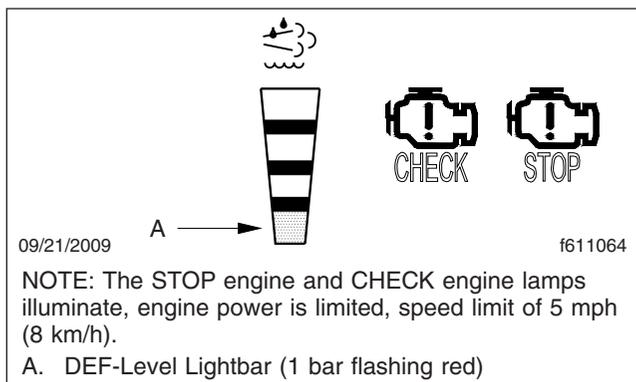


Fig. 4.10, DEF Empty and Ignored Warning

If contaminated DEF or tampering is detected, the SCR system activates a POOR DEF QUALITY message on the LBCU driver display screen and engine performance is limited with progressively harsher engine power limits applied. If the fault is not corrected, the CHECK engine lamp illuminates, then the STOP engine lamp illuminates and a 5 mph (8 km/h) speed limit is applied after the next engine shutdown, or while parked and idling. See [Fig. 4.10](#).

Ametek DEF Warnings and Engine Limits

IMPORTANT: Ignoring the DEF warning lights and not refilling the DEF tank will result in limited engine power with a speed limit of 5 mph (8 km/h) eventually being applied. See the engine manufacturer's operation and maintenance manual for further information.

DEF Level Low—Initial and Critical Warnings

When the DEF level reads low the following warnings strongly encourage the driver to refill the DEF tank. See [Fig. 4.11](#).

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

DEF Empty

When the DEF level reads empty, the following warnings are activated. See [Fig. 4.12](#).

- One bar of the DEF-level lightbar flashes red.

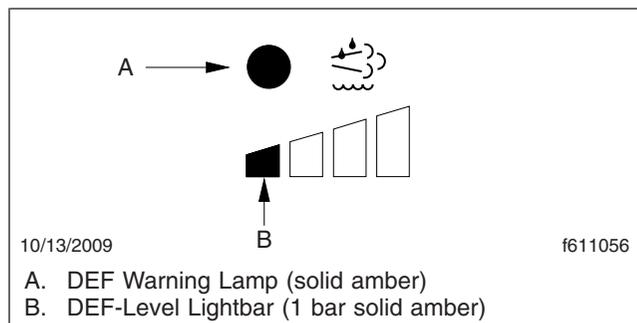


Fig. 4.11, DEF Level Low Initial and Critical Warnings

- The DEF warning lamp flashes.
- The CHECK engine lamp illuminates.

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

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

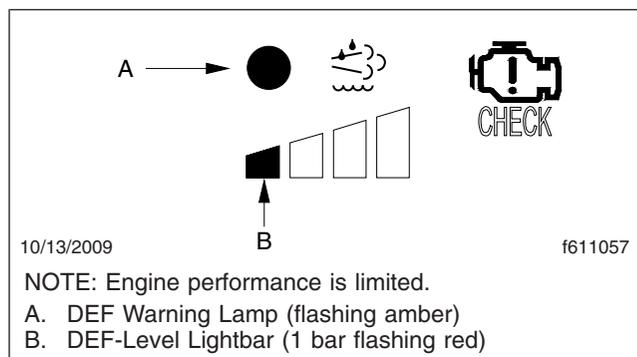


Fig. 4.12, DEF Empty Warning

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the red STOP engine lamp illuminates in addition to the DEF warning lamp and the CHECK engine warning lamp. See [Fig. 4.13](#).

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.

Engines

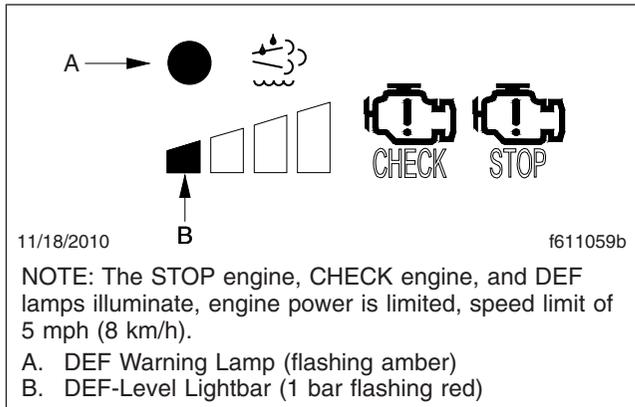


Fig. 4.13, DEF Empty and Ignored Warning

DEF Quality or SCR Tampering

NOTICE

Once contaminated DEF 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 performance is limited with progressively harsher engine power limits applied. If the fault is not corrected, the CHECK engine lamp illuminates, then the STOP engine lamp illuminates and a 5 mph (8 km/h) speed limit will be applied after the next engine shutdown, or while parked and idling. See [Fig. 4.13](#).

Engine Shutdown

NOTICE

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

1. With the vehicle stopped, place the transmission in the neutral (N) position and set the parking brake.
2. It is important to idle an engine for 3 to 5 minutes before shutting it down. This allows the lubricating oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, and seals.

IMPORTANT: 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 piston rings and may result in stuck valves.

3. Do not idle the engine for excessively long periods.
4. Turn the ignition key to the OFF position and shut down the engine.

5

Brake System

Air Brake System	5.1
Antilock Braking System (ABS)	5.2

Brake System

Air Brake System

General Information

 **WARNING**

Freightliner Custom Chassis Corporation (FCCC) neither recommends nor approves connecting a trailer or other towed vehicle's braking system directly to the vehicle braking system. FCCC also neither recommends nor approves tapping into the vehicle air brake system nor operating a towed vehicle or trailer's braking system by means of the vehicle braking system. Failure to observe this warning could result in personal injury or death, or substantial property damage.

A dual air brake system consists of two independent air brake systems which use a single set of brake controls. Each system has its own reservoir, plumbing, and brake chambers. The primary system operates the service brakes on the rear axle; the secondary system operates the service brakes on the front axle.

 **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.

The parking brake will apply when air pressure drops below 38 to 42 psi (262 to 290 kPa). Do not wait for the brake to apply automatically; when the warning light and buzzer first come on, immediately bring the vehicle to a safe stop. Before continuing operation of the vehicle, correct the cause of the air loss.

Air Brake System With External Fill (Schrader Valve)

Before a vehicle with insufficient brake system air pressure can be moved, the parking brake must be released by applying an external air source. First block the wheels, then turn the ignition switch to the ON position, then fill the appropriate system air reservoir using the Schrader valve on the inlet side of the air dryer. The parking brake will not release until air pressure reaches 65 psi (448 kPa). The low air buzzer will sound until air pressure reaches 65 to 73

psi (448 to 503 kPa) with the ignition switch in the ON position.

IMPORTANT: If the air pressure in the braking system drops back below 38 to 42 psi (262 to 290 kPa) the parking brake will reengage.

Operation

Before driving the vehicle, secure all loose items in the cab so that they will not fly forward during a full brake application. Make sure that all occupants are wearing seat belts.

Allow time for the air compressor to build up a minimum of 95 psi (655 kPa) pressure in both the primary and secondary systems. Monitor the air pressure system by observing the dual system air pressure gauges and the low-air-pressure warning light and buzzer. The warning light and buzzer shut off when the pressure in both systems reaches 65 to 73 psi (448 to 503 kPa).

The warning light and buzzer come on if air pressure drops below 65 to 73 psi (448 to 503 kPa) in either system. If this happens, check the air system pressure gauges to determine which system has low air pressure. Although the vehicle's speed can be reduced using the foot brake control pedal, either the front or the rear service brakes will not be operating, causing a longer stopping distance. Bring the vehicle to a safe stop and have the air system repaired before continuing.

During normal brake stops, depress the foot brake control pedal until braking action slows the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop. When the forward speed of the vehicle has decreased almost to the idling speed of the engine, shift the transmission into Neutral (N). Apply the parking brake if the vehicle is to be parked.

IMPORTANT: In the event of a total loss of service brakes with full system air pressure, use the parking brake control valve (yellow knob) to bring the vehicle to a complete stop in the safest location possible.

The yellow diamond-shaped knob on the control panel actuates the parking brake valve. See [Fig. 5.1](#). Pull the knob to apply the parking brake.



Fig. 5.1, Parking Brake Control Knob

WARNING

If the vehicle is equipped with an air suspension system, do not move the vehicle with the air suspension deflated. Doing so could result in a loss of vehicle control, possibly causing personal injury and property damage.

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 (L) or 1st 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.

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. Next, 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.

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.

Antilock Braking System (ABS)

Meritor WABCO® ABS

WARNING

Although the ABS improves vehicle control during emergency braking situations, the driver still has the responsibility to change driving styles

Brake System

depending on existing traffic and road conditions. Failure to change driving styles to accommodate existing traffic and road conditions could cause an accident, possibly resulting in personal injury or death, or property damage.

The Meritor WABCO ABS is an electronic wheel speed monitoring and control system that works with the air brake system. ABS 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.

IMPORTANT: For proper ABS operation, do not mismatch tire sizes among any of the tires on the vehicle. Mismatching tire sizes could result in a reduced braking force, leading to longer stopping distances and cause an ABS event to register on the electronic control unit (ECU).

WARNING

An accumulation of road salt, dirt, and debris on the ABS tone wheels and sensors can cause the ABS warning light to illuminate. If the ABS light illuminates while driving, have the ABS serviced. Operating the vehicle when the ABS needs to be serviced could cause an accident, possibly resulting in personal injury or death, or property damage.

IMPORTANT: During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle to ensure proper ABS functioning. The required frequency of cleaning will vary with conditions. In general, do not allow corrosive materials to remain on the underside of the vehicle for extended periods of time.

The electronic control unit monitors the wheel sensors, solenoid control valves, and the electrical circuitry. The ABS warning light illuminates after turning the ignition switch to the ON position. The warning light goes out only if all of the vehicle's ABS components are working properly.

The Meritor WABCO ABS combines one front-axle control channel with the rear axle (four sensor system) to form one control circuit. For example, the sensor and solenoid control valve at the left-front axle form a control circuit with the sensor and sole-

noid valve on the right-rear axle. If, during vehicle operation, the safety circuit senses a failure in any part of the ABS (a sensor, solenoid control valve, wiring connections, short circuit, etc.), the ABS warning light illuminates and the control circuit where the failure occurred is switched to normal braking action. The remaining control circuit will retain the ABS effect. *Even if the ABS is partially or completely inoperative, normal braking ability is maintained.* An exception would be if a solenoid control valve (or combination solenoid control valve) is damaged and inoperative. As these components are an integral part of the air brake system, normal braking may be impaired or inoperative.

WARNING

If any of the ABS warning lights do not work as described above or illuminates while driving, repair the ABS immediately to ensure full antilock braking capability. Operating the vehicle when the ABS needs to be serviced could cause an accident, possibly resulting in personal injury or death, or property damage.

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.

6

Transmissions

Driving Precautions	6.1
Allison Automatic Transmissions	6.1

Transmissions

Driving Precautions

The vehicle 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 5](#) for information on brake operation.

If the vehicle is stuck in sand or mud, do not attempt to pull the vehicle 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 down shift 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 the loss of vehicle control.

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

On slippery surfaces, avoid quick movements of the steering wheel. Decrease your speed and allow for extra stopping distance required by these conditions.

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 Automatic Transmissions

NOTICE

Do not allow the vehicle to coast in neutral. This can result in severe transmission damage. Also, no engine braking is available.

 **WARNING**

Never shift from neutral (N) to drive (D) or reverse (R) at engine speeds above idle. The vehicle will lurch forward or backward, which could cause property damage and personal injury.

NOTICE

The engine should never be operated for more than 30 seconds at full throttle with the transmission in gear and the output stalled. Prolonged operation of this type will overheat the transmission fluid and will result in severe damage to the transmission.

2500/3000/4000 MH Models

General Information

2500, 3000, and 4000 MH series automatic transmissions have six forward speeds and one Reverse (R) speed. These transmissions have electronic shift controls that can be programmed to allow the use of different numbers of geared speeds. See [Fig. 6.1](#). For instance the transmission can be programmed to operate as a 4-speed, 5-speed, or 6-speed unit in the "primary" shift mode. If needed, a "secondary" shift mode can be programmed to provide another shift configuration to optimize vehicle use under different operating conditions. To activate a secondary shift mode, or other special function programmed into the electronic control unit (ECU), depress the Mode button. A label just above the Mode button identifies the special function.

The 3000 and 4000 MH series transmission systems are designed to warn the driver of transmission malfunctions. The driver of a vehicle equipped with these transmissions should know the extent of the warning system in order

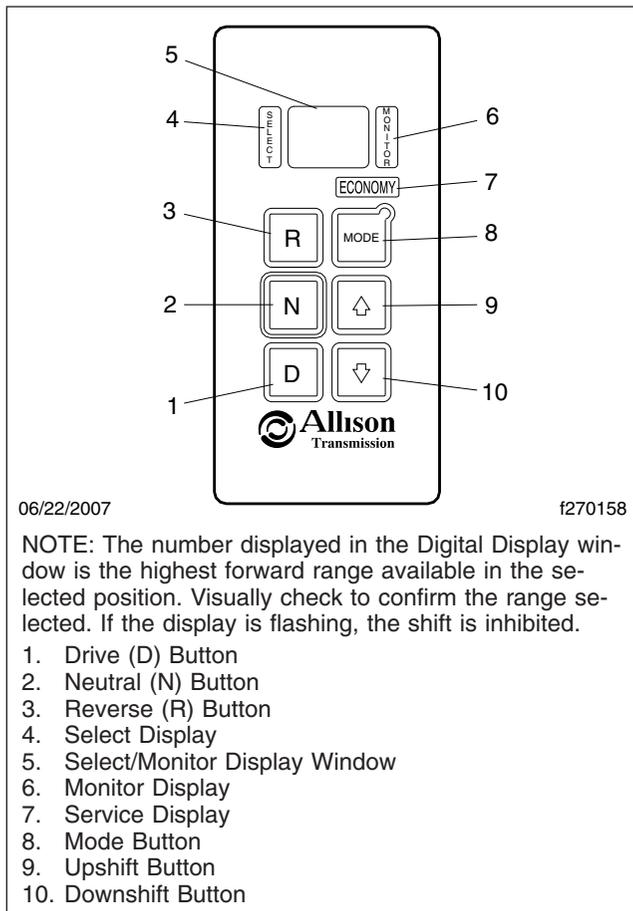


Fig. 6.1, GEN IV Shift Selector

to safely operate the vehicle. See [Chapter 2](#) for information on the warning system.

Operation

1. Start the engine.
2. Use Reverse (R) to back the vehicle. Completely stop the vehicle before shifting from a forward gear to Reverse (R) or from Reverse (R) to a forward gear. There is only one Reverse (R) gear.
3. Select Drive (D) for all normal driving conditions. The vehicle will start out in First (1) gear, and as speed increases, the transmission will upshift through each gear automatically. As the vehicle slows down, the transmission will downshift to the correct gear automatically.

The pressure of your foot on the accelerator pedal influences the automatic shifting. When the pedal is fully depressed, the transmission will automatically upshift near the governed speed of the engine. A partially depressed position of the pedal will cause the upshifts to occur at a lower engine speed.

4. Occasionally the road, load, or traffic conditions make it desirable to restrict the automatic shifting to a lower range. The lower the gear range, the greater the engine braking power.

Use the up or down arrow buttons on the shift selector to reach the desired gear.

5. Use Neutral (N) and apply the parking brake when the vehicle is parked with the engine running.

See the *Allison Transmission Owner's Manual* for more information on 3000 and 4000 MH transmission operation.

NOTE: In the lower gear ranges, the transmission will not upshift above the highest gear selected unless the engine governed speed is exceeded.

2100/2500 Models (Arens SBW)

General Information

The Arens shift-by-wire (SBW) push-button shift selector is part of an electronic shift control system used with Allison series 2100/2500 5-speed automatic transmissions. An electronic actuator is mounted to the transmission.

The 2100/2500 series transmissions have a park pawl and the SBW selector has a Park (P) position. See [Fig. 6.2](#).

In case the vehicle needs to be towed and the SBW system cannot be activated to move the transmission out of Park (P), a manual procedure is provided to shift the transmission. At the actuator, on the transmission, a port is provided to insert an Allen wrench to shift the transmission manually. See [Chapter 13](#) for more information.

Calibrating Arens SBW

If the vehicle shuts down in gear and will not start, check the two 10-amp fuses. Then check to see if either one or two Ns appear on the transmission

Transmissions

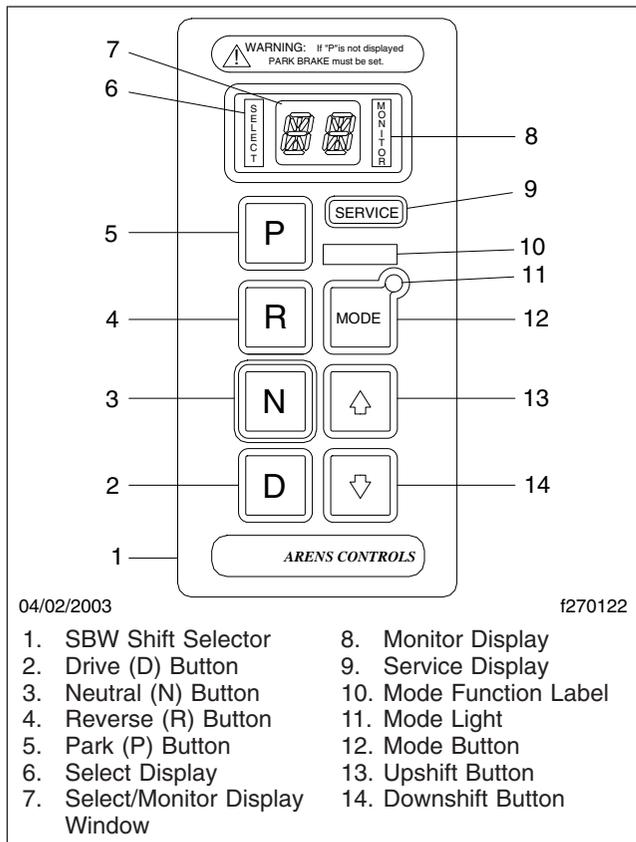


Fig. 6.2, SBW Shift Selector (2100/2500 series)

shifter and the vehicle will not start. To reset the transmission shifter, turn the ignition to the "ON" position. On the transmission shifter, go through the following sequence of N-R-N-D-N. This should reset the shifter and allow the vehicle to start.

Transmission Operation

- At the top left side of the selector, is the select display. On the left side of the display window, an LED character indicates which gear has been selected.
- At the top right side of the selector, is the monitor display. On the right side of the display window, an LED character indicates which gear is actually engaged.

WARNING

If the Park (P) position is selected and the letter P does not appear on the monitor side of the display window, the parking brake must be set. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

play window, the parking brake must be set. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

NOTE: Only the 1000/2400 series 5-speed transmissions have a park pawl and a Park (P) button.

- The Park (P) button shifts the transmission to Neutral (N) and engages the park pawl. When Park (P) is selected, the monitor side of the display window will show a letter P.

WARNING

Always place the transmission in the Park (P) or Neutral (N) position and set the parking brake before releasing the service brakes and exiting the vehicle. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

IMPORTANT: If the ignition switch is turned to the OFF position before selecting Park (P), a buzzer will sound and the monitor display will show the gear that is currently engaged. Select Park (P) to turn off the buzzer and the display. Also, with the engine not running (ignition switch in the ON position and park pawl not engaged), a buzzer will sound and the monitor display will show an N for Neutral (N). Select Park (P) to turn off the buzzer and the display.

- Select the R button to place the transmission in Reverse (R). An R will appear on both sides of the display window.

WARNING

Do not leave the vehicle if the transmission is in Neutral (N) without first setting the parking brake. The vehicle could roll or move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

- Select the N button to place the transmission in Neutral (N). An N will appear on both sides of the display window. The vehicle may be started in Neutral (N).
- Select the D button to place the transmission in Drive (D). The transmission will automatically

shift through the full range of First (1) through Fifth (5) gears. When Drive (D) is first selected, the display will show D1, indicating that Drive (D) was selected and that First (1) gear is engaged. As the transmission automatically upshifts and downshifts, the display will show the gear currently engaged (D1, D2, D3, D4, or D5).

7. With the transmission in Drive (D), select the downshift (down arrow) button to manually downshift one gear at a time, from Fifth (5) to First (1). The select display will show the selected gear and the monitor display will show the gear currently engaged. From D5 at the top of the Drive (D) range, the display will show 44, 33, 22, and 11 as progressively lower gears are manually selected.

NOTE: The transmission will remain in the manually selected gear until Drive (D) is selected. Select Drive (D) at any time during the manual downshifting sequence (or upshift progressively to Drive [D] using the up arrow button) and the transmission will upshift and downshift automatically.

8. With the transmission in 11, 22, 33, or 44, select the upshift (up arrow) button to manually upshift one gear at a time until Drive (D) is selected. The select display will show the selected gear and the monitor display will show the gear currently engaged. From 11 at the bottom of the Drive (D) range, the display will show 22, 33, 44, and D5 as progressively higher gears are manually selected.

NOTE: The transmission will remain in the manually selected gear until Drive (D) is selected. Select Drive (D) at any time during the manual upshifting sequence and the transmission will upshift and downshift automatically.

9. The function of the mode button may vary from vehicle to vehicle. The label above the button identifies the function.
10. A light in the upper right-hand corner of the mode button illuminates when the mode function is active.

IMPORTANT: An illuminated service display may indicate a loss of safety back-up systems. Use extra care when shifting to ensure that the transmission is operating properly.

11. The service display illuminates if a fault is detected in the SBW system. Have a qualified technician inspect the SBW system as soon as possible.
12. A flashing select/monitor display indicates that the transmission (and not the SBW system) has inhibited a selected transmission operation. See the *Allison Transmission Operator's Manual* for more information.

7

Steering System

Power Steering System	7.1
Steering Column Adjustment	7.1

Steering System

Power Steering System

NOTE: 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 and 3 o'clock positions or within 10 degrees to either side. See [Fig. 7.1](#).

The body builder is responsible for centering the steering wheel.

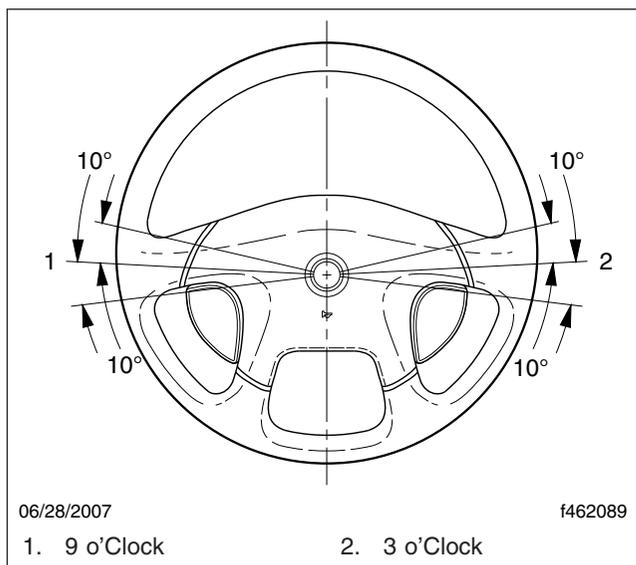


Fig. 7.1, Steering Wheel Centered

Steering Column Adjustment

TRW Tilt/Telescope Steering Column

WARNING

Never try to tilt or telescope the steering column while driving the vehicle. Doing so could cause loss of vehicle control and result in personal injury, or death, or property damage.

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. To telescope the steering column, lift up the lever on the steering column. Pull the steering wheel upward or push it downward until it is at the desired height. Release the lever to lock the steering column in place. See [Fig. 7.2](#).

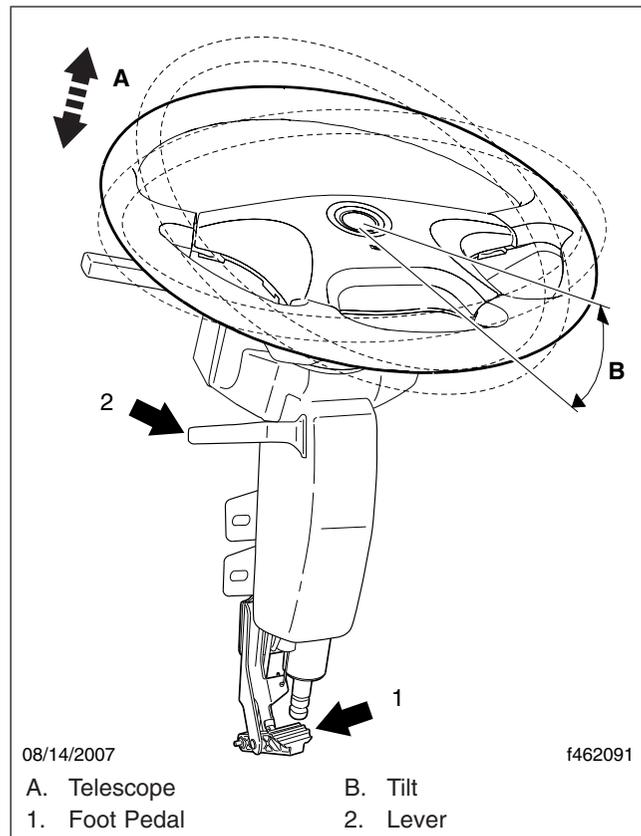


Fig. 7.2, TRW Tilt/Telescope Steering Column (typical)

NOTE: For safety, the steering column is locked at all times unless the foot pedal is depressed or if the lever is engaged.

8

Front-Engine Diesel Chassis

Instrumentation Control Unit	8.1
Aftertreatment System, EPA10 and Newer Engines	8.12
Diesel Exhaust Fluid and Tank, EPA10 and Newer Engines	8.16
EPA07 Aftertreatment System (ATS)	8.18
Allison Automatic Transmissions	8.20
Hydraulic Brake System	8.22

Front-Engine Diesel Chassis

Instrumentation Control Unit

Figure 8.1 and Fig. 8.2 shows a typical set of instruments for vehicles equipped with the MC Recreational Vehicle instrument cluster (ICU3-M2).

