



# WALK-IN VAN CHASSIS

## Operator's Manual

STI-471-6  
A24-01451-000

## 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 cab components. Not all of the information contained in this manual applies to every chassis. If parts on your chassis differ from those shown, they may have been installed by the body builder.

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 your selling dealer before making any alterations to the vehicle or 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 *Walk-In Van 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 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

# Foreword

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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, breakdown coordination, or Fleetpack assistance. Our people are knowledgeable, professional, and committed to following through to help you keep your vehicle moving. Please visit [www.Daimler-TrucksNorthAmerica.com](http://www.Daimler-TrucksNorthAmerica.com).

## Reporting Safety Defects

If you believe that your vehicle has a defect which could cause a crash or could cause injury or death, you should immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying 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](http://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](http://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](http://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](#).

INCOMPLETE VEHICLE IDENTIFICATION DATA		
 A Subsidiary of FREIGHTLINER LLC		
INCOMPLETE VEHICLE MANUFACTURED BY: FREIGHTLINER CUSTOM CHASSIS CORPORATION GAFFNEY, SOUTH CAROLINA 29341		
INCOMPLETE VEHICLE DOM: VIN:		
GVWR/PNBV:		
GAWR/PNBE:		
FRONT =		
WITH	TIRES	RIMS
PRESSURE =		(COLD)
FIRST INTMD =		
WITH	TIRES	RIMS
PRESSURE =		(COLD)
REAR =		
WITH	TIRES	RIMS
PRESSURE =		(COLD)
VEHICLE TYPE:		
MODEL:		
NOTE: ALL WEIGHTS LISTED IN kg (lb) PRESSURES LISTED IN kPa (psf)		
OVERSPEEDING OR OVERLOADING WILL VOID WARRANTY. THE ABOVE DATA REPRESENTS ORIGINAL EQUIPMENT.		
09/11/2002		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 vehicles 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 (VIN)

The chassis vehicle identification number is permanently attached to the chassis in the engine compartment (depending on vehicle options, usually on the metal panel where the steering driveline enters the engine compartment). See [Fig. 1.2](#). The last six digits are the chassis serial number. The chassis number is stamped on the left frame rail, over the front axle. A VIN label is also mounted by the body builder. Mounting locations vary, to include the glove box. See [Fig. 1.3](#).

FREIGHTLINER CUSTOM CHASSIS CORPORATION <b>4UZA4FVC0TC748531</b> GAFFNEY, SOUTH CAROLINA, USA	
04/18/2005	f080061a

Fig. 1.2, Vehicle Identification Number (VIN) Label

NOTE: Always include the chassis serial number (last six digits of the VIN) when communicating with 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

<p style="text-align: center; font-weight: bold;">INCOMPLETE VEHICLE COMPONENT INFORMATION</p> <p>INCOMPLETE VEHICLE MANUFACTURED BY: FREIGHTLINER CUSTOM CHASSIS CORPORATION GAFFNEY, SOUTH CAROLINA 29341 INCOMPLETE VEHICLE DOM: VIN:</p> <p>CHASSIS MODEL : ENGINE MODEL : TRANS MODEL : FRONT AXLE MODEL : REAR AXLE MODEL :</p> <p>PAINT MFR : PAINT NUMBER :</p>	<div style="text-align: center;">   <i>A Subsidiary of FREIGHTLINER LLC</i> </div> <p>USE VEHICLE ID NUMBER (VIN) WHEN ORDERING PARTS.</p> <p>WHEELBASE : ENGINE NUMBER : TRANS NUMBER : FRT AXLE NUMBER : REAR AXLE NUMBER : REAR AXLE RATIO :</p> <p>FOR COMPLETE PAINT INFORMATION SEE VEHICLE SPECIFICATION SHEET.</p>
12/04/2001	FREIGHTLINER CUSTOM CHASSIS CORPORATION GAFFNEY, SOUTH CAROLINA, USA
f080122	

**Fig. 1.3, Vehicle Identification Number Label, Typical**

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 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 would bring the engine/vehicle out of compliance with certification requirements [Ref: 42 U.S.C. S7522(a) (3)]. It is the owner's responsibility to maintain the vehicle so that it conforms to EPA regulations.

## Vehicle Emission Control Information Label

Model year 2013 and later vehicles meet additional requirements as specified by federal greenhouse gas and fuel efficiency regulations (GHG14). Model year 2017 and later vehicles meet similar requirements as specified by GHG17 requirements. These vehicles are equipped with components that increase fuel efficiency and reduce GHG emissions. Components may include, but are not limited to, low-rolling resistance tires.

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

# Vehicle Identification

Applicable Emissions System Based on Build Date and EPA Regulations	
Build Date	Regulation: Emissions Components
From January 1, 2016	GHG17: GHG14 components plus OBD16 instrumentation and sensor upgrades, and component technology that meets NHTSA and EPA 2017 fuel efficiency and greenhouse gas emission standards (GHG17) requirements.

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

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

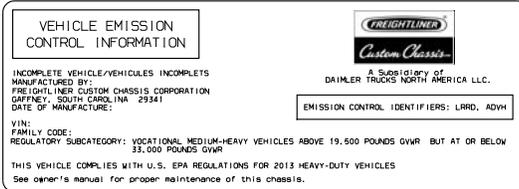
EXHAUST AFTERTREATMENT SYSTEM INFORMATION					
INDICATOR LAMP(S)	 (Solid) Level 1	 (Flashing) Level 2	 (Flashing) Level 3	 Level 4	 WARNING
Indicator Lamp Message(s)	Filter Regeneration Recommended.	Filter Regeneration Necessary	Parked Regeneration Required – Engine Derate	Service Regeneration Required.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

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**Fig. 1.4, ATS Indicators**

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.


<p>03/02/2012</p> <p style="text-align: right;">f080183</p>

**Fig. 1.5, Vehicle Emission Control Information Label**

## Certified Clean Idle Label

The California Air Resources Board (CARB) requires model year 2008 and newer heavy-duty diesel engines to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling in order to limit emissions of particulate matter and NOx.

Certified vehicles are equipped with a label placed near the bottom edge of the driver-side door. See [Fig. 1.6](#).



Fig. 1.6, CARB Clean Idle Label

# 2

## Instruments

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# Instruments

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## Ametek Instrument Panel

The following information describes a typical instrument panel manufactured by Ametek. **Figure 2.1** and **Fig. 2.2** show instrument panels for vehicles that are compliant with EPA10 and newer regulations, for both diesel and hybrid-electric vehicles (HEV). **Figure 2.3** and **Fig. 2.4** show instrument panels for vehicles that are EPA07-compliant for both diesel and HEV vehicles.

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
- Percent Engine Load
- Engine RPM

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

## Priority Messages

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

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

## Self-Test

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

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

## Menu System

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

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

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

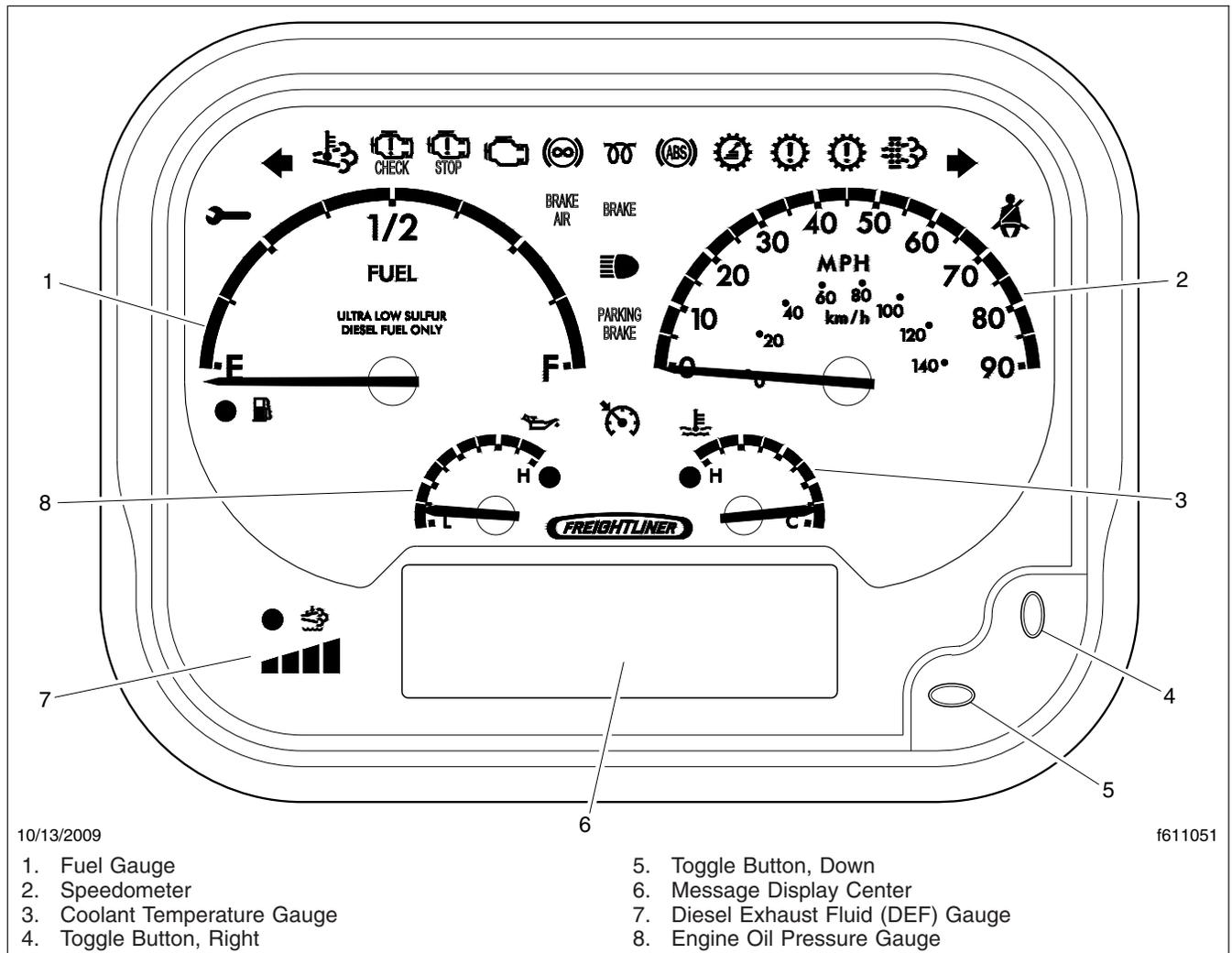


Fig. 2.1, Typical Ametek Instrument Panel (diesel), EPA10 and Newer Engines

## 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. 2.5, screens H, I, and J.

### Startup Screen

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

## LCD Contrast

Select contrast from the menu to set the LCD contrast. Use the down toggle button to set the contrast to the desired level. To navigate to the contrast screen, see Fig. 2.5, screen M.

## Reset Parameters

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

# Instruments

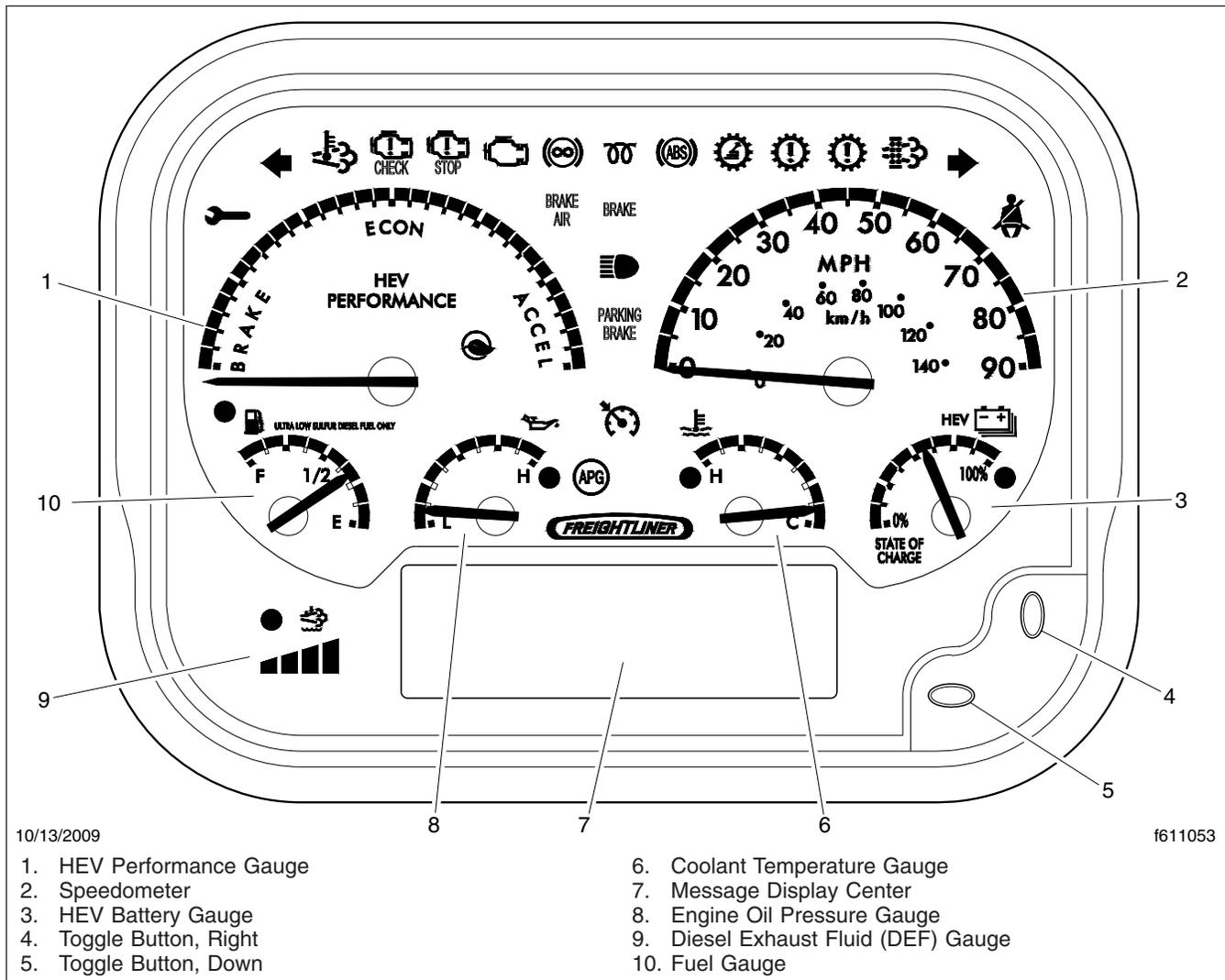


Fig. 2.2, Typical Ametek Instrument Panel (HEV), EPA10 and Newer Engines

## Maintenance Menu

The maintenance menu has the following three sub menus:

- maintenance intervals
- transmission oil life remaining
- transmission oil filter life monitor

## Maintenance Intervals

The maintenance intervals menu allows the driver to set the change intervals for engine oil and engine air

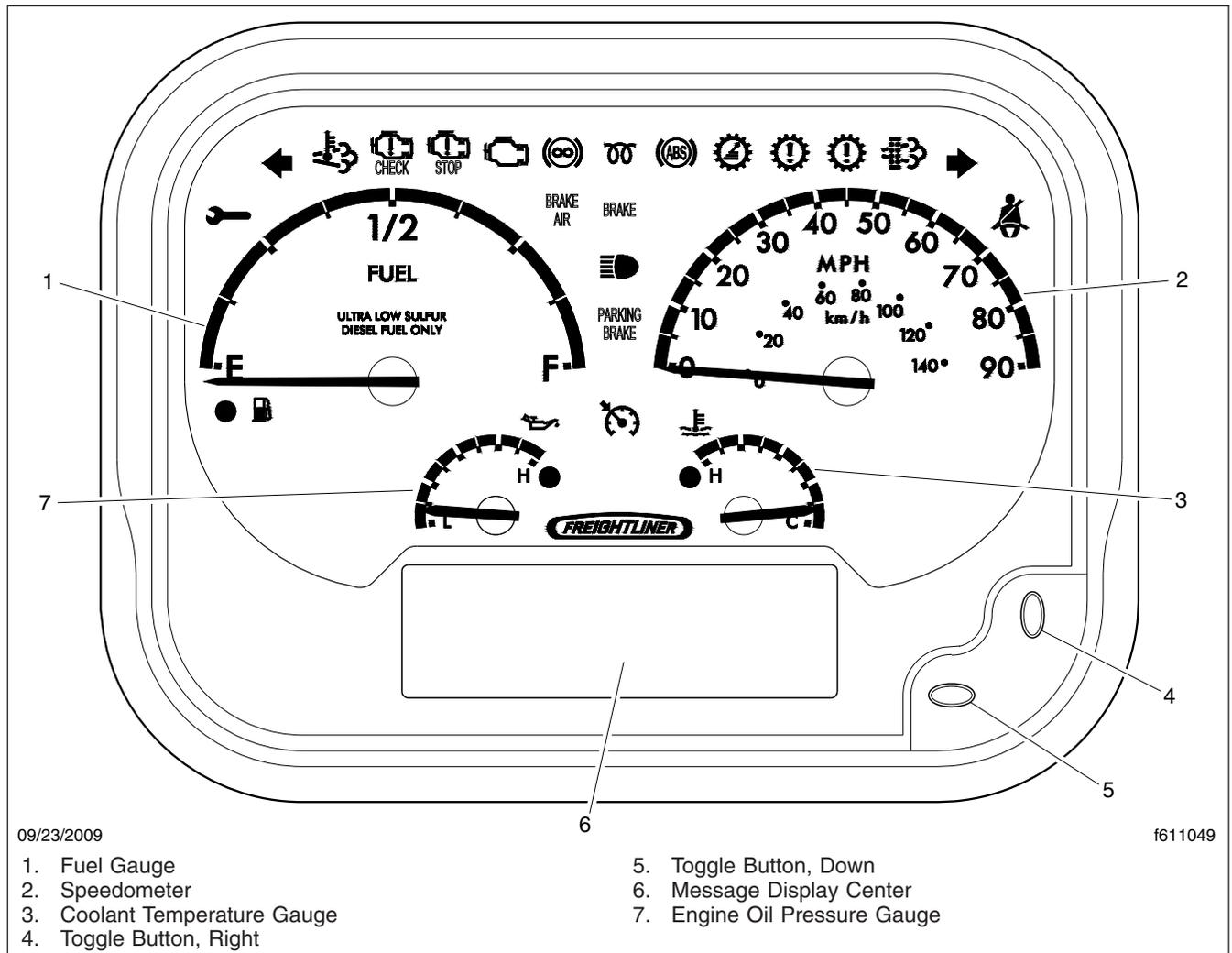
filter. If the intervals are set to zero, the maintenance warnings must be disabled.

## Transmission Oil Life Remaining

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

## Transmission Oil Filter Life Monitor

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



**Fig. 2.3, Typical Ametek Instrument Panel (diesel), EPA07-Compliant**

TRANS OIL FILTER FUNCTIONAL or TRANS OIL FILTER CLOGGED.

## Diagnostic Menu

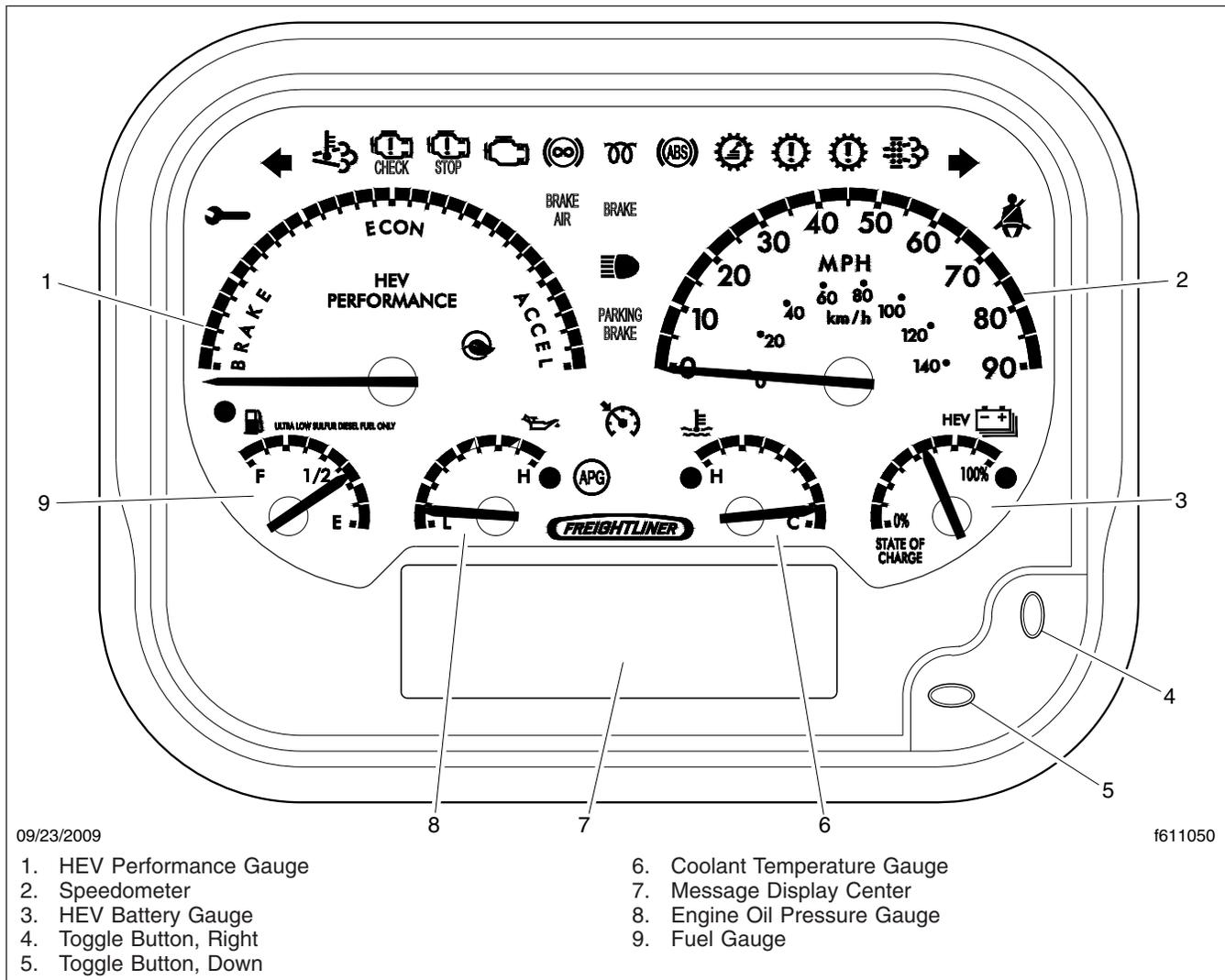
The diagnostic menu contains the following items:

- 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

# Instruments



**Fig. 2.4, Typical Ametek Instrument Panel (HEV), EPA07-Compliant**

sub-menu. Some of the more frequently used diagnostic menus are described further below.

## Engine Faults

This screen displays engine fault codes that are received from the engine electronic control unit (ECU). To navigate to the engine fault screen, see [Fig. 2.6](#), screen AA.

## Transmission Faults

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

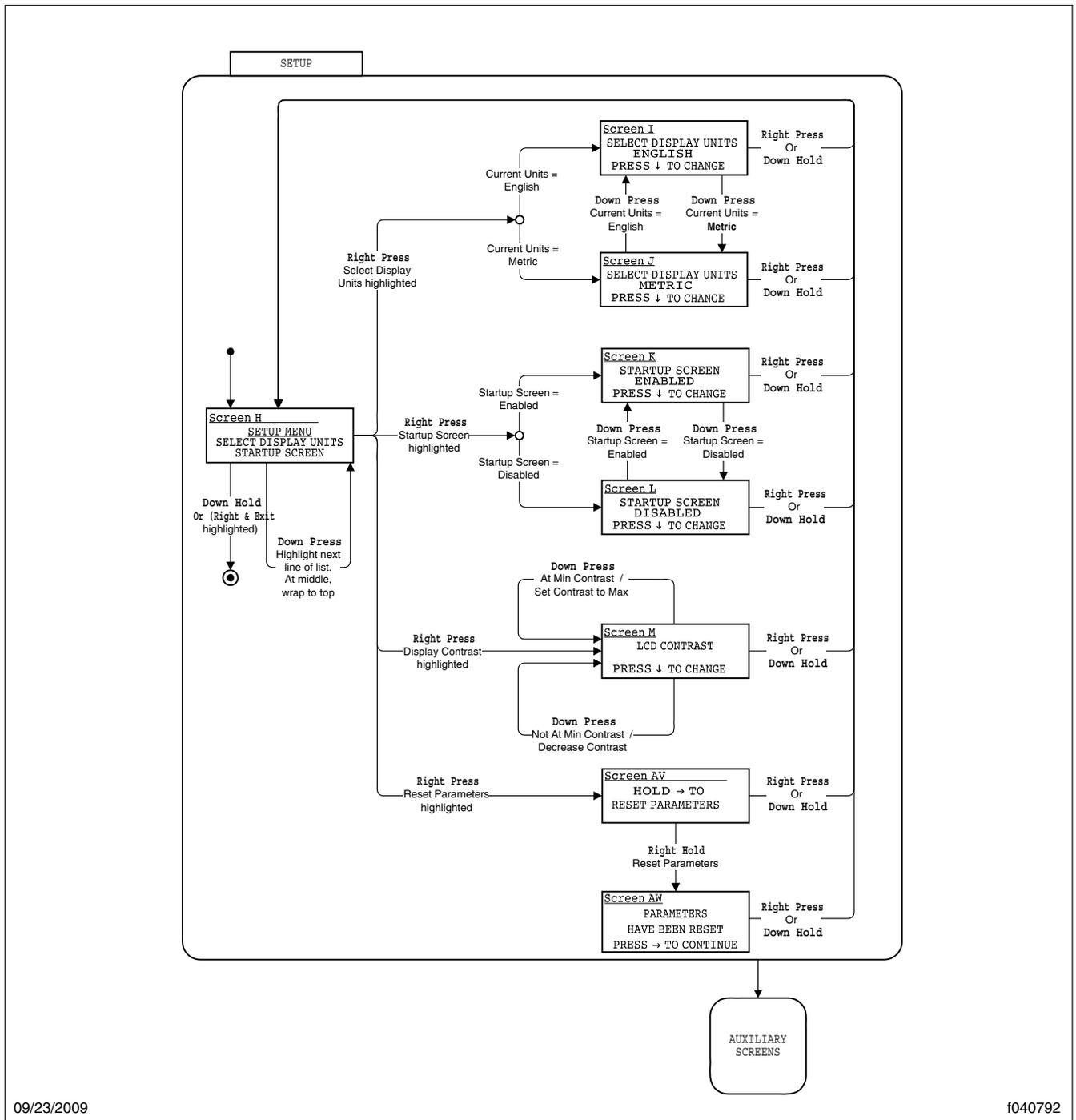
to the transmission fault screen, see [Fig. 2.6](#), screen AB.

## ABS Diagnostics

This screen displays Antilock Brake System (ABS) fault codes that are received from the ABS ECU. To navigate to the ABS diagnostic screen, see [Fig. 2.6](#), screen AC.

## Check Gauges

The check gauges screen allows the driver to set each gauge as a percentage of scale (either 0, 50, or



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**Fig. 2.5, Setup Menu Screens**

100%), as shown in the LCD. To navigate to the check gauges screen, see [Fig. 2.7](#), AG screens.