The MC Recreational Vehicle instrument cluster is an updated version of the basic electronic dashboard (ICU-3). It can accept information from the datalink and from various sensors installed on the vehicle, and deliver that information to electronic gauges.

The instrument cluster has the capability to drive independent stand-alone gauges such as those installed on the auxiliary dash panel. Figure 8.3 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 26 warning and indicator lights 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 lights. Warning messages and diagnostic fault codes will appear in the driver display screen. For more information on this system, see under the heading "Ignition Sequence".

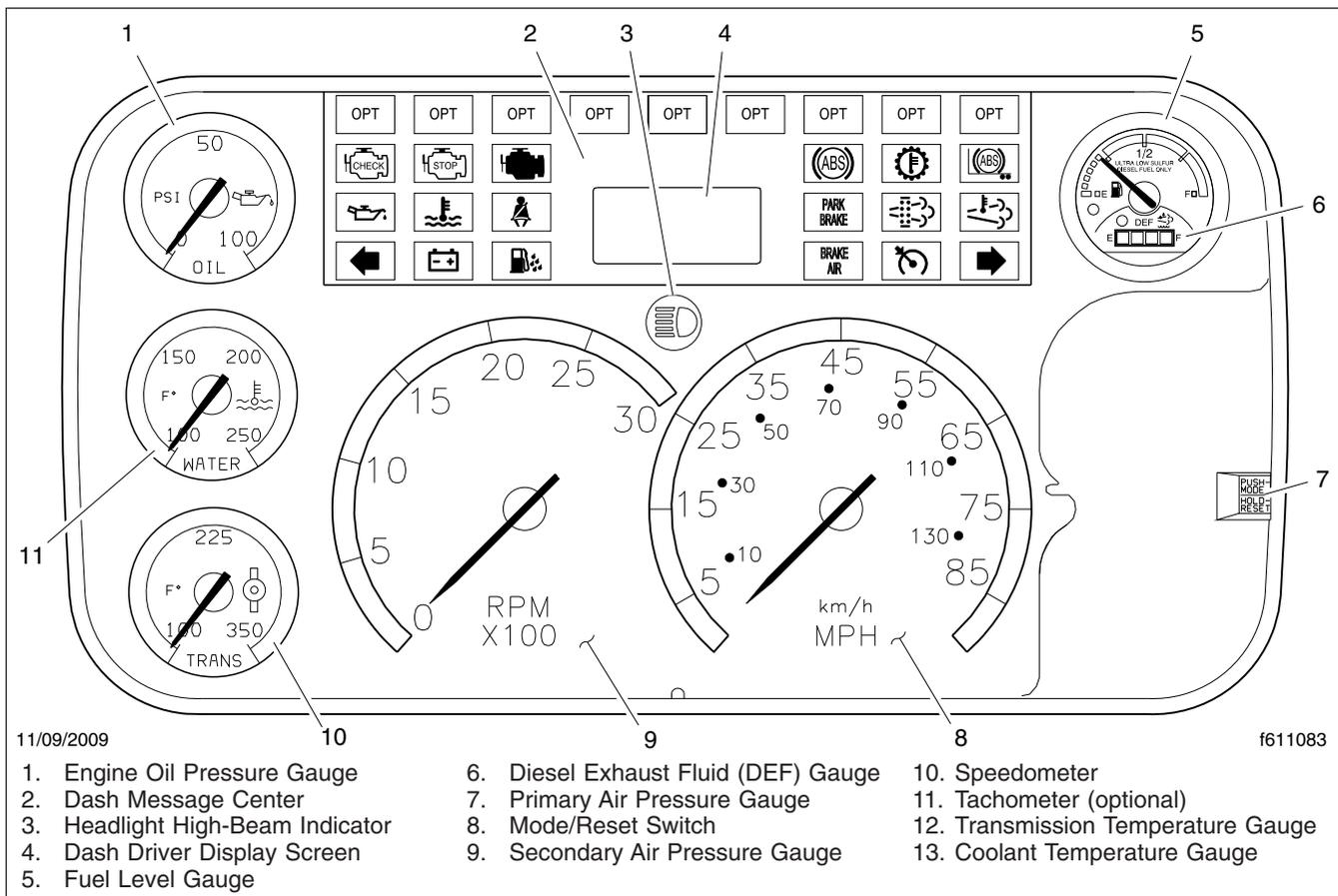


Fig. 8.1, Gauge Layout (typical, U.S.), EPA10 and Newer Engines

Front-Engine Diesel Chassis

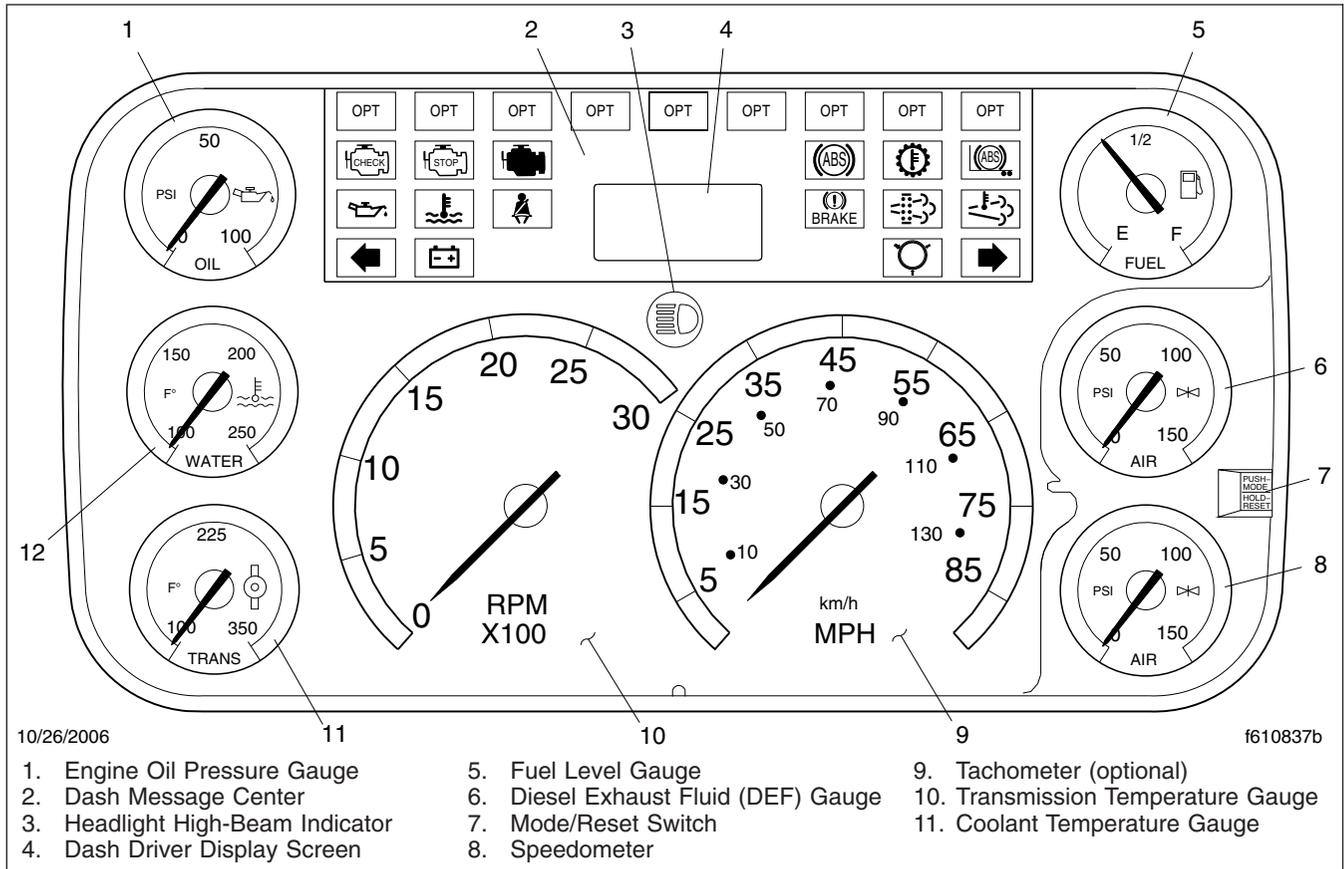


Fig. 8.2, Gauge Layout (typical, U.S.), EPA07-Compliant

Ignition Sequence

The dash message center goes through a prescribed ignition sequence each time the ignition switch is turned on. See [Fig. 8.4](#) for the ignition sequence.

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

The following lights illuminate during the ignition sequence:

- Fasten Seat Belt Warning
- Low Battery Voltage Warning
- High Coolant Temperature Warning
- Low Engine Oil Pressure Warning
- Parking Brake On Indicator

- All engine indicator/warning lights, including Check Engine and Engine Protection

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

When the ignition switch has been turned on, the ICU performs a self-test, looking for active faults. During the first half of the self-test, all segments of the display will illuminate as follows.

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

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

Front-Engine Diesel Chassis

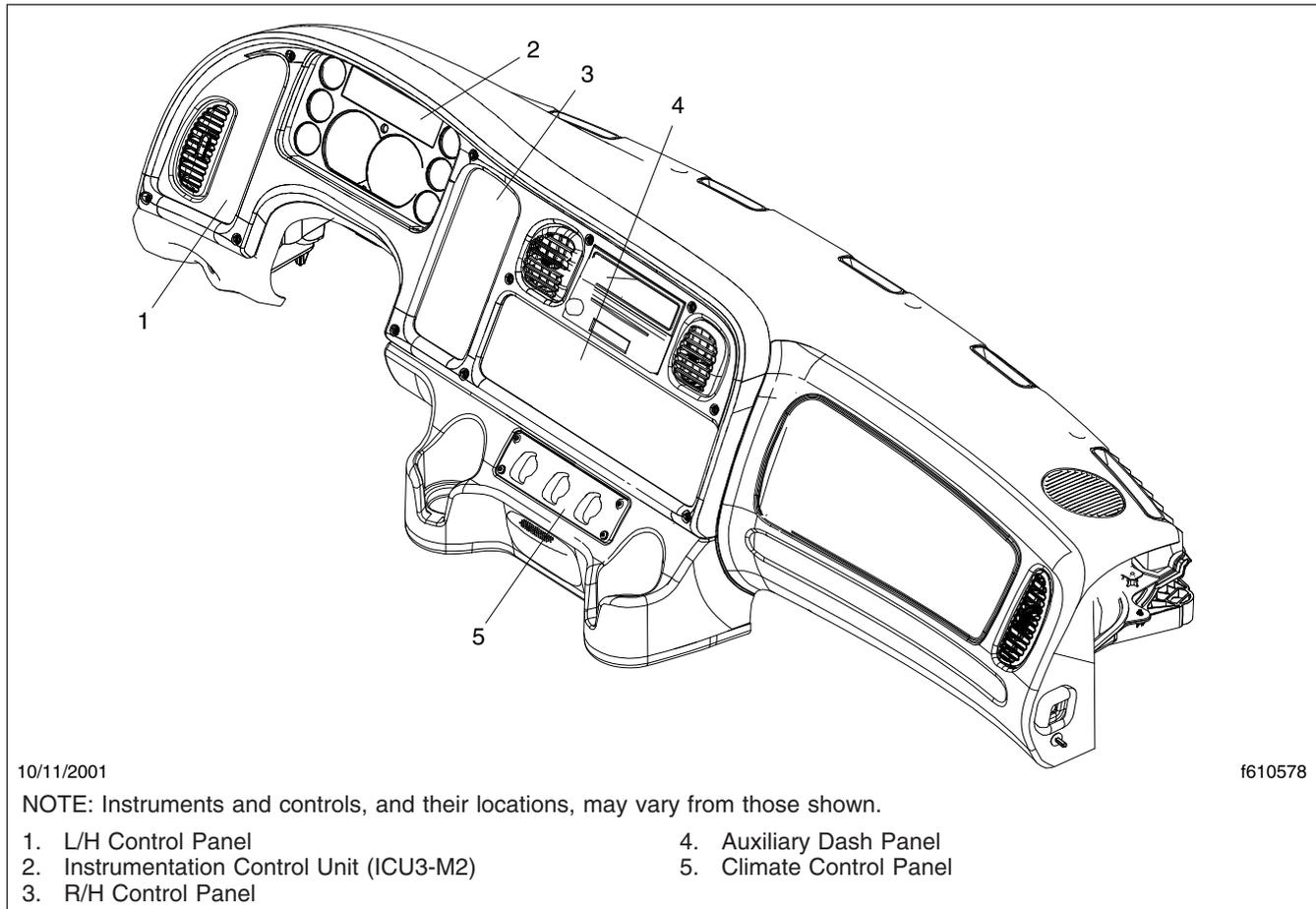


Fig. 8.3, Dash Panel Layout (typical)

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

If the instrument cluster has received active fault codes from the 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 Freightliner service facility.

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

Some examples of mission critical faults include:

- High coolant temperature
- Low coolant level
- Low engine oil pressure

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

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

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

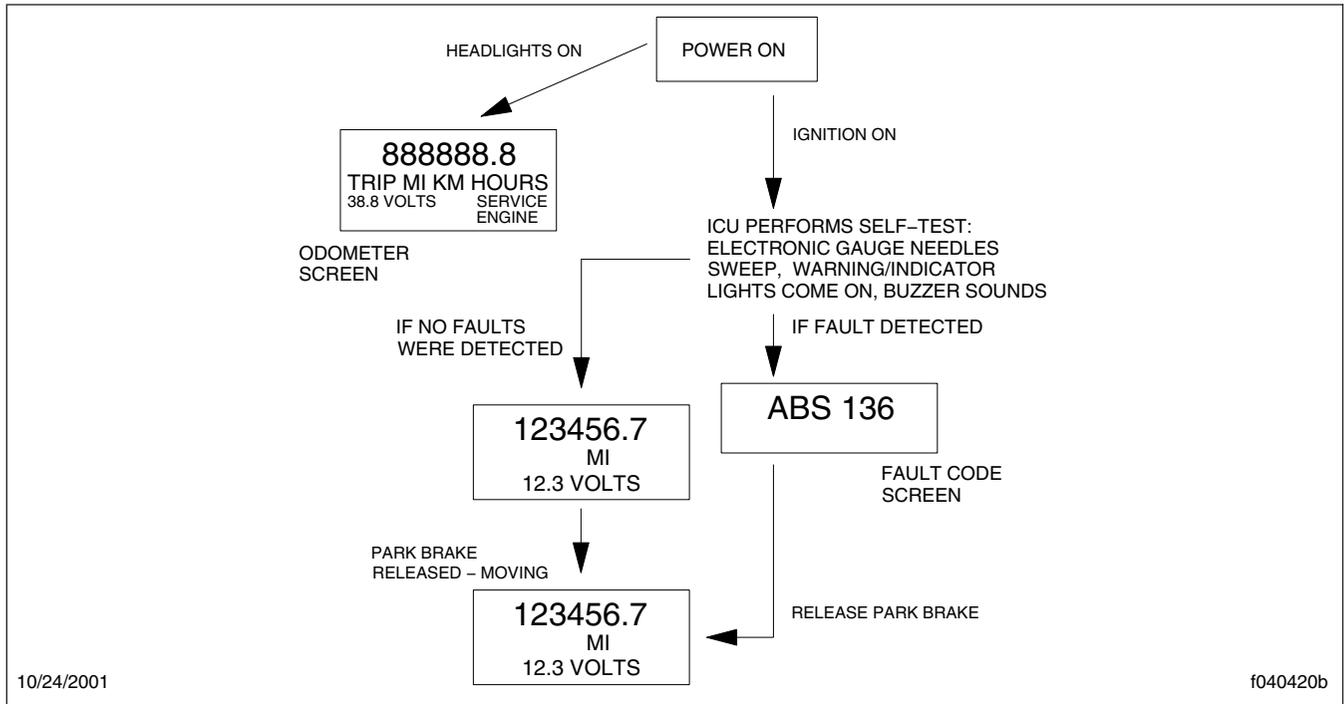


Fig. 8.4, Ignition Sequence

Odometer

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

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

Mode/Reset Switch

The mode/reset switch is located on the right side of the instrument cluster. See [Fig. 8.5](#). 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:

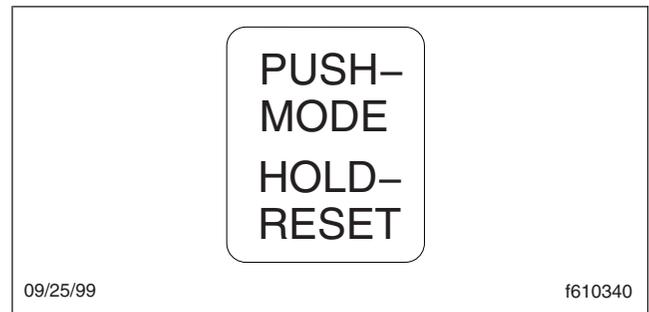


Fig. 8.5, Mode/Reset Switch

- Press the mode/reset switch once and the trip distance will display.
 - Press the mode/reset switch a second time and the trip hours (engine hours) will display.
 - Press the mode/reset switch a third time and the SELECT screen and the current units, MI or KM, will display.
 - Press the mode/reset switch a fourth time to return to the odometer reading.
- To reset trip miles and/or trip hours to zero, press the mode/reset switch for 1 second or

Front-Engine Diesel Chassis

longer. To toggle between MI (miles) or KM (kilometers), press the mode/reset switch while in the SELECT screen.

Warning and Indicator Lights

There can be up to 26 warning and indicator lights (telltales) installed in the dash message center. See **Fig. 8.6** and **Fig. 8.7**. There are four rows of lights. Lights installed in the top row are optional and their positions may vary. The lights in the bottom three rows are installed in fixed positions on all vehicles. Most are standard, but a few are optional.

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

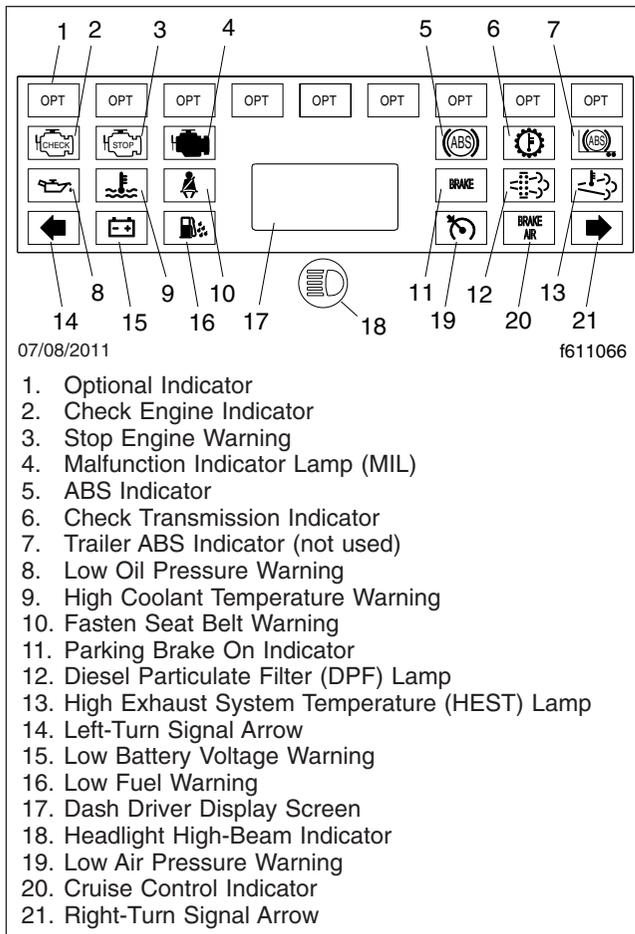


Fig. 8.6, Warning and Indicator Lights, EPA10 and Newer Engines

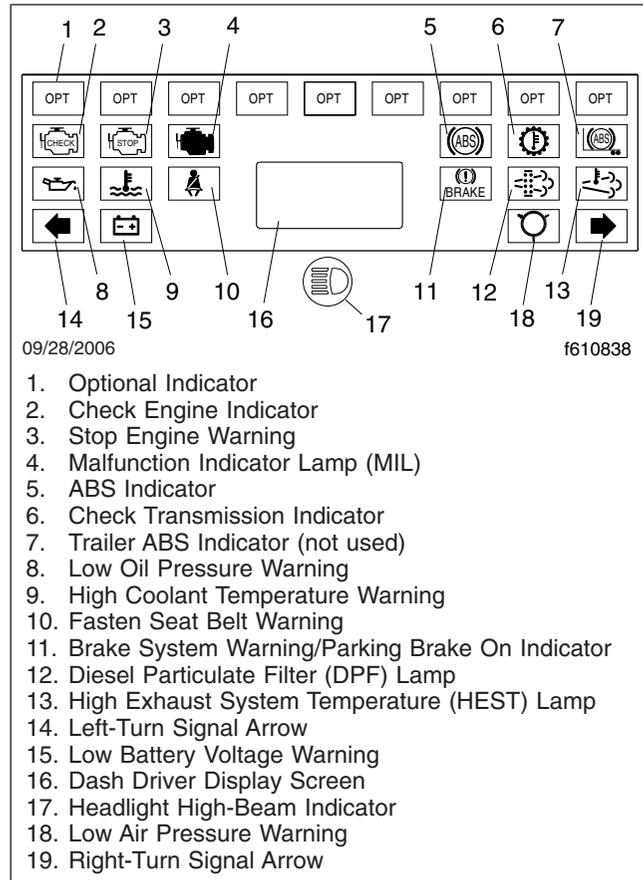


Fig. 8.7, Warning and Indicator Lights, EPA07-Compliant

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

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

Check Engine Indicator

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

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

Engine Protection Warning

The red engine protection warning light (ENGINE PROTECT legend) illuminates to indicate that the protection system available for the engine has been activated. On some engines, the engine ECU will derate the engine, allowing it to run, but at lower rpm and slower vehicle speed. The vehicle may be driven to a safe location.

The engine ECU will derate the engine. The driver must move the vehicle to a safe location as quickly as possible.

NOTICE

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

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

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

Alternator No Charge Indicator, Optional

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

Low Engine Oil Pressure Warning

The red low oil pressure warning light (oil can icon) and emergency buzzer activate whenever the engine oil pressure goes below the preset minimum specified by the engine manufacturer. See [Table 8.1](#).

High Coolant Temperature Warning

The red high coolant temperature warning light (thermometer icon) and emergency buzzer activate whenever the coolant temperature goes above a preset maximum specified by the engine manufacturer. See [Table 8.2](#).

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

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

† EPA07 MBE900 engines have an oil pressure switch. When above minimum pressure, the dash gauge will display the values shown in [Table 8.1](#). If below minimum oil pressure is reached, the dash gauge will read 0 psi.

Table 8.1, Oil Pressure Specifications

Maximum Coolant Temperature	
Engine Model	°F (°C)
Cummins ISB	220 (104)

Table 8.2, Maximum Coolant Temperature

Fasten Seat Belts Warning

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

Left-Turn Signal Arrow

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

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

Low Battery Charge Warning

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

Tractor ABS Indicator (not used)

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

NOTE: For more information about the ABS system, see [Chapter 5](#).

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Transmission Overheat Indicator

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

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

Brake System Warning/Parking Brake On Indicator

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

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

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

Air Filter Indicator

The optional amber air filter indicator light (AIR FILTER legend) illuminates when the air cleaner filter element is clogged. If the air filter indicator light is steadily illuminated for any period of time, check the air intake restriction gauge. If the yellow signal stays locked in the red zone once the engine is shut down, or is at or above 25 inH₂O, replace the air cleaner element.

IMPORTANT: Never attempt to clean the air filter.

Right-Turn Signal Arrow

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

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

Low Air Warning

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

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

High Beam Indicator

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

Emergency Buzzer

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

- the engine oil pressure falls below the preset level shown in [Table 8.1](#).
- the coolant temperature rises above the preset level shown in [Table 8.2](#).
- the air pressure falls below the preset level, which is 65 psi (448 kPa).
- the parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).

Diesel Particulate Filter (DPF) Lamp

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

Blinking indicates that a stationary regeneration is required immediately. An engine derate and 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.

Malfunction Indicator Lamp (MIL)

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

Optional Indicator Lights

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

Speedometer and Tachometer

Speedometer

Three kinds of speedometer faces are available. The U.S. version of the speedometer registers speed in both miles per hour (mph) and kilometers per hour (km/h), with mph in larger numbers. See Fig. 8.8.

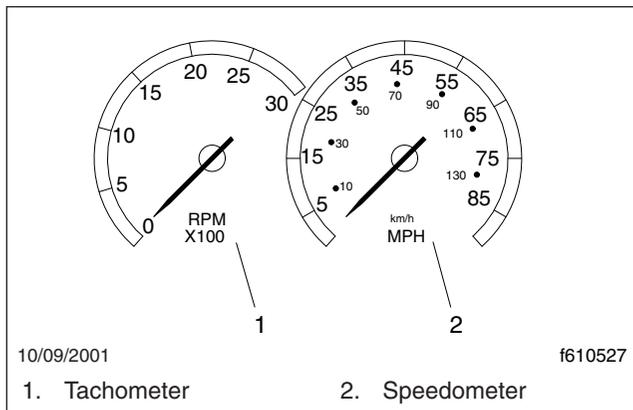


Fig. 8.8, Speedometer and Tachometer

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

Tachometer, Optional

The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range. See Fig. 8.8. For low idle and rated rpm, see the engine identification plate.

Gauges

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. 8.9. If the engine oil pressure falls below the preset levels shown in Table 8.1, first, the check engine light will illuminate, and, if the condition does not improve, the engine protection light will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

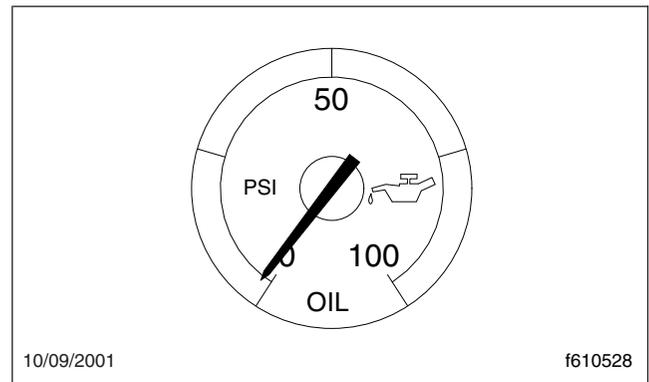


Fig. 8.9, Engine Oil Pressure Gauge

Coolant Temperature Gauge

NOTICE

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

During normal engine operation, the coolant temperature gauge should read 175 to 195°F (79 to 91°C). See Fig. 8.10. If the temperature remains

Front-Engine Diesel Chassis

below 160°F (71°C) or exceeds the maximum temperature shown in [Table 8.2](#), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

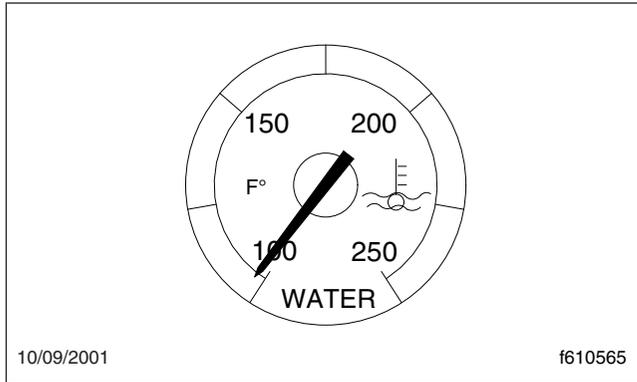


Fig. 8.10, Coolant Temperature Gauge

The coolant temperature gauge is mission-critical. See [Fig. 8.10](#). If the coolant temperature rises above the preset levels shown in [Table 8.2](#), first, the check engine light will illuminate, and, if the condition does not improve, the engine protection light will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

Transmission Fluid Temperature Gauge, Optional

The transmission fluid temperature gauge is optional. During normal operation, the transmission fluid temperature gauge reading should not exceed 250°F (121°C) at the sump. See [Fig. 8.11](#).

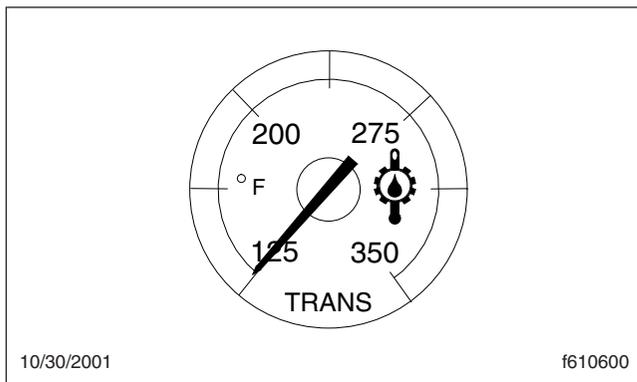


Fig. 8.11, Transmission Fluid Temperature Gauge

NOTICE

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

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

Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tank(s). See [Fig. 8.12](#) and [Fig. 8.13](#). For more detailed information on the fuel gauge used with EPA10 and newer engines, see [Chapter 4](#). One fuel gauge is standard. If equipped with a second (optional) fuel gauge, each fuel tank level is indicated on a separate gauge.

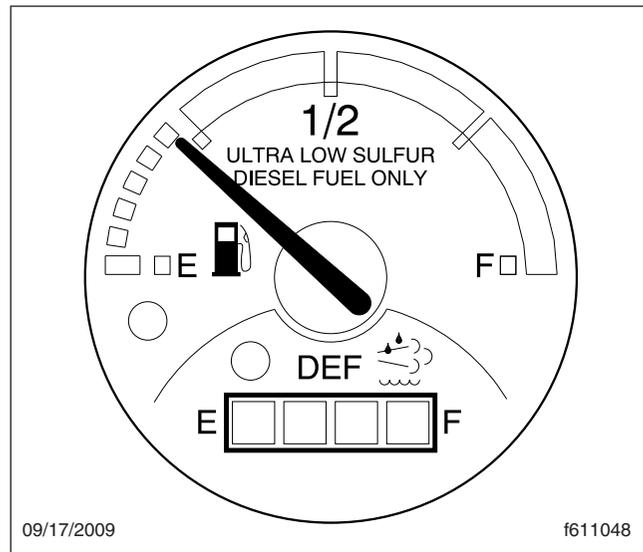


Fig. 8.12, Fuel Gauge, EPA10 and Newer Engines

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,

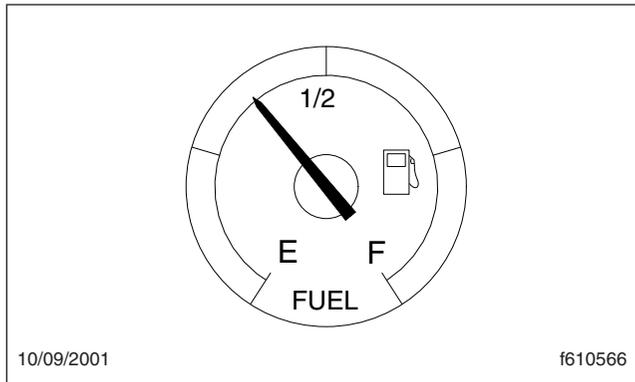


Fig. 8.13, Fuel Level Gauge

the driver can be aware of potential charging system problems and have them fixed before the batteries discharge enough to create starting difficulties.

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

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

Optional Instruments

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

Ammeter

An optional ammeter measures current flowing to and from the battery. See [Fig. 8.14](#). 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.

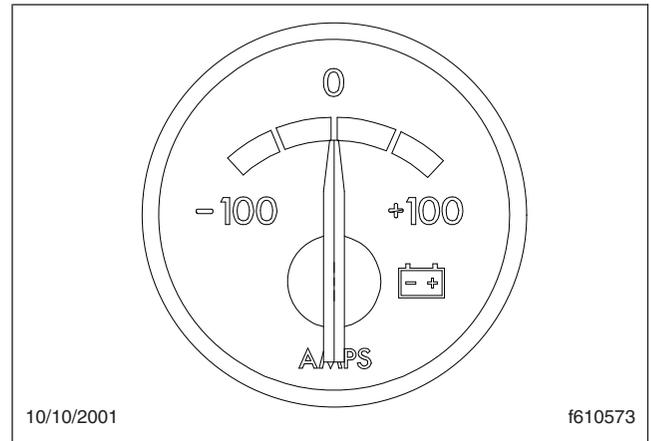


Fig. 8.14, Ammeter

Axle Oil Temperature Gauge, Rear

NOTICE

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

During normal operation, the optional rear axle oil temperature gauge should read between 160 and 220°F (71 and 104°C) for Detroit™ and Meritor™ drive axles. See [Fig. 8.15](#).

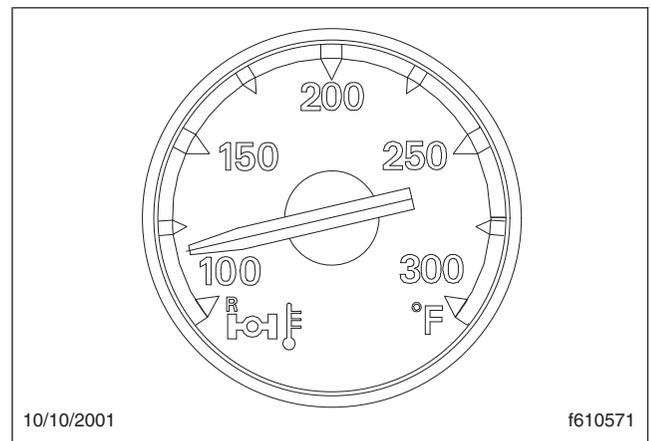


Fig. 8.15, Axle Oil Temperature Gauge

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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 brightness that automatically adjusts for day or night. The clock has a 24-hour alarm, with a three-minute snooze feature. See [Fig. 8.16](#).

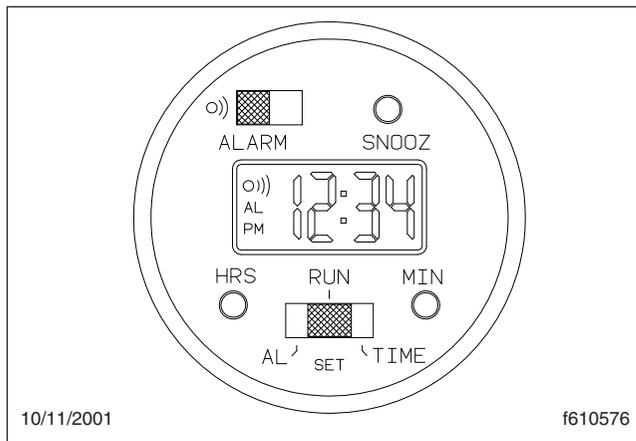


Fig. 8.16, Digital Clock

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 that you used to set the time of day; remember to set the hour for A.M. (no letters in the corner of the display), or P.M. as desired.
 - 2.3 Return the Run/Set switch to the middle (RUN) position; the readout will return to the time-of-day setting.

3. To operate the alarm:

- 3.1 With the alarm time set, push the alarm (upper) switch to the left. An alarm "wave" symbol and the letters AL will appear in the upper left corner of the display when the alarm is on.
 - 3.2 When the displayed time of day coincides with the alarm time, the alarm will sound. If the SNOOZ button is not pushed or the alarm switch is not moved, the alarm will automatically stop sounding after 1 minute and will not sound again for 24 hours.
 - 3.3 If desired, press the SNOOZ button while the alarm is sounding to shut the alarm off for 3 minutes. The alarm symbol will flash in the display when the button is pushed and will continue to flash until the alarm switch is moved or the alarm has sounded for one minute. The snooze procedure can be done as many times as desired.
 - 3.4 Move the alarm switch to the right when you wish to shut off or cancel the alarm; the alarm symbol will disappear.

Air Intake Restriction Gauge

The intake-air restriction indicator measures the vacuum on the engine side of the air cleaner at the air cleaner outlet. See [Fig. 8.17](#). On standard installations, it is mounted on the intake air piping in the engine compartment.

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.

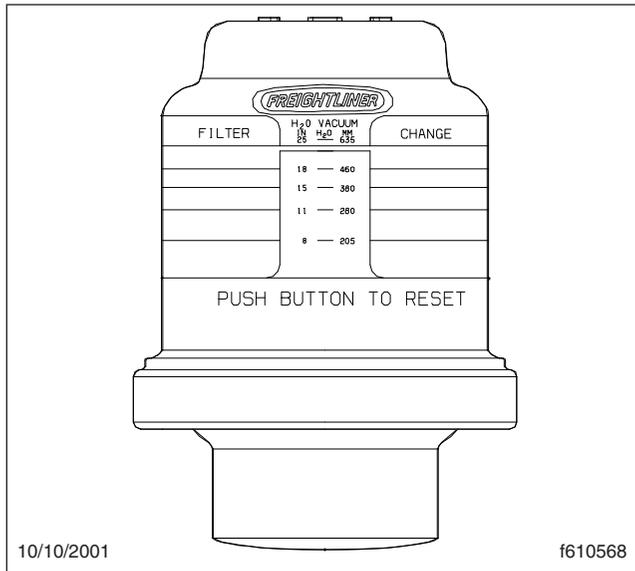


Fig. 8.17, Air Intake Restriction Gauge

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

Pyrometer

An optional pyrometer can be installed on the exhaust pipe. A pyrometer registers the exhaust temperature near the turbocharger. See **Fig. 8.18**. Maximum exhaust temperatures are listed in **Table 8.3**.

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.

Maximum Exhaust Temperature	
Engine Model	°F (°C)
Cummins ISB	1290 (700)

Table 8.3, Maximum Exhaust Temperature

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. 8.19**.

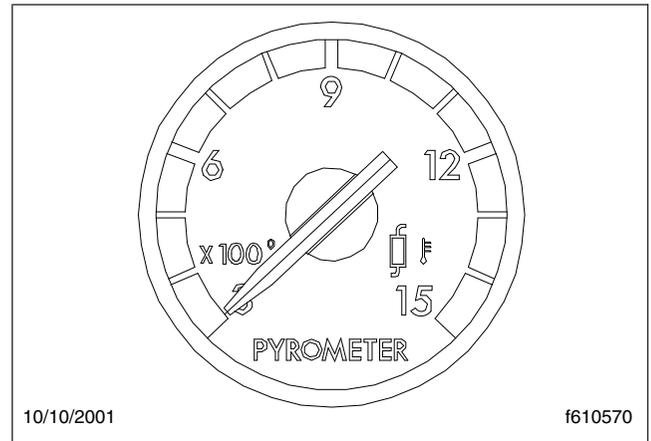


Fig. 8.18, Pyrometer

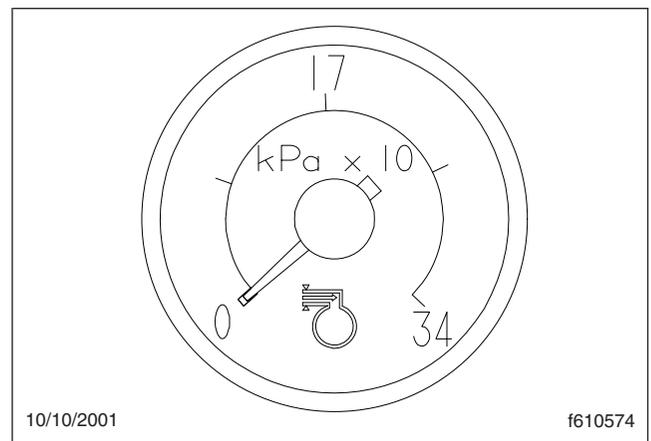


Fig. 8.19, Turbo Boost Pressure Gauge

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.

Model year 2013 and later vehicles meet additional requirements as specified by GHG14 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

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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 (NO_x) – 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 NO_x downstream of the engine.

NOTICE

Follow these guidelines for engines that comply with EPA10 or newer regulations, or damage may occur to the aftertreatment device (ATD) and the warranty may be compromised.

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

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.

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 diesel exhaust fluid (DEF) is injected into the exhaust stream, where heat converts it to ammonia (NH₃) gas. This mixture flows through the SCR device, where the ammonia gas reacts with the NO_x in the exhaust, to produce harmless nitrogen (N₂) and water vapor (H₂O), which then exits out of the tailpipe.

ATS Warning Lamps

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

- An illuminated DPF lamp indicates a regen is needed.
- A slow, 10-second flashing of the HEST lamp alerts the driver that a parked regen is in progress, but the exhaust temperatures are still relatively cool. It also indicates that the high-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. 8.20](#).

The regen switch, located on the dash, is used to initiate a parked regen of the aftertreatment device. See [Fig. 8.21](#).

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.)

To initiate a parked regeneration, perform the following steps.

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

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

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

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

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

Shorting Plug

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

The shorting plug is used to initiate a parked regen of the aftertreatment device. The shorting plug is located under the dash, next to the steering column. Mounting locations vary. See [Fig. 8.22](#).

To initiate a parked regeneration, perform the following steps.

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

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

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

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

3. Disconnect the shorting plug, as follows.

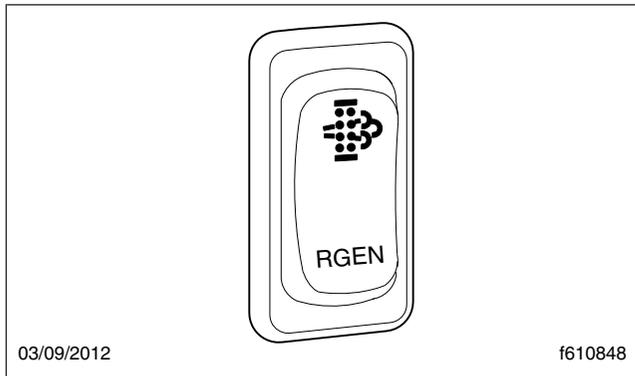
Front-Engine Diesel Chassis

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>					

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Fig. 8.20, Exhaust-Aftertreatment Warnings Reference Label

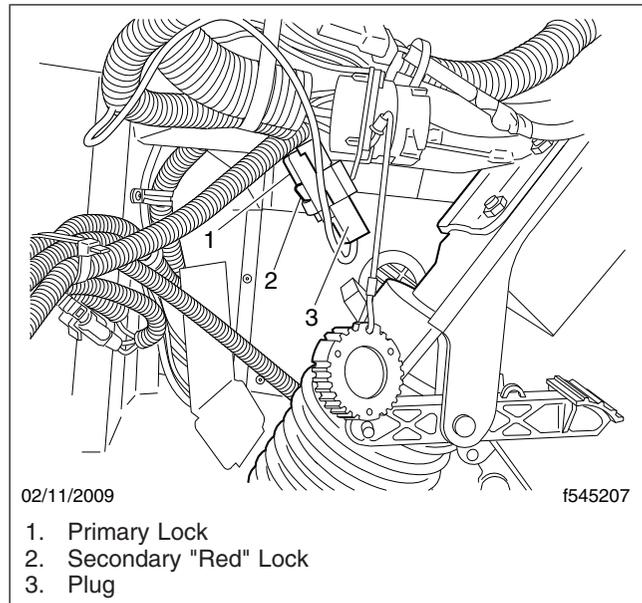


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Fig. 8.21, Regen Switch

- 3.1 Slide the secondary red lock away from the white cover. See [Fig. 8.22](#), Ref. 2.
- 3.2 Push the primary lock in. See [Fig. 8.22](#), Ref. 1.
- 3.3 Pull the plug apart. See [Fig. 8.22](#), Ref. 3.
4. Wait four seconds.
5. Connect the shorting plug.
6. Engine rpm will rise, and initiate the regen process.



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f545207

Fig. 8.22, Shorting Plug

7. After the parked regen has run for 20 to 40 minutes, the regen cycle is completed. The engine idle speed will drop to normal, and the vehicle may be driven normally. The HEST lamp may be

illuminated, but will go out when the vehicle speed exceeds 5 mph (8 km/h), or the system has cooled to normal operating temperature. The DPF light will shut off.

8. To stop a parked regen at any time during the process, engage the clutch, service 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; com-

plete 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. 10- and 11.5-gallon tank capacities are available. 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. 8.23](#).

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 very low, refill DEF
- One bar flashing red—DEF empty, refill DEF

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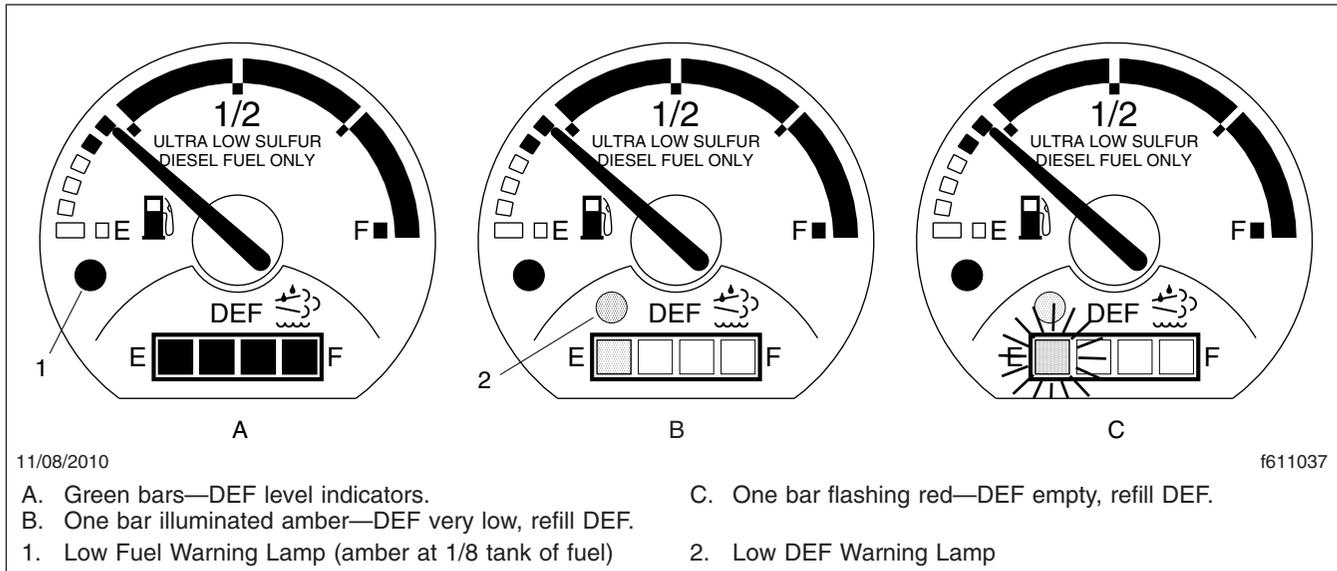


Fig. 8.23, Fuel/DEF Gauge

DEF Warnings and Engine Limits

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

DEF Level Low—Initial and Critical Warnings

When the DEF level reads low the following warnings strongly encourage the driver to refill the DEF tank. See [Fig. 8.24](#).

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

DEF Empty

When the DEF level reads empty, the following warnings are activated. See [Fig. 8.25](#).

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

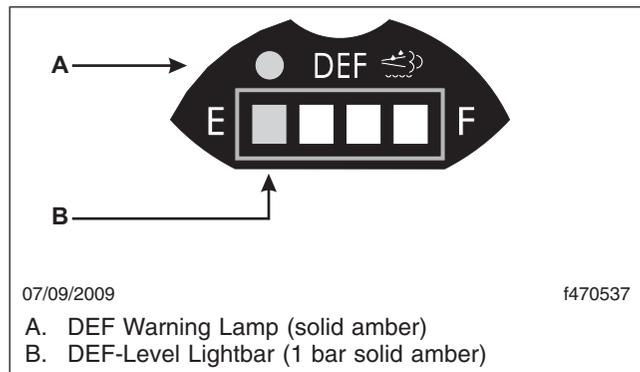


Fig. 8.24, DEF Level Low Initial and Critical Warnings

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

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

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the red STOP engine lamp illuminates in addition to the DEF warning lamp and the CHECK engine warning lamp. See [Fig. 8.26](#).

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.

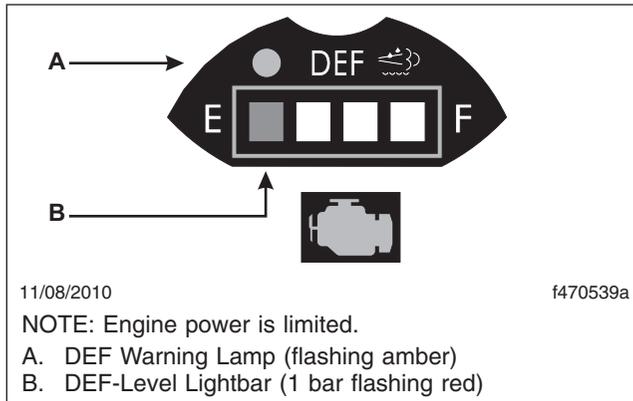


Fig. 8.25, DEF Empty Warning

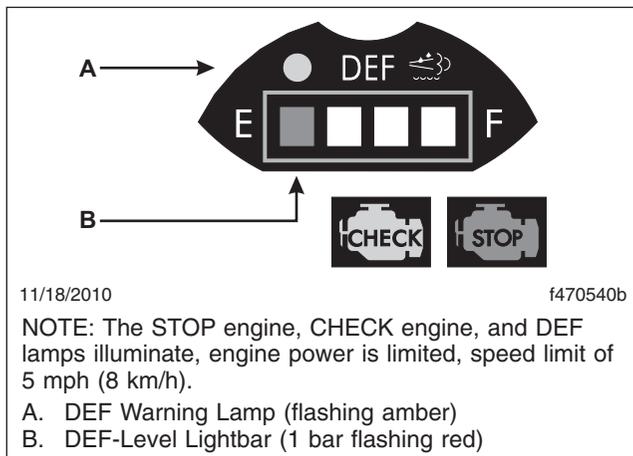


Fig. 8.26, DEF Empty and Ignored Warning

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 performance is limited with progressively harsher engine power limits applied. If the fault is not corrected, the CHECK engine lamp illuminates, then the STOP engine lamp illuminates and a 5 mph (8 km/h) speed limit will be applied after the next engine shutdown, or while parked and idling. See [Fig. 8.26](#).

EPA07 Aftertreatment System (ATS)

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

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

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

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

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

Inside the ATD on Mercedes-Benz, Detroit Diesel, and Cummins engines, the exhaust first passes over the diesel oxidation catalyst (DOC), then it passes through the diesel particulate filter (DPF), which traps soot particles. If exhaust temperature is high enough, the trapped soot is reduced to ash, in a process called passive regeneration (regen). **Passive regeneration** occurs as the vehicle is driven normally under load; the driver is not even aware that it is happening. The harder an EPA07 engine works, the better it disposes of soot, as the exhaust heat alone is enough to burn the soot to ash. Over the course of a workday, however, passive regeneration cannot always keep the ATD filter clean, so the filter must undergo **active regeneration**. In active regeneration,

Front-Engine Diesel Chassis

extra fuel is injected into the exhaust stream to superheat the soot trapped in the DPF and turn it to ash. Active regeneration happens only when the vehicle is moving above a certain speed, determined by the engine manufacturer. Consult manufacturers' documentation for details.

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

If conditions do not provide for at-speed active regeneration, the vehicle will need a driver-activated **parked regeneration**. The vehicle must be standing still, and the driver must initiate parked regen. Completing a parked regen takes 20 minutes to an hour, depending on ambient conditions.

The Powerliner chassis has a Cummins 500HP ISM engine. It is not equipped with an aftertreatment device, however, it is EPA2010-compliant, and uses ultralow-sulfur diesel fuel and low-ash engine oil.

DANGER

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

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

There are three warning lamps in the driver message center that alert the driver of the need to perform a manual regen, clean the filter, or of an engine fault that affects the emissions.