# Instruments

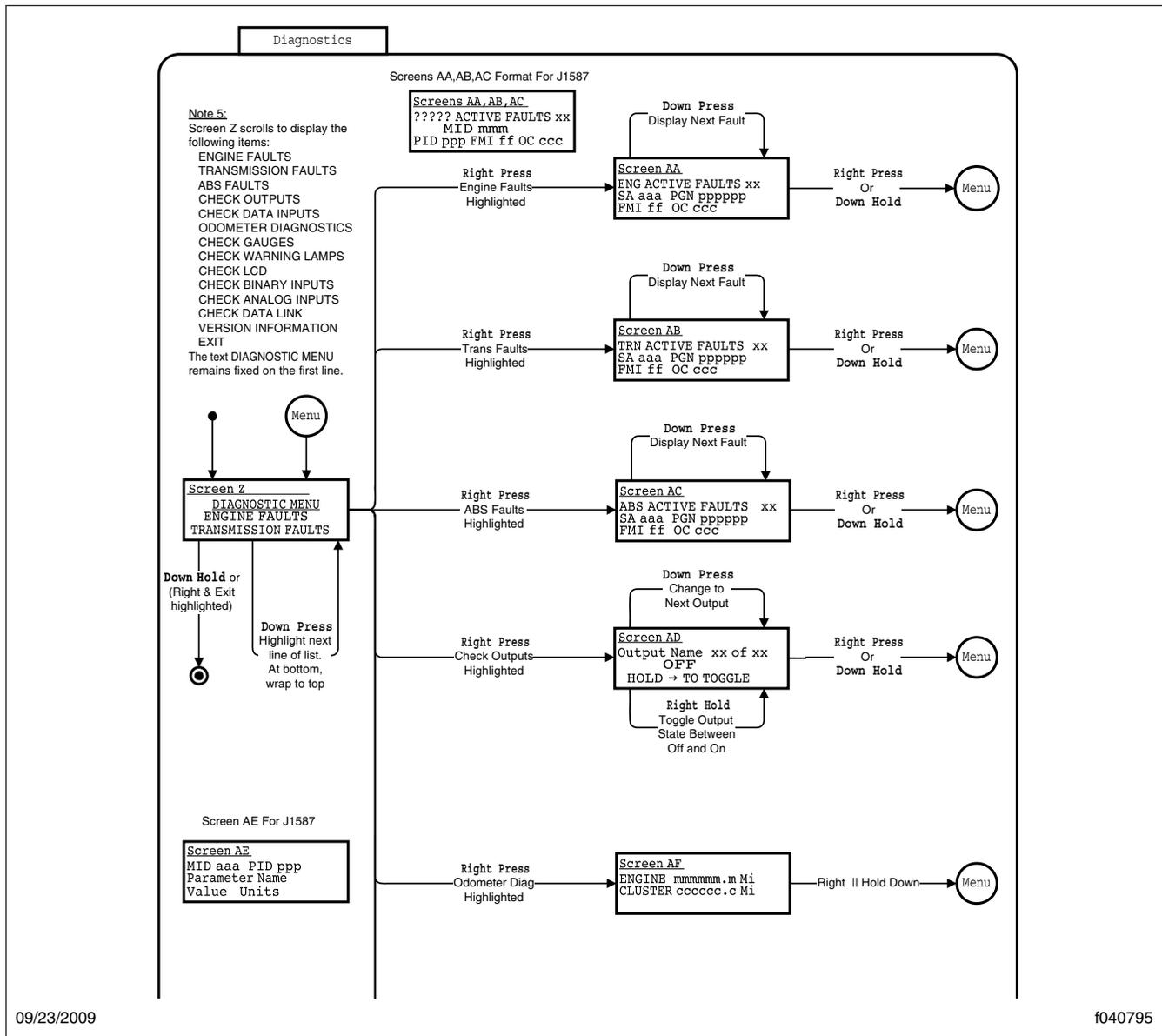


Fig. 2.6, Diagnostic Menu Screens, Screen 1

## Warning Lamp

The warning lamp screen allows the driver to test each warning lamp (not the vehicle load) on and then off, displaying the lamp name and status in the LCD. To navigate to the warning lamp screen, see [Fig. 2.7](#), screen AH.

## Check LCD

Selecting the check LCD screen displays the Freightliner Custom Chassis Corporation (FCCC) logo in normal and reverse video three times and then returns to the menu. To navigate to the check LCD screen, see [Fig. 2.7](#), screen AI.

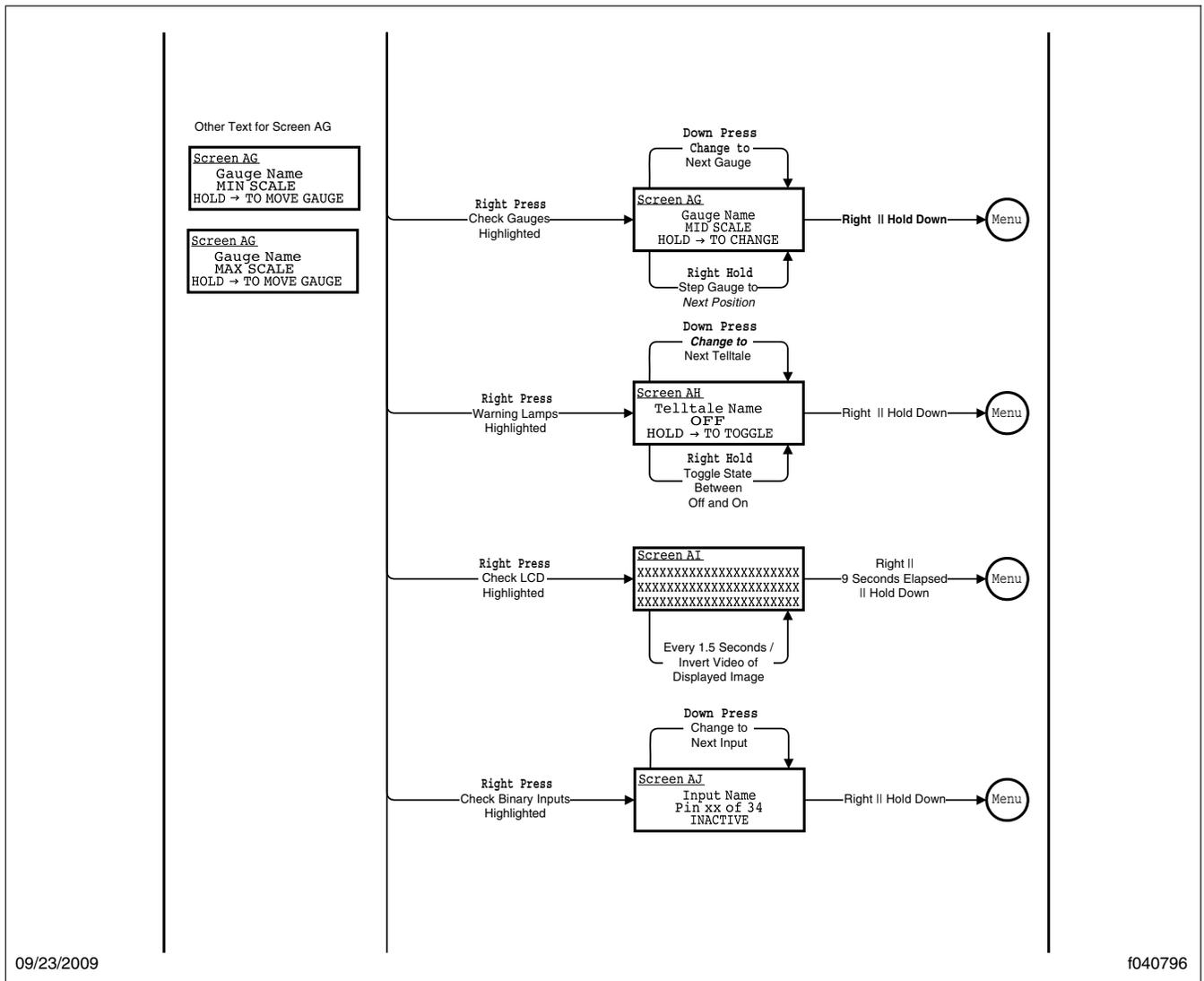
## Check Binary Inputs

The check binary inputs screen displays the pin number and status of each binary input. The toggle buttons allow the driver to select each binary input. This information is continuously updated to assist in troubleshooting. To navigate to the check binary inputs screen, see [Fig. 2.7](#), screen AJ.

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. 2.8](#), screen AK.

## Check Datalink

The check datalink screen allows the driver to view

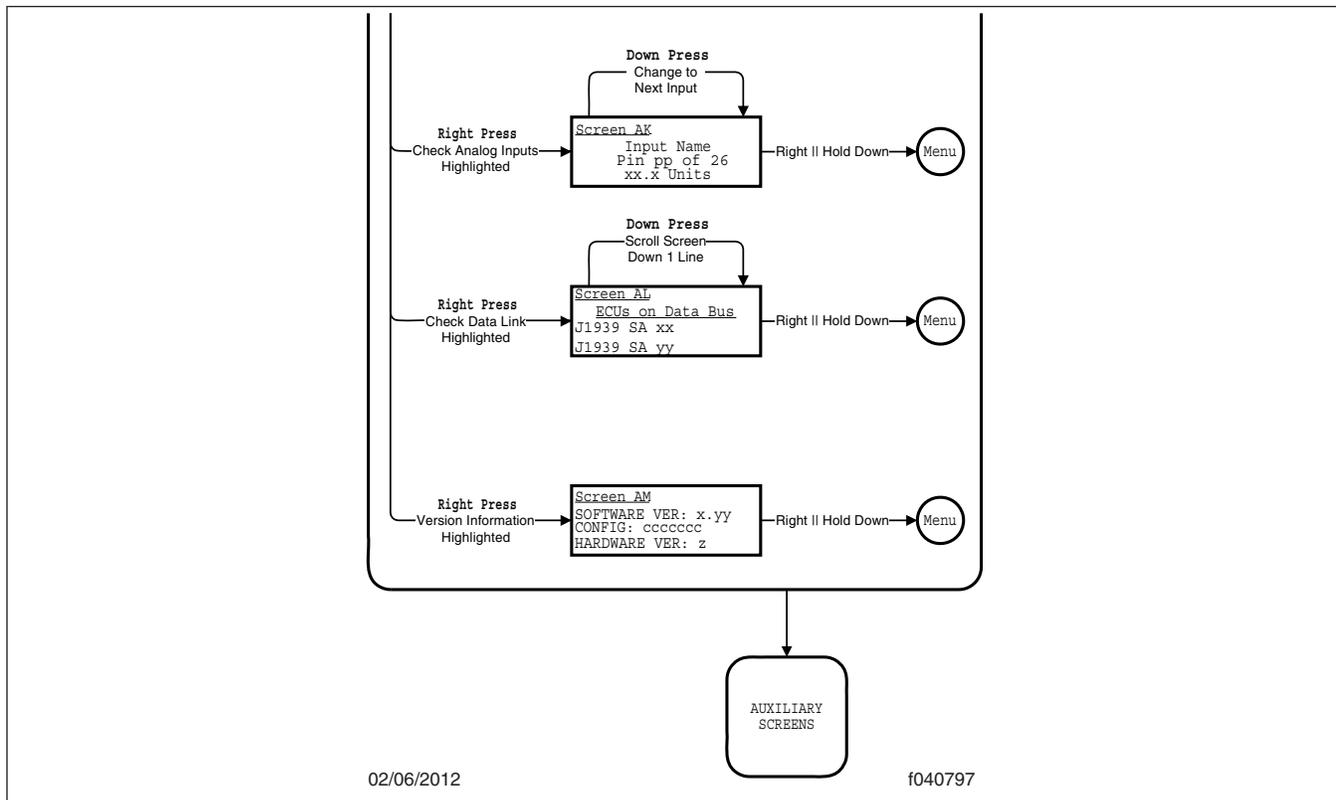


**Fig. 2.7, Diagnostic Menu Screens, Screen 2**

## 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

all devices that communicate on the J1939, J1587, and GMLAN datalinks. To navigate to the check datalink screen, see [Fig. 2.8](#), screen AL.



**Fig. 2.8, Diagnostic Menu Screens, Screen 3**

## 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. 2.5](#), [Fig. 2.6](#), [Fig. 2.7](#), [Fig. 2.8](#), [Fig. 2.9](#), [Fig. 2.10](#), [Fig. 2.11](#), [Fig. 2.12](#), [Fig. 2.13](#), [Fig. 2.14](#), [Fig. 2.15](#), [Fig. 2.16](#), and [Fig. 2.17](#).

**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. 2.11](#).

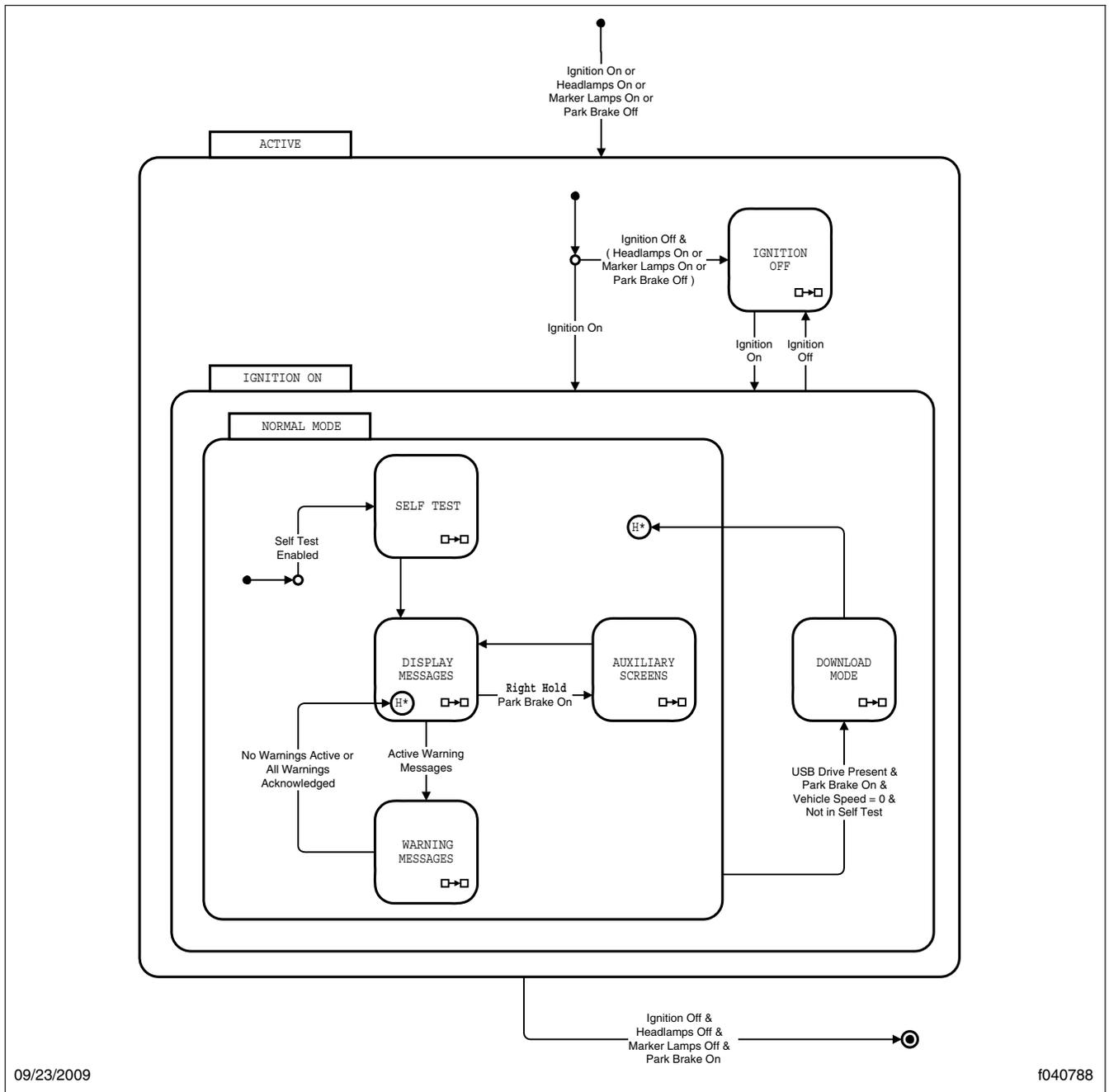
1. With the vehicle in park, turn the ignition to ON, and allow the self test to complete.

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. 2.11](#), as screen D.
4. Use the down toggle button to scroll through the available items.
5. Highlight the new item, then press the right toggle button. The selected item will now appear in the message display center.

## Warning and Indicator Lights

### General Information

The warning and indicator lights are located in the instrument panel and contain all of the standard and optional warning and indicator lights. See [Fig. 2.18](#) and [Fig. 2.19](#) for diesel and HEV compliant warning and indicator lights respectively.



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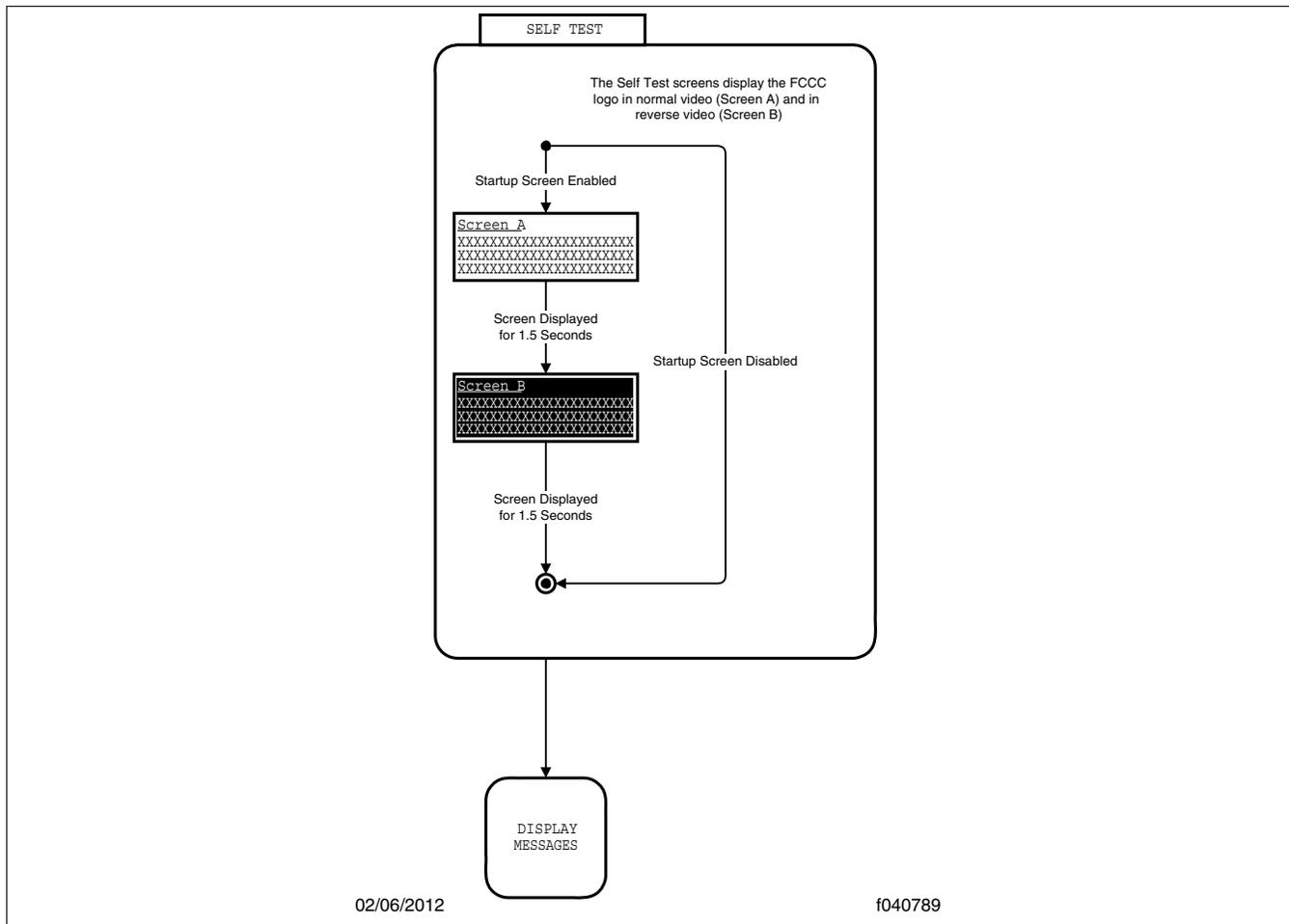
f040788

**Fig. 2.9, Ignition On, Normal Mode**

## Maintenance Warning Light

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

- **Oil Change Required**—alerts the driver that the engine has reached the recommended oil change interval.



**Fig. 2.10, Self Test**

- Air Filter Reminder—the air filter requires checking or replacement.
- Transmission Prognostics Warning—if the transmission has prognostics enabled.

## 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 on.

## High Exhaust System Temperature (HEST) Lamp

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.

The amber HEST lamp will illuminate as follows:

- Slow (10-second) flash, indicates a regeneration is in progress, and the driver is not controlling the engine idle speed.
- Solid illumination indicates a regeneration is in progress, with high exhaust temperatures at the outlet of the tailpipe, if the speed is below 5 mph (8km/h). It does not signify the need for service; it only alerts the vehicle operator of high exhaust temperatures. See the engine operator's manual for details.

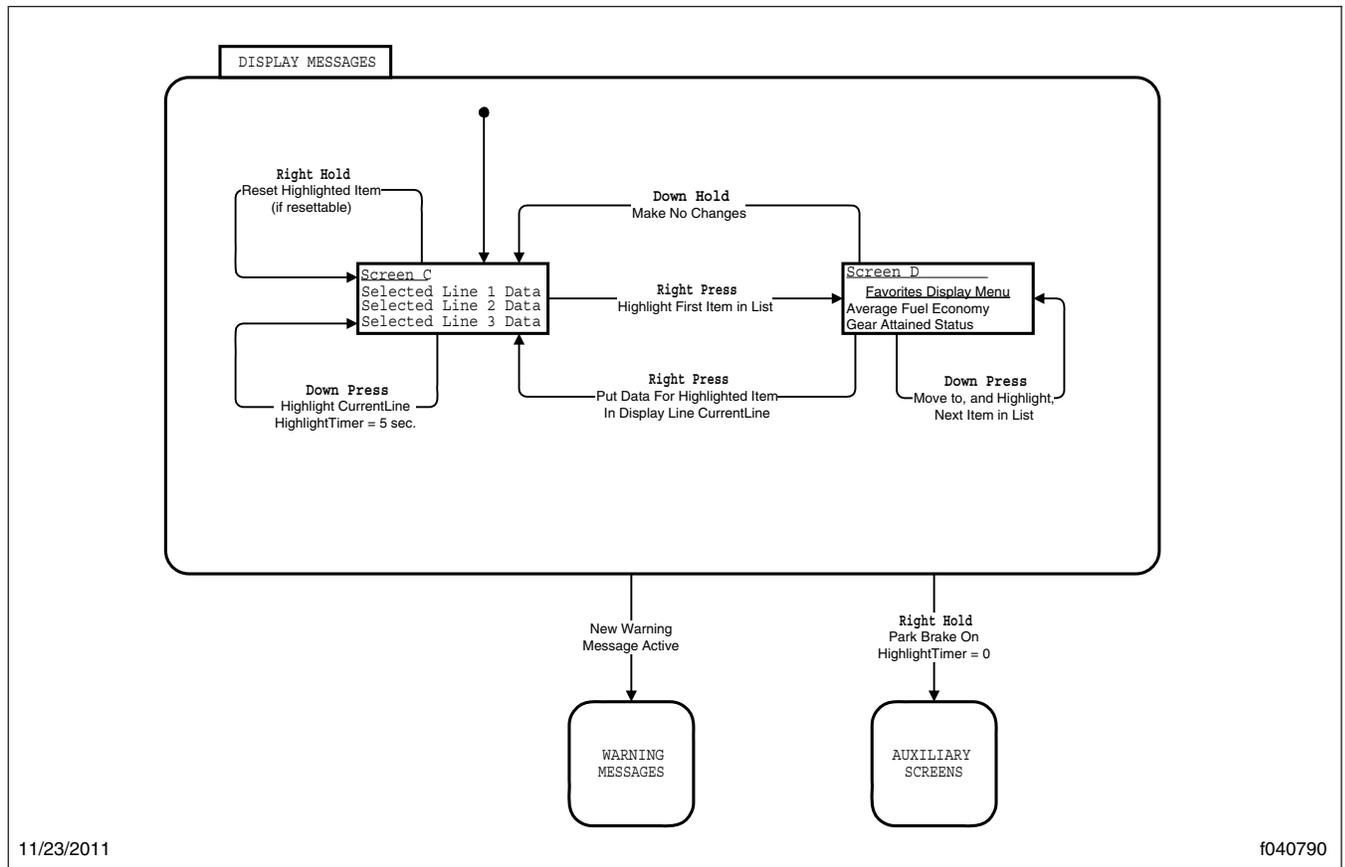


Fig. 2.11, Display Messages

## Check Engine Indicator

The amber check engine (CHECK) indicator light illuminates when the engine control unit senses a malfunction in the electronic engine control system.

## Stop Engine Warning

The red stop engine (STOP) warning light illuminates if a malfunction that could cause engine damage occurs. In most cases, the CHECK engine 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

The amber Malfunction Indicator Lamp (MIL) indicates an engine emissions-related fault. See the engine operators manual for details.

## Engine Brake Light

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

## Wait to Start Warning Light

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

# Instruments

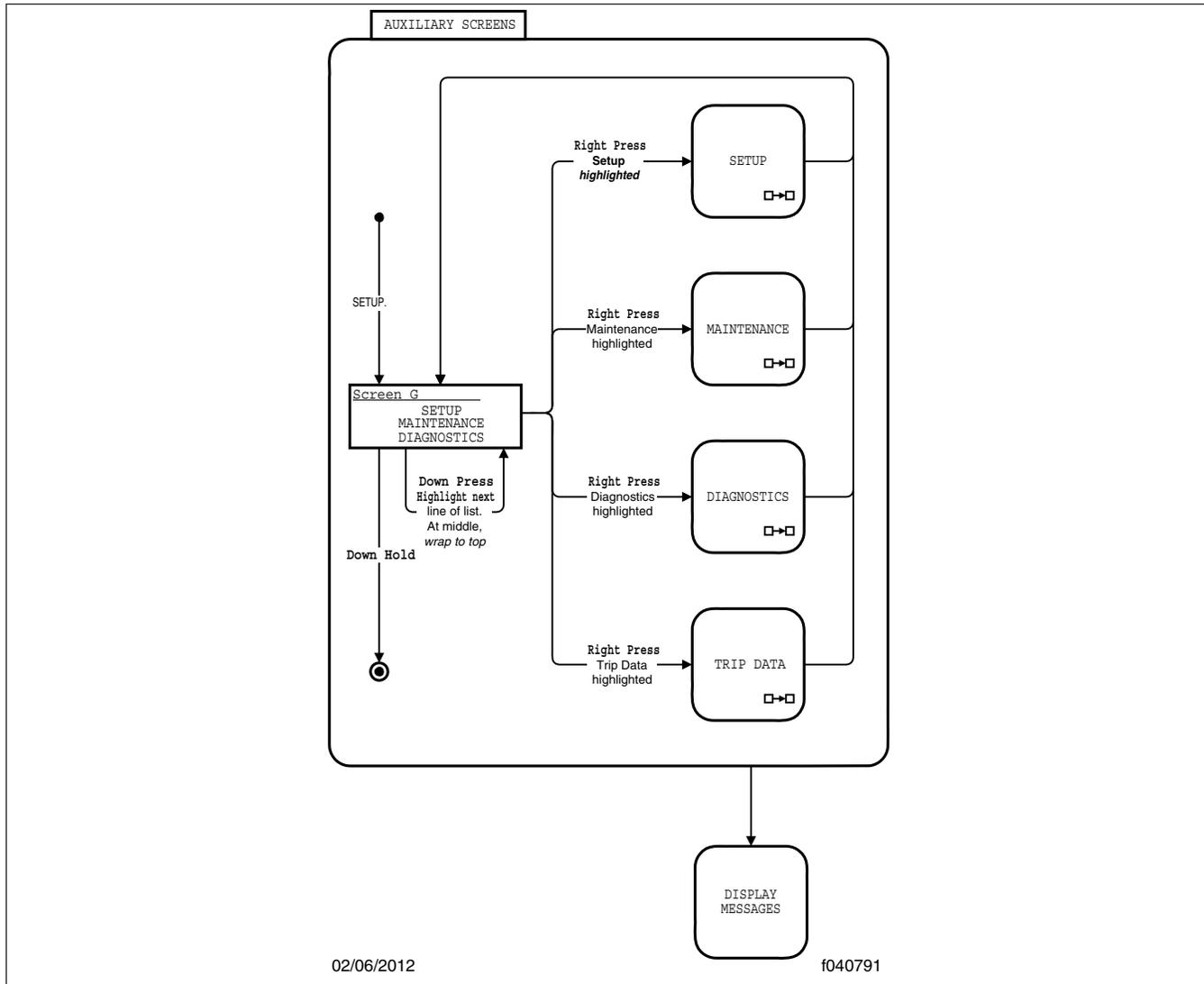


Fig. 2.12, Auxiliary Screens

## ABS Indicator

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

## Shift Inhibit Indicator

On vehicles equipped with Allison 2100/2200/2500 series transmissions, the amber shift inhibit indicator light illuminates whenever all conditions for safe transmission shifting have not been met.