WARNING

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

A slow (10-second) flash of the high exhaust system temperature (HEST) lamp, indicates a regeneration is in progress, and the driver is not controlling the engine idle speed.

A steadily illuminated high exhaust system temperature (HEST) lamp, alerts the operator of high exhaust

temperature during the regen process when the speed is below 5 mph (8 km/h), or during a manual regen. See [Fig. 8.27](#). The HEST lamp does not signify the need for any kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or explode.

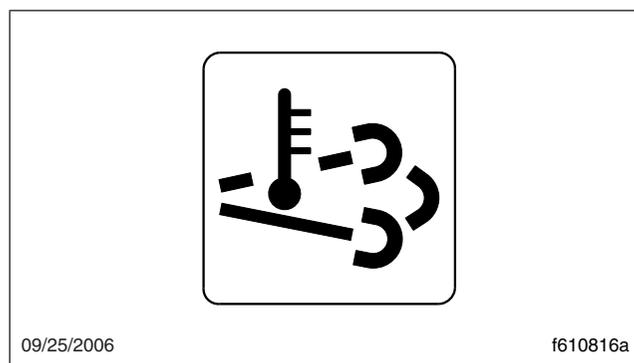


Fig. 8.27, High Exhaust System Temperature (HEST) Lamp

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.

A steadily illuminated yellow Diesel Particulate Filter (DPF) lamp indicates that a manual regen is required soon, and should be scheduled for the earliest convenient time. A blinking yellow DPF lamp indicates that a manual regeneration is required immediately, or an engine derate may occur. See [Fig. 8.28](#).

A steadily illuminated yellow Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the

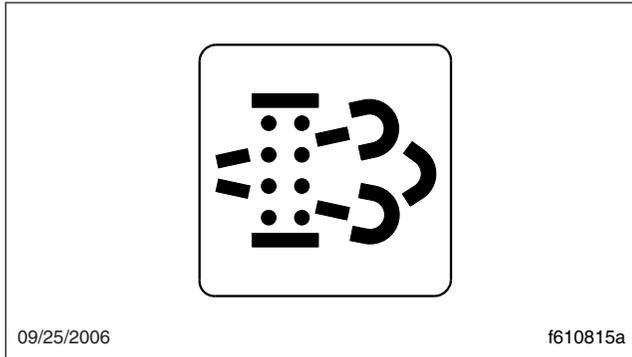


Fig. 8.28, Diesel Particulate Filter (DPF) Status Lamp

emissions. The MIL applies to the Mercedes-Benz engine only. See [Fig. 8.29](#).

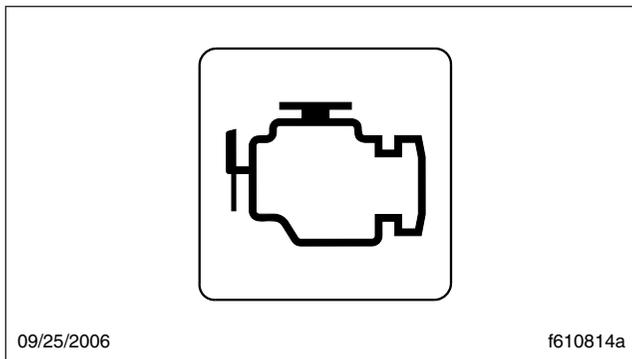


Fig. 8.29, Malfunction Indicator Lamp (MIL)

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

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

The DPF regen connector, located under the dash, may have two selectable positions:

- Request Regeneration
- Default (can include appropriate normal state condition—either in an automatic regeneration or inhibit state)

NOTE: The regen switch can start a regen only when at least one of two conditions exists: either the DPF light is lit, or the engine software

calls for it. If neither of those conditions exist, the regen switch cannot cause a regeneration to happen.

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

High-Soot-Load Idle Shutdown

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

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

Allison Automatic Transmissions

NOTICE

Do not allow the vehicle to coast in neutral. This can result in severe transmission damage. Also, no engine braking is available.

NOTICE

The engine should never be operated for more than 30 seconds at full throttle with the transmission in gear and the output stalled. Prolonged operation of this type will overheat the transmission fluid and will result in severe damage to the transmission.

1000/2100/2200/2350 MH Models

General Information

The Arens shift-by-wire (SBW) push-button shift selector is part of an electronic shift control system used with Allison series 1000/2100/2200/2350 5-speed automatic transmissions. An electronic actuator is mounted on the transmission.

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The 1000/2200/2350 series transmission has a park pawl and the SBW selector has a Park (P) position. The 2100 series transmission has a park brake (Pb) button. See [Fig. 8.30](#) and [Fig. 8.31](#).

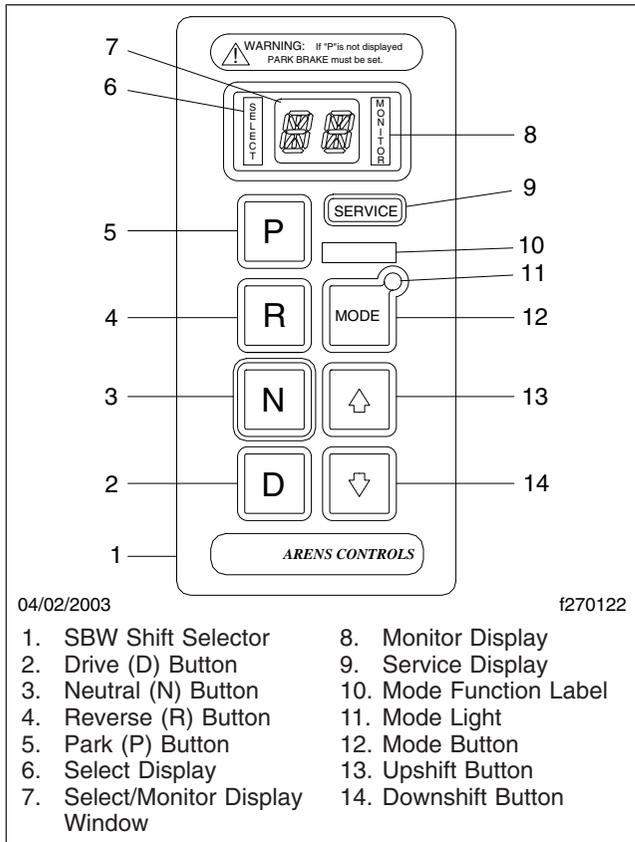


Fig. 8.30, SBW Shift Selector (1000/2200/2350 series)

In case the vehicle needs to be towed and the SBW system cannot be activated to move the transmission out of Park (P), a manual procedure is provided to shift the transmission. At the actuator, on the transmission, a port is provided to insert an Allen wrench to shift the transmission manually. See [Chapter 13](#) for more information.

Transmission Operation

- At the top left side of the selector, is the select display. On the left side of the display window, an LED character indicates which gear has been selected.
- At the top right side of the selector, is the monitor display. On the right side of the display win-

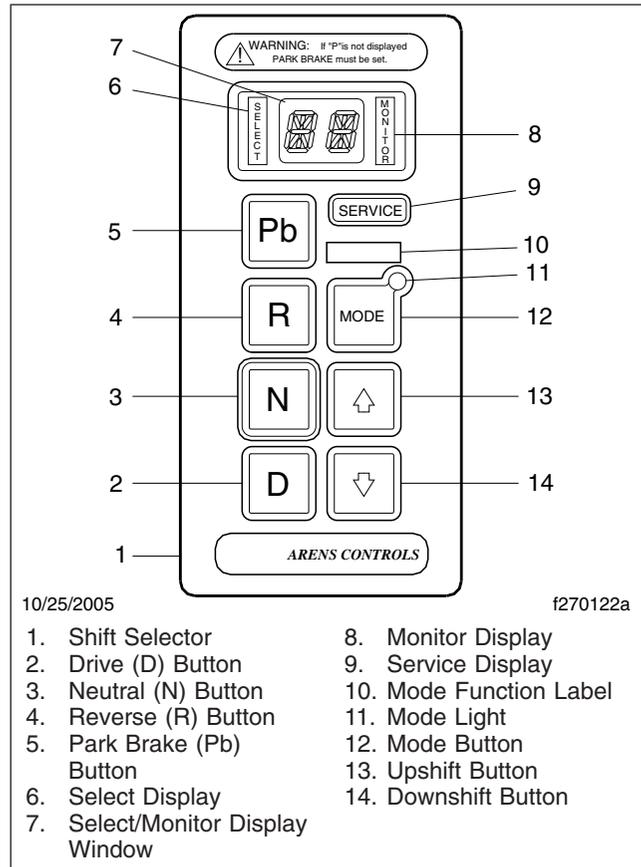


Fig. 8.31, SBW Pushbutton Shift Selector with Park Brake (Pb) Button (2100 series)

dow, an LED character indicates which gear is actually engaged.

⚠ WARNING

If the Park (P) position is selected and the letter P does not appear on the monitor side of the display window, you must set the parking brake. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

NOTE: Only the 1000/2200/2350 MH model transmissions have a park pawl and a Park (P) button.

- The Park (P) button shifts the transmission to Neutral (N) and engages the park pawl. When Park (P) is selected, the monitor side of the display window will show a letter P.

WARNING

Always place the transmission in the Park (P) or Neutral (N) position and set the parking brake before releasing the service brakes and exiting the vehicle. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

4. Select the R button to place the transmission in Reverse (R). An R will appear on both sides of the display window.

WARNING

Do not leave the vehicle if the transmission is in Neutral (N) without first setting the parking brake. The vehicle could roll or move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.

5. Select the N button to place the transmission in Neutral (N). An N will appear on both sides of the display window. The vehicle may be started in Neutral (N).
6. Select the D button to place the transmission in Drive (D). The transmission will automatically shift through the full range of First (1) through Fifth (5) gears. When Drive (D) is first selected, the display will show D1, indicating that Drive (D) was selected and that First (1) gear is engaged. As the transmission automatically upshifts and downshifts, the display will show the gear currently engaged (D1, D2, D3, D4, or D5).
7. With the transmission in Drive (D), select the downshift (down arrow) button to manually downshift one gear at a time, from Fifth (5) to First (1). The select display will show the selected gear and the monitor display will show the gear currently engaged. From D5 at the top of the Drive (D) range, the display will show 44, 33, 22, and 11 as progressively lower gears are manually selected.

NOTE: The transmission will remain in the manually selected gear until Drive (D) is selected. Select Drive (D) at any time during the manual downshifting sequence (or upshift progressively to Drive (D) using the up arrow button) and the transmission will upshift and downshift automatically.

8. With the transmission in 11, 22, 33, or 44, select the upshift (up arrow) button to manually upshift one gear at a time until Drive (D) is selected. The select display will show the selected gear and the monitor display will show the gear currently engaged. From 11 at the bottom of the Drive (D) range, the display will show 22, 33, 44, and D5 as progressively higher gears are manually selected.

NOTE: The transmission will remain in the manually selected gear until Drive (D) is selected. Select Drive (D) at any time during the manual upshifting sequence and the transmission will upshift and downshift automatically.

9. The function of the mode button may vary from vehicle to vehicle. The label above the button identifies the function.
10. A light in the upper right-hand corner of the mode button illuminates when the mode function is active.

NOTICE

To prevent transmission and axle damage, make sure the automatic transmission is in high range when performing an axle shift with the vehicle moving.

11. The service display illuminates if a fault is detected in the SBW system. Have a qualified technician inspect the SBW system as soon as possible.
12. A flashing select/monitor display indicates that the transmission (and not the SBW system) has inhibited a selected transmission operation. See the *Allison Transmission Operator's Manual* for more information.

Hydraulic Brake System

General Information

The hydraulic brake system includes a power booster, master cylinder, reservoir, hydraulic lines, a brake rotor on each wheel hub, and a brake caliper and pad assembly at each rotor. See [Fig. 8.32](#).

IMPORTANT: Make sure that the fluid level in the master cylinder reservoirs is up to the flange

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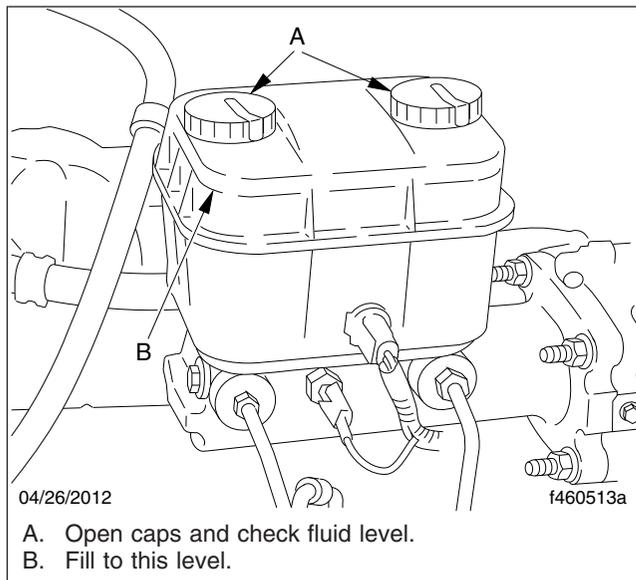


Fig. 8.32, Hydraulic Brake Reservoir

that surrounds the reservoir. Use only heavy-duty brake fluid, DOT 3, in the hydraulic brake system. Do not mix types and brands of fluid because of possible incompatibility.

The master cylinder controls braking power to the front and rear brakes. The Bendix Hydro-Max® power booster is attached to the rear of the master cylinder and is connected to the power steering system (which provides pressurized power steering fluid). An electrically powered "reserve" pump operates if there is inadequate fluid flow from the power steering pump to the power booster. The brake system warning light comes on if there is a problem within the system. Bring the vehicle to a safe stop and correct the problem before continuing operation of the vehicle.

Meritor WABCO® Antilock Braking System (ABS), Hydraulic Brake Systems

The Meritor WABCO Antilock Braking System (ABS) is an electronic wheel speed monitoring and control system that works with the hydraulic brake system. ABS 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 hydraulic brake system is in effect.

IMPORTANT: For proper ABS system operation, do not change tire sizes. The sizes of the tires installed during production are programmed into the electronic control unit. Installing different sized tires could result in inaccurate wheel speed signals to the ECU resulting in a reduced braking force, which could lead to longer stopping distances.

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 (located on the front-wall) which interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate wheel lockup, the appropriate control circuit signals the brake pressure modulator to increase or decrease braking pressure until wheelslip has been corrected.

The electronic control unit also has a safety circuit that constantly monitors the wheel sensors, brake pressure modulator, and the electrical circuitry. The dash warning light (ABS) comes on after the ignition is switched on. Once the vehicle moves faster than about 4 mph (6 km/h), the warning light goes out only if all the vehicle's ABS components are working.

If, during vehicle operation, the safety circuit senses a failure in any part of the ABS system (a sensor, brake pressure modulator, wiring connection; short circuit, etc.), the warning light (ABS) comes on and the control circuit where the failure occurred is switched to normal braking action. Even if the ABS system is partially or completely inoperative, normal braking ability is maintained. An exception would be if the brake pressure modulator, or hydraulic fluid line is damaged. As these components are an integral part of the hydraulic brake system, normal braking may be impaired or inoperative.

IMPORTANT: If any of the ABS warning lights do not work as described above, or come on while driving, repair the ABS system immediately to ensure full antilock braking capability.

During emergency or reduced-traction stops, fully depress the brake pedal until the vehicle comes to a safe stop; *do not pump* the brake pedal. With the brake pedal fully depressed, the ABS system will control all wheels to provide steering control and a reduced braking distance.

Although the ABS system improves vehicle control during emergency braking situations, the driver still has the responsibility to change driving styles depending on the existing traffic and road conditions. For example, the ABS system cannot prevent an accident if the driver is speeding or following too closely on slippery road surfaces.

Operation

Before driving the vehicle, secure all loose items in the vehicle so that they will not fly forward during a full brake application. Check that the brake system warning light is off after releasing the parking brake. If the warning light does not go off, correct the problem before continuing operation of the vehicle.

During normal brake stops, depress the foot brake control pedal until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop. When the vehicle comes to a complete stop, shift the transmission into park (P) on the shifter and apply the parking brake.

pressed, then a drive gear must be selected to release the parking brake. The "BRAKE" warning light will flash and a chime will sound when this procedure is performed.

NOTICE

If the vehicle is equipped with an air suspension system, do not park the vehicle or move the vehicle with the air suspension deflated. This may cause suspension component damage.

Auto-Apply Parking Brake Operation

Use the following instructions to operate the parking brake:

IMPORTANT: The service brake must always be depressed when shifting from the parking brake (Pb) position.

- Set by pressing (Pb) on the shift selector.
- To release the parking brake, depress the service brake and shift from the "Pb" position to any drive gear.
- Shifting from "Pb" to a drive gear and then to neutral (N) releases the parking brake and places the vehicle in neutral. The "BRAKE" warning light will flash when this procedure is performed.
- Shifting directly from "Pb" to "N" does not release the parking brake. "Pb" must be de-

9

Pre- and Post-Trip Checklists

Pretrip and Post-Trip General Information	9.1
Daily Pretrip Inspection and Maintenance Checklist	9.1
Weekly Post-Trip Inspection and Maintenance Checklist	9.3
Monthly Post-Trip Inspection and Maintenance Checklist	9.3

Pre- and Post-Trip Checklists

Pretrip and Post-Trip General Information

For the daily pretrip inspection and maintenance checklist see [Table 9.1](#).

Regulations in both Canada and the United States clearly indicate that it is the driver's responsibility to perform an inspection and ensure the complete road-worthiness of a vehicle before placing it into service for the day.

IMPORTANT: The pre- and post-trip checklists, and inspections and maintenance procedures detailed in this chapter, are **not all-inclusive**. Also refer to other component and body manufacturers' instructions for specific inspection and maintenance instructions.

Use the pretrip inspection checklist to ensure that vehicle components are in good working condition before each trip. Use the weekly and monthly post-trip inspection checklists to note any items that require attention before the next trip. A driver that is familiar with the vehicle, and drives it regularly, can perform the daily inspections, then add the weekly and monthly post-trip inspections as scheduled. If the driver does not operate the vehicle on a consistent basis, all three of the inspection procedures should be performed before the trip.

Pre- and post-trip inspections cannot be done quickly. However, careful inspections save time by eliminating stops later to adjust items overlooked or forgotten.

Numbers in parentheses within each of the checklists reference the corresponding detailed instructions found under "Daily (D), Weekly (W), or Monthly (M) Procedures" in [Chapter 10](#).

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, take the vehicle to an authorized Freightliner dealer for assistance.

Daily Pretrip Inspection and Maintenance Checklist

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

Pre- and Post-Trip Checklists

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
_____	Drain manually drained air reservoirs (that are not equipped with automatic drain valves)	D1
Check _____	windshield washer reservoir fluid	D2
Inspect _____	wheel seal and hub cap (for leakage)	–
Check _____	surge tank coolant level	D3
Check _____	radiator and charge air cooler	D4
Inspect _____	engine and chassis wiring	D5
Inspect _____	air intake system	D6
Inspect _____	intake-air restriction indicator mounted on air intake	D6
Check _____	engine oil level	D7
Check _____	power steering fluid level	D8
Check _____	fuel tank(s), fuel lines, and connections	D9
Check _____	fuel level	D10
Inspect _____	fuel/water separator	D11
Check _____	front and rear suspension components	D12
Check _____	headlights, mirrors, and window glass, and windshield wipers	D13
Check _____	doors (open without difficulty and close securely)	–
_____	Adjust driver's seat, then align rearview and downview mirrors	–
Check _____	dash-mounted intake-air restriction indicator	D6
Check _____	oil- and air-pressure warning systems	D14
Check _____	LBCU warning lights	D15
Check _____	ICU fault codes (front-engine diesel chassis)	D15
Check _____	horn, windshield wipers, and windshield washer	D16
Inspect _____	heater, defroster, and optional mirror heat controls	D17
Check _____	panel lights and interior lights	D18
Check _____	exterior lights and reflectors	D19
Check _____	tire pressure	D20
Check _____	tire condition	D20
Check _____	rims and wheels	D21
Check _____	automatic transmission fluid level	D22
Inspect _____	air brake chambers and pushrods	D23
Inspect _____	air brake lines	D24
Inspect _____	slack adjusters	D25
Inspect _____	air brake system operation	D26
Check _____	frame rails (missing bolts), crossmembers (bent or loose)	–
Check _____	Bendix Hydro-Max® brake booster (front-engine diesel chassis)	D27
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)	–
_____	Remove chocks and test service brakes	D28
Inspector _____ Date _____		

Table 9.1, Daily Pretrip Inspection and Maintenance Checklist

Pre- and Post-Trip Checklists

Weekly Post-Trip Inspection and Maintenance Checklist

For the weekly post-trip inspection and maintenance checklist see [Table 9.2](#).

Before performing any of these checks, apply the parking brake and chock the tires.

Procedure Performed (check off)	Weekly Post-Trip Inspections/Checks	Procedure Reference
_____	Manually drain air reservoirs that are equipped with automatic drain valves	—
Inspect _____	batteries and battery cables	W1
Check _____	wheel bearing lubricant level	W2
Inspect _____	steering components	W3
Check _____	drive belt condition	W4
Inspector _____ Date _____		

Table 9.2, Weekly Post-Trip Inspection and Maintenance Checklist

Monthly Post-Trip Inspection and Maintenance Checklist

For the monthly post-trip inspection and maintenance checklist see [Table 9.3](#).

Before performing any of these checks, apply the parking brake and chock the tires.

Procedure Performed (check off)	Monthly Post-Trip Inspections/Checks	Procedure Reference
_____	Clean the battery terminals	M1
Inspect _____	radiator hoses and heater hoses	M2
Check _____	fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 3 brake fluid)	—
Check _____	steering wheel play	M3
Check _____	outer surfaces of the body (for visible surface breaks and damage)	—
Check _____	hood tilt damper (attached at both ends)	—
Inspect _____	brake lining wear	M4
Inspect _____	driveshaft	—
Inspect _____	(and lubricate if needed) Meritor Roller Pins; inspect the brake shoes	M5
Inspector _____ Date _____		

Table 9.3, Monthly Post-Trip Inspection and Maintenance Checklist

10

Pre- and Post-Trip Inspections and Maintenance

Daily Pretrip Inspection and Maintenance Procedures	10.1
Weekly Post-Trip Inspection and Maintenance Procedures	10.12
Monthly Post-Trip Inspection and Maintenance Procedures	10.13

Pre- and Post-Trip Inspections and Maintenance

Daily Pretrip Inspection and Maintenance Procedures

Whenever equipment requires adjustment, replacement, and/or repair, take your vehicle to an authorized Freightliner dealer for assistance.

1. Drain manually drained brake system air reservoirs.

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 lanyard 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 towards anyone. Dirt or sludge particles may be in the air stream and could cause injury.

Failure to drain the air reservoirs as instructed could cause sludge formation in the air brake system. Sludge could adversely affect braking, causing loss of control, which could cause death, personal injury, or property damage.

- 1.2 Exhaust the remaining air and moisture from the system by opening the drain cocks on the bottoms of the remaining air reservoirs, or pull the lanyard(s) until the air is exhausted.
- 1.3 Water and oil emulsion often form pockets that will not drain while compressed air is in the reservoirs. Because of these pockets, leave the valves blocked open during the first part of the pretrip inspection.
- 1.4 If the drained water is cloudy or oily, it may indicate a problem with the compressor. If oil is allowed to contaminate the air dryer, it will not remove the water from the air brake system, which could adversely affect braking.

2. Check the fluid level in the windshield washer reservoir.

Add washer fluid as needed.

! WARNING

Washer fluids may be flammable and poisonous. Do not expose washer fluid to an open flame or any burning material, such as a cigarette. Always comply with the washer fluid manufacturer's recommended safety precautions.

3. Check the coolant level in the surge tank.

See **Fig. 10.1**. If the coolant is low, add a 50/50 mixture of water and the type of antifreeze currently installed in your vehicle. Fill the surge tank with coolant to the MAX line when the tank is cool. If the surge tank was empty, start the engine after refilling and check the level again when the engine is at operating temperature.

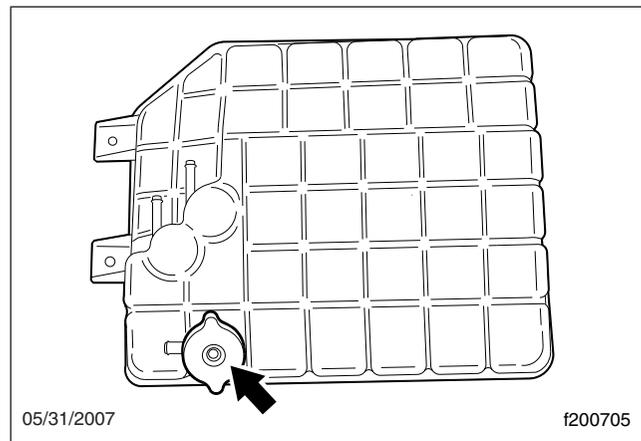


Fig. 10.1, Surge Tank Fill Cap

NOTICE

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

4. Inspect the radiator and charge air cooler.

- 4.1 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.

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- 4.2 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 (320 km).

- 4.3 Also inspect and clean the condenser. If clogged, the condenser can restrict airflow through the radiator.
- 4.4 Check the radiator for leaks. If leaks are found, have the radiator repaired or replaced. Take the vehicle to an authorized Freightliner dealer for assistance.
5. *Inspect the engine and chassis wiring.*
Check for loose wiring, chafed insulation, and damaged or loose hold-down clamps. Tighten loose wires or hold-down clamps; replace damaged wiring or clamps.
6. *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.

- 6.1 Check the intake-air restriction indicator to determine if the air cleaner needs to be changed. See **Fig. 10.2**.
- 6.2 Replace the air cleaner when the yellow line reaches 25 inH₂O. Take the vehicle to an authorized Freightliner dealer for assistance.

NOTE: After replacing the filter element, reset the restriction indicator by pressing the rubber reset button.