## Check Transmission Indicator

The amber check transmission indicator illuminates when the temperature of the transmission fluid goes above the preset level set by the transmission manufacturer.

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

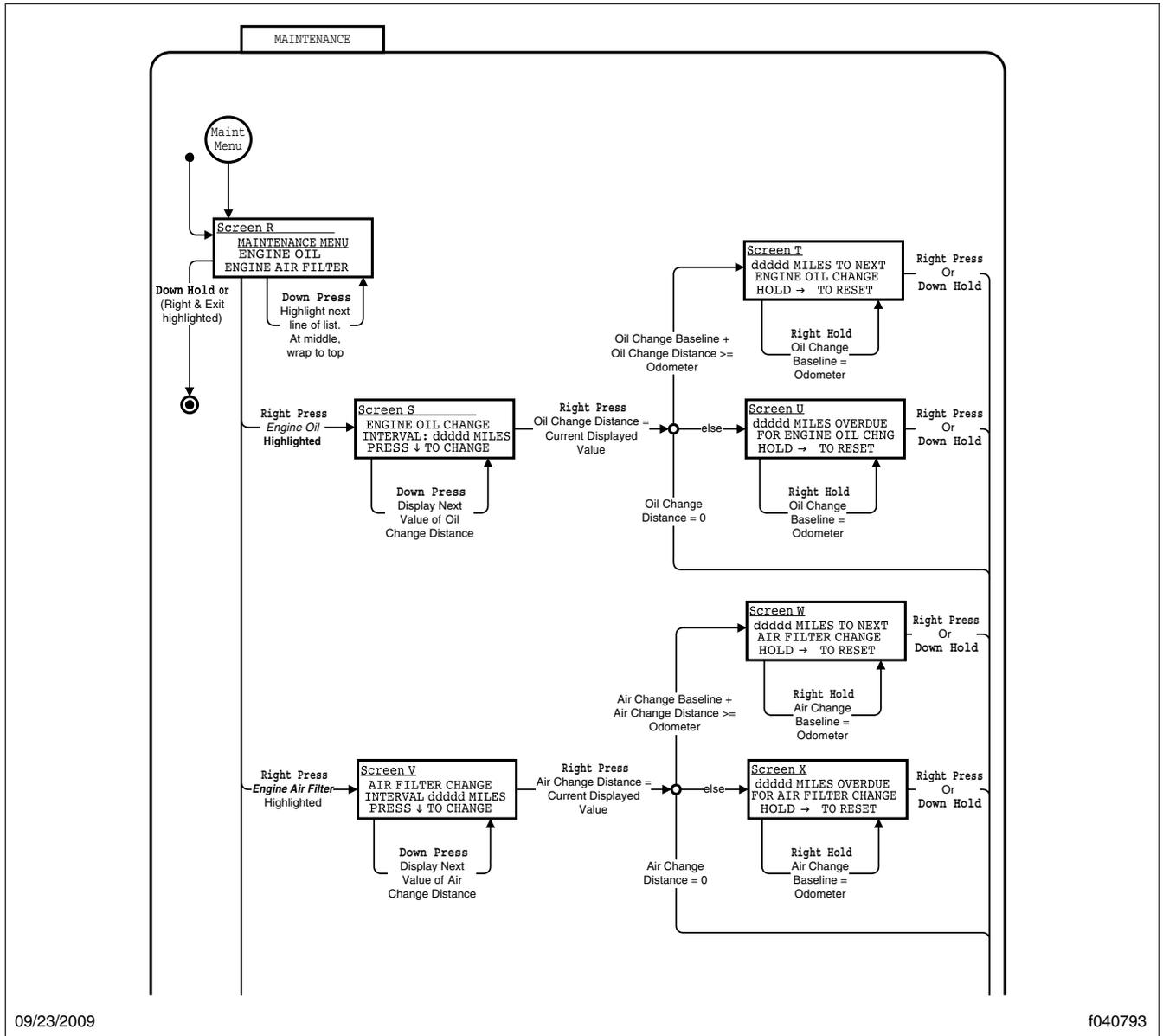


Fig. 2.13, Maintenance Menu Screens, Screen 1

## Stop Transmission (hybrid only)

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

## Diesel Particulate Filter (DPF) Lamp

A solid amber illuminated DPF lamp 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.

A blinking DPF lamp indicates that a stationary regeneration is required immediately. An engine derate and shutdown will occur. See the instructions in the

# Instruments

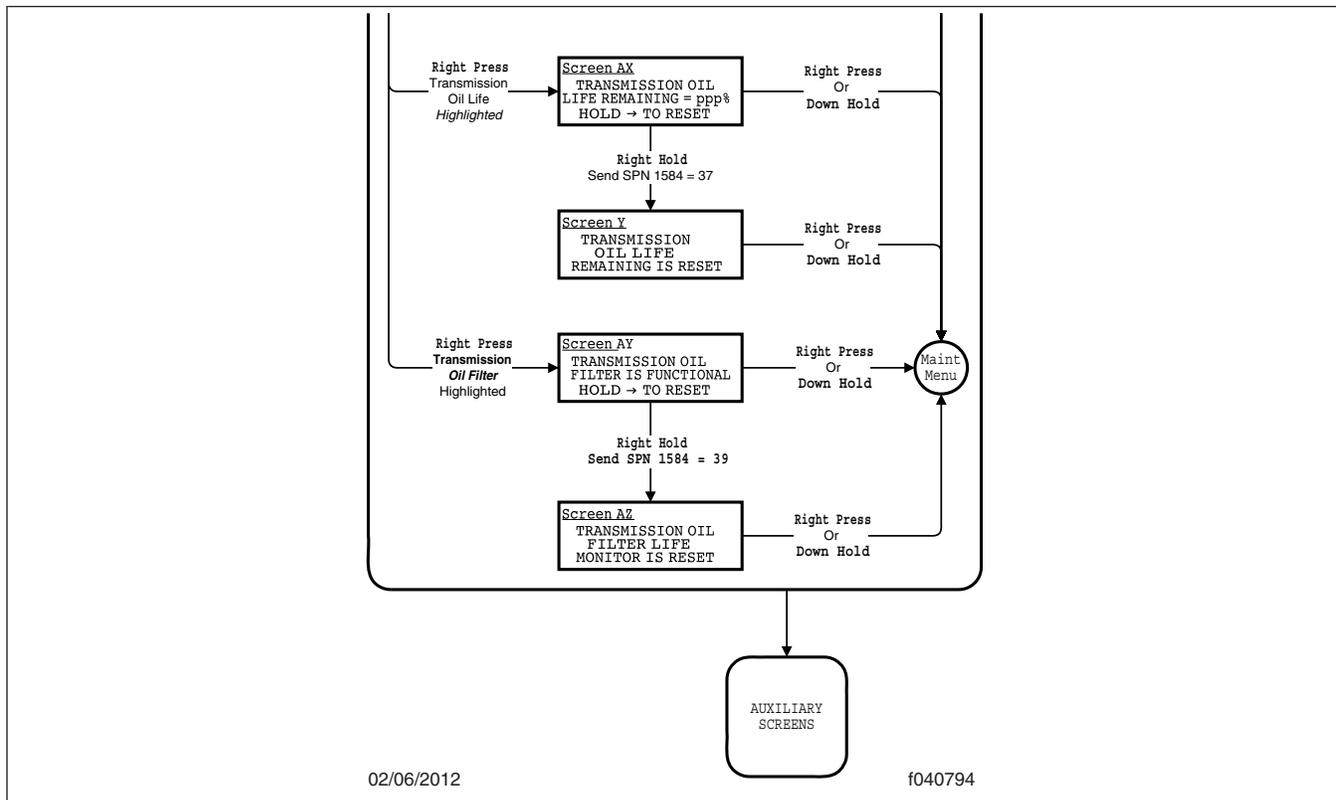


Fig. 2.14, Maintenance Menu Screens, Screen 2

engine manufacturer's operator's manual to perform a stationary regeneration.

## 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 on.

## 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.



**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.**

## Air Brake Indicator

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

## Hydraulic Brake System Warning

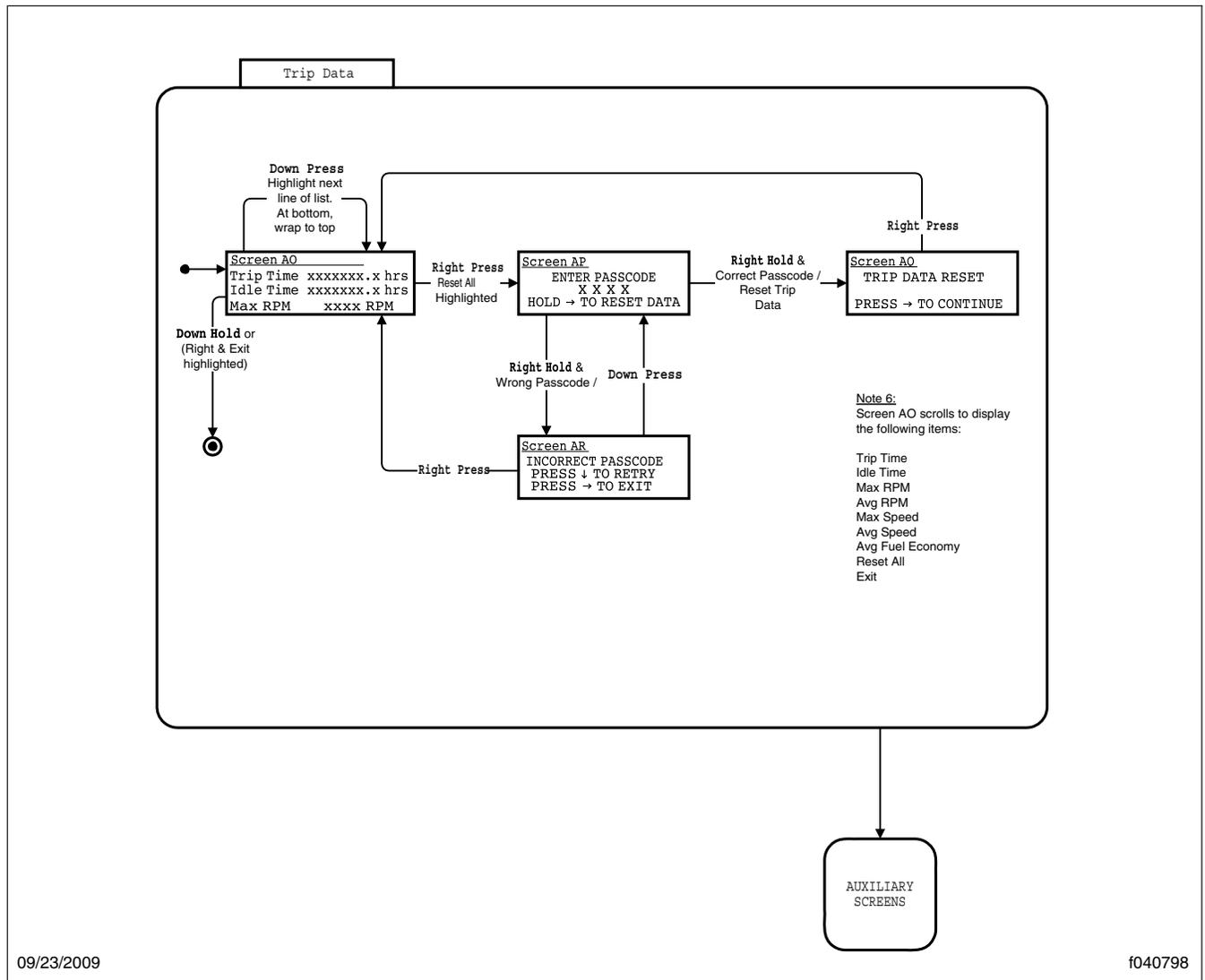
The red brake system warning illuminates if there is a hydraulic brake system failure, or if the vehicle is powered and the engine is not running.

## Headlight High-Beam Indicator

The blue high-beam indicator light illuminates when the headlights are switched to the high-beam position.

## Parking Brake On Indicator

The red parking brake indicator will flash for two minutes if the parking brake is not set when the ignition is turned off. It will also flash if the park brake is set



**Fig. 2.15, Trip Data**

and 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 and the driver display screen will show a PARK BRAKE SET message.

## Cruise Control Indicator

A green indicator illuminates when the cruise control is activated.

## Auxiliary Power Generator (hybrid only)

A green indicator illuminates when the auxiliary power generator is activated.

## Speedometer and Tachometer

Standard speedometers are shown in [Fig. 2.1](#), [Fig. 2.2](#), [Fig. 2.3](#), and [Fig. 2.4](#), item 2 respectively. Optional speedometer faces are available. The NAFTA version (not shown) of the speedometer face

# Instruments

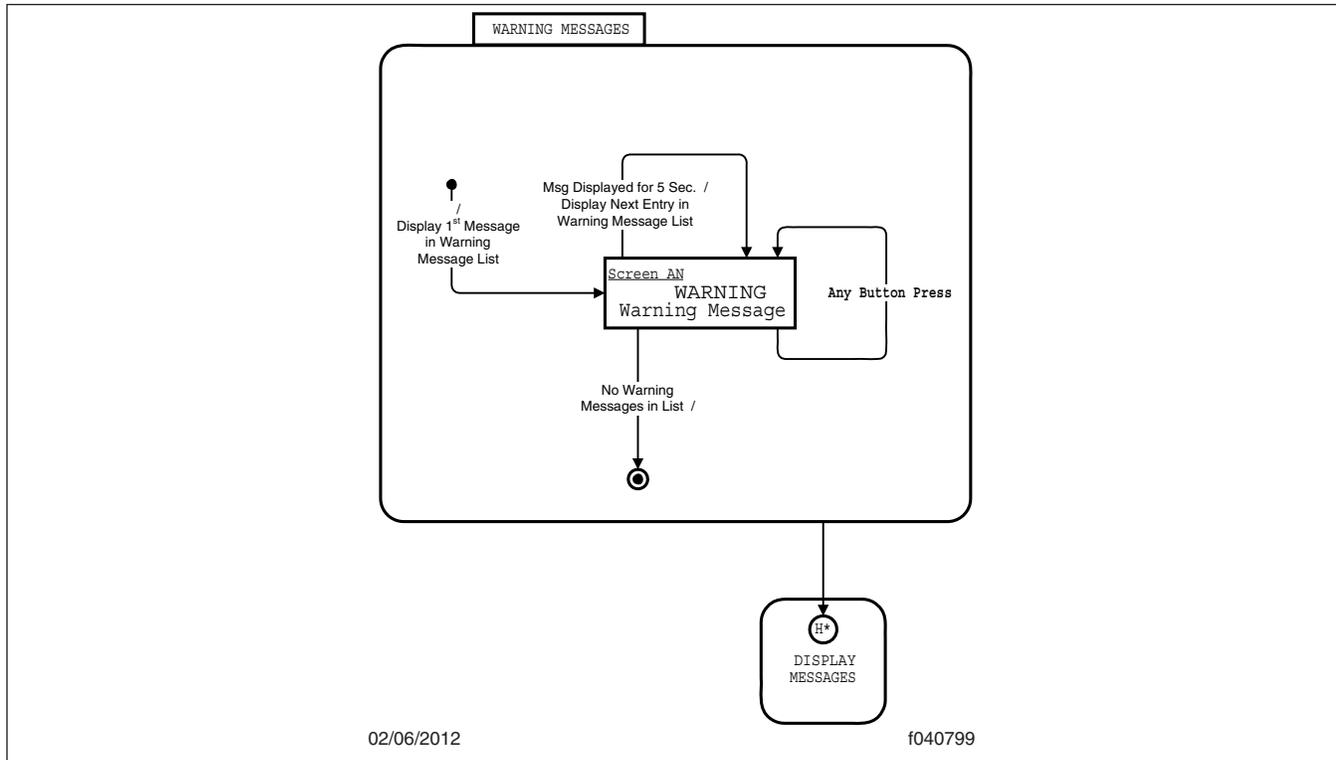


Fig. 2.16, Warning Messages

reverses this arrangement, with km/h in larger numbers.

A tachometer is available as an option. See "Optional Instruments."

## Standard Instruments

### Fuel Level Gauge

The fuel level gauge indicates the amount of fuel in the fuel tank.

### Low Fuel Warning Light

The low fuel warning light illuminates when the fuel level in the fuel tank drops to a predetermined level. When the low fuel warning light illuminates, refill the fuel tank as soon as possible.

### 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. If the engine oil pressure falls below preset levels, the check engine light will illuminate. If the condition does not improve, the CHECK engine 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.

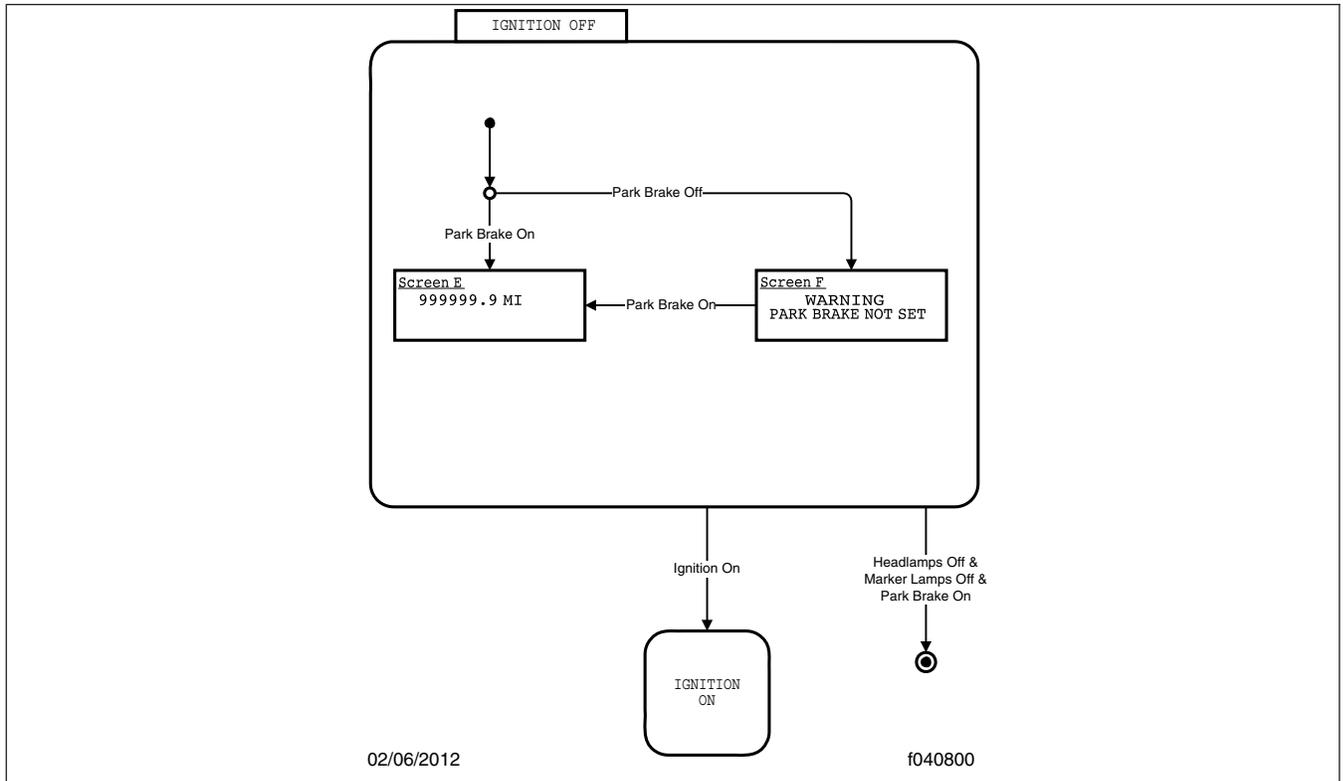


Fig. 2.17, Ignition Off (shown when ignition is keyed OFF)

## Low Oil Pressure Warning

The low oil pressure (oil can symbol) warning light illuminates and a buzzer sounds when the oil pressure falls below the minimum oil pressure recommended by the engine manufacturer.

## High Coolant Temperature Warning

A red high coolant temperature (thermometer symbol) warning light illuminates when the engine is running and the engine coolant temperature exceeds the maximum coolant temperature recommended by the engine manufacturer.

## 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.**

The coolant temperature gauge is mission-critical. If the coolant temperature rises above preset levels, the check engine light will illuminate. If the condition does not improve, the CHECK engine 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.

## Primary and Secondary Air Pressure Gauges

### WARNING

**If air pressure falls below minimum pressure, the braking ability of the vehicle will be limited. Slow the vehicle down and bring it to a gradual stop. Do not attempt to move the vehicle until air pressure has risen above the minimum level. Moving a vehicle without adequate braking power could**

# Instruments

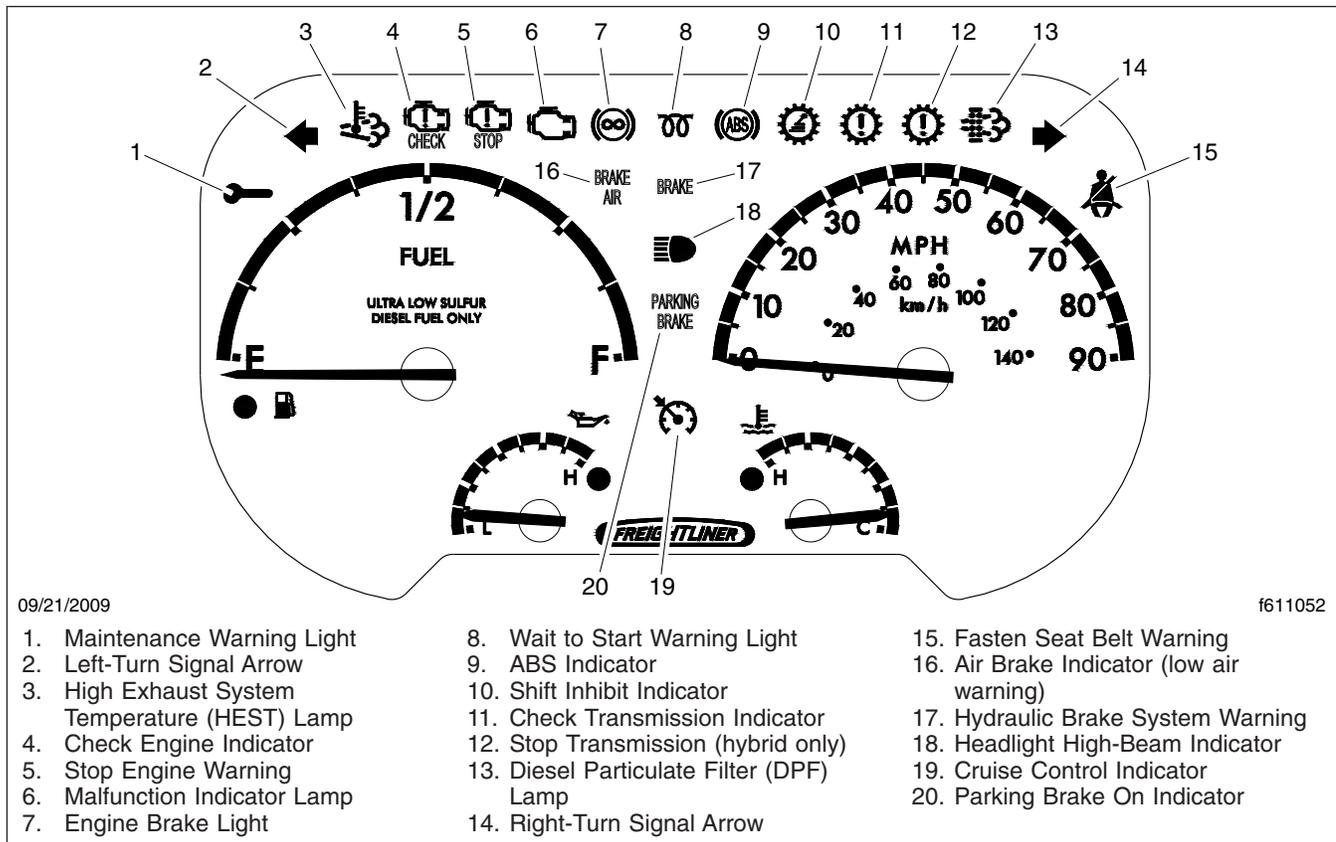


Fig. 2.18, Warning Lights, Diesel

cause an accident resulting in property damage, personal injury, or death.

Air pressure gauges register the pressure in the primary and secondary air systems. Normal pressure with the engine running is 100 to 120 psi (689 to 827 kPa) in both systems.

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

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

## Optional Instruments

### Air Intake Restriction Gauge

An intake-air restriction indicator, mounted in the engine compartment, measures the vacuum on the engine side of the air cleaner at the air cleaner outlet. See [Fig. 2.20](#).

Air intake restriction vacuum is measured in inches of water (inH<sub>2</sub>O). For vehicles equipped with a graduated indicator or a restriction gauge on the dash, check the gauge with the engine off. If restriction reaches 25 inH<sub>2</sub>O, replace the air cleaner element. Reset the indicator by pressing the button on the bottom.

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

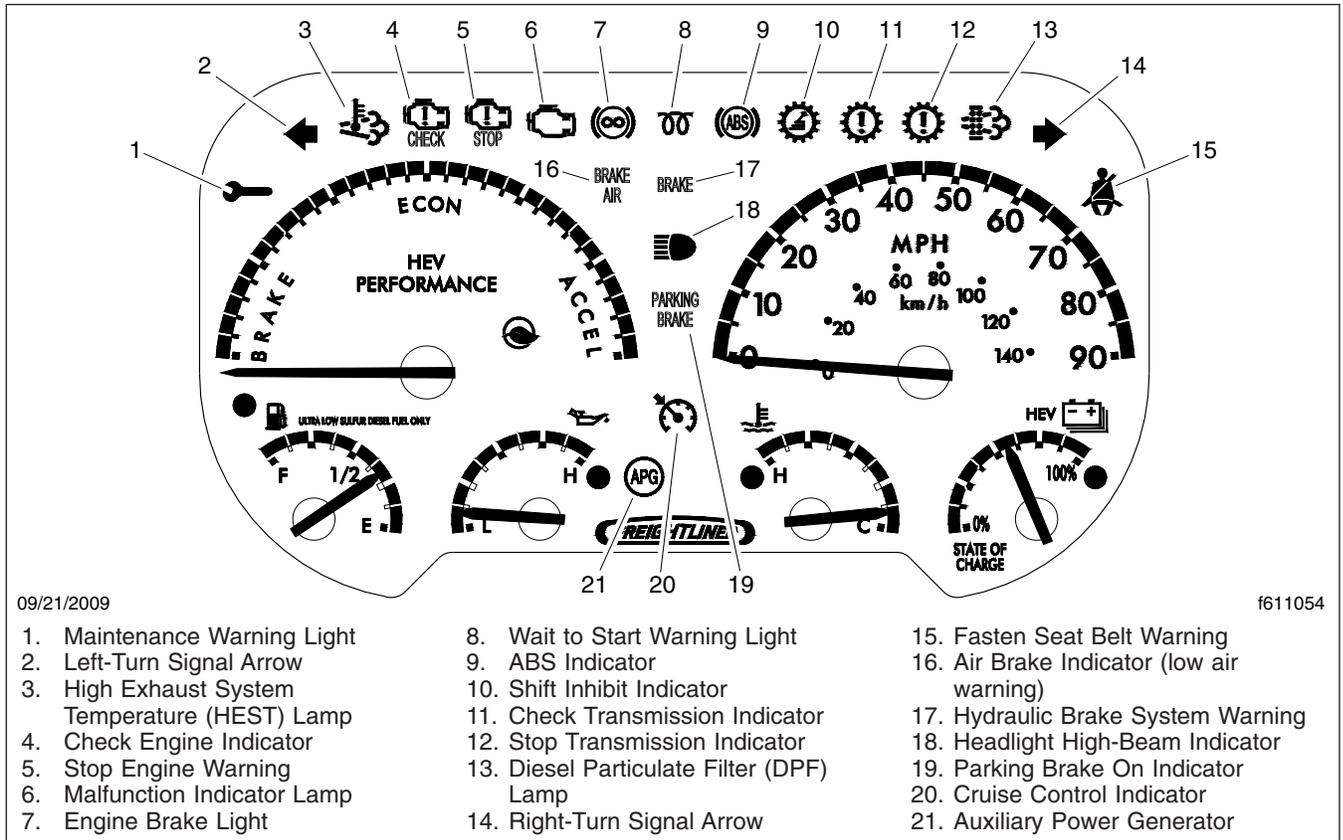


Fig. 2.19, Warning Lights, Hybrid Electric Vehicle

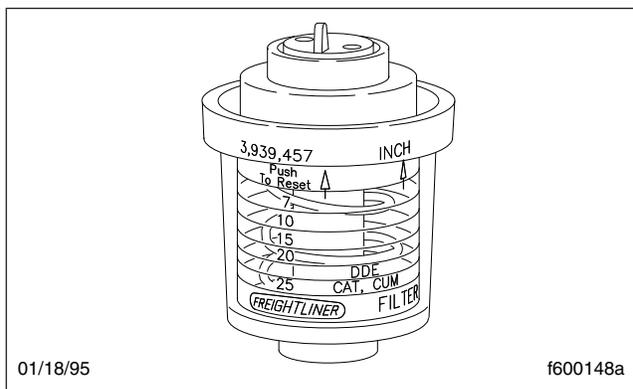


Fig. 2.20, Air Intake Restriction Gauge

## Single Air Pressure Gauge for Hydraulic Brakes with Air Provision

This option is only available with hydraulic brakes with air provision.

## Transmission Fluid Temperature Gauge

With an Allison automatic transmission, the transmission fluid temperature gauge reading should not exceed 250°F (121°C) during normal operation. If this occurs, a warning light will activate to alert the driver.

## Tachometer

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

# 3

## Controls

---

Ignition Switch and Key .....	3.1
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# Controls

## Ignition Switch and Key

On most vehicles, the ignition switch can be turned to four positions: ACCESSORY, OFF, ON, and START. See Fig. 3.1. An optional three-position keyless ignition switch does not have the ACCESSORY position.

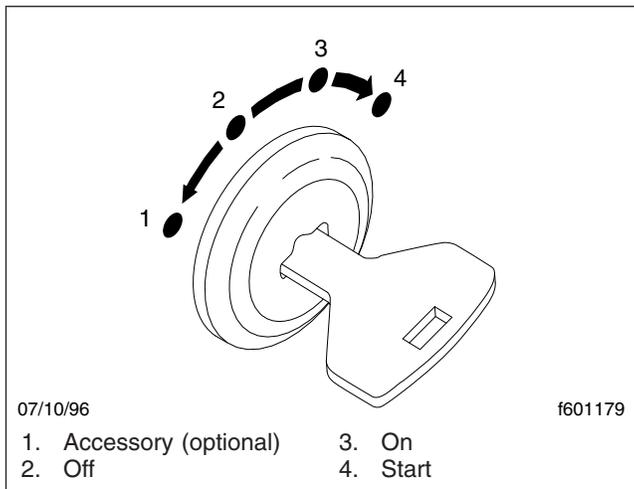


Fig. 3.1, Ignition Switch Positions

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

Turn the key fully clockwise to the START position, only when starting the engine. When the engine starts, release the key. When released, the key will rotate counterclockwise to the ON position.

In the ON position (key turned 45 degrees clockwise), all electrical systems are operable. The warning lights and the buzzer for low engine oil pressure operate until the engine is started and minimum engine oil pressure is achieved.

## Electrical System General Information

The Walk-In Van chassis uses multiple electrical signals that are carried along a simplified set of wires, reducing the size of wiring bundles. There are significantly fewer wires overall, meaning less chance of damage, shorts, and other problems. The information

in this chapter is to help familiarize the driver with the basic electrical system. Servicing the electrical system should be done only by qualified technicians. Special skills and equipment are required. Take the vehicle to an authorized Freightliner service facility for repairs.

### WARNING

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

## Battery Disconnect Switch (optional)

Some Walk-In Van 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 from power supplies in the event of an emergency. Mounting locations may vary. See Fig. 3.2.

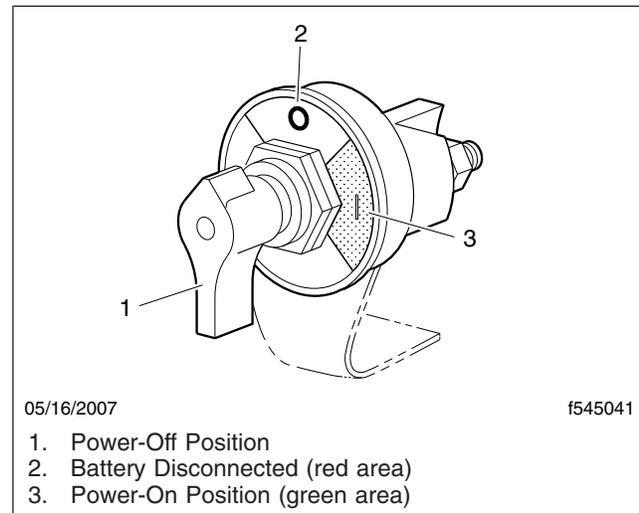


Fig. 3.2, Battery Disconnect Switch (optional)

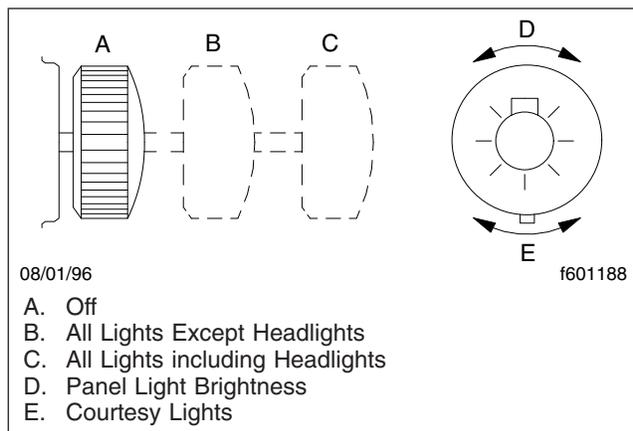
## Lighting Controls

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

## Headlight and Panel Light Controls

The control knob for the headlights, side marker lights, taillights, parking lights, license plate lights, and panel lights is located on the instrument panel. See **Fig. 3.3** and **Fig. 3.4**. Control knob positions are as follows:

- All lights are off if the knob is pushed all the way in.
- If pulled out to the first stop, all lights are on except the headlights.
- If pulled all the way out, all lights including the headlights are on.
- Turn the knob to the right to brighten the panel lights or turn it to the left to dim them.
- Turn the knob all the way to the left (past the click stop) to operate the courtesy lights.



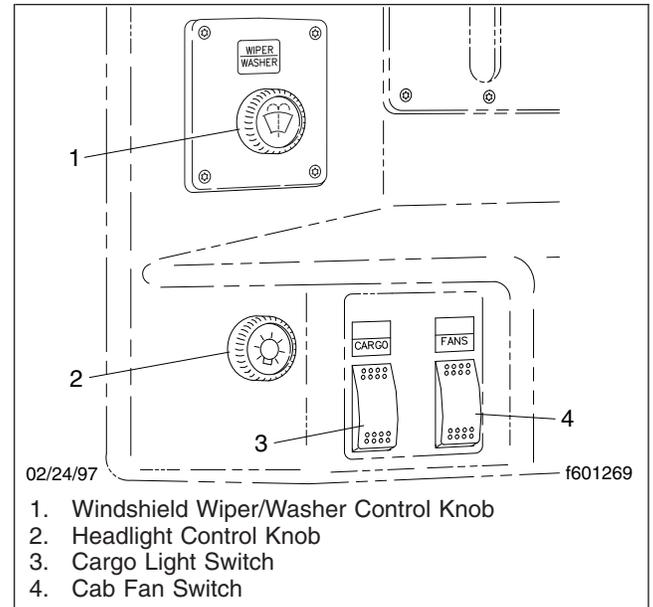
**Fig. 3.3, Headlight Control Knob**

## Headlight High-Beam/Dimmer Switch

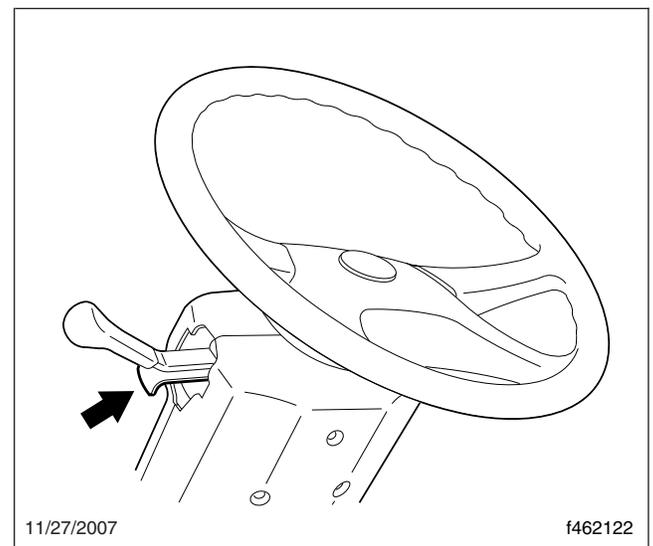
The headlight high beams are activated by pulling the turn signal lever toward the driver. When the headlights are on high beam, the high-beam indicator light comes on in the instrument panel.

## Hazard Warning Light Tab

The hazard warning light tab is located on the steering column under the turn signal lever. See **Fig. 3.5**. Pull the tab out to turn on the hazard warning lights. When the hazard warning light tab is pulled out, all of the turn signal lights and both of the indicator lights



**Fig. 3.4, Left-Hand Dash Panel**



**Fig. 3.5, Hazard Warning Light Tab**

on the control panel will flash. To cancel the warning lights, press the tab in.

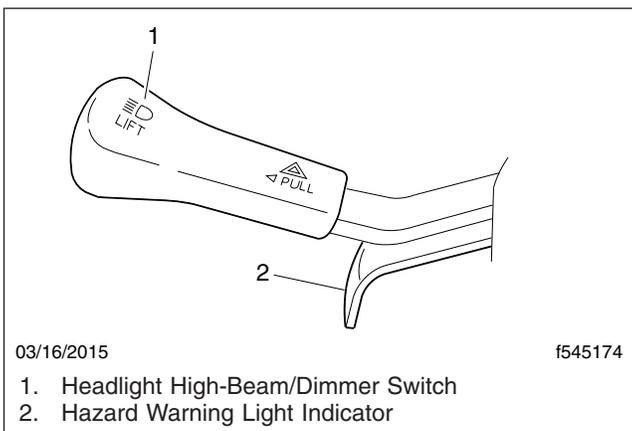
An additional hazard warning light control knob may be installed on the dash near the headlight controls. To activate the hazard warning lights, pull this knob out.

# Controls

## Turn Signal Switch

The turn signal switch lever is mounted on the steering column. See **Fig. 3.6**. Pushing the lever down turns on the left-turn signal lights; pulling the lever up turns on the right-turn signal lights. When one of the signal lights is on, a green indicator light flashes at the left or right side of the warning and indicator light panel. When the turn is completed, the signal will cancel and the lever will return to the neutral position.

**NOTE:** The hazard warning light indicator on the turn signal lever is to instruct the driver to pull the hazard warning light tab that is located under the turn signal lever.



**Fig. 3.6, Turn Signal Lever**

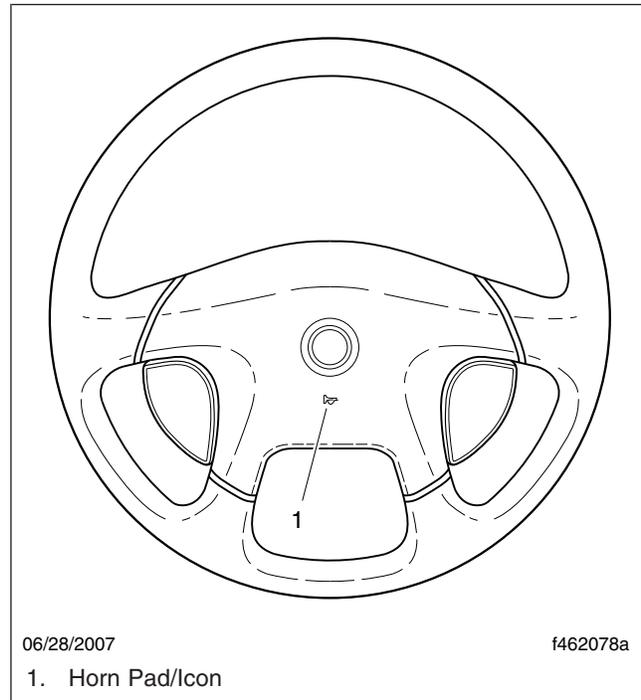
## Horn Controls

To sound the electric horn, push the horn icon on the steering wheel. See **Fig. 3.7**.

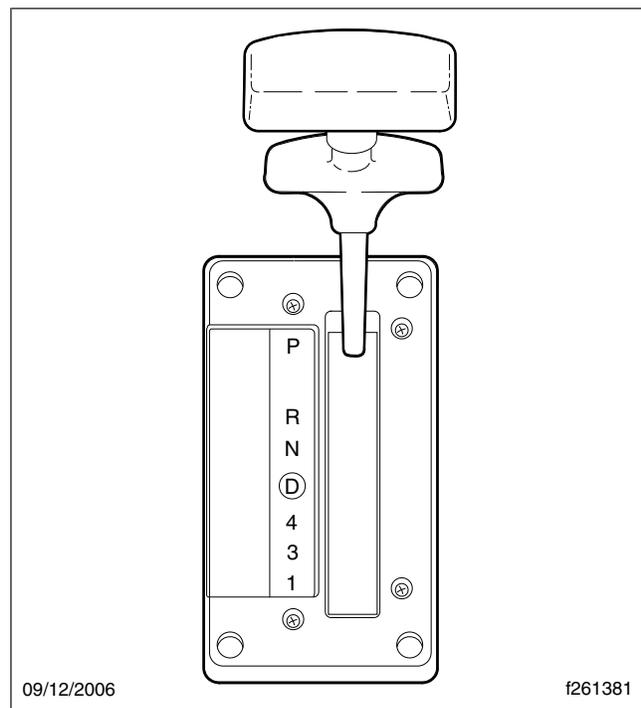
## Powertrain Controls

### Allison Automatic Transmissions

Allison automatic transmissions have either 6 or 7 shift positions on the selector lever. See **Fig. 3.8**. The selector lever is lighted for night driving. Electronically controlled transmissions have a push-button selector. See **Chapter 5** for complete transmission operating instructions.



**Fig. 3.7, Horn Control**



**Fig. 3.8, T-Handle Shift Control (typical)**

## Cruise Control (optional)

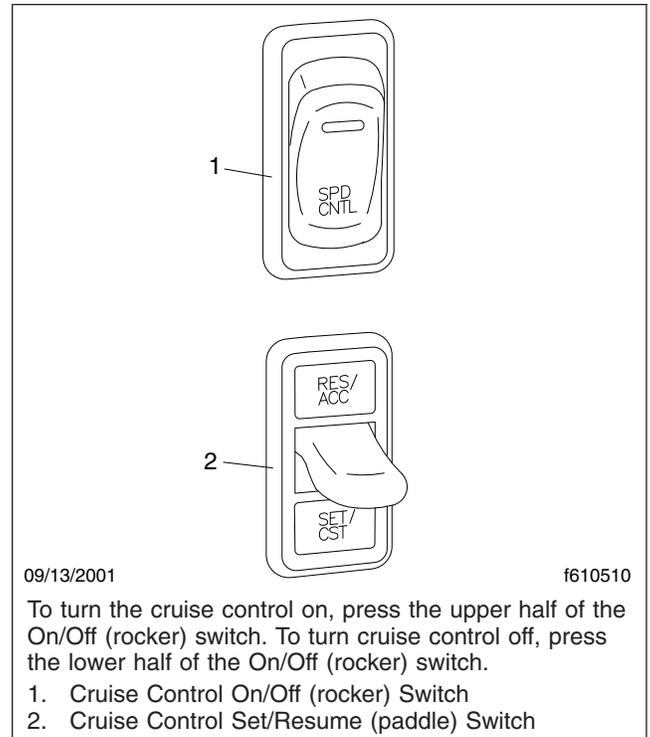
### **WARNING**

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.

NOTE: The maximum cruise control speed allowed is 75 mph (121 km/h). However, some vehicles may have a maximum cruise control speed that is lower than 75 mph (121 km/h), if the vehicle was ordered that way.

The cruise control is activated by two dash switches. See **Fig. 3.9**.

- The On/Off Switch—this two-position rocker switch bears the legend SPD CNTL on the lower half of the switch. When the cruise control is on, an amber light illuminates in the top part of the switch.
  - The Set/Resume Switch—this three-position paddle switch bears the legend RES/ACC above the paddle and SET/CST below the paddle.
1. To cruise at a particular speed, do these steps:
    - 1.1 Press the upper half of the On/Off (rocker) switch on the instrument panel.
    - 1.2 Hold the accelerator pedal down until the speedometer reaches the desired speed.
    - 1.3 Momentarily lower the paddle of the Set/Resume switch to SET/CST.
  2. To disengage the cruise control, do these steps:
    - 2.1 Press down the brake pedal (on automatic or manual transmission) *or*  
Press down the clutch pedal (on manual transmission only)
    - 2.2 Press the lower half of the On/Off (rocker) switch on the instrument panel.
  3. To resume a preselected cruise speed, do these steps:



**Fig. 3.9, Cruise Control Switches, Dash-Mounted**

- 3.1 If the On/Off (rocker) switch on the instrument panel is off, turn it on.
- 3.2 Momentarily raise the paddle of the Set/Resume switch to RES/ACC. Cruise will return to the last speed selected.

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

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

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

# Controls

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## Manual Dump Valve (optional)

On vehicles equipped with a manual dump valve, there are two ways to deflate the rear suspension. With the key in the OFF position, toggle the dump valve into the "lower" position. If the key is in the ON position, the parking brake must be set (ON) before the dump valve is toggled into the "lower" position.

NOTE: If the key is turned to the ON position and the parking brake is not engaged, the over-ride will cause reinflation of the air ride system.

## Backup Alarm (optional)

An optional backup alarm, sounds when Reverse ® gear is engaged. Check the operation of the backup alarm daily, if so equipped.

## Braking and Steering Controls

### Parking Brake Control

#### Hand-Operated Parking Brake

On all vehicles, a parking brake control lever is located to the left of the steering column. To apply the parking brake, depress the brake pedal, then pull up on the parking brake lever. To release the parking brake, depress the brake pedal and push the parking brake lever all the way down.

IMPORTANT: Take care to hold on to the parking brake lever while releasing it. Do **NOT** allow the lever to slam down while releasing it.

---

### NOTICE

---

**Overtightening of the knob can lead to cable breakage and/or damage to the knob and lever.**

If the parking brake does not hold the vehicle securely, depress the brake pedal and release the parking brake. Turn the knob on the end of the lever clockwise to increase the parking brake application.

If the parking brake still doesn't hold the vehicle securely (after adjustment), check the brake lining thickness. For instructions, see **Group 42** of the *Walk-In Van Chassis Maintenance Manual*.

#### Hydraulic Parking Brake (optional)

To apply the hydraulic parking brake, pull the yellow knob labeled PARKING BRAKE on the dash panel.

In order to release the hydraulic parking brake, the engine must be running (hydraulic pressure is needed to release the brake) and the gear selector must be in the Neutral (N) position. To release the parking brake, push the knob in.

---

### CAUTION

---

**On vehicles with hydraulic parking brakes, loss of all hydraulic pressure will cause the parking brake to automatically engage.**

NOTE: If the gear selector is not in the Neutral (N) position and the parking brake is on, a buzzer will sound to let the driver know to place the gear selector in the Neutral (N) position.

If the ignition key is in the OFF position and the parking brake is not applied, a buzzer will sound to let you know that you should apply the parking brake.

With the engine shut down, the hydraulic pump will actuate with your foot on the brake pedal; this could cause the battery to run down. If the engine is inoperable, see the "Emergency Release of Parking Brake" procedure that follows.

#### Emergency Release of Parking Brake (automatic transmission)

If your engine will not start and you want to release the parking brake, do the following. Block the wheels and turn the ignition switch to the ON position.

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### NOTICE

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**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.**

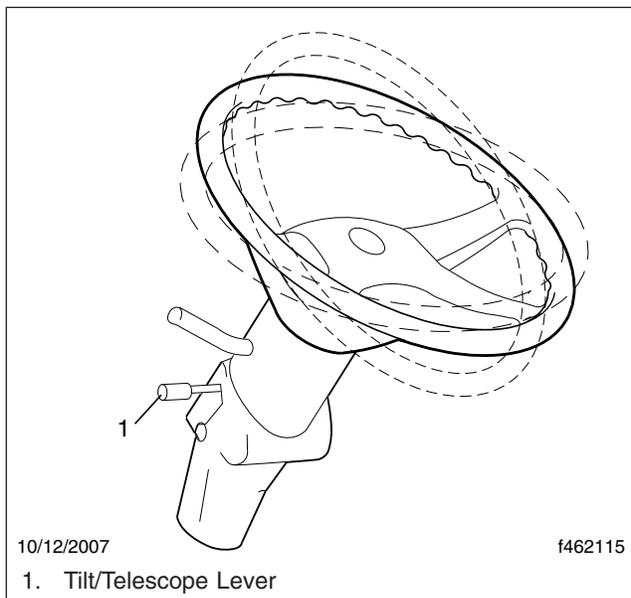
Use the ignition switch to turn the engine over several times with the gear shift selector in the Neutral (N) position and the parking brake knob in the released (pushed) position.

NOTE: The emergency release will not work in all cases. The system requires hydraulic fluid to provide pressure for the procedure to work. Since the system is pressurized when the brake is released, the parking brake will come back on

in 10 minutes, or longer depending on internal pressure.

## Tilt/Telescope Steering Column Lever Adjustment (optional)

To change the position of the steering wheel, pull the lever upward and move the steering wheel to the desired position. See [Fig. 3.10](#). Release the lever to lock the position. The steering wheel can be tilted up to provide easier exit and reentry.

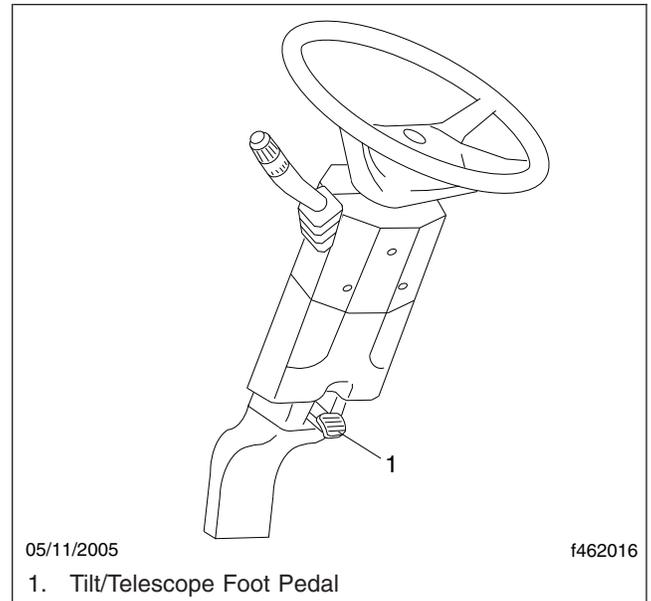


**Fig. 3.10, Tilt/Telescope Steering Column with Lever Adjustment**

If the chassis is equipped with a telescoping steering column, push the lever down and extend or retract the steering wheel as desired.

## Foot Pedal Adjustment (optional)

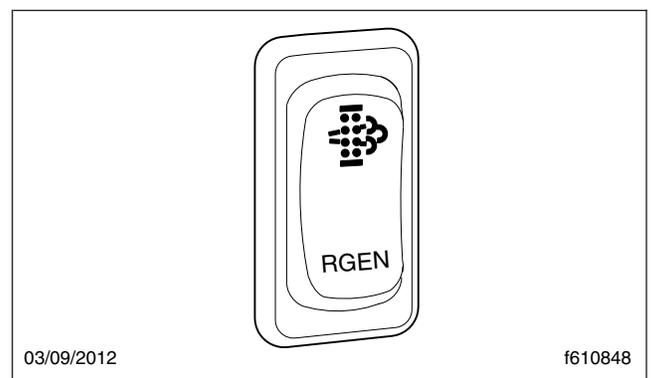
If the tilt/telescope steering column is equipped with a foot pedal adjustment, depress the foot pedal to move the steering column to the desired position. Release the foot pedal to lock the position. See [Fig. 3.11](#).



**Fig. 3.11, Tilt/Telescope Steering Column with Foot Pedal Adjustment**

## Dash-Mounted Controls

### Aftertreatment System (ATS) Regen Switch



**Fig. 3.12, ATS Regen Switch**

A regen switch is located on or under the dash with which the driver can control two states. See [Fig. 3.12](#). These include:

- Request regeneration
- Default (automatic regeneration)

# Controls

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

## Low Idle Adjustment Switch

**NOTE:** The low idle adjustment switch is not available on hydraulic hybrid units.

On some vehicles equipped with Cummins ISB engines, the engine low idle speed can be adjusted in 25 rpm increments with a low idle adjustment switch. On these vehicles, the engine control unit is programmed to allow low idle speeds between 700 and 875 rpm.

## Windshield Wiper Switch

The windshield wipers are controlled by a dash-mounted knob. See [Fig. 3.4](#). For a single wipe cycle, turn the knob counterclockwise. Hold it in this position until the wipers start, then release the knob. For steady wiping at low speed, turn the knob clockwise one position. For high-speed wiping, turn the knob clockwise to the high-speed position.

**NOTE:** Heavy snow or ice can overload the wiper motor. A circuit breaker will stop the motor until it cools. Make sure that the windshield is cleared of snow or ice to prevent a circuit overload.

## Windshield Washer Switch

Push in and hold the windshield wiper control knob until the desired amount of washer fluid is sprayed on the windshield. See [Fig. 3.4](#). The wipers will operate on low speed until they are turned off.

# 4

## Engines

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Engine Starting .....	4.1
Engine Operation .....	4.2
High Idle Options .....	4.3
Exhaust Aftertreatment System (ATS) .....	4.3
Engine Shutdown .....	4.9

# Engines

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## Engine Starting

### General Information

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** and **Chapter 3** of this manual for detailed information on how to read the instruments and operate the controls.

### 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 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 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.

## 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.

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.

# Engines

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- 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 Idle Options

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

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

## High Idle with Cruise Control

1. Place the shift lever in Neutral (N) or Park (P) and set the parking brake.
2. Press the cruise switch located on the dash to the ON position. Press the RESUME switch to accelerate the engine revolutions per minute (rpm) to the minimum set speed. To increase the engine rpm, press and hold the RESUME switch. To decrease the engine rpm, press and hold the SET switch.