- 6.3 Inspect the air cleaner, and replace it when it becomes clogged or dirty.
- 6.4 Check the engine air intake piping from the air cleaner to the engine intake. Inspect the piping for loose connections,

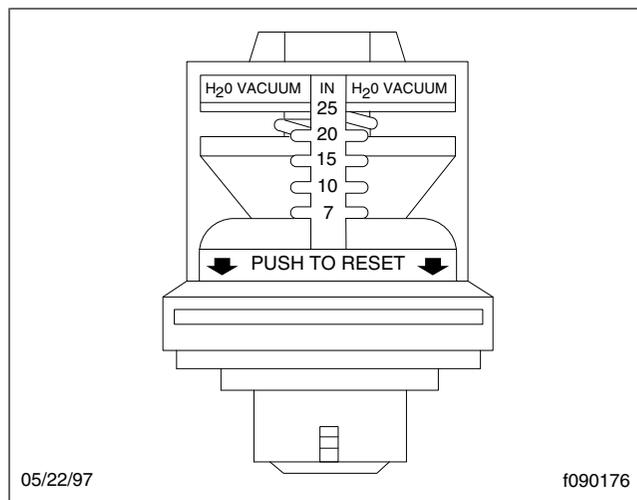


Fig. 10.2, Air Restriction Indicator

cracks, torn or collapsed hoses, punctures, and other damage. Tighten loose connections, and have damaged components replaced. Make sure the piping system is airtight so that all intake air passes through the air cleaner. Engine damage can occur if the air intake system is not properly maintained.

7. *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.

- 7.1 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: Follow the engine manufacturer's guidelines for engine shutdown time requirements prior to checking the oil level.

- 7.2 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.

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- 7.3 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. 10.3](#).

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

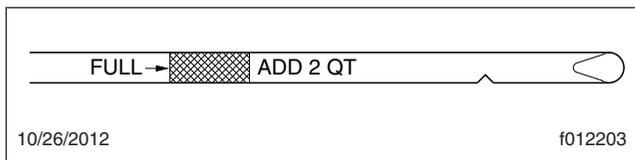


Fig. 10.3, Oil Dipstick

NOTICE

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

8. Check the fluid level in the steering system hydraulic fluid reservoir. See [Fig. 10.4](#).

If needed, fill the reservoir to a level between the MIN and MAX marks. Use only Dexron® III ATF, or an equivalent.

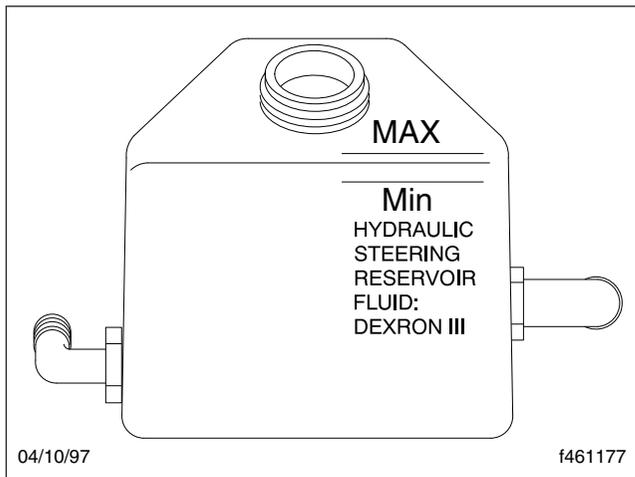


Fig. 10.4, Steering System Hydraulic Fluid Reservoir

IMPORTANT: Do not confuse coolant with hydraulic fluid. Both are pink in color.

9. Inspect the fuel tanks, fuel lines, and connections for leaks.

Replace leaking fuel tanks; repair or replace any mechanisms, lines, or connections that are leaking. Take the vehicle to an authorized Freightliner dealer for assistance.

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. Federal regulations prohibit filling a fuel tank to more than 95 percent of its liquid capacity. Select the proper grade of fuel as specified by the engine manufacturer.

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 and 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: Use ultralow-sulfur diesel (ULSD) fuel with 15 ppm sulfur content or less, based on ASTM D2622 test procedure. Failure to use ultralow-sulfur diesel fuels may void the warranty on emission components.

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 may be started again.

11. Check the fuel/water separator and drain any water present.

NOTE: The fuel/water separator may be relocated by the body manufacturer and the locations may vary.

- 11.1 Shut off the engine.
11.2 Remove the fuel cap.

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- 11.3 Open the valve until draining occurs. Drain the filter sump of water until clear fuel is visible.
- 11.4 Close the drain and install the fuel cap.
- 11.5 Run the engine and check for leaks.
- 12. *Inspect the front and rear suspension components, including springs, spring hangers, shocks, and suspension brackets.*
 - 12.1 Check for broken spring leaves, loose U-bolts, cracks in the suspension brackets, and loose fasteners in the spring hangers and shackles.
 - 12.2 Inspect the shock absorbers for loose fasteners and leaks.
 - 12.3 Tighten all loose fasteners and have any components replaced that are worn, cracked, or otherwise damaged.
 - 12.4 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.

- 13. Clean the windshield, side, and rear windows with a long-handled or telescoping window cleaning device and standard cleaning solutions. 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.

Check the condition of the windshield wiper arms and blades.

Be sure the windshield wiper blades are tensioned against the windshield.

Inspect the wiper blades for damage and deteriorated rubber.

Replace the wiper arms if the wiper blades are not tensioned against the windshield.

Replace damaged or deteriorated wiper blades.

WARNING

When cleaning windshields and windows, always stand on the ground or on a secure ladder or platform. Use a long-handled window cleaner. Do not use the cab steps, tires, fenders, fuel tanks, engine, or under-hood components to access the windshield or windows. Doing so could cause a fall and result in an injury.

Replace wiper arms and blades when necessary to maintain good visibility. Poor visibility could interfere with the driver's ability to control the vehicle, possibly resulting in serious personal injury or death.

- 14. *Check the oil- and air-pressure warning systems.*

When the engine is started, oil- and air-pressure warnings will come on until the oil and air pressure rise above a preset minimum. After starting the engine, make sure the oil- and air-pressure warning systems are operating and that the buzzer stops sounding when the preset minimum is reached.

- 14.1 If the warning systems do not come on when the ignition is turned on, have the systems repaired.
- 14.2 If the air pressure in both systems is above the preset minimum when the engine is started, test the low air pressure warning system by repeatedly pumping the brake pedal to lower the pressure to below this range, or until the warning system comes on.

NOTE: The air pressure in both the primary and secondary air reservoir systems must be above 65 psi (448 kPa) on most vehicles.

- 15. *Check the lightbar for warning lights.* During the ignition sequence, if any warning lights remain on, see [Chapter 2](#) for detailed instructions on warning lights.

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For Front-Engine Diesel Chassis, check the instrumentation control unit (ICU) for fault codes.

During the ignition sequence, if an active fault is detected in any device that is connected to the datalink, the message display screen will show the active fault codes, one after the other until the parking brake is released or the ignition switch is turned off. See [Chapter 8](#) for detailed operating instructions for the ICU.

16. *Make sure that the horn, windshield wipers, and windshield washers are operating properly. These devices must be in good working order for safe vehicle operation.*
 - 16.1 Make sure that the horn works. If a horn is not working, have it repaired before trip departure.
 - 16.2 Check the wiper and washer control on the multifunction turn signal switch. If the wipers and/or washers are not working, have them repaired before trip departure.
17. *During cold weather; make sure the heater, defroster, and optional mirror heat controls are operating properly. If so equipped, turn on the mirror heat switch and make sure the system is working.*
18. *Check the operation of all the panel lights and interior lights.*

Turn on the headlights, dash lights, and four-way flashers and leave them on. If any of the gauge bulbs, the dome light bulbs, or the right- and left-turn indicator bulbs are not working, replace them.
19. *Make sure all the exterior lights are working properly. Check that all the lights and reflectors are clean.*
 - 19.1 Check that the brake lights, taillights, headlights, parking lights, turn signals, road lights (if so equipped), and front clearance lights are working properly and are clean.
 - 19.2 Test the high and low beams of the headlights.
 - 19.3 Replace the light bulbs or sealed beam units that are not working. Refer to the body builder book for light bulb replacement.

20. Check the tire inflation pressures, and inspect each tire for bulges, cracks, cuts, and punctures.

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 or inflation. Some wheels are stamped with a maximum load and maximum cold inflation rating. If the load exceeds the maximum wheel capacity, the load must be adjusted or reduced. See and adhere to the tire load and cold inflation pressure specifications stated on the vehicle specification label.

NOTE: Tire load limits refer only to individual tires and do not indicate the weights for the entire axle.

- 20.1 Check the inflation pressures of the tires before each trip, using an accurate tire pressure gauge. See [Fig. 10.5](#). Check tire pressures when the tires are cool. The maximum inflation pressure for each tire is provided on the outer wall of the tire. Inflate the tires to the applicable pressures, if needed. Be sure that valve stem caps are used on every tire, and that they are screwed on finger-tight.

See either the Michelin *Recreational Vehicle Tire Guide* or Goodyear *Service Manual* for correct tire inflation pressures for the vehicle load.

Overinflation gives the treaded surface of the tire a convex shape. See [Fig. 10.6](#). This causes premature tire wear in the middle part of the tire since this section is primarily in contact with the road.

Underinflation gives the tread surface a concave shape. See [Fig. 10.6](#). This causes excessive tire wear on the outer edges of the tire since those edges are primarily in contact with the road.



Do not operate the vehicle with underinflated or overinflated tires. Incorrect inflation can stress the tires and make the tires and rims more susceptible to damage, possibly leading to rim or

Pre- and Post-Trip Inspections and Maintenance

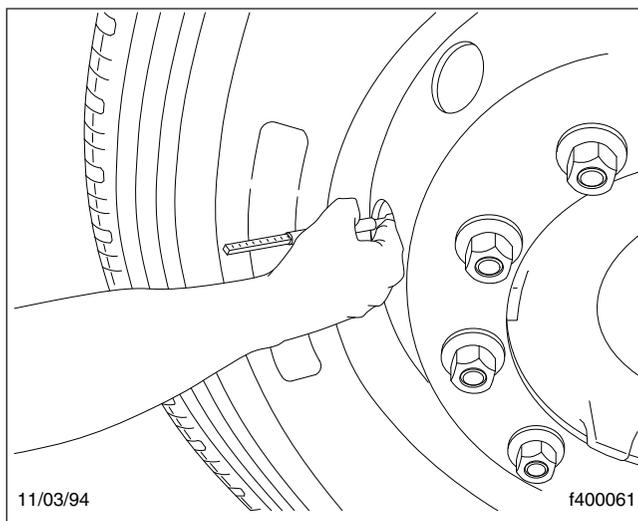


Fig. 10.5, Checking Tire Pressures

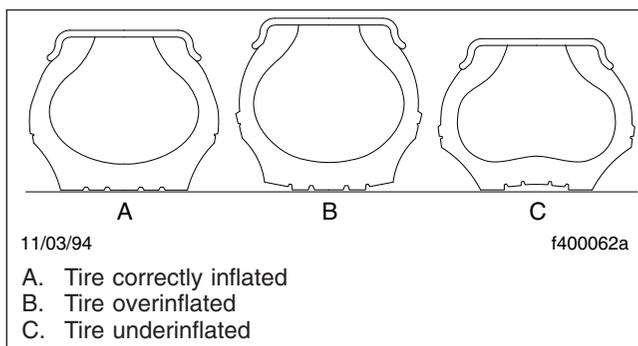


Fig. 10.6, Checking Tire Inflation

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

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

IMPORTANT: Moisture inside a tire can result in body ply separation or a sidewall rupture. During tire inflation, compressed air reservoirs and lines must be kept dry. Service inline moisture traps regularly.

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 full 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.

- 20.3 Inspect the tires for bulges, cracks, cuts, or penetrations. A tire pressure check will assist in uncovering hidden damage; a weekly pressure loss of 4 psi (28 kPa) or more in a tire may indicate damage, and the tire should be inspected and repaired or replaced.

NOTE: Do not use after-market products such as Fix-A-Flat. Such products are messy, and dealer's do not like cleaning them up.

- 20.4 If the tires are wearing irregularly, see the tire manufacturer's recommendations. Have the front axle alignment checked to determine the cause of irregular tire wear.

Government regulations require the removal of front axle tires at 4/32-inch (3-mm) remaining tread depth and rear axle tires at 2/32-inch (1.5-mm) remaining tread depth.

- 20.5 Inspect the tires for oil contamination. Fuel, oil, gasoline, and other petroleum derivatives, if allowed to contact the tires, will soften the rubber and destroy the tire.

IMPORTANT: Do not use tire dressings. These will cause premature wear and deterioration of the tire material. Use only soap and water to clean tires.

WARNING

On vehicles equipped with ZF independent front suspension (IFS) and ZF SB 7000 front air disc brakes, the only approved front wheels and valve stems are those that come on the chassis as delivered from the FCCC manufacturing plant. These wheels have a special bolt pattern. Valve stems other than those delivered with the chassis may interfere with the brake calipers. The use

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of unapproved front wheels and/or front wheel valve stems could cause component damage and result in personal injury or death, or property damage.

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

Check the wheel nuts for indications of looseness. Remove all dirt and foreign material from the assembly. Dirt or rust streaks from the stud holes, metal buildup around stud holes, or out-of-round or worn stud holes may be caused by loose wheel nuts. Tighten the wheel nuts to the correct torque specifications in the proper tightening sequences. See **Group 40** of the *Recreational Vehicle Chassis Maintenance Manual* for instructions.

Examine the wheel assembly 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 occur, possibly resulting in serious personal injury or death.

22. Check the oil level in the automatic transmission. See **Fig. 10.7** and **Fig. 10.8**.

NOTE: The automatic transmission fluid must be warm to ensure an accurate check. The fluid level rises as temperature increases. Check the oil level with the vehicle on a level surface.

- 22.1 Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.
- 22.2 Park the vehicle. Set the parking brake, and place the transmission in the Neutral (N) position. Let the engine run at idle.
- 22.3 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. 10.9**.

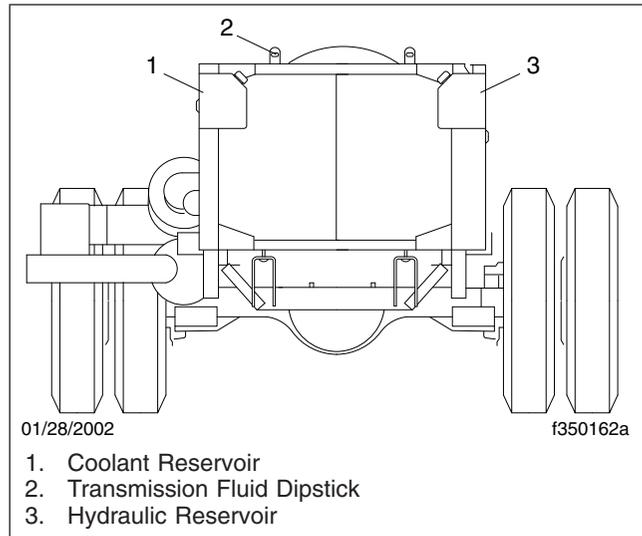


Fig. 10.7, Transmission Fluid Level Check

22.4 If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT run band. See **Table 10.1** for fluid types and capacities.

Transmission Lubricant Capacities	
Series	Refill Capacity*†
1000, 2000	16.0 (15.1)
3000, 4000 MH	17.5 (16.5)

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

† Some Allison 3000 MH transmissions have a deeper oil sump than other models. These models require 3 additional quarts (2.8 L) of automatic transmission fluid (ATF).

Table 10.1, Transmission Lubricant Capacities

IMPORTANT: For all transmissions, use TranSynd synthetic automatic transmission fluid (ATF).

NOTE: A cold check may be made when the sump temperature is 60 to 104°F (15 to 40°C). Follow the substeps below.

- 22.5 Run the engine for at least one minute to clear the fluid system of air.
- 22.6 With the engine running, wipe the dipstick clean and check the fluid level. Any level within the COLD run (lower) band is satisfactory for operating the vehicle. If the

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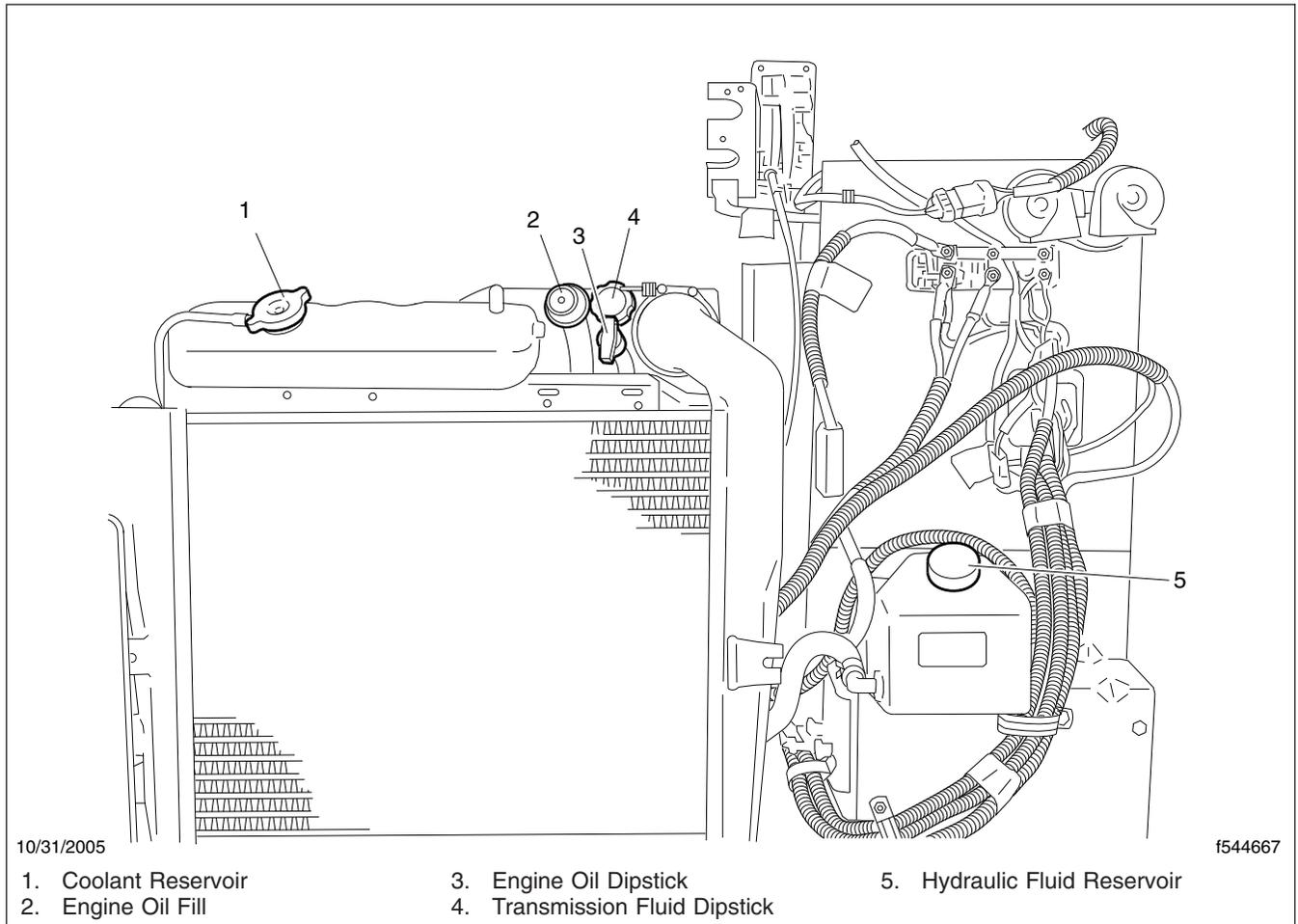


Fig. 10.8, Transmission Fluid Level Check (front-engine diesel chassis)

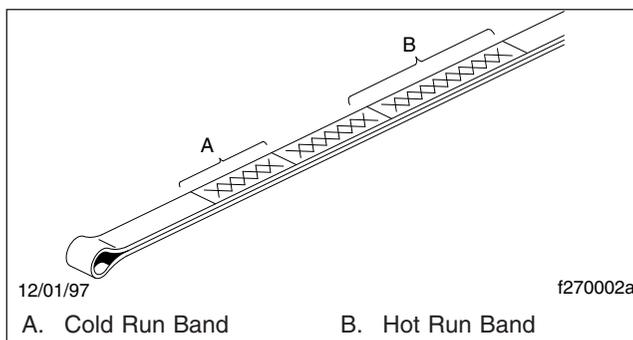


Fig. 10.9, Automatic Transmission Dipstick Markings

level is not within the COLD run band, add or drain fluid until it reaches the middle of the COLD run band.

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

23. *Inspect the air brake components including the brake chamber pushrod, air reservoirs, and air lines.*

Inspect the front air brake lines for leaks at the fitting where they enter the air chamber.

With an assistant at the front wheels to inspect the brake lines, turn the wheels to full lock in one direction. While holding the service brake pedal down, inspect the front brake air lines closely where they enter the air chambers.

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Turn the wheels to full lock in the other direction, hold the service brake pedal down, and repeat the inspection.

If there is a leak, the hose should be replaced. Take your vehicle to an authorized Freightliner dealer for assistance.

Look for worn clevis pins on brake chamber pushrods and missing or damaged cotter pins on the brake chamber pushrods clevis pins. Replace worn clevis pins and install new cotter pins if necessary.

Visually inspect the piston rod engagement with the clevis. At least 7 threads of engagement are required; there should be 1 inch (25 mm) of clearance from the centerline of the clevis pin hole to the end of the piston rod. See [Fig. 10.10](#). Take your vehicle to an authorized Freightliner dealer for assistance.

See if the chamber piston rod is in line with the slack adjuster. Misalignment can cause the piston rod to rub on the non-pressure chamber and cause a dragging brake. Take your vehicle to an authorized Freightliner dealer for assistance.

Visually inspect the exterior surfaces of the chamber for damage. Make sure that breather holes in the non-pressure section(s) are open and free of debris. Take your vehicle to an authorized Freightliner dealer for assistance.

Inspect the air lines as follows.

- 23.1 Check the clearance between the hoses, exhaust manifold, and turbocharger, or other hot spots. Excessive heat will cause the material in the hoses to deteriorate rapidly or become brittle. Provide at least 6 inches (150 mm) of clearance. More clearance is recommended if the hose is located above the heat source.
- 23.2 Check for kinks, dents, or swelling of the hoses. If a hose is damaged, replace it with the same size and type.
Do not route the hose on top of anything likely to be stepped on or walked on.
- 23.3 Check for damage to hoses located near moving parts, such as drivelines, suspensions, and axles. If the moving parts are catching or pinching the lines, correct as needed.

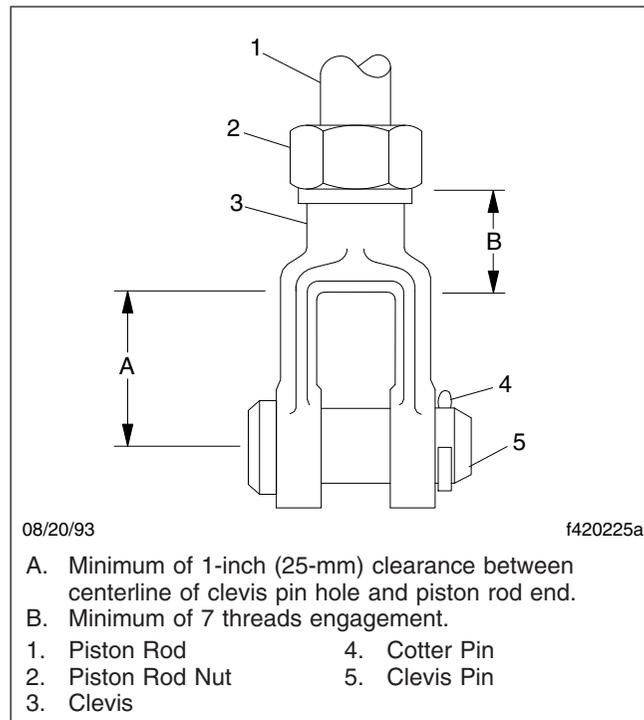


Fig. 10.10, Piston Rod Engagement With the Clevis

- 23.4 Check for hose damage caused by abrasion. If a hose is abraded, replace it. Check for the cause of abrasion, such as loose or damaged hose clamps. Repair or replace the clamps as needed.
- 23.5 Observe the hose cover condition, especially hoses exposed to water splash and ice. If any hose is dried out or ragged (the wire or liner is showing through the cover), replace the hose.
- 23.6 Inspect air tubing, especially tubing made of nylon. In cold weather, nylon tubing is sensitive to damage, such as nicks or cuts. Replace nicked or cut tubing, even if it is not leaking.
- 23.7 Check the bend radii of all hoses. See [Fig. 10.11](#). The minimum bend radius of a hose is that bend which the hose will withstand without experiencing damaging stresses or kinking. For minimum bend radius values, take your vehicle to an authorized Freightliner dealer for assistance.

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When a rubber hose bend does not meet minimum radius requirements, the outside may appear smooth even if the inner tube is kinked. Reroute the hose or replace it with one of adequate length if the bend radius is not within minimum specifications.

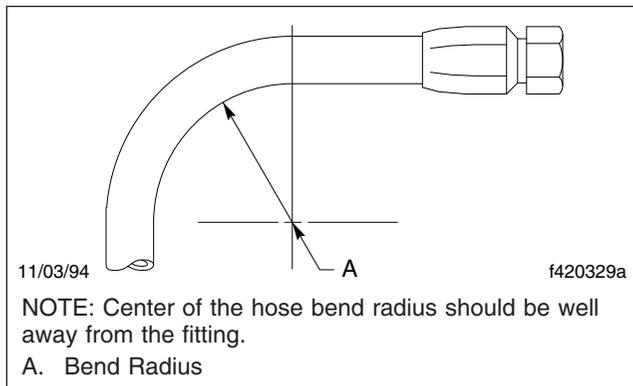


Fig. 10.11, Bend Radius

23.8 Check straight hose installations (those hoses that do not bend along their routing). Pressure changes can cause a hose to lengthen up to 2 percent, or shorten up to 4 percent. A 100-inch (2540-mm) length of hose, for example, can contract to 96 inches (2440 mm). If the hose has no slack when it is exhausted of air, replace it with one of adequate length to avoid a possible blow-off from the fitting during vehicle operation.