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

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

## Voltage-Based Auto High Idle

1. Place the shift lever in Neutral (N) or Park (P) and set the parking brake.
2. The idle rpm will automatically increase when the voltage drops below 12.2 volts for 10 seconds. The rpm will incrementally increase every five seconds until 13.4 volts is achieved and maintained.

3. The Voltage-Based Auto High Idle system is disengaged by depressing the service brake pedal.

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

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

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

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## NOTICE

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**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 run-

ning 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.

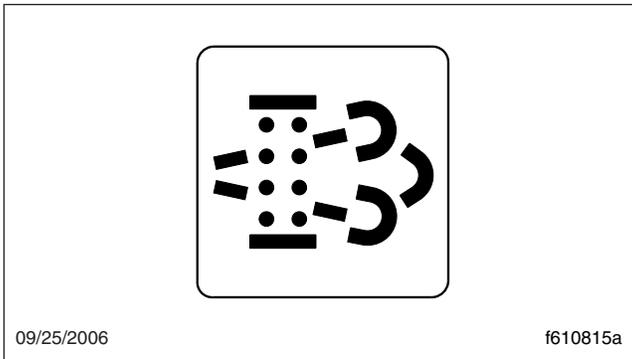
After the exhaust stream passes through the ATD, it flows through another canister housing the SCR device. A controlled quantity of diesel exhaust fluid (DEF) is injected into the exhaust stream, where heat converts it to ammonia (NH<sub>3</sub>) gas. This mixture flows through the SCR device, where the ammonia gas reacts with the NOx in the exhaust, to produce harmless nitrogen (N<sub>2</sub>) and water vapor (H<sub>2</sub>O), 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.

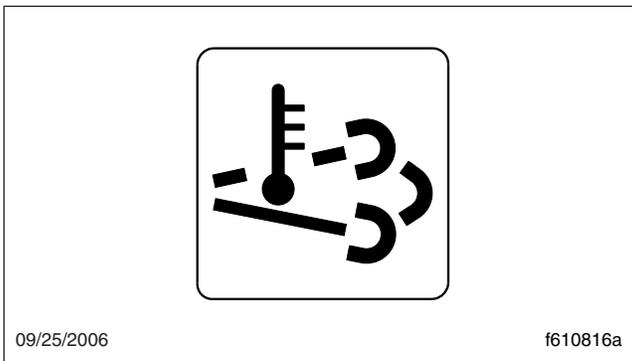
- An illuminated DPF lamp indicates a regen is needed. See [Fig. 4.1](#).
- A slow, 10-second flashing of the high exhaust system temperature (HEST) lamp alerts the driver that a parked regen is in progress, but the exhaust temperatures are still relatively

# Engines



**Fig. 4.1, Diesel Particulate Filter (DPF) Lamp**

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



**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](#).

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 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, 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.

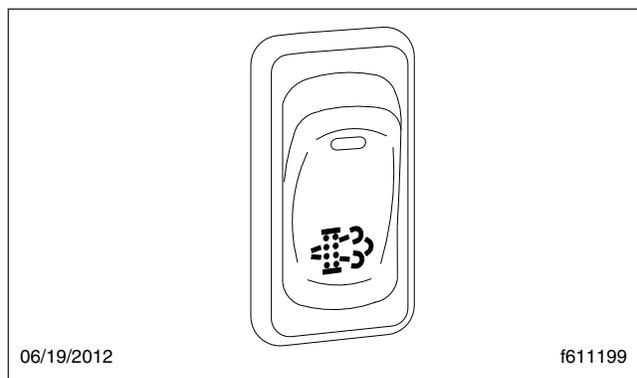
3. Press and hold the regen switch for 4 seconds. The engine will increase rpm and initiate the regen process.
4. The regen cycle will finish after 20 to 60 minutes, at which time engine idle speed will drop to normal and the vehicle can be driven normally. The HEST lamp may be illuminated, but will 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.

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.	<b>Flashing</b> 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.	<b>Solid</b> 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.					
<b>See Engine Operator's Manual for complete Regeneration Instructions.</b>					
<small>24-01583-000B</small>					

06/29/2009

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**Fig. 4.3, Exhaust-Aftertreatment Warnings Reference Label**



06/19/2012

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**Fig. 4.4, Regen Switch**

## 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

# Engines

DEF is frozen; an immersion heater with engine coolant flowing through it warms the DEF once the engine is running, allowing the SCR system to operate.

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

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

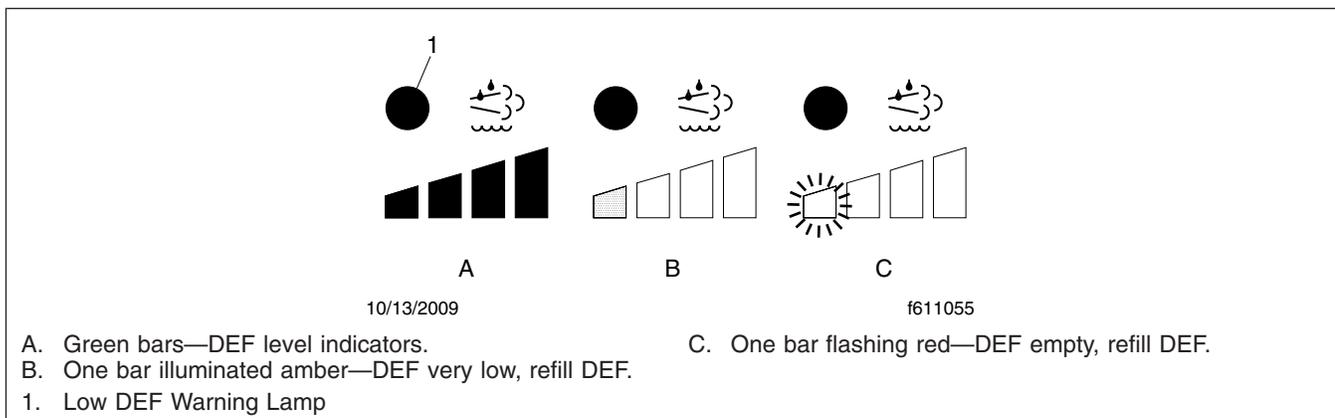
## DEF Tank

Engines that are compliant with EPA10 and newer regulations are equipped with a DEF tank located between the ATS and the fuel tank, or an optional location forward of the fuel tank. The DEF tank has a 19 mm filler neck inlet that prevents the hose from a diesel outlet from being inserted, and has a blue cap for easy identification.

The DEF tank will require filling a minimum of approximately every second diesel refuel depending on the DEF tank capacity. The Walk-In Van uses a 10-gallon tank capacity. DEF consumption is approximately 2% of fuel consumption, dependent on vehicle operation. For every 50 gallons of diesel fuel consumed, approximately 1 gallon of DEF will be consumed.

## DEF Gauge

The DEF level is measured in a stand-alone gauge. See [Fig. 4.5](#).



**Fig. 4.5, DEF Gauge**

The DEF gauge has a warning lamp that illuminates when the DEF tank is near empty, and a DEF light-bar 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

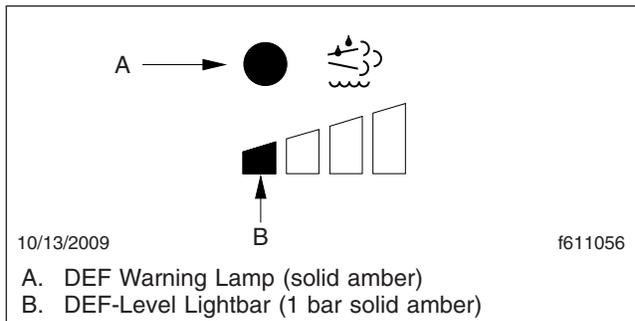
## DEF Warnings and Engine Limits

**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. 4.6](#).

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



**Fig. 4.6, DEF Level Low Initial and Critical Warnings**

## DEF Empty

When the DEF level reads empty, the following warnings are activated. See [Fig. 4.7](#).

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

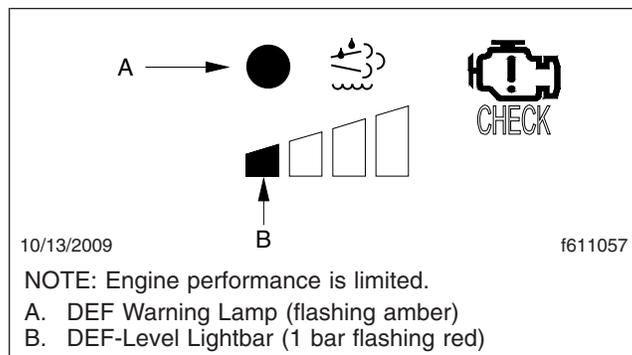
Engine performance is limited, with progressively harsher engine power limits applied.

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

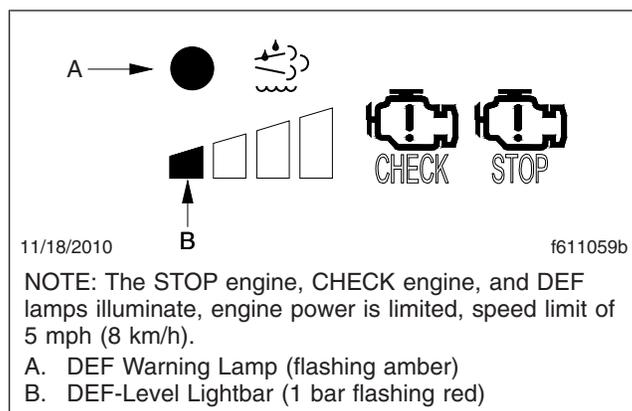
## DEF Level Empty and Ignored

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. 4.8](#).

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



**Fig. 4.7, DEF Empty Warning**



**Fig. 4.8, 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. 4.8](#).

# Engines

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## 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

## Transmissions

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Allison Automatic Transmissions .....	5.1
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# Transmissions

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## Allison Automatic Transmissions

### General Information

Allison four- and five-speed automatic transmissions have six or seven shift positions on the selector lever. The selector lever is lighted for night driving. Each forward shift position provides a range of forward gears that are selected automatically according to the speed of the vehicle, engine temperature, and throttle position. The 1000 Series, 2000 Series, and 2500 Series are fully automatic transmissions. See the Allison website for additional information, at [www.allisontransmission.com](http://www.allisontransmission.com).

### 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 7](#) 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 downshift the transmission. Do not hold the brake pedal down too long or too often while going down a steep or long grade. This could cause the brakes to overheat, reducing their effectiveness. As a result, the vehicle will not slow down at the usual rate. Failure to take these steps could result in loss of vehicle control.**

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

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

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.

### Series 1000, 2000, and 2500 Transmission Operation

#### WARNING

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

#### 1000 Series

On vehicles with Allison 1000 series transmissions, do the following steps if you have to leave the cab with the engine running (for example, when checking the transmission fluid):

##### Without Park (P) Position

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

##### With Park (P) Position

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.

3. Put the transmission in Park (P).
4. Apply the parking brake and make sure that it is properly engaged.
5. Engage the Park (P) range by slowly releasing the service brake.
6. Check the rear tires and take any other steps necessary to keep the vehicle from moving.

## 2000 Series

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

### Without Auto-Apply Parking Brake (PB)

Follow the instructions for vehicles with 1000 series transmissions, under the heading "Without Park (P) Position."

### With Auto-Apply Parking Brake (PB)

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.
3. Put the transmission in Auto-Apply Parking Brake (PB).
4. Ensure that the parking brake is properly engaged.
5. Check the rear tires and take any other steps necessary to keep the vehicle from moving.

## 2500 Series

On vehicles with 2500 series transmissions, instructions are as follows.

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.
3. Put the transmission in Park (P).
4. Apply the parking brake and make sure that it is properly engaged.
5. Engage the Park (P) range by slowly releasing the service brake.
6. Check the rear tires and take any other steps necessary to keep the vehicle from moving.

## Range Inhibit Indicator, 2000 Series

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

Shift inhibits occur under the following conditions:

- Shifts from Neutral (N) to Reverse (R) or from Neutral (N) to a forward range when the engine is above idle, greater than 900 rpm.
- Forward/Reverse (R) directional shifts are typically not permitted if appreciable output shaft speed is detected.
- When some types of unusual transmission operating conditions are detected by the TCM, the TCM temporarily limits transmission operation until the vehicle can be driven to a service location. When this type of situation is detected, the TCM will lock the transmission in a safe gear range.

## Operating Instructions, On-Highway Transmissions

Allison 1000/2000/2500 automatic transmissions are electronically controlled and provide five or six forward ranges and one Reverse (R) range. Typically, a T-handle shift control is used by the driver to select the ranges. See [Fig. 5.1](#) and [Fig. 5.2](#).

### Park (P) [optional on 1000 and 2500 Series]

Use Park (P) when starting or shutting down the engine, to check vehicle accessories, and to operate the engine in idle for longer than 5 minutes. This position places the transmission in Neutral (N) and engages the park pawl.

### Auto-Apply Parking Brake (PB) [optional on 2000 Series]

The Auto-Apply Parking Brake (PB) places the vehicle in Neutral (N) and applies the parking brake.

# Transmissions

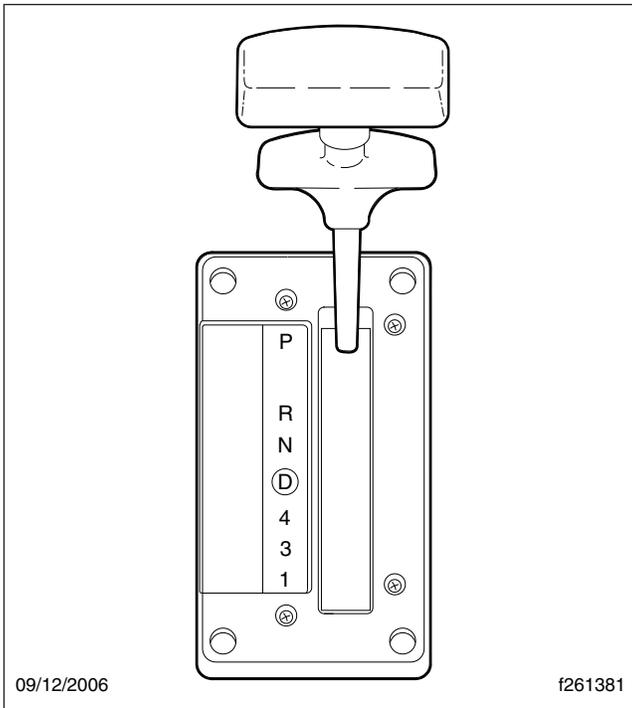


Fig. 5.1, T-Handle Shift Control (typical shifter)

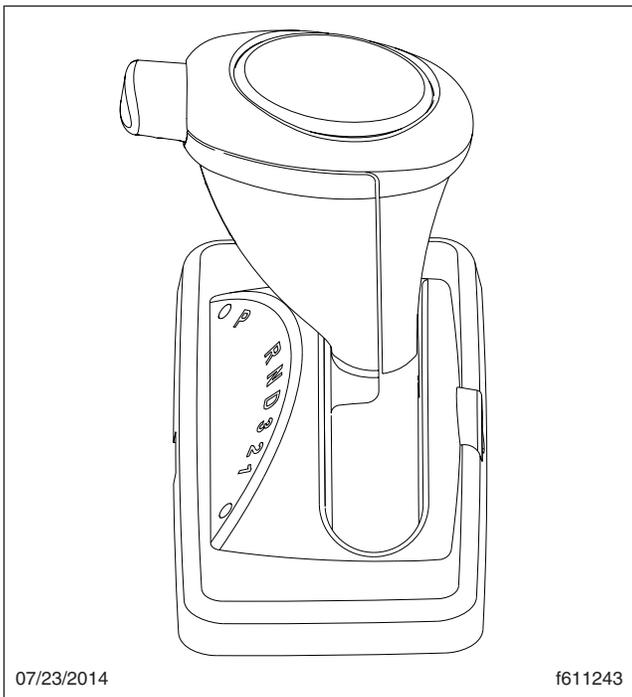


Fig. 5.2, T-Handle Shift Control (optional shifter)

## Reverse (R)

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

## NOTICE

**Extended idling in Reverse (R) may cause transmission overheating and damage.**

Do not idle in Reverse (R) for more than 5 minutes. Select Park (P), Auto-Apply Parking Brake (PB), or Neutral (N) when time at idle exceeds 5 minutes.

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

## Neutral (N)

The Neutral (N) position places the transmission in Neutral (N). This position is used when starting the engine and for stationary operation.

## WARNING

**Failure to apply the vehicle parking brakes when the transmission is in neutral may allow the vehicle to move unexpectedly, possibly causing property damage or personal injury.**

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

## WARNING

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

Do not let the vehicle coast in Neutral (N). If the vehicle is allowed to coast in Neutral (N), you could lose control of the vehicle.

## NOTICE

**Coasting in Neutral (N) can cause severe transmission damage.**

### Drive (D)

#### **WARNING**

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

In the Drive (D) position, the transmission will initially go into First (1) range when Drive (D) is selected. As vehicle speed increases, the transmission will upshift automatically through each available range up to Fourth (4) range or Fifth (5) range. As the vehicle slows, the transmission will downshift automatically.

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

## NOTICE

**Do not idle in Drive (D) for more than 5 minutes. Extended idling in Drive (D) may cause transmission overheating and damage. Always select Auto-Apply Parking Brake (PB) or Park (P) if time at idle is longer than 5 minutes.**

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

### Fourth and Third Ranges (4 and 3) [optional]

Use the Fourth (4) or Third (3) range for city traffic and for braking on steep downgrades.

### Third and Second Ranges (3 and 2) [standard]

Use the Third (3) or Second (2) range for heavy city traffic and for braking on steeper downgrades.

### First Range (1)

Use First (1) range when pulling through mud or deep snow, when maneuvering in tight spaces, or when driving up or down very steep grades. First (1) range provides the vehicle with its maximum driving torque and maximum engine braking effect.

# 6

## Steering System

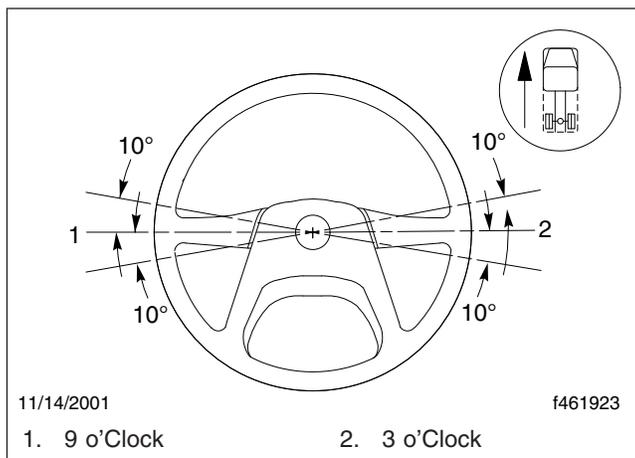
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Steering General Information .....	6.1
Power Steering System .....	6.1
Tilt/Telescope Steering Column .....	6.1

# Steering System

## Steering General Information

When there is no load on the vehicle and the front tires are pointed straight ahead, the steering wheel spokes should be at the 9 o'clock and 3 o'clock positions, or within 10 degrees to either side. See **Fig. 6.1**. See **Group 46** of the *Walk-In Van Chassis Workshop Manual* for steering adjustment procedures.



**Fig. 6.1, Steering Wheel Centered**

## Power Steering System

The power steering system consists of a steering gear (which includes a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder), hydraulic hoses, power steering pump, reservoir, and other components. The power steering pump, driven by the engine, provides the power assist for the steering system. If the engine is not running, there is no power assist.

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

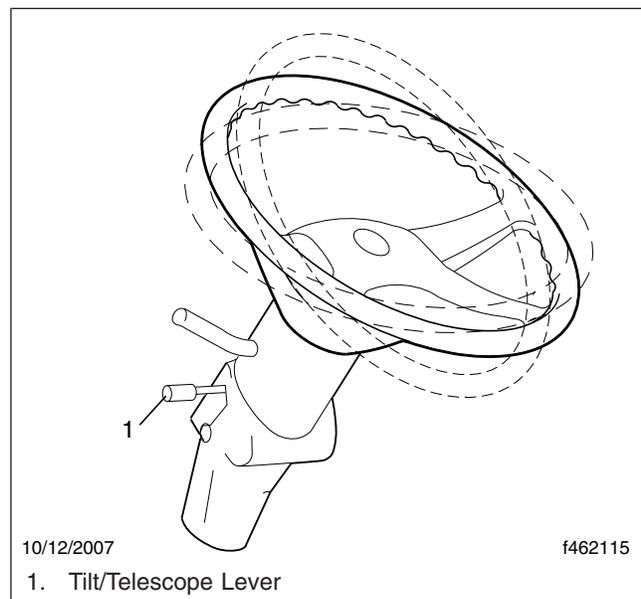
### **WARNING**

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

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

## Tilt/Telescope Steering Column Lever Adjustment (optional)

To change the position of the steering wheel, pull the lever upward and move the steering wheel to the desired position. See **Fig. 6.2**. Release the lever to lock the position. The steering wheel can also be tilted up to provide easier exit and reentry.



**Fig. 6.2, Tilt/Telescope Steering Column with Lever Adjustment**

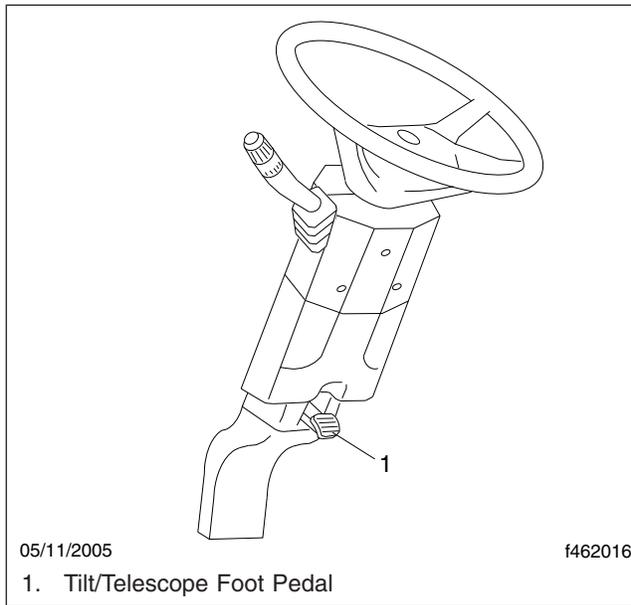
If the chassis is equipped with a telescoping steering column, push the lever down and extend or retract the steering wheel as desired.

### **WARNING**

Make sure that the control lever is in the locked (neutral) position before driving the vehicle. Never tilt the column while driving the vehicle. Doing so could cause loss of vehicle control and result in personal injury and property damage.

## Foot Pedal Adjustment (optional)

If the tilt/telescope steering column is equipped with a foot pedal adjustment, depress the foot pedal to move the steering column to the desired position. Release the foot pedal to lock the position. See **Fig. 6.3**.



**Fig. 6.3, Tilt/Telescope Steering Column with Foot Pedal Adjustment**

### **WARNING**

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

# 7

## Hydraulic and Air Brake Systems

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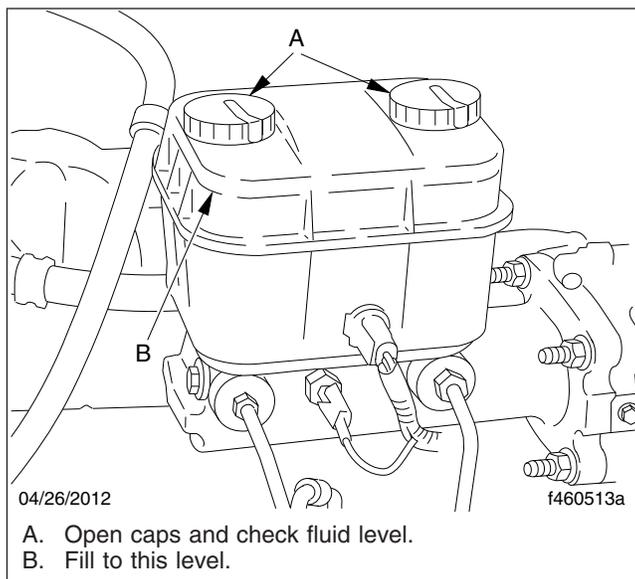
Hydraulic Brake System .....	7.1
Air Brake System .....	7.2

# Hydraulic and Air Brake Systems

## Hydraulic Brake System

### General Information

The hydraulic brake system includes a power booster, master cylinder, reservoir, hydraulic brake lines, a brake rotor on each wheel hub, and a brake caliper and pad assembly at each rotor. See [Fig. 7.1](#).



**Fig. 7.1, Hydraulic Brake Reservoir (MT-45 and MT-55)**

**IMPORTANT:** Make sure that the fluid in the master cylinder reservoirs is up to the level of the ridge that surrounds the reservoir. Use only heavy-duty brake fluid, DOT 3, in the hydraulic brake system.

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. See **Group 42** of the *Walk-In Van Chassis Workshop Manual* for hydraulic brake system troubleshooting and adjustment procedures.

### Operation

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

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

### Meritor WABCO® Antilock Braking System (ABS)

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, the front and rear tires must rotate at speeds within 16% of one another. Installing different sized tires on just the front or rear axle will 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 frame rail) that 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 wheel slip 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

# Hydraulic and Air Brake Systems

is switched to the ON position. Once the vehicle moves faster than about 4 mph (6 km/h), the warning light goes out only if all of the vehicle's ABS components are working properly.

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. Since these components are an integral part of the hydraulic brake system, normal braking may be impaired or inoperative.

**IMPORTANT:** If the ABS warning light does not work as described above or comes on while driving, repair the ABS system immediately to ensure full antilock braking capability.

See the diagnostic menu screens in **Chapter 2**, and follow the steps to read the fault codes in the instrument panel diagnostic menu.

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.

## WARNING

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

## Air Brake System

### General Information

A dual air brake system consists of two independent air brake systems that use a single set of brake controls. Each system has its own reservoir, plumbing, and brake chambers. The primary 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.**

Before driving your vehicle, allow time for the air compressor to build up a minimum of 95 psi (655 kPa) pressure in both the primary and the 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 comes 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.

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 (Shrader) Valve

If your engine will not start and it is desirable to release the parking brake, do the following: Block the wheels. Turn the ignition switch to the ON position. Fill the air reservoir for the braking system by external means. 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 psi (448 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.

# Hydraulic and Air Brake Systems

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## 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.

During normal braking stops, depress the foot brake control pedal until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop. When the forward speed of the vehicle has decreased to almost the idling speed of the engine, push the clutch pedal in (if equipped) and shift the transmission into Neutral (N). Apply the hand 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. Pull out the knob to apply the parking brake. See [Fig. 7.2](#).



Fig. 7.2, 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 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 First (1) gear and lightly apply the brakes to heat and dry them.

Allow hot brakes to cool before using the parking brake. Always chock the tires.

## Automatic Slack Adjusters

Automatic slack adjusters are required on all vehicles equipped with air brakes manufactured after October 20, 1994. Automatic slack adjusters should never be manually adjusted except during routine maintenance of the foundation brakes (e.g., replacing shoes), during slack adjuster installation, or in an emergency situation.

When the brake pushrod stroke exceeds the legal brake adjustment limit on a vehicle, there is likely a mechanical problem with the foundation brake components or the adjuster is improperly installed.

Visit a repair facility as soon as possible when brakes equipped with automatic slack adjusters are determined to be out of adjustment.

### **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.**

# 8

## Compressed Natural Gas Fuel System

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CNG General Information .....	8.1
CNG Fuel Tank Filling Procedure .....	8.1
Engine Starting .....	8.2
CNG Safety Precautions .....	8.3

# Compressed Natural Gas Fuel System

## CNG General Information

Natural gas is a mixture of hydrocarbon gasses with a high concentration of methane gas, which burns completely into carbon dioxide and water, resulting in lower emissions than with diesel or gasoline.

Natural gas is less energy dense than diesel, therefore, a larger volume of natural gas is required to produce the same power. This is one reason for the slightly lower maximum power in natural-gas-powered vehicles. The power difference is a reduction in maximum power only and does not affect normal driving. The power reduction is evidenced only in wide-open throttle, high-torque conditions.

**IMPORTANT:** The natural gas fuel system should be routinely inspected for gas leakage. Use a natural gas detector to check the fuel tanks, fuel filtering and regulating mechanisms, and the fuel lines. If necessary, replace leaking fuel tanks; repair or replace any lines, devices, or connections that are leaking.

Natural gas is nontoxic, but it can cause asphyxiation in certain circumstances. Commercial compressed natural gas normally contains an odor-producing chemical, which enables users to detect gas leaks, but a natural gas detector is recommended for checking for leaks.

A typical natural gas fuel system consists of:

- Fuel supply containers or tanks storing the gas at high pressure.
- A pressure relief valve and manual shutoff valves.
- A filling connection with a check valve to prevent the gas from flowing back out of the connection.
- A valve that automatically closes if the engine stops.
- A high-pressure fuel filter and a low-pressure fuel filter.
- A pressure regulator to reduce the fuel tank pressure to the lower pressure needed for the engine.
- A gas-air mixer to produce a flammable mixture for the engine.

- A pressure gauge to indicate the fuel supply in the tanks.

## CNG Fuel Tank Filling Procedure

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

CNG fuel cylinders cannot be filled to their full capacity of 3600 psi (24 821 kPa) in cooler weather. Since temperature change causes gas to expand and contract, less pressure in the cylinders on a cold day is equal to the same amount of gas at a higher pressure on a warm day. The fuel station dispenser has a temperature-pressure compensating device, which accounts for ambient temperature during fueling. See **Table 8.1** for approximate full cylinder pressures at various temperatures.

CNG Temperature/Pressure Compensation Values		
Temperature: °F (°C)	Fill Station Pressure Set Point	
	3000 psi (20 684 kPa) Set Point	3600 psi (24 821 kPa) Set Point
100 (37.8)	3415 (23 546)	4086 (28 172)
90 (32.2)	3276 (22 587)	3909 (26 952)
80 (26.7)	3138 (21 636)	3754 (25 883)
70 (21.1)	3000 (20 684)	3600 (24 821)
60 (15.6)	2861 (19 726)	3445 (23 752)
50 (10)	2723 (18 774)	3288 (22 670)
40 (4.4)	2584 (17 816)	3131 (21 587)
30 (-1.1)	2446 (16 865)	2973 (20 498)
20 (-6.7)	2307 (15 906)	2814 (19 402)
10 (-12.2)	2169 (14 955)	2655 (18 306)
0 (-17.8)	2031 (14 003)	2495 (17 202)
-10 (-23.3)	1893 (13 052)	2336 (16 106)
-20 (-28.9)	1755 (12 100)	2180 (15 031)
-30 (34.4)	1616 (11 142)	2024 (13 955)
-40 (-40)	1477 (10 184)	1868 (12 879)

**Table 8.1, CNG Temperature/Pressure Compensation Values**

Use the following steps to fuel a CNG vehicle.

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

# Compressed Natural Gas Fuel System

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

## WARNING

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

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

**IMPORTANT:** If at any time the service pump or vehicle begins to vent CNG uncontrollably, notify a station attendant or activate the service station emergency shut-off switch to cease the flow of CNG.

9. Switch on the service pump. A slight hissing noise may be heard as the fuel cylinders fill.
10. Watch the pressure gauge on the service pump. When the gauge reads approximately 3600 psi (24 821 kPa), or when the fill pressure stops climbing, the CNG cylinders are full. The service pump will shut itself down automatically. See [Table 8.1](#) for pressure compensation values based on ambient temperatures.
11. Move the selector knob on the service pump to the VENT position, if equipped. A short hiss will

be heard as a small amount of natural gas is vented into the hose.

## WARNING

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

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

## Engine Starting

1. Set the parking brake.
2. Move the fuel shut-off valve handle to the RUN position.

## NOTICE

**Protect the turbocharger during engine start-up by not opening the throttle or accelerating the engine above 1000 rpm until normal engine idle oil pressure registers on the gauge.**

3. For automatic transmissions, make sure that the transmission shift control is in Neutral (N), Park (P), or the Park Brake (PB) position.
4. Turn the ignition switch to the START position. See [Fig. 8.1](#) for the four-position ignition switch and [Fig. 8.2](#) for the three-position ignition switch. After the engine starts, release the key.

## 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.**

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

# Compressed Natural Gas Fuel System

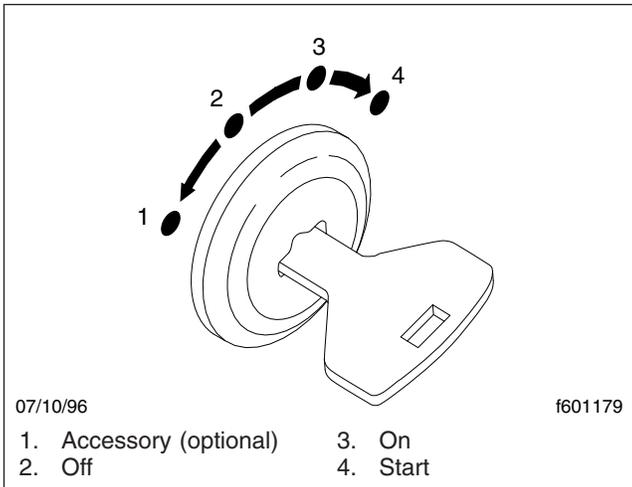


Fig. 8.1, Four-Position Ignition Switch

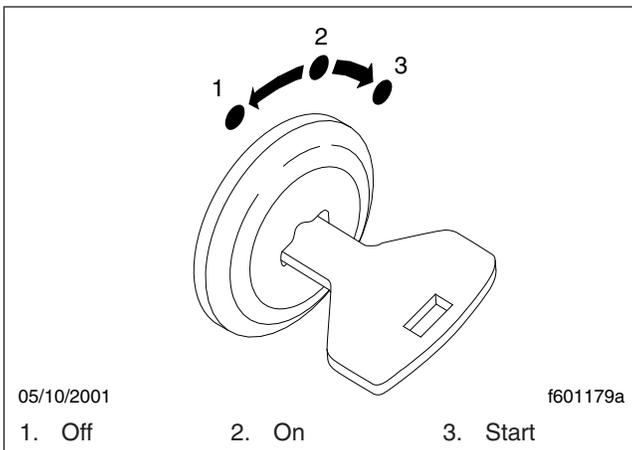


Fig. 8.2, Three-Position Ignition Switch

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

## CNG Safety Precautions

**! DANGER**

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

### CNG General Safety Information

Since compressed natural gas is highly flammable, if you should smell gas, immediately shut off all engines and ignition sources. Avoid causing sparks, and stay away from arcing switches and equipment. Extinguish any 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 engine or any other type of equipment until the gas leak is corrected and the area cleared of natural gas.

Natural gas is odorless before a scent is added for safety. Natural gas is also colorless and nontoxic. Still, at high enough concentration, natural gas can suffocate a person simply by excluding adequate oxygen to sustain life.

Natural gas is flammable in concentrations ranging from 4 percent to 16 percent by volume in air.

**! WARNING**

**When bleeding the dispensing hose after filling the tank, the handle gets extremely cold. This may freeze the hands if appropriate safety gloves are not used.**

When filling the vehicle tanks with compressed natural gas (CNG), vent the dispensing hose before disconnecting it from the vehicle. The pressure in the hose may cause a disconnected hose to become uncontrollable.

CNG storage tanks have a limited usable life-span, due to the high pressures that they must sustain. Periodic inspections are required by law to ensure continued safety in their use.

If a tank receives an impact or has deep scratches or gouges, it should be inspected before refilling.

# Compressed Natural Gas Fuel System

## CNG Workshop Precautions

Because natural gas is less dense than air, it rises. The shop ceiling needs to be equipped with a vent system that will allow the gas to escape and dissipate.

Use only safety fluorescent extension shop lights. Ordinary light bulbs can explode if dropped, possibly causing a fire.

The shop must be equipped with an alarm system that activates when gas concentration in the air becomes dangerous.

Fire extinguishers should be the CO<sub>2</sub> type (ABC minimum) and should be strategically located, highly visible, and easily accessed.

Permit no smoking or other ignition sources in the shop area.

## Servicing the CNG System

Observe the following safety precautions when servicing natural-gas-powered vehicles:

- Before making non-CNG system repairs on a CNG vehicle, close the shutoff valve at the outlet of the CNG container, and keep it closed throughout the repair procedure. Have the CNG system checked by a qualified technician before reopening the fuel shutoff valve.
- Allow only qualified technicians trained in automotive CNG system repair to perform repairs.
- Close the fuel shutoff valve(s) before performing maintenance and repairs, and when storing the vehicle inside. Open the valve(s) only if natural gas is needed to operate the engine or to check for leaks.
- Vent the gas outdoors to a safe location.
- Always use a natural gas detector to test the system for leaks, whether an odor is present or not. Commercial compressed natural gas normally contains an odor-producing chemical to enable users to detect leaks by smell. But because the odor-producing chemical can fade, a leak detector is necessary.
- Routinely inspect the fuel tanks, the fuel filtering and regulating mechanisms, and the fuel lines. Use a natural gas detector to check for any leaks. A soap-and-water solution can be used to pinpoint the exact location of leaks.

Replace leaking fuel tanks; repair or replace any lines, devices, or connections that are leaking.

- Always tighten fasteners and fuel connections to the required torque specification, since over-tightening or undertightening could cause gas leakage. Tightening to the correct torque specification is critical to the system.

## Major Repair and Replacement of CNG Parts

When a vehicle is involved in an accident or a fire causing damage to the fuel tank, the fuel tank must be replaced. If damage occurred to other parts of the fuel system, also replace those parts.

Any and all replacement parts (valves, fittings, tubing, etc.) of the CNG fuel system must be designed specifically for CNG automotive use and must be officially approved and rated for the pressures and conditions that pertain.

Install parts and components in accordance with the manufacturer's instructions.

Replace (do not repair) damaged fuel lines. When replacing fuel lines, install the lines securely in a protected location, or shield them from heat sources and from contact with unsecured objects. Before assembly, apply a natural gas-impervious pipe thread jointing material to all male pipe threads. Ensure that all lines and fittings are clear and free of cuttings, threading burrs, and scales, and that the ends of all lines are reamed. Protect lines passing through a panel by means of grommets or similar devices. Locate joints and connections so that they are accessible.

Do not use aluminum or copper pipe, tubing, or fittings between the fuel tank and the first-stage pressure regulator because of the high pressure involved.

Ensure that shutoff valves have a rated service pressure not less than the rated service pressure of the entire fuel supply system, and that they are capable of withstanding a hydrostatic test of at least four times the rated service pressure.

## Hybrid Electric Vehicle

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Disabling the Hybrid Electric Vehicle (HEV) System .....	9.4
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# Hybrid Electric Vehicle

## Safety Precautions

The hybrid electric vehicle (HEV) has high-voltage components, including 340-volt Direct Current (DC) batteries and a 500-volt Alternating Current (AC) motor.

Never touch or cut high-voltage cables or connectors. If it is necessary to remove occupants using cutting equipment, avoid high-voltage cables and the Power Electronics Carrier (PEC). See [Fig. 9.1](#) for the location of the high-voltage cables and PEC.

### DANGER

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

## Foot Pedal-Operated Parking Brake

To set the foot pedal-operated parking brake, place the gear selector in Neutral (N) and depress the parking brake foot pedal down to the floor. To release the parking brake, press the parking brake release knob located on the dash. See [Fig. 9.2](#).

## Engine Starting and Shutdown

### Engine Starting

**IMPORTANT:** When starting the engine it is recommended that the operator's foot be firmly pressing the service brake pedal.

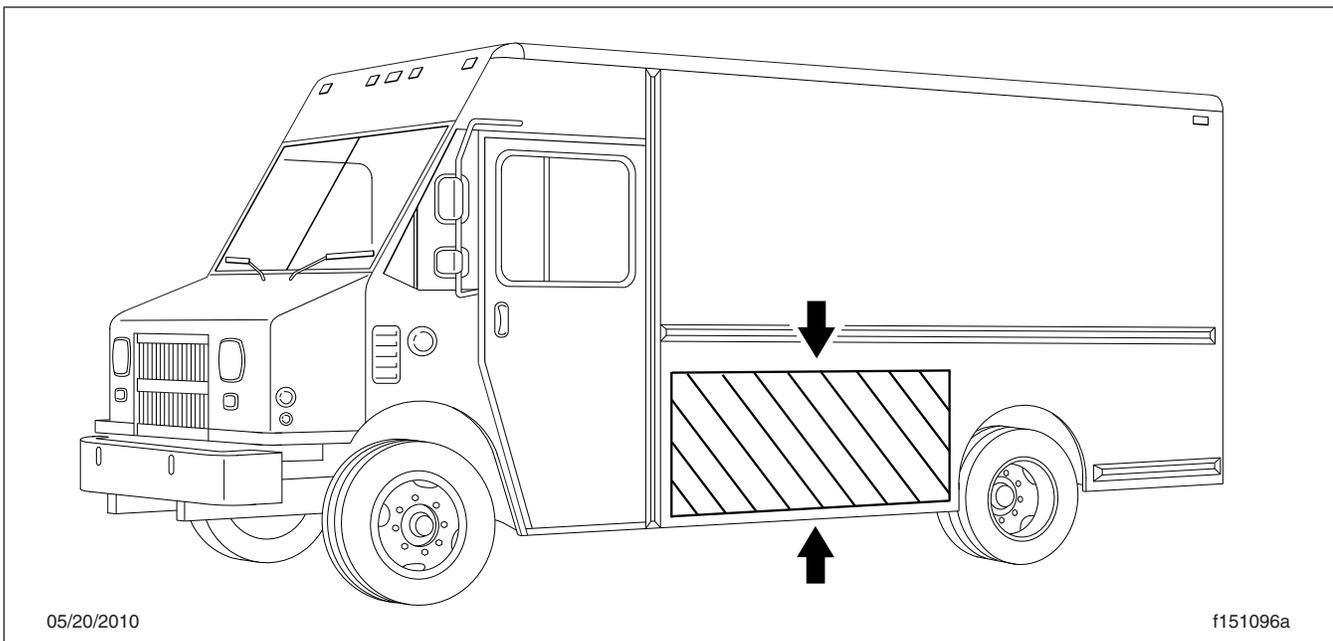
1. Set the parking brake.

**IMPORTANT:** The hybrid drive transmission has a parking pawl that engages when Park (P) is selected.

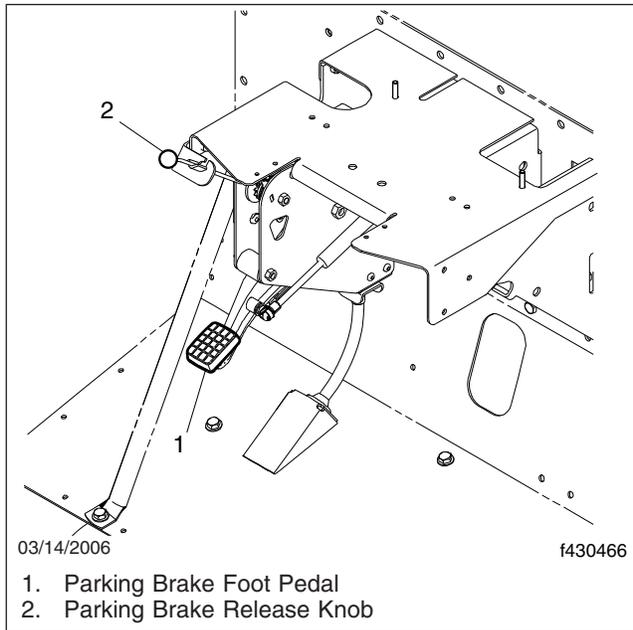
### WARNING

The vehicle could roll away if the parking brake is not set, which could result in personal injury or property damage.

2. Start the engine with the key, or, if equipped with an ignition reader, position the wristband approximately 1 inch (25 mm) above the electronic wristband reader on the ignition pad and press the green button located on the ignition reader for approximately one second. Continue to press and hold the green button to start the engine. See [Fig. 9.3](#).



**Fig. 9.1, Power Electronics Carrier (PEC) Location**



**Fig. 9.2, Foot Pedal-Operated Parking Brake**

3. Press and hold the service brake pedal.
4. Release the parking brake. See **Fig. 9.2**.
5. While continuing to press the service brake pedal, press Reverse (R), Neutral (N), or Drive (D) on the electronic push-button shifter to put the vehicle into gear.

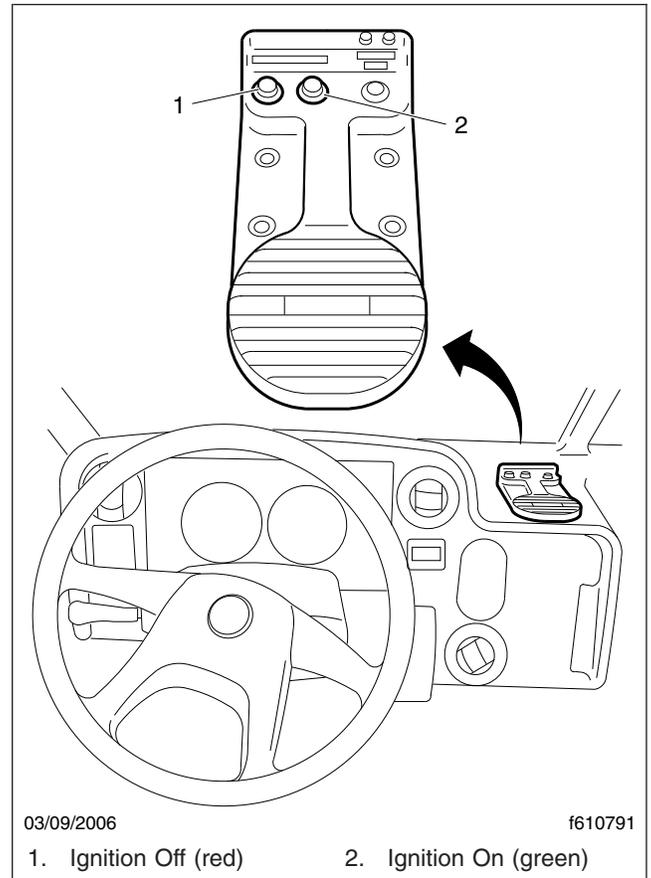
## Engine Shutdown

1. With the vehicle stopped, press and hold the service brake pedal.
2. Press Park (P) on the electronic push-button shifter, if so equipped.

### **WARNING**

**The vehicle could roll away if the parking brake is not set, which could result in personal injury or property damage.**

3. Apply the parking brake.
4. Press and hold the red button located on the ignition reader, until the engine shuts down.



**Fig. 9.3, Ignition Reader (optional on some vehicles)**

## Idle-Off Shutdown Procedure

Some vehicles may be equipped with an idle-off option. A warning label like the one shown in **Fig. 9.4** will be displayed in vehicles with this option. For the idle-off feature to activate, all of the following conditions must be met for 4 seconds:

- transmission shifter is in drive (D)
- vehicle grade sensor range is between -10% to 10%
- HEV battery charge is more than 30%
- battery voltage is greater than 12.3V
- previous vehicle speed (at first key start) is above 5 mph (8 km/h)
- service brake is applied
- seat belt is fastened

# Hybrid Electric Vehicle

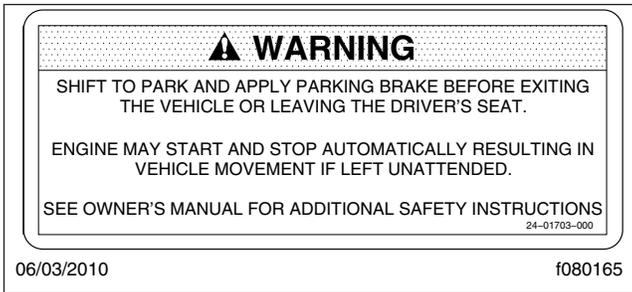


Fig. 9.4, Idle-Off Warning Label

- ABS/HSA faults are not active
- engine fault is not active
- hood is closed
- air pressure is more than 65 psi (448 kPa)
- steering pressure is less than 600 psi (4137 kPa)
- HEV fault is not active

## T-Handle Shifter

The hybrid electric vehicle (HEV) is equipped with an Eaton automated manual transmission. A T-handle shift control is used by the driver to select the transmission ranges. See [Fig. 9.5](#).

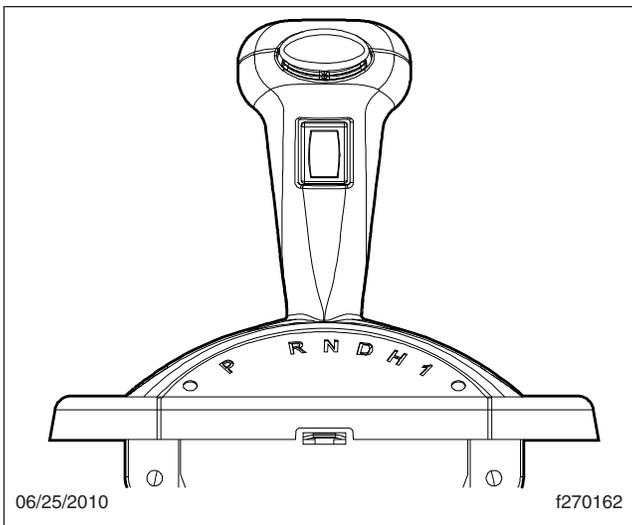


Fig. 9.5, T-Handle Shift Control

## P (Park)

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

NOTE: This does not apply the parking brake.

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

## R (Reverse)

The reverse position selects the reverse gear once the vehicle speed is less than 2 mph (3 km/h). When the selector is in reverse, the reverse warning signal will sound. Always bring the vehicle to a complete stop before shifting from a forward range to reverse, or from reverse to a forward range.

Do not idle in reverse for more than 5 minutes. Select P (park), or N (neutral) when time at idle exceeds 5 minutes.

## N (Neutral)

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

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

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

## D (Drive)

The drive position selects the default start gear and automatically upshifts and downshifts. In the drive position, the transmission will initially go into first range when drive is selected. As vehicle speed increases, the transmission will upshift automatically through each available range up to fourth range or

fifth range. As the vehicle slows, the transmission will downshift automatically.

When going downhill, downshift to a lower transmission range to increase engine braking and to help maintain control. During downhill operation, the transmission may upshift to the next higher range, if the engine is exceeding its governed speed in the lower range.

## H (Hold)

This hold position on the T-handle shifter holds the transmission in the current gear.

## 1 (Low Gear)

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

## Disabling the Hybrid Electric Vehicle (HEV) System

The following information describes the three methods to disable the HEV system.

### Option 1 (preferred method)

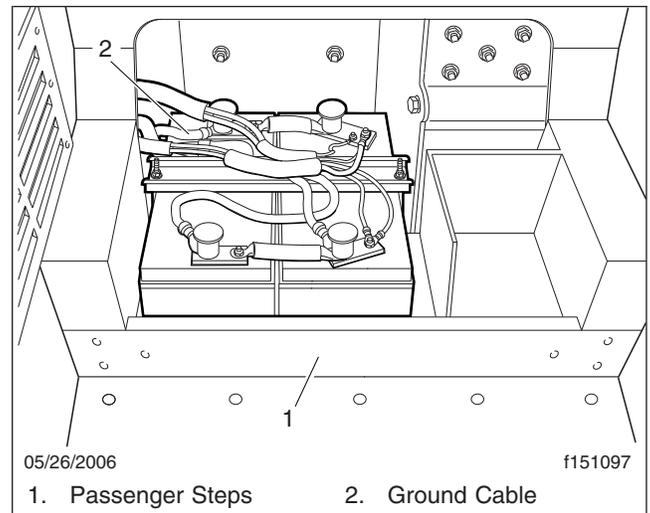
Turn off the ignition, or if equipped with an ignition reader, press the red button on the ignition pad. See [Fig. 9.3](#).

- The engine will shut down.
- The dash lights will shut down.
- The HEV system will shut down.
- The HEV batteries are still active, but are isolated in the Power Electronics Carrier (PEC).

### Option 2

Disconnect the low-voltage (12 volt) vehicle batteries. See [Fig. 9.6](#).

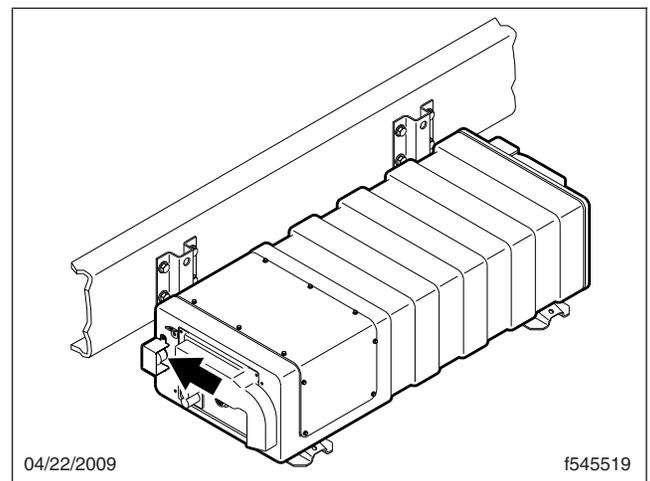
- The engine will shut down.
- The HEV system will shut down.
- The HEV batteries are still active, but are isolated in the Power Electronics Carrier.



**Fig. 9.6, Battery Location**

### Option 3

Push in the service switch in the Power Electronics Carrier and shut down the engine. See [Fig. 9.7](#).



**Fig. 9.7, Service Switch**

**IMPORTANT:** The red service switch on the PEC should only be used for an emergency shutdown or when the service manual or troubleshooting guide directs the Hybrid-Trained Technician to perform work on the high-voltage system.

- Hybrid system will be disabled

# Hybrid Electric Vehicle

- HEV batteries are still "live" but are isolated in the PEC.

**IMPORTANT:** These procedures should only be used for an emergency. If service is required on the vehicle, refer to the "Hybrid Services Shut-down" procedure found in TRSM1000 located on [www.roadranger.com](http://www.roadranger.com).

## In Case of an Emergency

1. When conditions allow, pull the vehicle onto the shoulder of the road and stop.
2. Apply the parking brake.



**The vehicle could roll away if the parking brake is not set, which could result in personal injury or property damage.**

3. Push Park (P) on the electronic push-button shifter, if so equipped.
4. Turn the ignition key off, or, if equipped with an ignition reader, press the red button on the ignition pad to turn off the ignition.
5. Exit the vehicle.

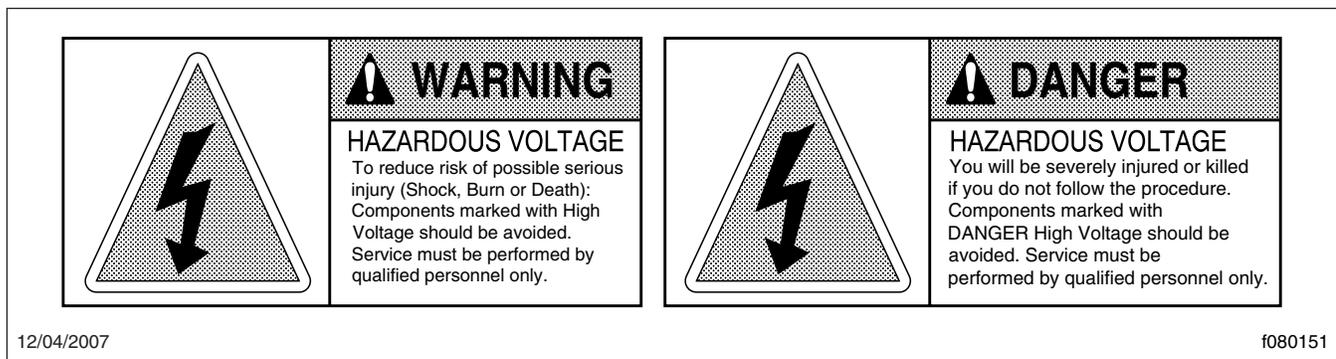
If the HEV becomes involved in an accident or fire, be aware of the following:

- Use CO2 or dry chemical extinguishers. Lithium ion batteries are contained in the Power Electronics Carrier (PEC).