23.9 Check for kinked or twisted hoses. A 7 percent twist in the hose can reduce its life by up to 90 percent. Also, a twisted hose under pressure tends to untwist. This could cause it to loosen the fitting. Reconnect hoses that are twisted.

24. *Inspect the air brake lines.*

24.1 Check the clearance between the hoses and the exhaust manifold or other hot spots. Excessive heat will cause material in hoses to deteriorate rapidly or become brittle. Provide at least 6 inches (150 mm) of clearance. More clearance is recommended if the hose is located above the heat source.

24.2 Check for kinks, dents, or swelling of the hoses. If damaged, have the hose replaced with the same size and type.

NOTE: Do not route the hose on top of anything likely to be stepped on.

24.3 Check for damage to hoses located near moving parts, such as drivelines, kingpins, suspensions, and axles. If moving parts are catching or pinching the lines, correct as needed.

24.4 Check for hose damage caused by abrasion. If abraded, have the hose replaced. Check for the cause of abrasion, such as loose or damaged hose clamps. Have the clamps repaired or replaced as needed.

24.5 Observe the hose cover condition, especially hoses exposed to water splash and ice. If dried out or ragged (the wire is showing through the cover), have the hose(s) replaced.

24.6 Inspect the air tubing, especially tubing made of nylon. In cold weather, nylon tubing is sensitive to damage, such as nicks or cuts. Have nicked or cut tubing replaced, even if it is not leaking.

NOTE: The front brake lines flex continuously in vehicle operation, so they require special examination. Give particular attention to the areas near where they connect to the front air brake chambers.

24.7 This inspection requires two people, one in the driver's seat, and another to inspect the brake line connections at the wheels.

Both wheel air lines must be inspected with the emergency brake set, engine idling, air pressure at 80 to 90 psi (550 to 620 kPa), and the brake pedal held down.

24.8 Turn the wheels to full lock in one direction and inspect both air lines where they connect to the air chambers, then turn the wheels to full lock in the other direction and inspect both lines. If a hose is leaking, have it replaced.

IMPORTANT: ABS-equipped vehicles operating in regions where especially corrosive ice removal chemicals are used may experience

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higher than normal rotor corrosion. Tone rings should be routinely inspected for corrosion. Severe corrosion of the integral ABS tone ring may cause the ABS warning lamp in the dash to illuminate due to false wheel speed readings. If the ABS warning lamp illuminates at any time other than at vehicle start-up, have the problem repaired immediately.

25. Inspect the slack adjusters.

Inspect the slack adjuster for any signs of damage. If damaged, have the slack adjuster replaced.

Inspect the slack adjuster boot for cuts or tears. If the boot is damaged, have it replaced. Take your vehicle to an authorized Freightliner dealer for assistance. See [Fig. 10.12](#).

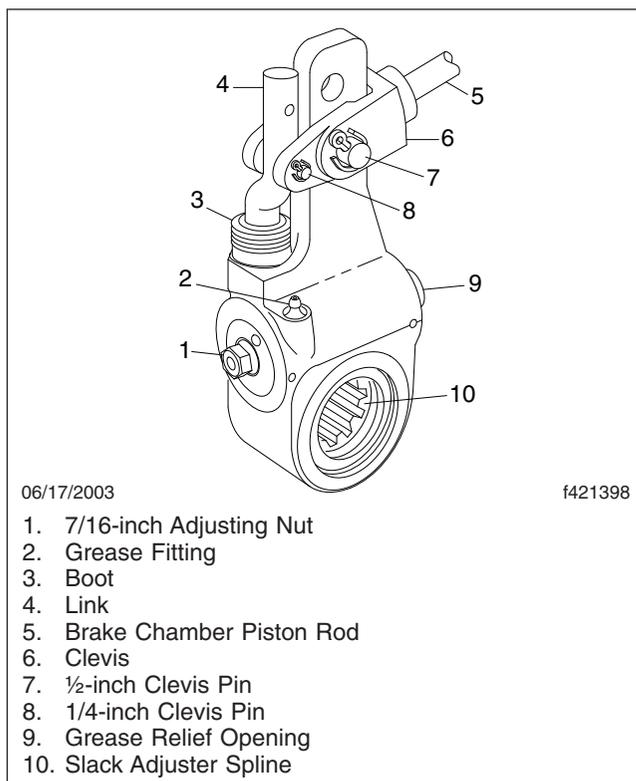


Fig. 10.12, Gunitite Automatic Slack Adjuster

IMPORTANT: Brake checking and adjusting is necessary for all vehicles, including those equipped with automatic slack adjusters.

26. Check the air brake system for proper operation.

26.1 Check the air governor cut-in and cut-out pressures as follows:

Run the engine at fast idle. The air governor should cut out the air compressor at approximately 120 psi (827 kPa). With the engine idling, apply the brake pedal several times. The air governor should cut in the air compressor at approximately 100 psi (689 kPa). If the air governor does not cut in and cut out as described above, it must be adjusted to these specifications. If the air governor cannot be adjusted or repaired, replace it before operating the vehicle.

26.2 Check the air pressure buildup time as follows:

With the air system fully charged to 120 psi (827 kPa), make one full brake application and note the air pressure reading on the gauge. Continue to reduce the air pressure by moderate brake applications to a maximum of 90 psi (620 kPa), then run the engine at governed rpm. If the time required to raise the air pressure to 120 psi (827 kPa) (from the pressure noted after one brake application) is more than 30 seconds, eliminate any leaks or replace the air compressor before operating the vehicle.

26.3 Check the air pressure reserve as follows:

With the air system fully charged to 120 psi (827 kPa), stop the engine and note the air pressure. Then make one full brake application and observe the pressure drop. If it drops more than 25 psi (172 kPa), all areas of leakage must be eliminated before operating the vehicle.

26.4 Check the air leakage in the system as follows:

With the parking brake (spring brake) applied, the transmission out of gear, and the tires chocked, charge the air system until cut-out pressure of 120 psi (827 kPa) is reached.

Pre- and Post-Trip Inspections and Maintenance

With the service brakes released, shut down the engine, wait one minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

Charge the air system until cut-out pressure of 120 psi (827 kPa) is reached. With the parking brakes released and the service brake applied, shut down the engine, wait one minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

If leakage exceeds the limits shown in [Table 10.2](#), repair all areas of leakage before driving the vehicle.

Maximum Air Leakage Per Minute	
Brakes Released	Brakes Applied
2 psi (14 kPa)	3 psi (21 kPa)

Table 10.2, Maximum Allowable Service Brake Leakage

27. Check the operation of the Bendix Hydro-Max® brake booster, as follows.
 - 27.1 With the ignition off, depress the brake pedal and listen for the back-up motor to engage. The operator should also feel the pedal force relieve and the pedal should depress easily.
 - 27.2 With the engine running, and the parking brake released; operator is to ensure that the BRAKE warning indicator light is **not** on. This is a dual indicator, and indicates that the parking brake is set, and warns if there is a Hydro-Max failure condition other than loss of back-up motor power.

28. Test the service brakes.

When starting to move the vehicle and before picking up speed, test the brakes with the foot pedal and parking brake control valve (yellow knob) to be sure they will bring the vehicle to a safe stop.

Weekly Post-Trip Inspection and Maintenance Procedures

1. *Inspect the batteries and battery cables.*

Access the batteries. Be sure the battery hold-down is secure. If it is loose, tighten the hold-down bolts; if it is broken, replace it.

Remove any corrosion from the hold-down and the top of the battery. Use diluted ammonia or a soda solution to neutralize the acid present, then rinse off the ammonia or soda solution with clean water.

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 dielectric grease to the posts and terminals to help retard corrosion.

2. Check the level of the wheel bearing lubricant in the hub cap at each end of the front axle. See [Fig. 10.13](#).

If needed, fill the hubs to the level indicated on the hub cap. See [Chapter 15](#) for recommended lubricants.

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

3. *Examine the steering components.*

See [Fig. 10.14](#). If repairs are needed, take your vehicle to an authorized Freightliner dealer for assistance.

- 3.1 Check the mounting bolts and pitman arm nut, for tightness.
- 3.2 Check the drag link nuts for missing cotter pins.
- 3.3 Inspect the steering drive shaft and steering linkage for excessive looseness, or other damage.
- 3.4 Tighten loose nuts and have damaged parts replaced as needed.

4. *Check the condition of the drive belt.*

Look for signs of wear (frayed edges) and damage (breaks or cracks). If a belt is worn or damaged, have the belt replaced. Take your vehicle to an authorized Freightliner dealer for assistance.

Pre- and Post-Trip Inspections and Maintenance

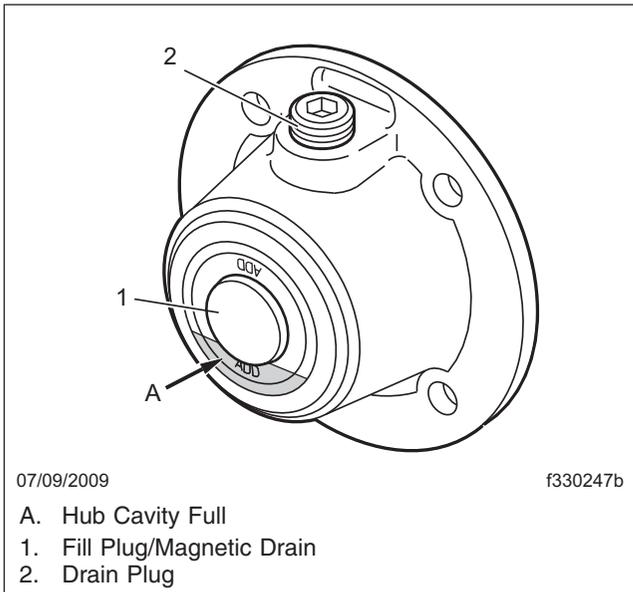


Fig. 10.13, Oil-Filled Hub Cap

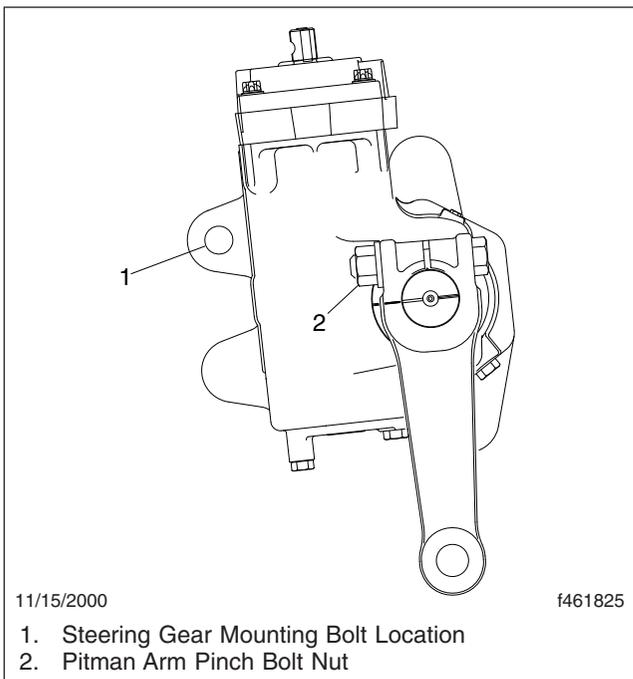


Fig. 10.14, TRW Steering Gear Installation

Monthly Post-Trip Inspection and Maintenance Procedures

1. Clean the batteries.

- 1.1 Remove any corrosion from the hold-down and the top of the battery. Use a soda solution to neutralize the acid present, then rinse off the soda solution with clean water.

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 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.

WARNING

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. To prevent possible personal injury, always wash your hands after handling battery parts and related accessories.

2. Inspect the radiator and heater hoses, including the clamps and support brackets.
 - 2.1 Make sure the radiator inlet and outlet hoses are pliable and are not cracking or ballooning. Replace hoses that show signs of cracking, weakening, or ballooning.
 - 2.2 Make sure the heater hoses are pliable and are not cracking or ballooning. Replace hoses that show signs of cracking, weakening, or ballooning.
 - 2.3 Tighten the hose clamps as necessary, but do not overtighten, as hose life can be adversely affected.
 - 2.4 Be sure the hose support brackets are securely fastened. Make sure the hoses are not located near sources of wear, abrasion, or high heat.

IMPORTANT: Replace all hoses, including heater hoses, at the same time. Service-type knitted or braided yarn-reinforced neoprene

Pre- and Post-Trip Inspections and Maintenance

hose is acceptable. Silicone hoses having an extended service life can be substituted for the reinforced neoprene type. Contact your local Freightliner dealer for assistance.

3. Check the steering wheel for excessive play. See [Fig. 10.15](#).

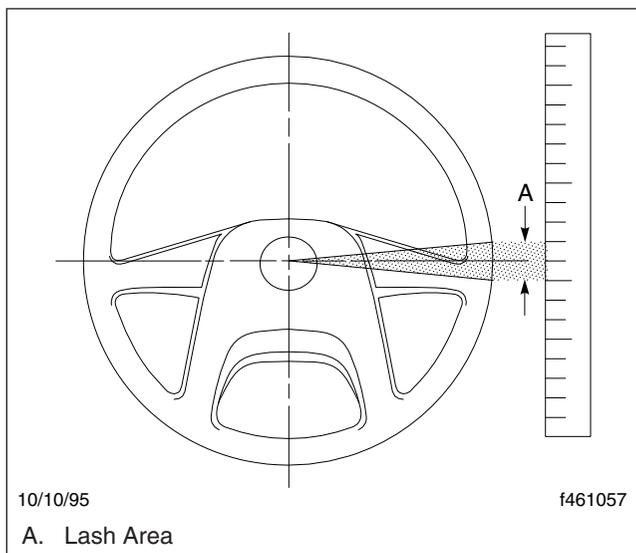


Fig. 10.15, Measuring Lash at the Steering Wheel

- 3.1 With the front tires straight ahead, turn the steering wheel until motion is observed at the front wheels. Hold the steering wheel in this position.
 - 3.2 Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels.
 - 3.3 Determine the lash (free play) at the rim of the steering wheel. Excessive lash exists if steering wheel movement exceeds 2-1/4 inches (57 mm) with an 18 inch (450 mm) steering wheel.

See local/federal regulations for acceptable ranges of lash.
4. Check the brake lining wear on all vehicles, including those with automatic slack adjusters. Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.
 - 4.1 Check that brake linings are free of oil and grease.

- 4.2 Inspect the thickness of the brake linings. If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs. If *any brake linings are worn to less than approximately 1/4 inch (6.4 mm) at the thinnest point, have the linings replaced on all brake assemblies on that axle. Take your vehicle to an authorized Freightliner dealer for assistance.*

- 4.3 Check the brake drums for wear and cracks.

- 4.4 Check that the inspection plugs in the dust shields or backing plates, if so equipped, are installed.

5. Inspect brake shoe components and perform Meritor Roller Pin lubricating, **if needed**, as follows. See [Fig. 10.16](#).

- 5.1 Check the anchor pins, rollers and bushing for lubricant and excessive debris.

- 5.2 If the parts are damaged in any way, replace them.

- 5.3 While the brake is disassembled during inspection, apply anchor pin grease with Bentone thickeners, NLGI grade 1, Meritor specification 0-616-A, 0-617-B or equivalent. See [Fig. 10.16](#) for brake lubrication areas.

Pre- and Post-Trip Inspections and Maintenance

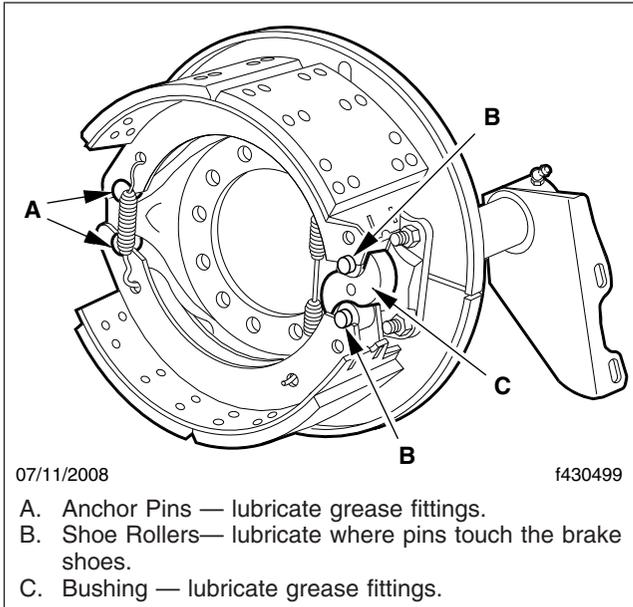


Fig. 10.16, Meritor Roller Pin Lubrication Areas

11

Cleaning and Care

Washing and Polishing	11.1
Wheel Cleaning	11.1
Care of Chrome Parts	11.1
Dashboard and Instrument Panel Care	11.1

Cleaning and Care

Washing and Polishing

To protect the finish of your new vehicle, follow these guidelines carefully:

- During the first 30 days, rinse your vehicle frequently with water. If the vehicle is dirty, use a mild liquid soap. Do not use detergent.
- During the first 30 days, do not use anything abrasive on your vehicle. Brushes, chemicals, and cleaners may scratch the finish.
- During the first 120 days, do not wax your vehicle.

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

- Avoid washing your vehicle in the hot sun. Always use water. After the vehicle is completely washed, dry it with a towel or chamois.
- Do not dust painted surfaces with a dry cloth, as this will scratch the paint.
- Do not remove ice or snow from a painted surface with a scraper of any sort.
- To prevent damage to the finish, wax it regularly. If the finish has become dull, before waxing, remove oxidized paint using a cleaner specifically designed for this purpose. Remove all road tar and tree sap before waxing. Freightliner recommends that a quality brand of cleaner or cleaner-polish and polishing wax be used.
- Do not let diesel fuel or antifreeze stand on a painted surface. If either should occur, rinse the surface off with water.
- To prevent corrosion, have any nicks or other damage on the finish touched up as soon as possible.
- Park your vehicle in a sheltered area whenever possible.

Wheel Cleaning

Accuride® Machined and Polished Aluminum Wheels

Regular cleaning of Accuride machined or polished aluminum wheels is recommended to keep the wheel finish bright and shiny. The use of an aluminum

wheel polish or carnauba wax will protect the polished wheel surfaces, will help prevent corrosion and pitting on the aluminum wheel surfaces caused from natural environmental contamination, and will make future cleaning and polishing easier.

1. Rinse the wheel with high-pressure water to remove any debris, grit, or dirt particles.
2. Use a 100% cotton cloth dipped in a mild soap solution to help remove built up dirt and grease.
3. Rinse the remaining soap residue from the wheel.
4. Dry the wheel thoroughly with a 100% cotton cloth.
5. Use metal cleaner/polish that is compatible with aluminum to remove spots and stains from the surfaces of the wheel as necessary.
6. Apply carnauba wax to the visible wheel surfaces. Carnauba wax should be reapplied on a regular basis to maintain the wheel luster.

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.

12

In an Emergency

Freightliner Help	12.1
Hazard Warning Lights	12.1
Towing	12.1
Emergency Starting With Jumper Cables	12.1
Changing a Flat Tire	12.3
Running Out of Fuel	12.3

In an Emergency

Freightliner Help

In the event of a vehicle emergency, 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, or breakdown coordination.

Hazard Warning Lights

Pull out the hazard warning light switch on the steering column to activate the hazard warning lights. When the hazard warning light switch is pulled out, all of the turn signal lights and both of the turn signal indicator lights on the instrument panel will flash. To cancel the warning lights, push the switch in.

Towing

See [Chapter 13](#) for towing information.

Emergency Starting With Jumper Cables

When using jumper cables, follow the instructions below.

 **WARNING**

Batteries release explosive gas. Do not smoke when working around batteries. Put out all flames and remove all sources of sparks or intense heat in the vicinity of the battery. Do not allow the vehicles to touch each other. Do not lean over the batteries when making connections, and keep all other persons away from the batteries. Failure to follow these precautions could lead to severe personal injury as a result of an explosion or acid burns.

NOTICE

Make sure 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 (location will vary) to access the batteries. Slide the battery tray out.

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. 12.1](#).
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.

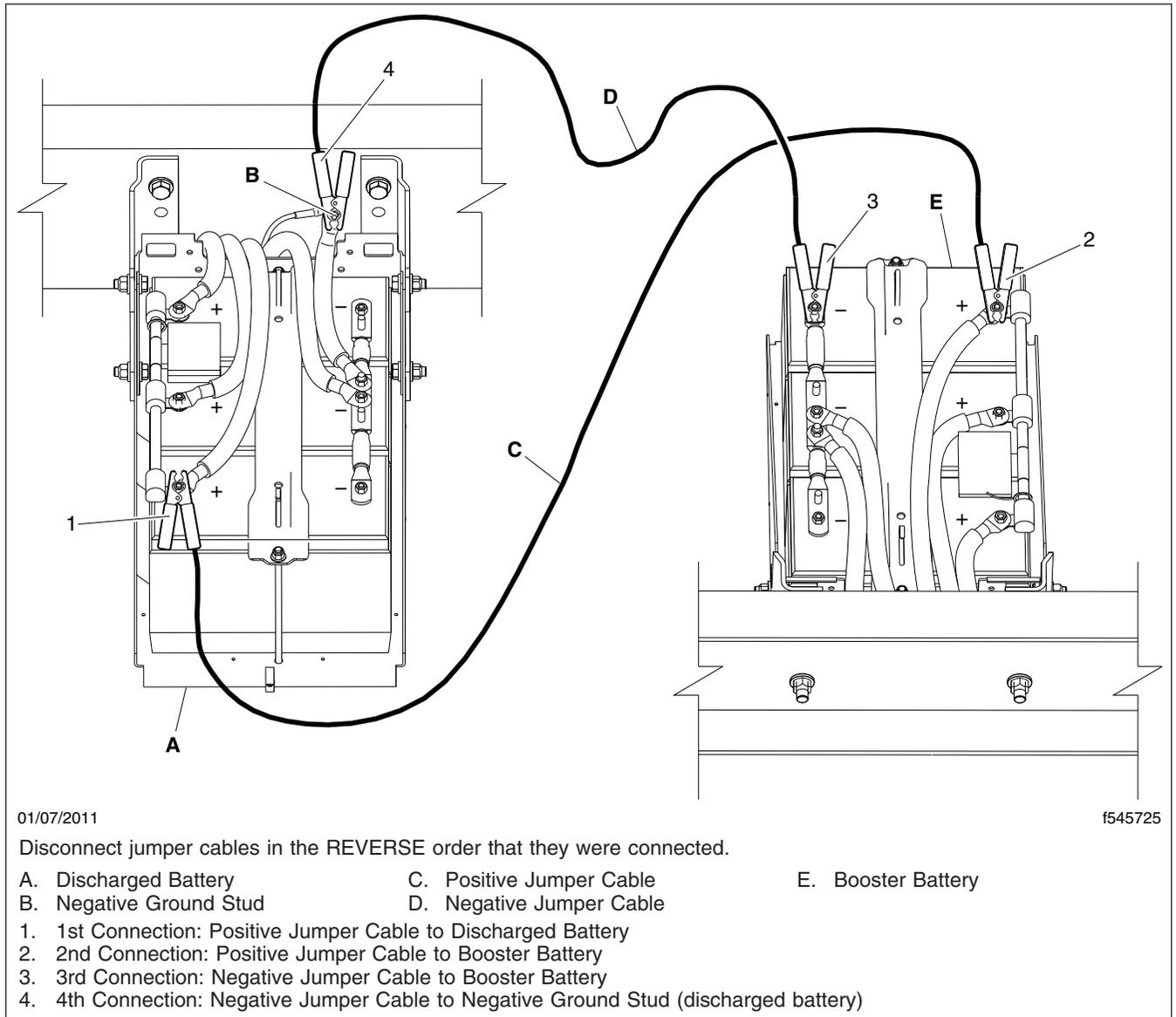


Fig. 12.1, Jumper Connections (three battery system shown for clarity)

⚠ 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

- Slide the battery tray back into position and close the battery door.

Changing a Flat Tire



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 the vehicle to a safe location as quickly as possible.

- If possible, stop the vehicle on a level surface, away from traffic.
- Set the parking brake and turn the ignition switch to the OFF position.
- Turn on the hazard warning lights.
- Remove the spare wheel, jack, jack handle, and lug wrench from storage, if so equipped.
- Use a block to chock the wheel diagonally opposite the wheel being changed.

NOTE: The jacking point for the front and rear wheels is directly under the axle. See [Fig. 12.2](#) and [Fig. 12.3](#) for correct jack placement.

- Place the jack on a solid surface. Insert the jack handle and pump the handle to slightly raise the vehicle. *Do not raise the wheel off of the ground.* Loosen the wheel lug nuts, but do not remove them.
- Raise the vehicle until the wheel is off of the ground. Remove the lug nuts and the wheel.
- Install the spare wheel and the lug nuts. Make sure that the beveled sides of the nuts face inward.
- In a star pattern, tighten the nuts evenly until snug.
- Lower the vehicle until the wheel touches the ground. Tighten the wheel nuts to the correct torque specifications in the proper tightening sequences. See **Group 40** of the *Recreational Ve-*

hicle Chassis Maintenance Manual for instructions.

- Finish lowering the vehicle to the ground, then remove the jack.
- Remove the wheel chock (the block), then stow the jack, jack handle, and lug wrench.
- After operating the vehicle for 50 to 100 miles (80 to 161 km), retighten the nuts. Tighten the wheel nuts to the correct torque specifications in the proper tightening sequences. See **Group 40** of the *Recreational Vehicle Chassis Maintenance Manual* for instructions.