- The high-voltage wiring is covered in orange insulation or convoluted tubing and marked with warning labels at the connectors.
- All Eaton® Hybrid Electric vehicles will be marked 'Hybrid' on the outside of the vehicle, along with the shift label on the dash.
- Do not cut into or open the PEC.
- Do not cut into or open the DC/AC converter.
- Do not cut into or open the inverter.
- Do not cut into high-voltage cables.
- Do not cut into the passenger side of the body. The PEC is located behind the sheet metal. See [Fig. 9.1](#).

## High-Voltage Safety Features

All high-voltage safety cables are covered in orange insulation and clearly labeled near each connector end. Each high-voltage component is clearly tagged with a warning or danger label. See [Fig. 9.8](#).



**Fig. 9.8, High-Voltage Warning and Safety Labels**

# 10

## Pre- and Post-Trip Checklists

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Pretrip and Post-Trip Inspection General Information .....	10.1
Daily Pretrip Inspection and Maintenance Checklist .....	10.2
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# Pre- and Post-Trip Checklists

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## Pretrip and Post-Trip Inspection General Information

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

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

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

Numbers in parentheses within each of the checklists reference the corresponding detailed instructions found under "Daily (D), Weekly (W), or Monthly (M) Procedures in [Chapter 11](#).

If any system or component does not pass this inspection, it must be corrected before operating the vehicle. Whenever equipment requires adjustment, replacement, repair, addition of lubricants, or a change of lubricants, see the *Walk-In Van Chassis Workshop Manual* for procedures and specifications, or take the vehicle to an authorized Freightliner dealer.

**IMPORTANT:** The pretrip and post-trip checklists in this chapter, and the maintenance procedures detailed in [Chapter 11](#) and in the *Walk-In Van Chassis Maintenance Manual* are **not all inclusive**. Also, refer to the inspection and maintenance instructions of the major component manufacturers and the body manufacturer.

# Pre- and Post-Trip Checklists

## Daily Pretrip Inspection and Maintenance Checklist

See [Table 10.1](#) for a checklist of the procedures that should be performed daily, before the first trip.

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

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
_____	Drain manually drained air reservoirs (that are not equipped with automatic drain valves)	D1
Check _____	surge tank coolant level	D2
Inspect _____	radiator and charge air cooler	D3
Check _____	engine for fuel, oil, or coolant leaks	D4
Check _____	CNG engines for natural gas leaks, using a natural gas detector	D4
Check _____	intake-air restriction indicator and air intake system	D5
Check _____	engine oil level	D6
Check _____	automatic transmission fluid level, if equipped	D7
Check _____	fuel/water separator for contaminants and leaks, if equipped	D8
Check _____	fuel tank(s), fuel lines, and connections	D9
Check _____	fuel level	D10
Check _____	diesel engine fuel cap vent area is clean	D10
Check _____	CNG engine pressure gauge mounted in fuel fill box	D10
Check _____	front and rear suspension components	D11
Check _____	oil- and air-pressure warning systems	D12
Check _____	horn	D13
Check _____	backup alarm, if equipped	–
Check _____	headlights, mirrors, and window glass	D14
Check _____	air brake chambers and pushrods	D15
Check _____	slack adjusters	D16
Check _____	tire pressure	D17
Check _____	tire condition	D18
Check _____	rims and wheels	D19
Check _____	air brake system	D20
Check _____	parking brakes	D21
Inspect _____	frame rails (missing bolts), crossmembers (bent or loose)	–
Check _____	mud flaps (aren't damaged, at least 10 inches above the ground, and brackets are secure)	–
Check _____	exhaust system (mounted securely, connected tightly, no signs of leaks such as soot trails)	–
Check _____	Bendix Hydro-Max® brake booster	D22
Inspect _____	engine and chassis wiring	D23
_____	remove chocks and test service brakes	D24
Inspector _____	Date _____	

**Table 10.1, Daily Pretrip Inspection and Maintenance Checklist**

# Pre- and Post-Trip Checklists

## Weekly Post-Trip Inspection and Maintenance Checklist

See [Table 10.2](#) for a checklist of the procedures that should be performed weekly, post-trip.

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

Procedure Performed (check off)	Weekly Post-Trip Inspections/Checks	Procedure Reference
_____	Manually drain air reservoirs that are equipped with automatic drain valves	—
Inspect _____	batteries and battery cables	W1
Check _____	wheel bearing lubricant level	W2
Inspect _____	steering components	W3
Check _____	drive belts	W4
Check _____	drive belt tension	W5
Inspect _____	seat belts and tether belts	—
Inspector _____ Date _____		

Table 10.2, Weekly Post-Trip Inspection and Maintenance Checklist

## Monthly Post-Trip Inspection and Maintenance Checklist

See [Table 10.3](#) for a checklist of the procedures that should be performed monthly, post-trip.

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

Procedure Performed (check off)	Monthly Post-Trip Inspections/Checks	Procedure Reference
_____	Clean the battery terminals	M1
Inspect _____	radiator hoses and heater hoses	M2
Check _____	fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 6 brake fluid)	—
Check _____	fluid level in the hydraulic brake fluid reservoir, if equipped	M3
Check _____	steering wheel play	M4
Check _____	outer surfaces of the hood and body (for visible surface breaks and damage)	—
Inspect _____	brake lining wear	M5
Inspect _____	driveshaft	—
Inspector _____ Date _____		

Table 10.3, Monthly Post-Trip Inspection and Maintenance Checklist

# 11

## Pre- and Post-Trip Inspections and Maintenance

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Safety Precautions .....	11.1
Daily Pretrip Inspection and Maintenance Procedures .....	11.1
Weekly Post-Trip Inspection and Maintenance Procedures .....	11.9
Monthly Post-Trip Inspection and Maintenance Procedures .....	11.11

# Pre- and Post-Trip Inspections and Maintenance

## Safety Precautions



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

## Daily Pretrip Inspection and Maintenance Procedures

Whenever equipment requires adjustment, replacement, repair, addition of lubricants, or a change of lubricants, see the *Walk-In Van Chassis Workshop Manual* for repair procedures and specifications. Specific references to the manual will be found where appropriate.

1. Drain manually drained air reservoirs (that are not equipped with automatic drain valves).

Water and oil normally enter the air reservoir in the form of vapor because of the heat generated during compression. After the water and oil condense, drain the resulting emulsion as follows:

- 1.1 Open the wet tank valve. The drain cock or pull chain drain is located on the forward end of the supply air reservoir, which is connected directly to the air compressor. Block the valve open.

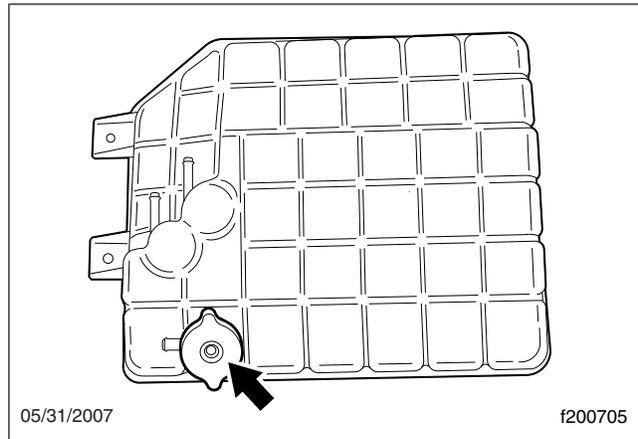


When draining the air reservoir, do not look into the air jets or direct them toward anyone. Dirt or sludge particles may be in the airstream and could cause injury.

- 1.2 Exhaust the remaining air and moisture from the system by opening the drain cocks on the bottoms of the remaining air reservoirs. Block the valves open.
- 1.3 Water and oil emulsion often form pockets that will not drain while compressed air is in the reservoirs. Because of these pockets, leave the valves blocked open during the first part of the pretrip inspection.

2. Check the coolant level in the surge tank.

See **Fig. 11.1**. If the coolant is low, add a 50/50 mixture of water and the type of antifreeze currently installed in your vehicle. Fill the surge tank with coolant to the MAX line when the tank is cool. See **Table 11.1** for approved coolants. If the surge tank was empty, start the engine after refilling, then check the level again when the engine is at operating temperature.



**Fig. 11.1, Surge Tank Fill Cap**

Approved Coolants		
Engine Type	Coolant Manufacturer	Coolant Designation*
Diesel	Old World Industries	Fleet Charge®
	Shell	Shell HD/N Antifreeze
	Texaco	JC04 Antifreeze
	Van Waters and Rogers Ltd. (Canada)	Diesel Antifreeze No. 6038
Gasoline	GM	GM DEX-COOL®†
Propane		

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

† GM DEX-COOL is approved for use in gasoline and propane engines only.

**Table 11.1, Approved Coolants**

# Pre- and Post-Trip Inspections and Maintenance

## NOTICE

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

3. Inspect the radiator and charge air cooler.
    - 3.1 Inspect the radiator and charge air cooler for clogged fins. Use compressed air or water directed from the fan side of the core to backflush any material restricting airflow.
    - 3.2 Inspect the radiator and charge air cooler for damage and accumulated debris. Straighten bent or damaged fins to permit airflow across all areas of the cores.
- NOTE: When traveling through areas of high insect concentration, it may be necessary to clean the exterior of the radiator or the charge air cooler core as often as every 200 miles (320 km).
- 3.3 Also inspect and clean the condenser. If clogged, the condenser can restrict airflow through the radiator.
  - 3.4 Check the radiator for leaks. If leaks are found, have the radiator repaired or replaced. Take the vehicle to an authorized Freightliner dealer for assistance.

4. *Inspect the engine for fuel, oil, and coolant leaks. On vehicles equipped with a compressed natural gas (CNG) engine, use a natural gas detector to check for natural gas leaks.*

Correct any leaks found.

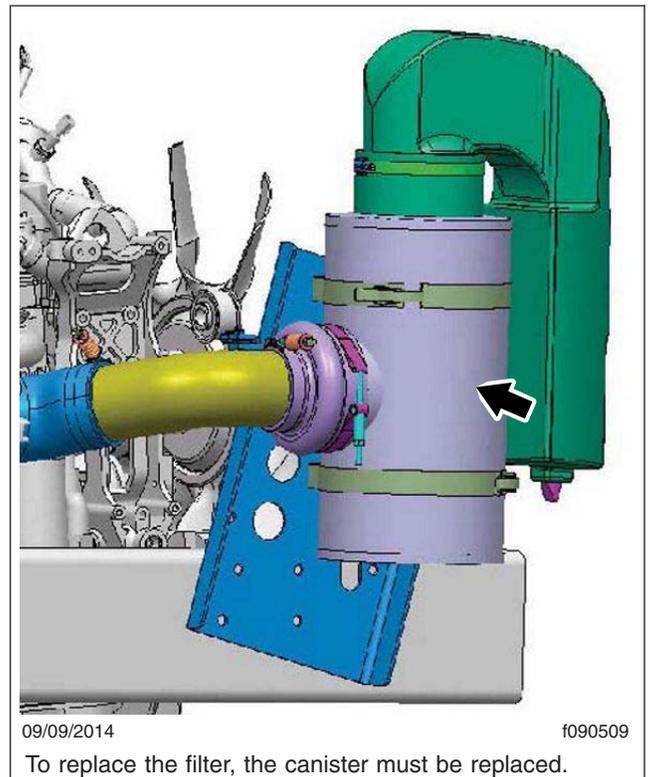
5. *Inspect the air intake system for leaks or damage.*

## NOTICE

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

- 5.1 Check the intake-air restriction indicator, if so equipped.
- 5.2 Replace the primary filter element in the air cleaner when filter restriction reaches

25 inH<sub>2</sub>O for Cummins engines or 15 inH<sub>2</sub>O for GM engines. See **Group 09** of the *Walk-In Van Chassis Workshop Manual* for filter element replacement instructions, or take the vehicle to an authorized Freightliner dealer. See **Fig. 11.2** and **Fig. 11.3**.

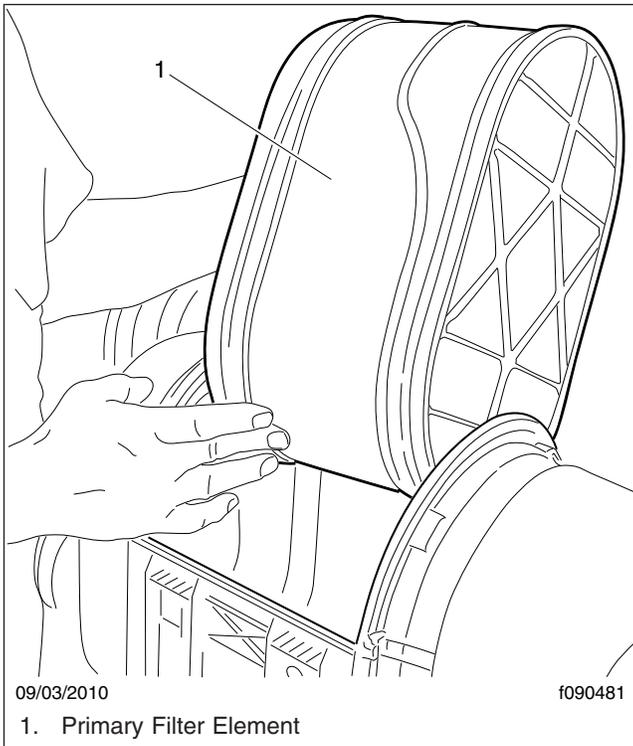


**Fig. 11.2, Farr Air Cleaner Filter Element**

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

- 5.3 Inspect the secondary or safety filter element in the air cleaner when replacing the primary element, and replace it when clogged or dirty. This element should be replaced with every third primary element replacement.
- 5.4 Check the engine air intake piping from the air cleaner to the engine intake. Inspect the piping for loose connections, cracks, torn or collapsed hoses, punctures, and other damage. Tighten loose

# Pre- and Post-Trip Inspections and Maintenance



**Fig. 11.3, Donaldson Air Cleaner Filter Element**

connections, and have damaged components replaced. Make sure the piping system is airtight so that all intake air passes through the air cleaner.

## 6. Check the engine oil level.

### NOTICE

**Operating the engine with the oil level below the minimum fill (or "add") mark or above the maximum fill (or "full") mark could result in engine damage.**

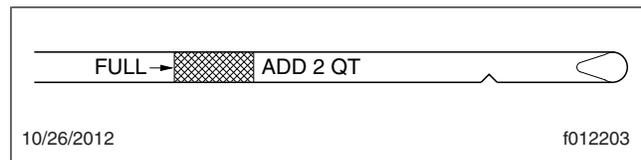
- 6.1 Park the vehicle on a level surface. Allow several minutes for the oil to drain back into the oil pan to ensure an accurate reading.

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

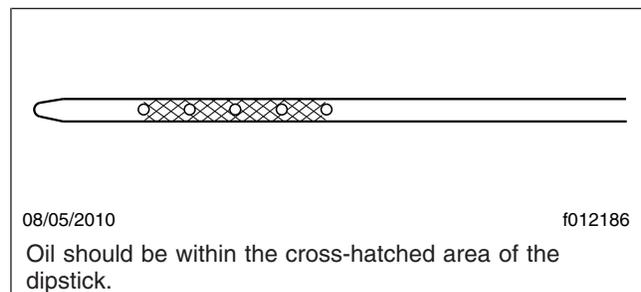
- 6.2 Pull out the dipstick and clean it with a paper towel or cloth, then push the dipstick back in all the way. Remove it again, keeping the tip down, and check the oil level.
- 6.3 If the oil is below the cross-hatched area, or the add mark, at the tip of the dipstick, add at least one quart (liter) of the recommended oil. See **Fig. 11.4** for diesel engines and **Fig. 11.5** for gasoline and liquid propane gas (LPG) engines.

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

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



**Fig. 11.4, Oil Dipstick (diesel engine)**



**Fig. 11.5, Oil Dipstick (gasoline and propane engines)**

### NOTICE

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

## 7. Check the oil level in the automatic transmission.

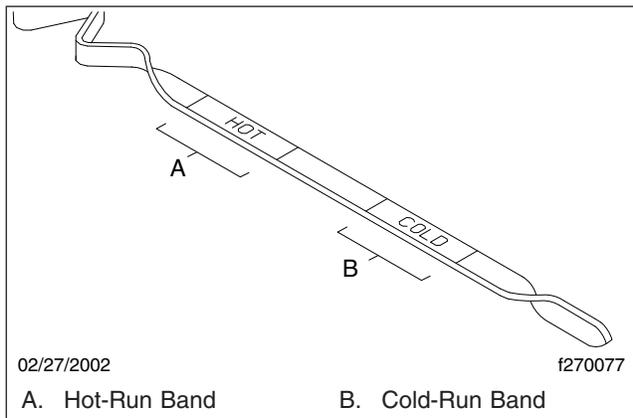
**NOTE:** The fluid must be warm to ensure an accurate check. The fluid level rises as temperature increases.

# Pre- and Post-Trip Inspections and Maintenance

With the vehicle on a level surface, check the oil level in the transmission using one of the following procedures:

## Hot Check

- Operate the transmission in a Drive (D) range until normal operating temperature, 160 to 200°F (71 to 93°C), is reached.
- Park the vehicle. Shift to Neutral (N) and apply the parking brake. Let the engine run at idle.
- Wipe the dipstick clean and check the fluid level. A safe operating level is any level within the HOT-run (upper) band on the dipstick. See **Fig. 11.6**.



**Fig. 11.6, Automatic Transmission Dipstick Markings**

- If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT-run band. See the *Walk-In Van Chassis Maintenance Manual* for fluid types and capacities.

**IMPORTANT:** Do not drain the fuel/water separator completely. Drain no more than three tablespoons of fluid at a time.

8. Check the fuel/water separator for contaminants and leaks.

**IMPORTANT:** When draining fluid from a fuel/water separator, drain the fluid into an appropriate container and dispose of it properly. Many states now issue fines for draining fuel/water separators on the ground. On all types of separators, stop draining fluid when you see fuel come out of the separator drain valve.

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

On vehicles equipped with a compressed natural gas (CNG) engine, inspect the fuel tanks, fuel regulators, fuel filters, and the fuel lines. Use a natural gas detector to check for any leaks, or spray the components with a soap-and-water solution and check for bubbles.

- 9.1 Check that the fuel tanks are secured to their mounting brackets and that the mounting brackets are secured to the frame.
- 9.2 Replace leaking fuel tanks.
- 9.3 If lines or connections are leaking, have them repaired or replaced.  
For repair and/or replacement procedures, see **Group 47** of the *Walk-In Van Chassis Workshop Manual*, or take the vehicle in to an authorized Freightliner dealer.
- 9.4 If equipped with fuel tank shutoff valves, be sure the valves are fully open.

## **! WARNING**

**Never operate the engine with the fuel tank shut-off valves partly closed. This could damage the fuel pump, causing sudden loss of engine power, possibly resulting in serious personal injury due to reduced vehicle control.**

10. Check the fuel level in the fuel tank(s).

On vehicles equipped with a diesel engine be sure that the fuel cap vent area is clean. Check the fuel/water separator (if so equipped) for leaks and, if needed, prime the fuel tank system.

On vehicles equipped with a compressed natural gas (CNG) engine, check the pressure gauge mounted in the fuel fill box to determine the amount of fuel in the fuel tanks.

## **! WARNING**

**Never fill fuel tanks to more than 95 percent of their liquid capacity. This could make them more likely to rupture from impact, possibly causing fire and resulting in serious personal injury or death by burning.**

# Pre- and Post-Trip Inspections and Maintenance

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

- 10.1 To keep condensation to a minimum, fill diesel fuel tanks at the end of each day, but not to more than 95 percent of liquid capacity. Select the proper grade of fuel, as specified by the engine manufacturer.

## WARNING

**Do not mix gasoline or alcohol with diesel fuel. This mixture could cause an explosion, possibly resulting in serious personal injury or death. Do not fill the fuel tanks in the presence of sparks, open flames, or intense heat. These could ignite the fuel, possibly causing severe burns.**

- 10.2 Always strain or filter diesel fuel before putting it into the tanks. This will lengthen the life of the engine fuel filter and reduce the chances of dirt entering the engine.
11. *Inspect the front and rear suspension components, including springs, spring hangers, shocks, and suspension brackets.*
  - 11.1 Check for broken spring leaves, loose U-bolts, cracks in the suspension brackets, and loose fasteners in the spring hangers and shackles.
  - 11.2 Inspect the shock absorbers for loose fasteners and leaks.
  - 11.3 Tighten all loose fasteners and have any components replaced that are worn, cracked, or otherwise damaged.
  - 11.4 On vehicles with air suspensions, check for leaks. Check air suspension components for cuts and bulges.

## WARNING

**Do not replace individual leaves of a damaged front or rear suspension leaf spring assembly; replace the complete spring assembly. Visible damage, such as cracks or breaks, to one leaf causes hidden damage to other leaves. Replace-**

**ment of only the visibly damaged part(s) is no assurance that the spring is safe. If cracks or breaks exist on front spring assemblies in either of the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.**

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

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

- 12.1 If the warning systems do not come on when the ignition is turned on, have the systems repaired.
- 12.2 If the air pressure in both systems is above the preset minimum when the engine is started, test the low air pressure system by lowering the pressure to below this range, or until the warning system comes on.

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

13. *Make sure that the electric horn works.*

If a horn is not working, have it replaced before trip departure.

14. *Make sure all the exterior lights are working.* Check the high and low beams of the headlights. Clean the windshield, side, and rear windows (if equipped) with a long-handled or telescoping window cleaning device and standard cleaning solutions. Stand only on the ground, on a 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.

## DANGER

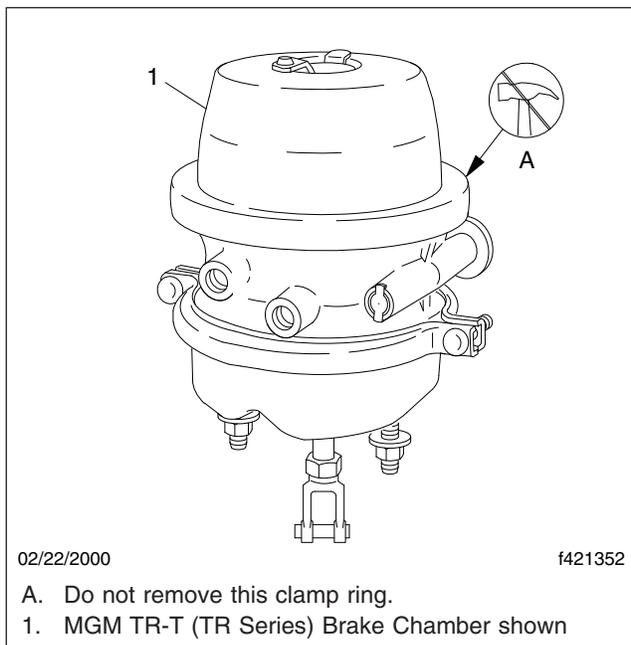
**Do not loosen or remove the parking brake clamp ring for any purpose. See Fig. 11.7. The parking/emergency brake section of the brake chamber is**

# Pre- and Post-Trip Inspections and Maintenance

not intended to be serviced. Serious injury or death may result from sudden release of the power spring.

Before doing any repairs or adjustments on a service/parking brake chamber, read the applicable warnings and instructions in Group 42 of the *Walk-In Van Chassis Workshop Manual*.

15. Inspect the air brake chamber and the air brake chamber pushrods. See **Fig. 11.7**.

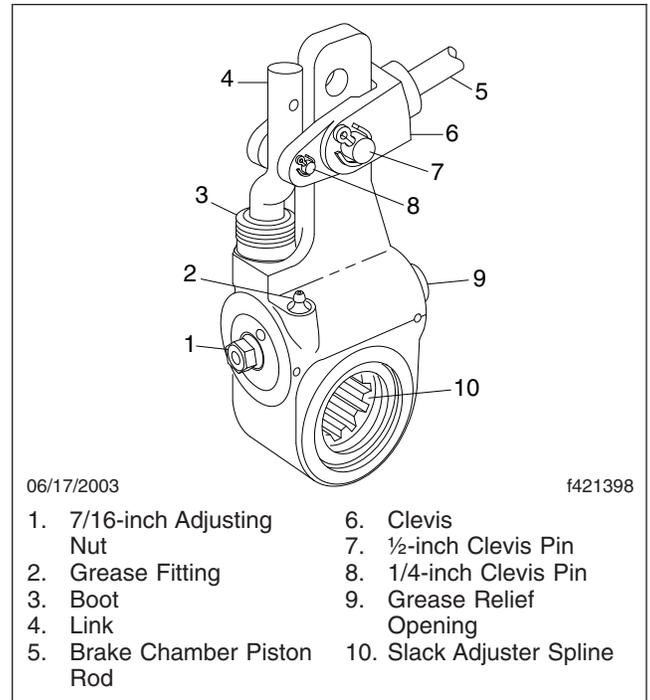


**Fig. 11.7, Parking Brake Chamber Clamp**

16. Inspect the slack adjusters.
  - 16.1 *Meritor Slack Adjusters:* Check the boot for cuts, tears, or other damage. Have it replaced if necessary.
  - 16.2 Inspect the slack adjuster boot for cuts or tears. If the boot is damaged, have it replaced. See **Fig. 11.8**.
17. Check tire inflation pressures using an accurate tire pressure gauge.

Tires should be checked when cool. For inflation pressures and maximum loads (per tire) see the tire manufacturer's guidelines.

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



**Fig. 11.8, Automatic Slack Adjuster (typical)**

- 17.2 Inflate the tires to the applicable pressures if needed.
- 17.3 If a tire has been run flat or underinflated, check for possible wheel or tire damage before adding air.

Moisture inside a tire can result in body ply separation or a sidewall rupture. During tire inflation, compressed air reservoirs and lines must be kept dry. Use well maintained inline moisture traps and service them regularly.

## **WARNING**

**Do not operate the vehicle with underinflated or overinflated tires. Incorrect inflation can stress the tires and make the tires and wheels susceptible to damage, possibly leading to wheel or tire failure and loss of vehicle control, resulting in serious personal injury or death.**

**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

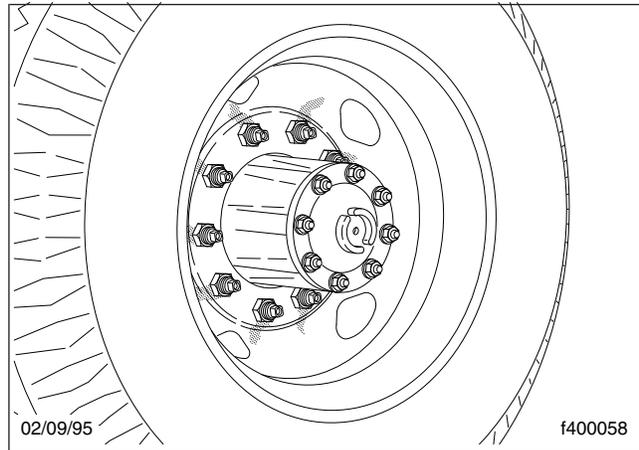
# Pre- and Post-Trip Inspections and Maintenance

inflation. Some wheels are stamped with a maximum load and maximum cold inflation rating. If they are not stamped, consult the wheel manufacturer for the correct tire inflation pressure for the vehicle load. If the load exceeds the maximum wheel capacity, the load must be adjusted or reduced.

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

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

18. *Inspect each tire for wear, bulges, cracks, cuts, penetrations, and oil contamination.* A weekly pressure loss of 4 psi (28 kPa) or more in a tire may indicate damage. The tire should be inspected and if necessary, repaired or replaced.
  - 18.1 Check the tire tread depth. If tread is less than 4/32 inch (3 mm) on any front tire, or less than 2/32 inch (1.5 mm) on any rear tire, replace the tire.
  - 18.2 Inspect each tire for bulges, cracks, cuts, and penetrations.
  - 18.3 Inspect each tire for oil contamination. Fuel, oil, gasoline, and other petroleum derivatives, if allowed to contact the tires, will soften the rubber and destroy the tire.
19. Check the wheel nuts for indications of looseness. Examine each wheel component.
  - 19.1 Remove all dirt and foreign material from the assembly. Dirt or rust streaks from the stud holes, metal buildup around stud holes, or out-of-round or worn stud holes may be caused by loose wheel nuts. See [Fig. 11.9](#) and [Fig. 11.10](#).
  - 19.2 Examine the wheel components (including studs and nuts) for cracks or other damage.