Running Out of Fuel



Diesel fuel is flammable. When you approach a vehicle and the smell of diesel fuel is present, immediately shut off all engines and ignition sources. Avoid causing sparks and stay away from arcing switches and equipment. Extinguish cigarettes, pilot lights, flames, or other sources of ignition in the area and adjacent areas. Immediately provide extra ventilation to the area. Do not start the vehicle or any other type of equipment until the fuel leak is corrected and the area cleared of fuel. Failure to perform these actions could lead to the ignition of the fuel, which could cause personal injury or death, or severe property damage.

If the vehicle runs out of fuel, try to stop the vehicle on a level location away from traffic. Add at least 2 gallons (8 liters) of fuel to the fuel tank in order to restart the engine. If the vehicle is not level, up to 6 gallons (22 liters) of fuel may be required. Prolonged engine cranking may be required to pump fuel from the fuel tank to the engine before the engine will start.

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.

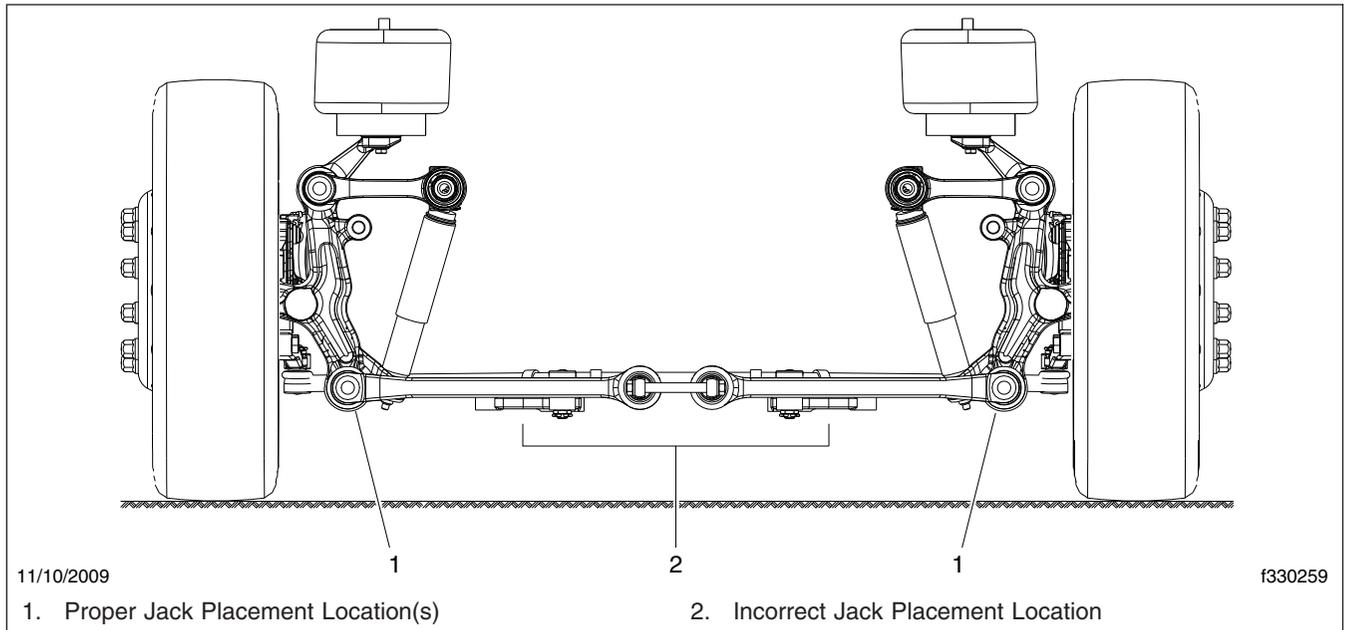


Fig. 12.2, Jack Placement for ZF IFS

If the vehicle will not start by cranking the engine, the fuel system may need to be primed. See the applicable engine manufacturer's operation and maintenance manual.

In an Emergency

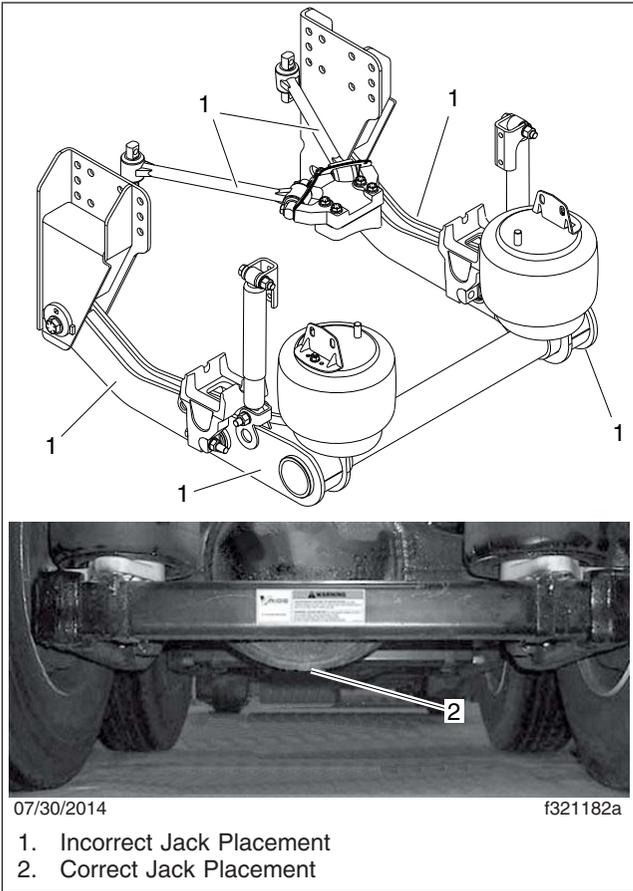


Fig. 12.3, Jack Placement for V-Ride

13

Towing

Towing the Vehicle	13.1
Towing With the Vehicle	13.2

Towing

Towing the Vehicle

IMPORTANT: When it is necessary to tow the vehicle, follow the instructions below closely to prevent damage to the vehicle.

On vehicles equipped with an independent front suspension, do not tow the vehicle by the suspension assembly. Components of the suspension can be damaged.

When towing or pushing any vehicle equipped with an Allison transmission, disconnect the driveshaft at the rear axle and support it as necessary, regardless of the distance or speed traveled.

Removing the Transmission from the Park (P) Position

If a vehicle with a shift-by-wire (SBW) system needs to be towed and the system cannot be activated to take the transmission out of Park (P), follow the steps in the procedure below.

1. Set the parking brake on the tow vehicle.
2. Chock the tires of the tow vehicle.
3. Set the parking brake on the disabled vehicle.
4. Chock the tires of the disabled vehicle.
5. Underneath the disabled vehicle, at the transmission, remove the access hole plug at the rear of the SBW actuator. See [Fig. 13.1](#).
6. Insert a 3/16-inch allen wrench or hex key through the access hole into the rear of the actuator. Turn the allen wrench in a clockwise direction until the transmission comes out of the Park (P) position.
7. Replace the access hole plug.
8. Remove the chocks from the tires of both vehicles.

NOTE: The transmission may also be placed in the Park (P) position using this procedure.

Front Towing Hookup

1. Disconnect the battery ground cable.
2. If the vehicle is to be lifted and towed, remove the driveshaft.

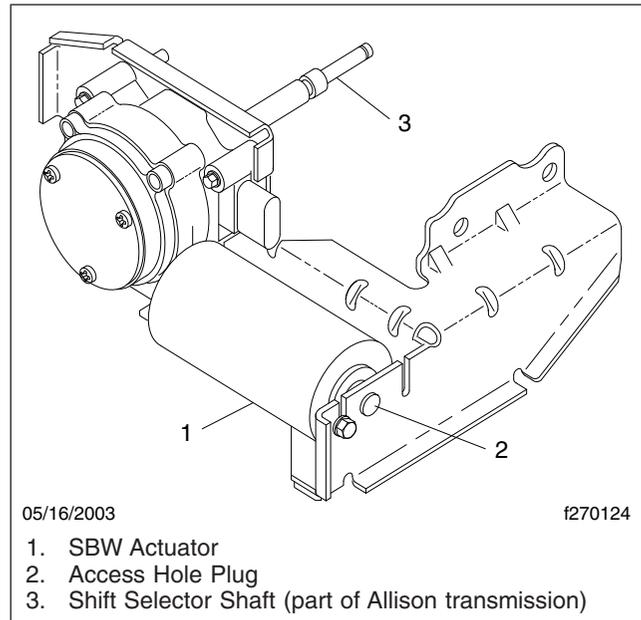


Fig. 13.1, SBW Actuator (at transmission)

NOTICE

Failure to remove the driveshaft when towing the vehicle with the rear wheels on the ground could result in damage to the transmission and other parts.

WARNING

Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the tow vehicle operator. The operator must be familiar with standard towing industry safety measures. Improper procedures could result in personal injury or death.

3. Attach the towing device.
4. Lift the vehicle and secure the safety towing chains. If additional clearance is needed, remove the front wheels.
5. Connect the clearance lights, taillights, and signal lights. Connect any special towing lights required by local regulations.

WARNING

Before releasing the parking brakes, make the connection to the towing vehicle or chock the tires on the disabled vehicle. Failure to do so could result in hazardous conditions because the vehicle could suddenly roll and injury could occur.

6. Release the parking brake.

NOTICE

Before attempting to tow a vehicle with air suspension (and during the towing operation), ensure that the air suspension is properly aired. Air the suspension through the Schrader valve on the air dryer. Attempting to tow a vehicle with an improperly aired suspension may result in damage to the chassis and body.

Rear Towing Hookup

1. Position the front tires so that they point straight ahead and secure the steering wheel in this position.
2. Disconnect the battery ground cable.

WARNING

Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the tow vehicle operator. The operator must be familiar with standard towing industry safety measures. Improper procedures could result in personal injury or death.

3. Attach the towing device.
4. Lift the vehicle and secure the safety towing chains. If additional clearance is needed, remove the bumper extension, if so equipped.
5. Connect the clearance lights, taillights, and signal lights. Also connect any special towing lights required by local regulations.

NOTICE

Before attempting to tow a vehicle with air suspension (and during the towing operation), ensure that the air suspension is properly aired. Air

the suspension through the Schrader valve on the air dryer. Attempting to tow a vehicle with an improperly aired suspension may result in damage to the chassis and body.

Towing With the Vehicle

WARNING

Freightliner neither recommends nor approves connecting a trailer or other towed vehicle's braking system directly to the vehicle braking system. Freightliner also neither recommends nor approves tapping into the vehicle air brake system, nor operating a towed vehicle or trailer's braking system by means of the vehicle braking system. Failure to observe this warning could result in severe injury or death, or substantial property damage.

The towing vehicle's brake system is rated for operation at the GVWR and does not include the towed weight. Separate functional brake systems and chocks must be used for safe control and parking of towed vehicles and trailers weighing more than 1500 lbs (681 kg).

Do not tow unbraked vehicles if the combined weight of both vehicles is more than the sum of the gross axle weight ratings (GAWR) of the towing vehicle. Otherwise brake capacity will be inadequate, which could result in personal injury or death.

General Information

IMPORTANT: An auxiliary braking system is strongly recommended when towing. Follow your state's motor vehicle regulations and the body builder's recommendations to determine if an auxiliary system is required for towing.

1. Never load the vehicle over the Gross Vehicle Weight Rating (GVWR). Considerable damage to the drivetrain may result if the vehicle is over its GVWR. Check the GVWR safety compliance certification label (provided by the final manufacturer) to find the GVWR.
2. Use the Gross Combined Weight Rating (GCWR) and Gross Vehicle Weight (GVW) to determine

Towing

the towing capacity. Refer to the final manufacturer for GCWR. If the GCWR is exceeded, serious damage to the drivetrain and brake system may result. Loading past the GCWR may lead to unsafe operating and braking conditions.

3. Subtract the GVW (which is the actual weight of the vehicle alone) from the GCWR (which is the total weight this vehicle can safely pull) to determine the acceptable weight this vehicle can tow.
4. Make sure that the towing equipment is properly and safely attached to your vehicle.
5. When descending a steep grade, shift the transmission into the next lower gear or use the exhaust brake to provide additional engine braking.

NOTE: In a high-altitude operating environment, your engine will lose power at the rate of 1 percent per 1000 feet (305 meters) of elevation. For these high-altitude operating conditions, a reduction in gross vehicle weights and gross combination weights is recommended and will result in improved vehicle performance.

6. To avoid vehicle damage and handling difficulty, evenly distribute the trailer load. Always tie the load down securely.

7-Pin Connector

The following information lists the amperage (amp) load limits for each of the connections in the 7-pin connector. See **Fig. 13.2** for an example of the 7-pin connector.

- Electric Brakes (to brake the system) — A 12 gauge wire interfaces with the 7-pin connector trailer tow plug. See the brake manual for exact specifications.
- RH Stop/Turn — 20 amp
- Back Up Lamps — 10 amp
- LH Stop/Turn — 20 amp
- Running Lamps — 20 amp
- Ignition [+] (to charge the tow vehicle batteries) — 40 amp
- Ground [-] — for all

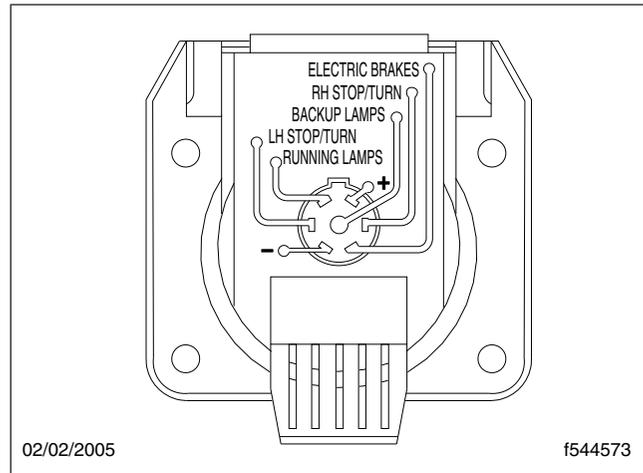


Fig. 13.2, 7-Pin Connector

Hitches

Use a hitch and ball recommended by your vehicle manufacturer or your dealer, and make sure that its location is compatible with that of the trailer. Use a good weight-carrying hitch that uniformly distributes the trailer tongue loads through the bumper and the frame. Do not exceed the recommended towing capacity of the vehicle.

NOTICE

Always disconnect the battery and the engine ECM (electronic control module) before welding anything to the chassis frame.

Do not use single-clamp bumper hitches or hitches that attach to the vehicle axle. However, multi-clamp bumper hitches for occasional use of a rental trailer are acceptable if properly attached. Follow the towing instructions of a reputable rental agency. Never attach safety chains to the bumper.

Whenever a trailer hitch is removed, be sure to have all mounting holes in the underbody properly sealed to prevent possible entry of exhaust fumes, dirt, or water.

Hitch Rating

A standard hitch has two ratings depending on the mode of operation; see **Table 13.1**.

- **Weight Carrying**—Requires a draw bar and hitch ball. The draw bar supports all of the vertical tongue load of the trailer.
- **Weight Distributing**—Requires an aftermarket weight distributing system, consisting of a draw bar, hitch ball, spring bars, and snap-up brackets. The vertical tongue load of the trailer is distributed between the truck and the trailer by this system.

IMPORTANT: The towing vehicle's brake system is rated for operation at the GVWR and does not include the towed weight. Separate functional brake systems and wheel chocks must be used for safe driving control and parking of towed vehicles or trailers weighing more than 1500 lbs (681 kg).

The maximum vehicle weight rating and towing capacities are based on the powertrain and chassis equipment options specified on your vehicle. **Table 13.1** defines the maximum vehicle and trailer weight ratings according to the vehicle transmission options. The actual vehicle weight and towing capacities of your vehicle may be less due to the chassis and OEM equipment combinations specified by the final stage manufacturer (body builder). Refer to the manufacturer's certification labels for actual vehicle weight ratings.

Trailers

WARNING

Always use safety chains between the vehicle and the trailer. Failure to do so could cause personal injury or death if the hitch fails.

IMPORTANT: Before connecting a trailer lighting system directly to the lighting system of the vehicle, see your dealer or rental trailer agency for the correct type of wiring and relays for your trailer and for heavy-duty flashers.

WARNING

Do not exceed the GVWR or the GAWR specified on the certification label. **Table 13.1 lists the**

maximum GVWR and GAWR for recreational vehicle chassis. Towing trailers beyond the maximum recommended gross trailer weight exceeds the limit of the vehicle and could result in engine damage, transmission damage, structural damage, or loss of vehicle control. Failure to observe this warning could result in severe injury or death, or substantial property damage.

Parking With A Trailer

Park the vehicle on a flat surface. Chock the tires as follows:

1. Select Neutral (N) on the gear shift selector while depressing the service brake.
2. Continue depressing the service brake and have another person place wheel chocks under the trailer wheels.
3. Once the wheel chocks are in place, release the service brake, making sure that the chocks are holding the vehicle and trailer.
4. Apply the park brake.
5. Depending on the series of transmission, select either Neutral (N) or Park (P) on the gear shift selector.

Trailer Towing Tips

Towing a trailer significantly alters the manner in which the towing vehicle performs.

- Before starting on a trip, practice turning, stopping, and backing in an area away from heavy traffic to gain experience in handling the extra weight and length of the trailer. Take enough time to learn the "feel" of the vehicle/trailer combination before starting out on a trip. Make certain you know what clearance is required for the trailer roof.
- Skillful backing requires practice. Back very slowly, with someone outside at the rear of the trailer to guide your efforts. Place your hand at the bottom of the steering wheel and move it in the direction you want the rear of the trailer to swing. Make small corrections instead of exaggerated ones. A slight movement of the steering wheel will result in a much larger movement of the rear of the trailer.

Towing

Trailer Weight Ratings*					
Chassis Model	Allison Transmission	Maximum GVWR lbs (kg)	Maximum GCWR lbs (kg)	Hitch Type	Maximum Gross Trailer Weight lbs (kg)
XC, MC	1000 MH	22,000 (9988)	26,000 (11 804)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
	2100 MH	26,000 (11 804)	30,000 (13 620)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
	2200 MH	26,000 (11 804)	26,000 (11 804)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
	2350 MH	30,000 (13 620)	30,000 (13 620)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
	2500 MH	33,000 (14 982)	33,000 (14 982)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
	2550 MH	30,000 (13 620)	30,000 (13 620)	Weight Carrying	10,000 (4540)
				Weight Distributing	12,000 (5448)
XC	3000 MH	*	*	Weight Carrying	15,000 (6810)
				Weight Distributing	16,000 (7264)
	4000 MH	*	*	Weight Carrying	15,000 (6810)
				Weight Distributing	16,000 (7264)

* Values shown are the maximum for each model. Actual vehicle weight and tow ratings may be less, depending on the chassis and body manufacturer's equipment options. Refer to the manufacturer's certification labels for the actual vehicle weight ratings.

Table 13.1, Trailer Weight Ratings

- Allow considerably more room for stopping when the trailer is attached. If you have a manual brake controller, "lead" with the trailer brakes (if so equipped) when approaching a stop, if possible. Trailer brakes are also handy for correcting trailer side-sway. Just touch them for a moment without using your vehicle brakes and the trailer should settle down and track steadily again.
- To assist in attaining good handling of the vehicle trailer combination, it is important that the trailer tongue load be maintained at approximately 10 to 15 percent of the loaded trailer weight.
- Check everything before starting out on the road. After you have traveled about 50 miles (80 km), stop in a protected location and double-check your trailer hitch and electrical connections for security. Also, examine the trailer wheel lug nuts for tightness.
- Because trailer wheels will be closer than the towing vehicle wheels to the inside of the turn, drive slightly beyond the normal turning point to avoid obstructions.
- Allow extra distance for passing other vehicles. Downshift to a lower gear for better acceleration, if necessary. Use caution when passing, as the added weight of the trailer can dramatically decrease the acceleration of the towing vehicle.
- Ahead of the vehicle, allow at least the equivalent of one vehicle and trailer length combined for each 10 mph (16 km/h) of speed.
- If your vehicle begins to lose speed as you climb a hill, downshift to a lower gear for more power at the rear wheels.
- Before descending a steep grade, slow down and shift to a lower gear. Driving with the transmission in a lower gear will assist in reducing downhill speed. If the trailer should begin to sway, touch the trailer brakes (if so equipped), not the vehicle brakes, and the trailer should settle down.
- When possible, do not park on a grade with a trailer. However, when this is necessary, apply the service brakes and hold while someone else places chocks under the trailer's wheels.

To start out when parked on a grade, apply the service brake pedal and with the vehicle either in Neutral (N) or Park (P), start the engine. Shift the transmission into gear and release the parking brake. Then release the brake pedal and move the vehicle uphill to free the chocks. Apply the brake pedal while another person retrieves the chocks.

14

Vehicle Storage

Preparation for Storage	14.1
Removal from Storage	14.1

Vehicle Storage

Preparation for Storage

When storing your recreational vehicle for an extended period of time (60 days or more), the following steps should be taken to give it maximum protection. Note the date and mileage on the vehicle when it is placed in storage.

- Fill the fuel tank and add a high-quality fuel stabilizer to the fuel. Never store the vehicle with a partially full tank of fuel.
- Change the engine oil and filter. Used oil does not provide adequate protection.
- The cooling system was originally protected with antifreeze to -34°F (-37°C). If colder temperatures are expected, adjust the mixture. If the coolant has been in the vehicle for five years or 100,000 miles (160 900 km), flush the cooling system and fill it with an appropriate mixture of antifreeze and water, making sure that the coolant contains a rust inhibitor.
- If it has been more than 18 months or 24,000 miles (38 616 km) since the transmission was serviced, change the transmission fluid and filter.
- Service the fuel filters.
- Run the engine until it is fully warmed up.
- Operate the air conditioning.
- If possible, store the vehicle in a dry, well ventilated area, protected from sunlight.
- Check the tires for damage and set the tire pressure to maximum as indicated on the sidewall of the tire. Clean the tires using a mild soap that would be used to clean the vehicle.
- If possible, raise the vehicle onto safety stands. Do not store the vehicle on hydraulic leveling jacks. Hydraulic jacks will bleed pressure over time, lowering the coach back onto the tires.
- Cover the tires to protect them from heat and sunlight.
- If possible, release the parking brake.
- Remove and clean the battery. Always disconnect the negative cable first, then the positive cable. Store the battery in a cool, dry place and keep it charged.
- Lubricate all grease fittings on the chassis and drivetrain.
- Cover all engine and transmission openings with moisture-resistant tape.

Removal from Storage

Follow these steps when the recreational vehicle is removed from storage.

- Remove the covers from the tires and thoroughly inspect the tires for damage. Inflate them to the correct pressure for the actual weight on the tires. Consult the Michelin or Goodyear manual included with your chassis for correct tire pressure. Weigh the vehicle if you do not know how much it weighs.
- Check for fluid leaks. Repair as necessary.
- Check the engine oil level. Add oil if needed.
- Check the coolant level in the reservoir and radiator. Add coolant if needed.
- Check the hydraulic fluid level in the reservoir. Add fluid if needed.
- Check the engine belts for wear, damage, or cracking.
- Check the engine fan for damage.
- Check the fuel/water separator. If it is empty, prime the fuel system. Priming instructions can be found in [Chapter 4](#) of the *Recreational Vehicle Chassis Operator's Manual*.
- Check the engine compartment for nesting animals. Check for leaks and damage to the hoses and wiring.
- Check the rear axle lubricant level.
- Lubricate all grease fittings on the chassis and drivetrain.
- Check the charge level of the battery. Clean the ends of the battery cables. If the batteries need to be replaced, install a clean and fully charged battery. Always connect the positive cable first, then connect the negative cable. Coat the battery terminals and connectors with a dielectric protectant sealant.
- If the vehicle was stored on safety stands, lower the vehicle at this time and set the parking brake.

- Turn the ignition to the RUN position. Verify that the fuel gauge and voltmeter are working correctly.
- Run the engine until it is warm, then check again for fluid leaks.
- Check the transmission fluid level using the cold check method in the Allison Operator's Manual.
- Check all exterior lights and replace as necessary.

15

Specifications

Fluids and Lubricants	15.1
Fuse/Relay/Circuit Breaker Identification	15.2
Electric Service Center	15.3
Torque Charts	15.8
Conversion Charts	15.12

Specifications

Fluids and Lubricants

In the engine cooling system use 50 percent water and 50 percent corrosion-inhibiting antifreeze to protect the engine to -34°F (-37°C) year round.

See [Table 15.1](#) for engine coolant capacities.

See [Table 15.2](#) for approved coolants.

See [Table 15.3](#) for approved Allison transmission lubricants.

See [Table 15.4](#) for approved Allison transmission lubricant capacities.

See [Table 15.5](#) for approved driveline lubricants.

See [Table 15.6](#) for approved power steering fluids.

See [Table 15.7](#) and [Table 15.8](#) for axle lubricant capacities.

Coolant Capacities*	
Engine Make	Coolant Volume: qt (L)
Cummins	12 (11)

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

Table 15.1, Coolant Capacities

Approved Coolants	
Coolant Manufacturer	Coolant Designation*
Old World Industries	Fleet Charge®
Shell	Shell HD/N Antifreeze
Texaco	JC04 Antifreeze
Van Waters and Rogers Ltd. (Canada)	Diesel Antifreeze No. 6038

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

Table 15.2, Approved Coolants

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

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

Table 15.3, Approved Allison Transmission Lubricants

Allison Transmission Lubricant Capacities	
Transmission Model	Fill Capacity:* qt (L)
1000/2000 Series (standard sump)	14.8 (14)
1000/2000 Series (shallow sump)	12.7 (12)
2100/2200/2500 Series (shallow sump)	13 (12)
3000 Series (4 inch)	29 (27)

Allison Transmission Lubricant Capacities	
Transmission Model	Fill Capacity:* qt (L)
3000 Series (2 inch)	26 (25)

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

Table 15.4, Allison Transmission Lubricant Capacities

Approved Driveline Lubricants	
Lubricant and Specification	Lubricant Brands
Universal joint, slip joint, and spline grease must meet ArvinMeritor Specification O-634-B (NLGI Grade No. 2, Lithium 12-Hydroxy Stearate with Molybdenum Disulfide)	Phillips Petroleum Philube MW-EP2 Grease
	Exxon 5160
	Amalie All Purpose Grease with Moly-L1-2M
	Shell Super Duty Special FF
	Marathon Maralube Molycode 529
	Shell Moly Poly Grease
	Kendall L424 Grease
	Amoco Super Chassis Grease
Ford Specification M1C-75B or part number C1AZ 19590	

Table 15.5, Approved Driveline Lubricants

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

* Fill the power steering reservoir only with approved clean fluid. Do not mix fluid types. Wear eye protection when changing the fluid and filter.

Table 15.6, Approved Power Steering Fluids

Freightliner Drive Axle Lubricant Capacity	
Differential/Hubs	Capacity: qt (L)
Differential Only	5.8 (5.5)
Differential and Hubs	7.4 (7.0)

Table 15.7, Freightliner Drive Axle Lubricant Capacity

Meritor Drive Axle Lubricant Capacity	
Axle Model	Capacity: pt (L)*
RS-15-120	16 (7.6)
RS-17-145	33.6 (15.9)
RS-19-145	34.4 (16.3)
RS-21-145	32 (15.1)
RS-23-160	42 (19.9)

Meritor Drive Axle Lubricant Capacity	
Axle Model	Capacity: pt (L)*
RS-23-165	42 (19.9)

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

Table 15.8, Meritor Drive Axle Lubricant Capacity

Fuse/Relay/Circuit Breaker Identification

Circuit breakers protect against circuit overload. If a circuit becomes overloaded (usually caused by a short to ground), the circuit breaker opens, stopping current flow. The vehicle may be equipped with auto-reset breakers.

Fuse/Relay/Circuit Breaker Identification (front-engine diesel chassis)

The electrical system has 5 separate power distribution modules (PDMs) containing both fuses and relays. An optional tow power PDM is also available. The PDMs are mounted in two places:

See [Fig. 15.1](#) and [Fig. 15.2](#).

- Two inside the cab area, typically at the base of the steering column
- Three outside, typically mounted to the right of the operator's station

Fuse/Relay/Circuit Breaker Identification

The electrical system has a box that contains both fuses and relays. The box is mounted in varying locations (typically in the cab under the dash) depending on the design of the chassis. The fuses and relay boxes shown vary depending on chassis options. See [Fig. 15.3](#), [Fig. 15.4](#), [Fig. 15.5](#), and [Fig. 15.6](#).

Specifications

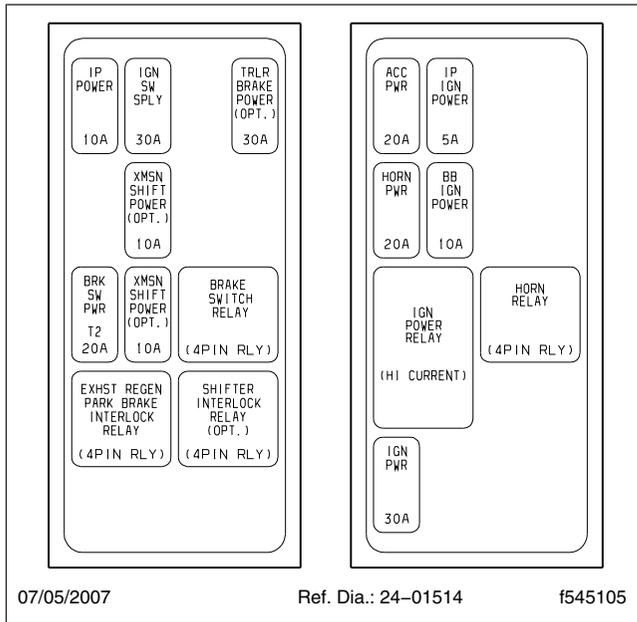


Fig. 15.1, Cab PDMs (inside cab)

Electric Service Center

The information under this heading is to help familiarize the driver with the basic electrical system. Servicing the electrical system should be done only by qualified technicians. Special skills and equipment are required. Take your vehicle to an authorized Freightliner service facility for repairs. The Recreational Vehicle chassis uses multiple electrical components (and fuel and hydraulic filters). Each component is mounted in varying locations on the chassis. If equipped with an Arens service center, it is mounted in one specific location, and that mounting location will vary. See [Fig. 15.7](#). See [Table 15.9](#), [Table 15.10](#), and [Table 15.11](#) for connector information.

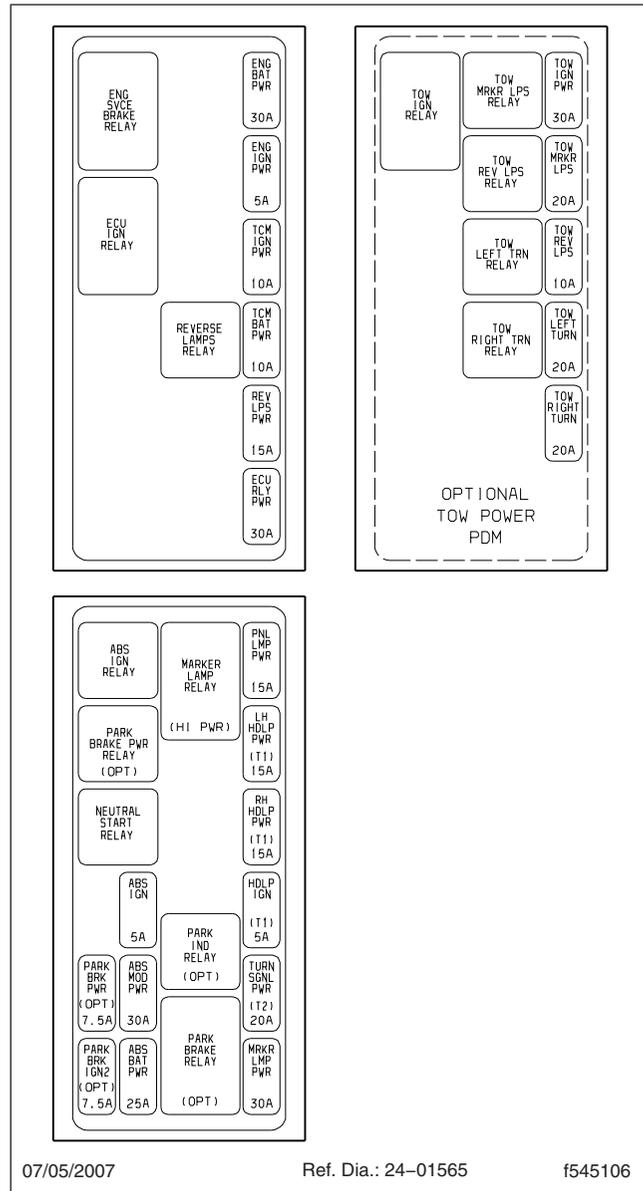


Fig. 15.2, Chassis and Optional Tow Power PDMs (chassis mounted)

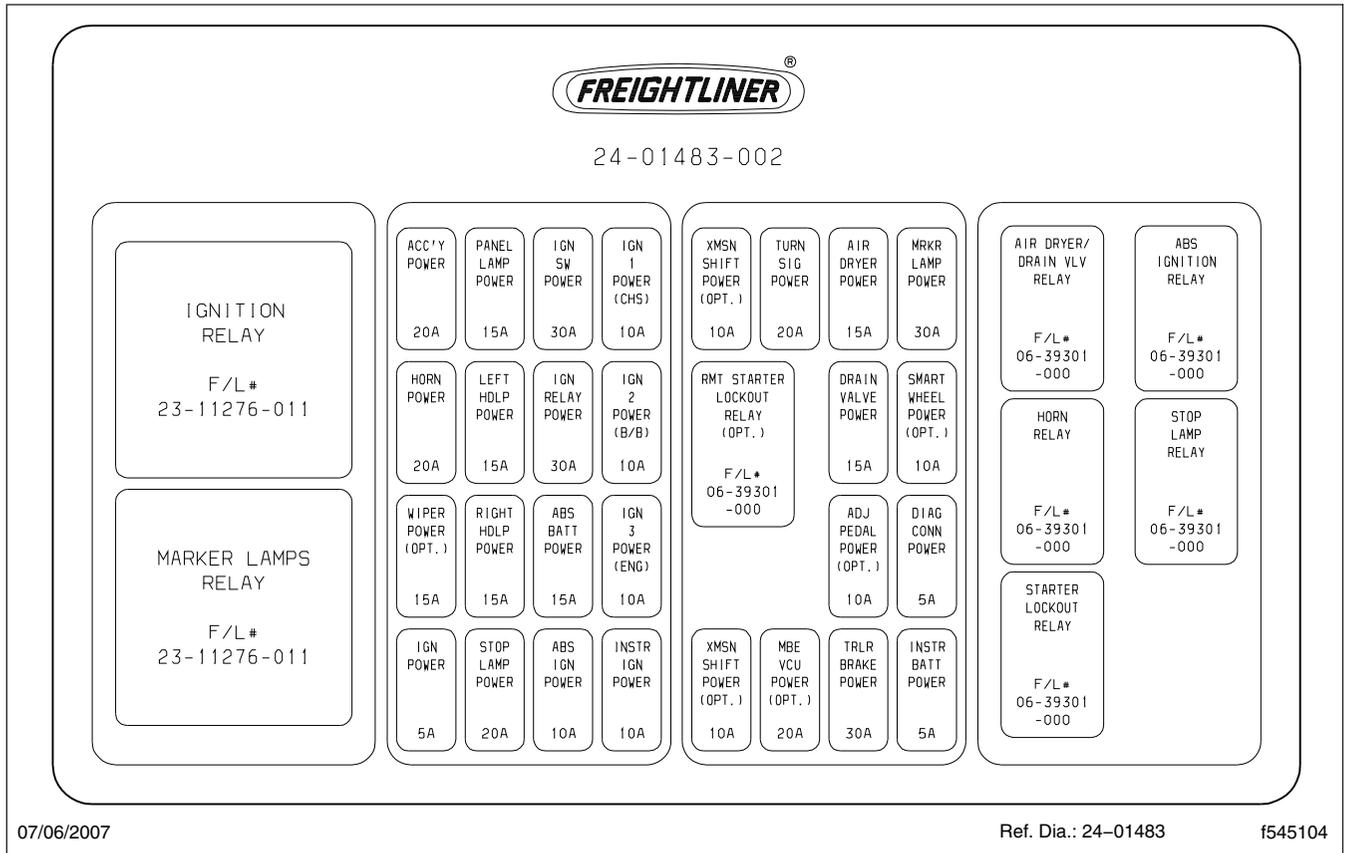


Fig. 15.3, Fuse/Relay (typical install)

Specifications

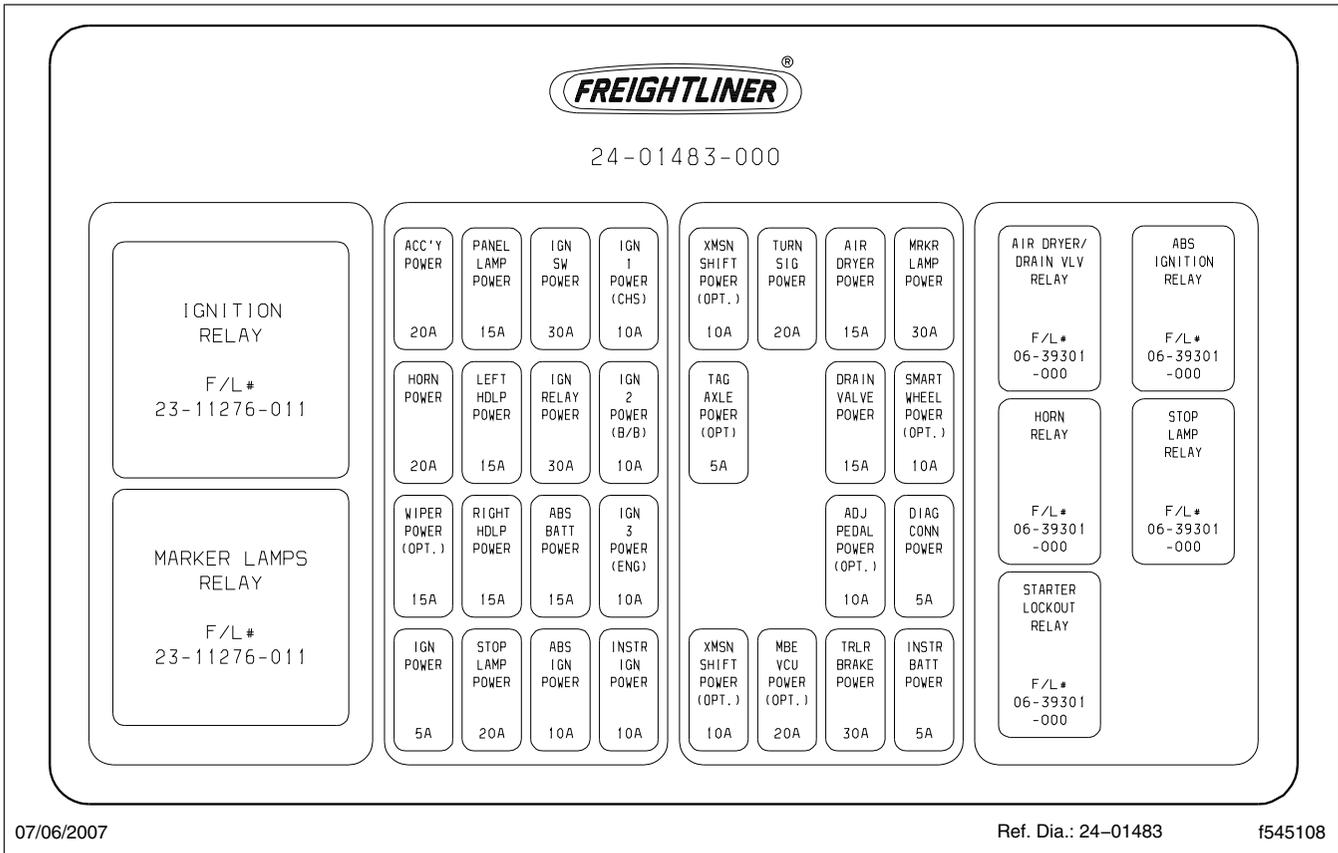


Fig. 15.4, Fuse/Relay (typical install)

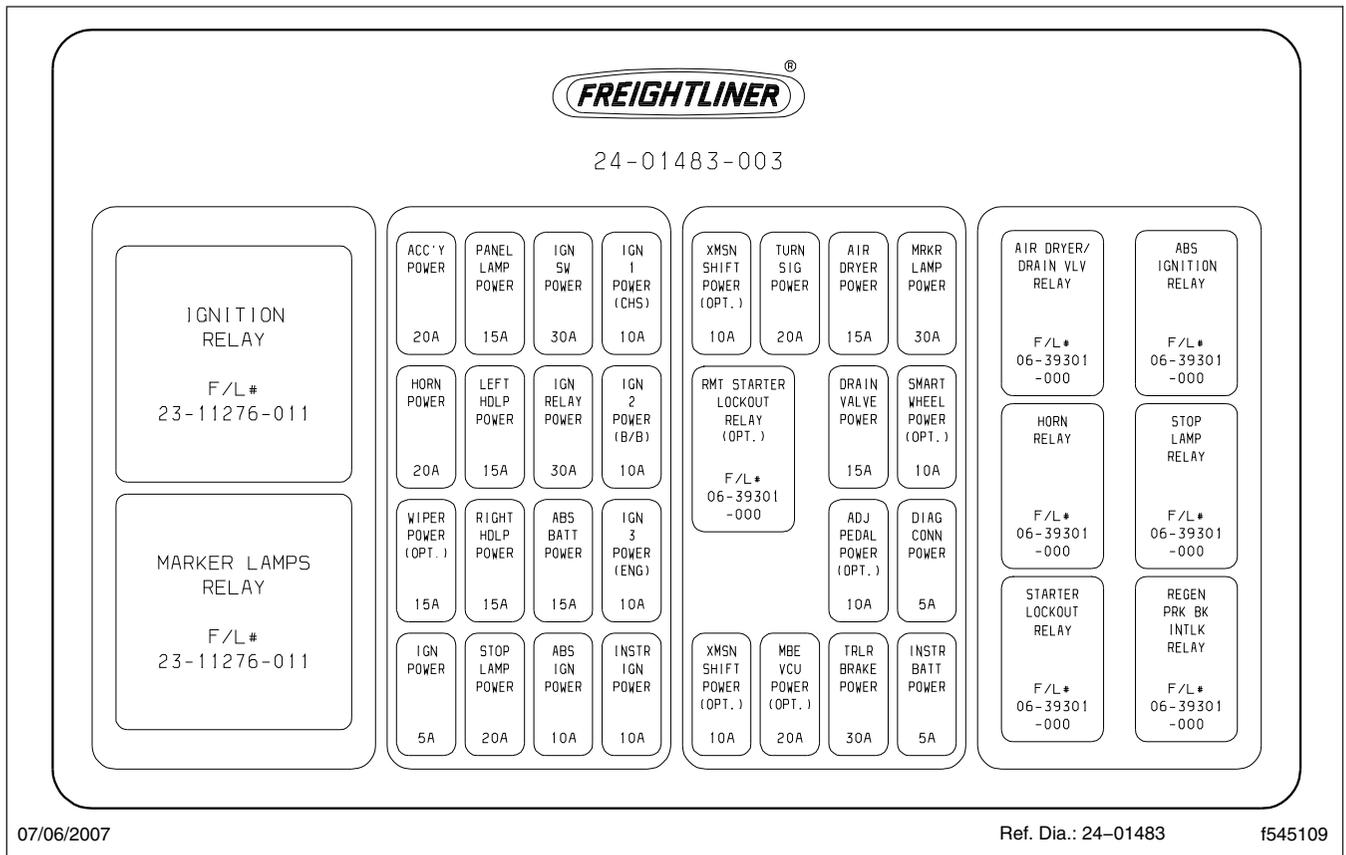


Fig. 15.5, Fuse/Relay (typical install)

Specifications

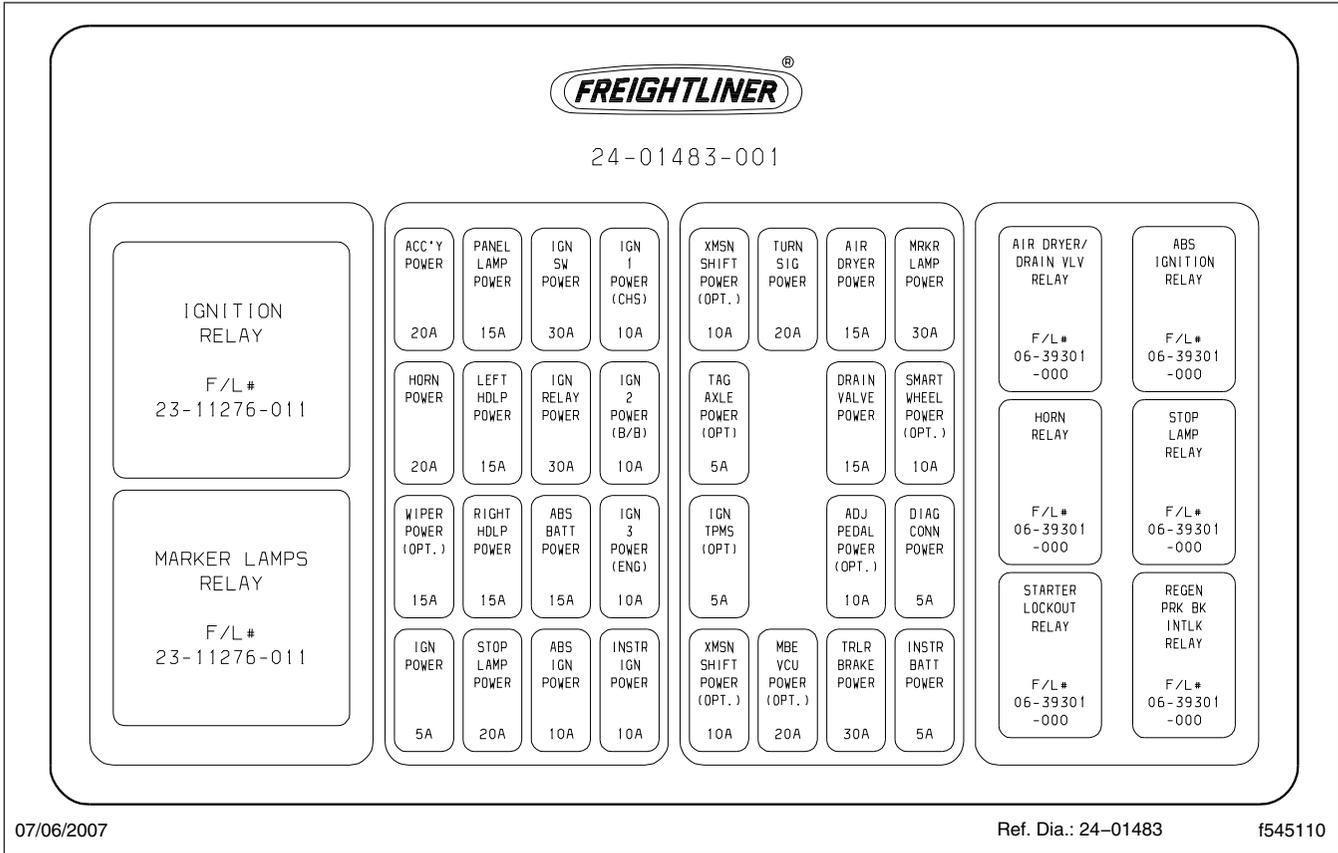


Fig. 15.6, Fuse/Relay (typical install)

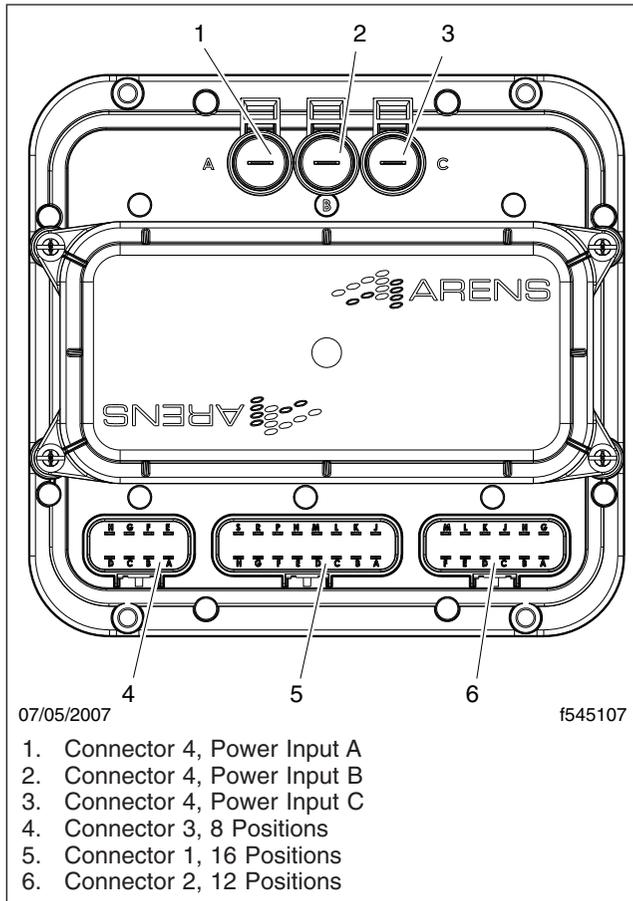


Fig. 15.7, Arens Controls

Connector 1	
Connector Position	Description
1A	ECU-IGN
1B	FAN-SIG
1C	FAN NO
1D	EXTRA
1E	ECM BATT
1F	SPARE
1G	SPARE NC
1H	DIAG PWR
1J	FAN NC
1K	FAN RTN

Connector 1	
Connector Position	Description
1L	MBE ECM BATT
1M	HYD FAN MOD
1N	SPARE COM
1P	IGN
1R	SPARE NO
1S	SPARE SIG

Table 15.9, Connector 1

Connector 2	
Connector Position	Description
2A	IGN SW START
2B	TCM BATT
2C	TCM BATT
2D	L TURN SIG
2E	REV LPS SIG
2F	REV LPS OUT
2G	GND
2H	START OUT
2J	NEU START SIG
2K	TCM
2L	MARKER SIG
2M	R TURN SIG

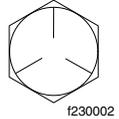
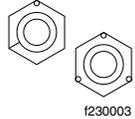
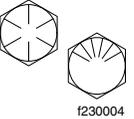
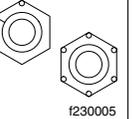
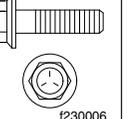
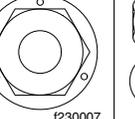
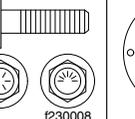
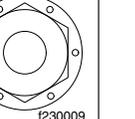
Table 15.10, Connector 2

Connector 3	
Connector Position	Description
3A	REV TOW
3B	EXTRA
3C	EXTRA
3D	EXTRA
3E	R TURN OUT
3F	MARKER OUT
3G	L TURN OUT
3H	IGN OUT TOW

Table 15.11, Connector 3

Torque Charts

Specifications

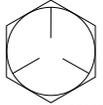
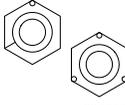
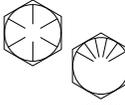
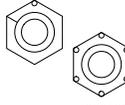
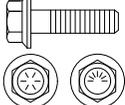
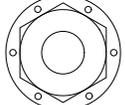
Torque Values for U.S. Customary Thread Fasteners With Lubricated* or Plated Threads†								
Thread Diameter—Pitch	Regular Hex				Flanged			
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 5 Bolt	Grade B Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft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

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

Table 15.12, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads

Specifications

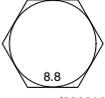
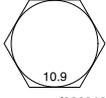
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter—Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)		Torque: 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 15.14](#). Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

Table 15.13, 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)	

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

Table 15.14, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads

Conversion Charts

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 15.15, Metric/U.S. Customary 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 15.16, Temperature Conversion

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