**Fig. 11.9, Dirt and Rust Streaks from the Stud Holes**

See **Group 33** or **Group 35** of the *Walk-In Van Chassis Workshop Manual* for service procedures on the studs and hubs, and see **Group 40** in the same manual for wheel and tire servicing, or take the vehicle to an authorized Freightliner dealer.

## **WARNING**

**Have any worn or damaged wheel components replaced by a qualified person using the wheel manufacturer's instructions and the wheel industry's standard safety precautions and equipment. Otherwise a vehicle or workshop accident could occur, possibly resulting in serious personal injury or death.**

- 19.3 Make sure all wheel nuts are tightened 450 to 500 lbf-ft (610 to 678 N·m) for Ac-curide wheels with unlubricated threads. Use the tightening pattern in [Fig. 11.11](#) for 10-hole wheels and [Fig. 11.12](#) for 8-hole wheels. See **Group 40** of the *Walk-In Van Chassis Workshop Manual*.

## **NOTICE**

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

# Pre- and Post-Trip Inspections and Maintenance

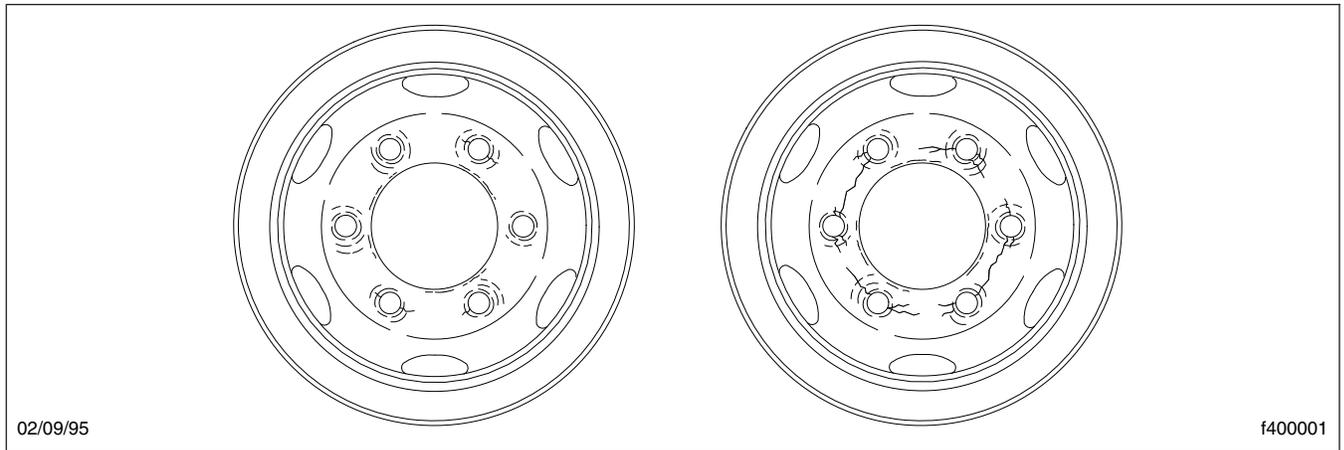


Fig. 11.10, Worn Stud Holes

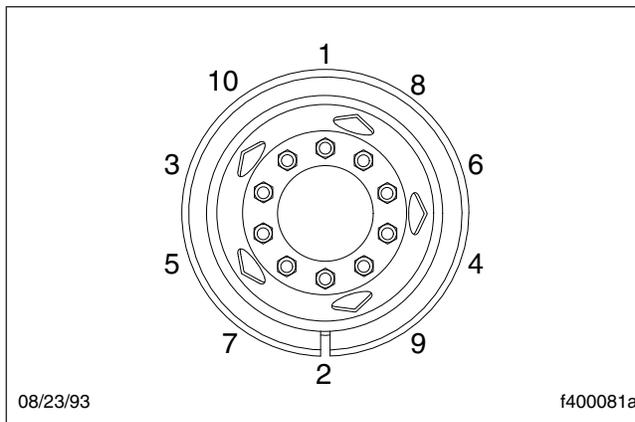


Fig. 11.11, Tightening Pattern, 10-Hole Wheels

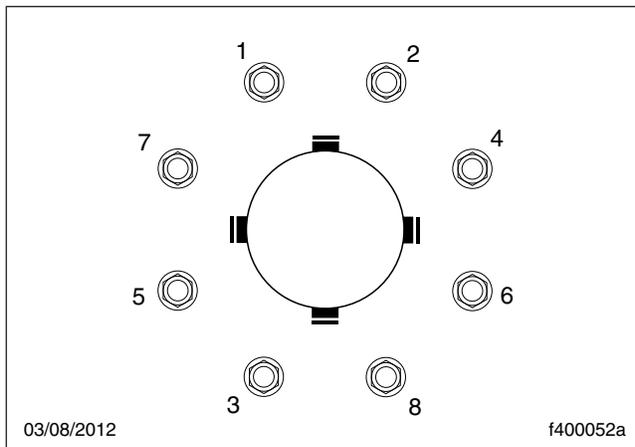


Fig. 11.12, Tightening Pattern, 8-Hole Wheels

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

20. Check the air brake system for proper operation.

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

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

20.2 Check the air pressure buildup times as follows:

With the air system fully charged to 120 psi (827 kPa), make one full brake application and note the air pressure reading on the gauge. Continue to reduce the air pressure by moderate brake applications to a maximum of 90 psi (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

# Pre- and Post-Trip Inspections and Maintenance

than 30 seconds, eliminate any leaks or replace the air compressor before operating the vehicle.

20.3 Check the air pressure reserve as follows:

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

20.4 Check the air leakage in the system as follows:

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

With the service brakes released, shut down the engine, wait 1 minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

Charge the air system until cut-out pressure of 120 psi (827 kPa) is reached. With the parking brakes released and the service brake applied, shut down the engine, wait 1 minute and note the air pressure gauge reading. Observe the air pressure drop in psi (kPa) per minute.

If leakage exceeds the limits shown in [Table 11.2](#), repair all areas of leakage before driving the vehicle.

Maximum Allowable Service Brake Leakage	
Brakes Released	Brakes Applied
2 psi/min. (14 kPa)	3 psi/min. (21 kPa)

**Table 11.2, Maximum Allowable Service Brake Leakage**

21. *Test the parking brake on a 20 percent grade.*

Apply the hand brake with the vehicle on a 20 percent grade (or as steep a grade that the vehicle may normally be parked on). The ramp surface should be made of Portland cement or equivalent. If the parking brake does not hold the vehicle, repair the parking brake system.

22. Check the operation of the Bendix® Hydro-Max brake booster, as follows.

22.1 With ignition off, depress the brake pedal and listen for the back-up motor to engage. Also, note that the pedal force relieves; the pedal should depress easily.

22.2 With the ignition off, engine running, parking brake released, 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 other than loss of back-up motor power.

23. *Inspect the engine and chassis wiring.*

Check for loose wiring, chafed insulation, and damaged or loose hold-down clamps. Tighten loose wires or hold-down clamps; replace damaged wiring or clamps.

24. *Test the service brakes.*

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

## Weekly Post-Trip Inspection and Maintenance Procedures

1. *Inspect the batteries and battery cables.*



**WARNING**

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

1.1 Check the battery cables for chafing and proper routing. Be sure the battery hold-down is secure. If it is loose, tighten the hold-down bolts; if it is damaged, replace it. Replace the battery cable if damaged.

1.2 If the battery is equipped with a built-in hydrometer, examine the hydrometer. If a green dot shows in the sight glass, the battery is sufficiently charged.

# Pre- and Post-Trip Inspections and Maintenance

If the sight glass is dark, the charge is low and the battery must be recharged.

If the sight glass is clear, the battery has a low level of electrolyte and must be replaced.

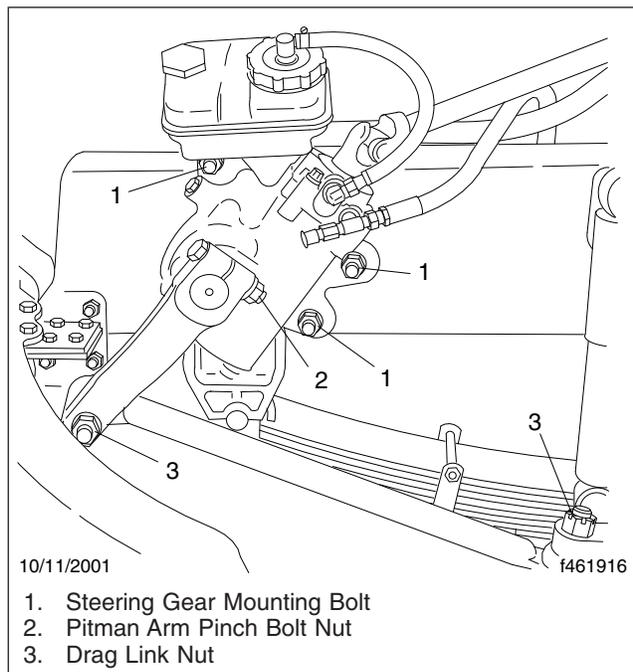
2. Check the level of the wheel bearing lubricant in the hub cap at each end of the front axle.

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

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

3. Examine the steering components.

See [Fig. 11.13](#). If repairs are needed, see **Group 46** of the *Walk-In Van Chassis Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer.



**Fig. 11.13, Steering Gear Fasteners**

- 3.1 Check the mounting bolts and pitman arm nut, for tightness.
- 3.2 Check the drag link nuts for missing cotter pins.

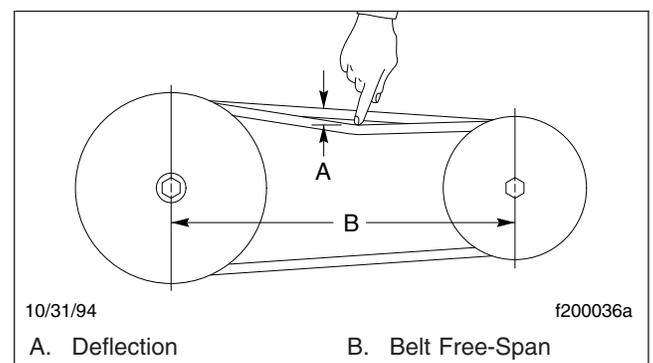
- 3.3 Inspect the steering drive shaft and steering linkage for excessive looseness, or other damage.

- 3.4 Tighten loose nuts and have damaged parts replaced as needed.

4. Check the condition of the drive belts.

Check the fan belt(s), alternator belt, and refrigerant compressor belt for signs of glazing, wear (frayed edges), damage (breaks or cracks), or oil contamination. If a belt is glazed, worn, damaged, or oil soaked, replace the belt, following the instructions in **Group 01** of the *Walk-In Van Chassis Workshop Manual*.

5. Check the drive belt for proper tension. Use your index finger to apply approximately 25 pounds (11 kg) of force at the center of the belt free-span. See [Fig. 11.14](#). Deflection should be one belt thickness per 1 foot (300 mm) of belt free-span. If the tension is more than or less than this value, measure it with a belt-tension gauge and adjust it to the proper tension. See **Group 01** of the *Walk-In Van Chassis Workshop Manual* for instructions.



**Fig. 11.14, Checking Belt Tension**

**NOTE:** On Cummins engines, a belt tensioner automatically adjusts the fan and alternator belt to correct tension. If the belt slips, repair or replace the tensioner. For instructions, see the *Cummins Engine Operation and Maintenance Manual*.

# Pre- and Post-Trip Inspections and Maintenance

## Monthly Post-Trip Inspection and Maintenance Procedures

### WARNING

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

1. Clean the batteries.
  - 1.1 Remove any corrosion from the hold-down and the top of the battery.

### NOTICE

Take care to keep the vent plugs tight so that the neutralizing solution does not enter any of the battery cells and damage the battery.

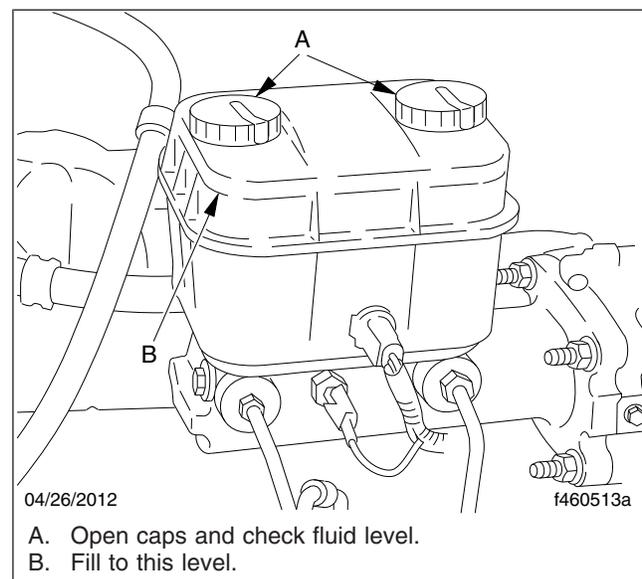
- 1.2 Use a soda solution to neutralize the acid present, then rinse off the soda solution with clean water.
- 1.3 If the battery posts or cable terminals are corroded, disconnect the terminals from the posts. Clean them with a soda solution and a wire brush. After cleaning, connect the terminals to the battery posts, then apply a thin coat of petroleum jelly to the posts and terminals to help retard corrosion.
2. Inspect the radiator and heater hoses, including the clamps and support brackets.
  - 2.1 Make sure the radiator inlet and outlet hoses are pliable and are not cracking, weakening, or ballooning.
  - 2.2 Make sure the heater hoses are pliable and are not cracking or ballooning. Replace hoses that show signs of cracking, weakening, or ballooning.
  - 2.3 Tighten hose clamps as necessary, but do not overtighten, as hose life can be adversely affected.

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

**IMPORTANT:** Replace all hoses, including heater hoses, at the same time. Service-type knitted or braided yarn-reinforced neoprene hose is acceptable. Silicone hoses having an extended service life can be substituted for the reinforced neoprene type. See the *Freightliner Service Parts Catalog* or contact your Freightliner Dealer.

3. Check the fluid level in the hydraulic brake fluid reservoir, if so equipped.

If needed, fill the reservoir up to the ridge that surrounds the reservoir. Use only heavy-duty brake fluid, DOT 6. See [Fig. 11.15](#).

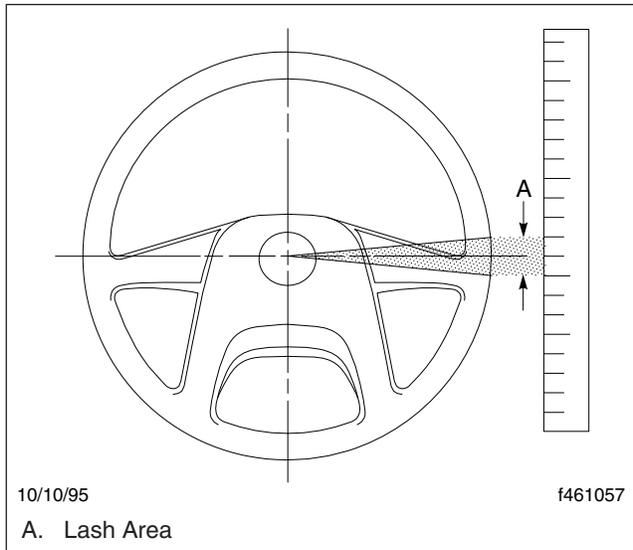


**Fig. 11.15, Check the Hydraulic Brake Fluid Level (MT-45/55 reservoir shown)**

4. Check the steering wheel for excessive play.

With the front tires pointing straight ahead, turn the steering wheel until motion is observed at the front wheels. Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels. Measure the lash (free play) at the rim of the steering wheel. See [Fig. 11.16](#).

# Pre- and Post-Trip Inspections and Maintenance



**Fig. 11.16, Measuring Lash at the Steering Wheel**

Excessive lash exists if steering wheel movement exceeds 4-3/4 inches (121 mm) with an 18-inch (470 mm) steering wheel. If there is excessive lash, check the steering system for wear or incorrect adjustment of the linkage and steering gear before operating the vehicle.

5. Check the brake lining wear on vehicles equipped with air brakes. Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.
  - 5.1 Apply the parking brakes, and chock the tires to prevent vehicle movement.
  - 5.2 If the axle assembly is not equipped with a dust shield or backing plate, measure the axle brake lining thickness. If *any* of the brake linings are worn to less than 3/16 inch (4.8 mm) at the thinnest point, replace the linings on *all* brake assemblies on that axle. See **Group 42** of the *Walk-In Van Chassis Workshop Manual* for lining replacement instructions and camshaft end play inspection.
  - 5.3 If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs to inspect the brake lining thickness. If any of the brake linings are worn to less than approximately 3/16 inch (4.8 mm) at the thinnest point, replace the linings on all brake assemblies on that

axle. See **Group 42** of the *Walk-In Van Chassis Workshop Manual* for lining replacement instructions and camshaft end play inspection.

- 5.4 Install the inspection plugs in the dust shields or backing plates, if so equipped.
- 5.5 Remove the chocks from the tires.

# 12

## Cleaning and Care

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Washing and Polishing .....	12.1
Care of Chrome Parts .....	12.1
Dashboard and Instrument Panel Care .....	12.1

# Cleaning and Care

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## Washing and Polishing

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

- Rinse the undercarriage regularly during the winter months to protect it from mud and road salt corrosion.
- Do not let diesel fuel or antifreeze stand on a painted chassis surface. If either should occur, rinse the surface off with water.
- To prevent frame corrosion, have any nicks or other damage on the frame finish touched up as soon as possible.

To prevent delamination and deterioration of labels and stickers on the cab, follow these guidelines carefully:

- Do not pressure wash the label or sticker or surfaces near it.
- Do not use strong alkaline soaps on or near the label or sticker.

## 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

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### NOTICE

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**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.

# 13

## In an Emergency

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Hazard Warning Lights .....	13.1
Towing .....	13.1
Emergency Starting With Jumper Cables .....	13.1
Changing a Flat Tire .....	13.3
Running Out of Fuel .....	13.3

# In an Emergency

## Hazard Warning Lights

The hazard warning light tab is located on the steering column. See [Fig. 13.1](#). Pull the tab out to activate the hazard warning lights. When the hazard warning light tab is pulled out, all of the turn signal lights and both of the indicator lights on the instrument panel will flash. To cancel the hazard warning lights, push the tab in.

An additional hazard warning light control knob may be installed on the dash near the headlight controls. To activate the hazard warning lights, pull the knob out.

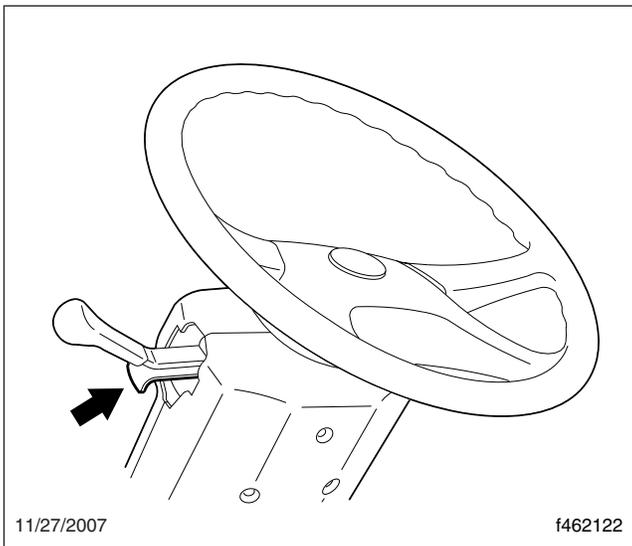


Fig. 13.1, Hazard Warning Light Tab

## Towing

See [Chapter 14](#) 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 ve-**

**hicles 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. Access the batteries under the passenger steps.

### NOTICE

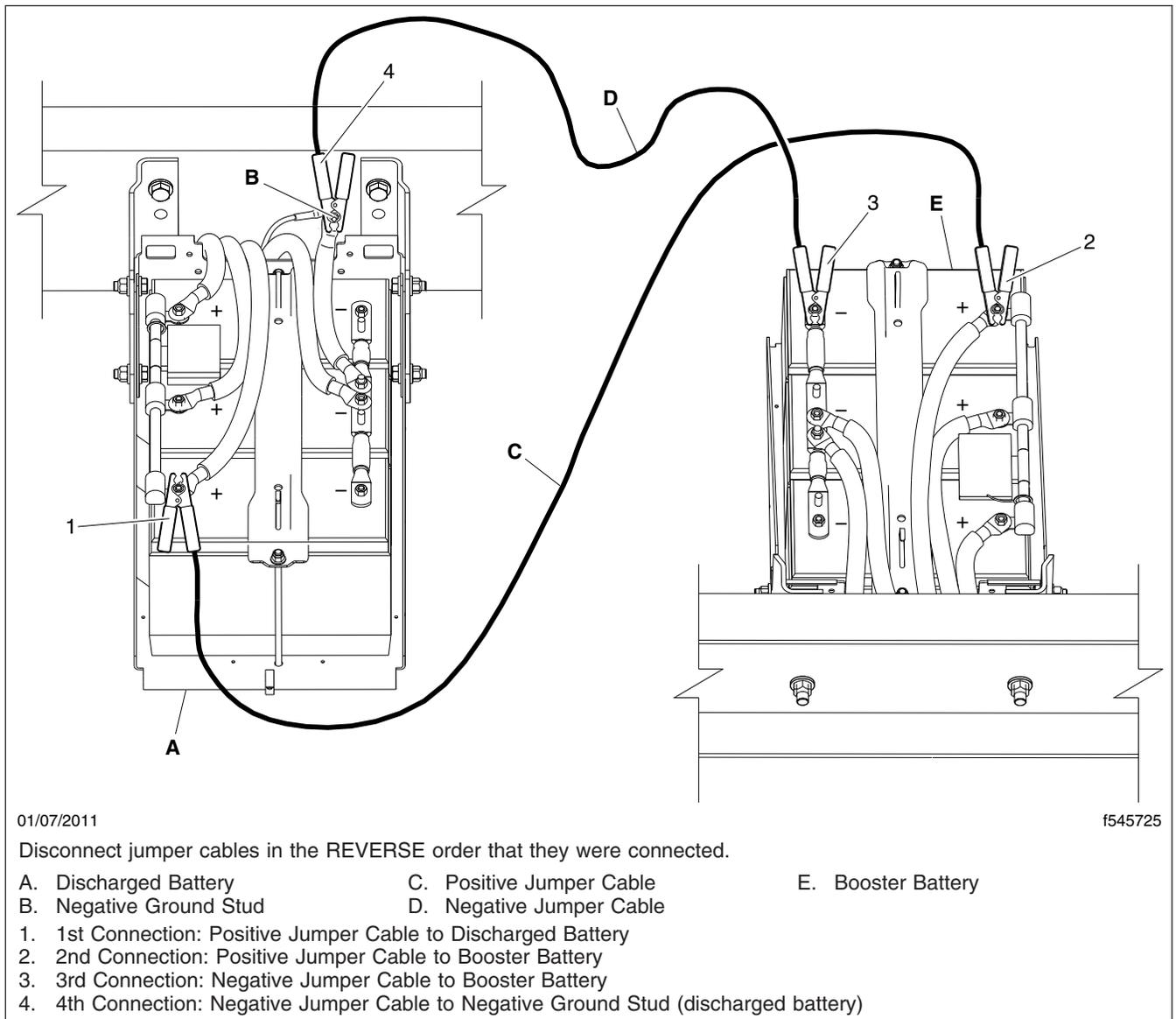
**Always connect the batteries and jumper cables correctly (positive-to-positive and negative-to-negative). Connecting a charging device backwards (positive-to-negative) can severely damage the vehicle electrical content and cause non-warrantable failures.**

3. Connect the positive (+) jumper cable to the positive terminal on the discharged battery. See [Fig. 13.2](#).
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.



**Fig. 13.2, Jumper Connections (three battery system shown for clarity)**

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.

**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.

## 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**

# In an Emergency

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## 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.
14. Close the battery access door at the passenger steps.

## Changing 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.

1. If possible, stop the vehicle on a level surface away from traffic.
2. Apply the parking brake and place the transmission in Park (P). Turn the ignition switch to the OFF position.
3. Turn on the hazard warning lights.
4. Remove the spare wheel, jack, jack handle, and lug wrench (if so equipped) from storage.
5. Block the wheel diagonally opposite the wheel being changed.

## NOTICE

**The jacking point for the front and rear wheels is directly under the axle. Insert a wooden block between the axle and the jack. Do not jack directly on the axle housing.**

6. 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.

**NOTE:** Dual stud-piloted rear wheels are attached using inner and outer (2-element) lug nuts. The larger nut retains the outer dual (stud-piloted), 2-piece wheel. The inner square nut retains the inner dual (stud-piloted) wheel. Remove and install these nuts separately. The rear dual outer lug nut must be removed and loosened to check and retighten the inner nut. Hub-piloted wheels use a single outer lug nut that holds both discs on the hub pilot.

7. Raise the vehicle until the wheel is off of the ground. Remove the lug nuts and the wheel.
8. Install the spare wheel and lug nuts. Make sure that the beveled sides of the nuts face inward.
9. In a star pattern, tighten the nuts evenly until snug.
10. Lower the vehicle until the wheel touches the ground. Tighten the nuts in the same pattern 450 to 500 lbf·ft (610 to 678 N·m).
11. Finish lowering the vehicle to the ground, then remove the jack.
12. Remove the block, then stow the jack, jack handle, and lug wrench (if so equipped).
13. After operating the vehicle for 50 to 100 miles (80 to 161 km), retighten the nuts (for stud-piloted dual discs, all inner, then all outer) 450 to 500 lbf·ft (610 to 678 N·m).

## Running Out of Fuel

### Diesel Engines

## WARNING

**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 4 gallons (16 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.

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## NOTICE

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**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.**

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.

## Compressed Natural Gas (CNG) Engines

 **WARNING**

**Compressed natural gas is highly flammable. When inspecting or servicing a vehicle, avoid causing sparks or using arcing switches and equipment. Extinguish cigarettes, pilot lights, flames, or other sources of ignition. Failure to perform these actions or to take other precautions could lead to the ignition of the natural gas, which could cause serious bodily injury, death, or severe property damage.**

If the vehicle runs out of fuel, park on a level location away from traffic. Restart the engine after adding at least 30 psi (207 kPa) of fuel.

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## NOTICE

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**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.**

# 14

## Towing

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Front Towing Hookup .....	14.1
Rear Towing Hookup .....	14.1

# Towing

---

## Front Towing Hookup

 **WARNING**

Do not tow an unbraked vehicle if the combined weight of both vehicles is more than the sum of the gross axle weight ratings (GAWR) of the towing vehicle. Otherwise brake capacity will be inadequate, which could result in personal injury or death.

IMPORTANT: When it is necessary to tow the vehicle, make sure the instructions below are closely followed to prevent damage to the vehicle.

NOTE: Towing rules and regulations vary from federal, state, local, and transit authority. These laws must be followed when towing the vehicle.

## Front Towing Hookup

1. Disconnect the battery ground cables.

————— **NOTICE** —————

Failure to remove the axle shafts when towing the vehicle with the rear wheels on the ground could result in damage to the transmission and other parts.

Remove the rear driveshaft before towing a vehicle equipped with a hydraulic hybrid system. Failure to do so will damage the hydraulic hybrid components. Once the driveshaft has been removed, do not attempt to start a vehicle equipped with a hydraulic hybrid drive system. Doing so will damage the hydraulic hybrid system components.

2. Remove the drive axle shafts.
3. On a vehicle equipped with a hydraulic hybrid system, remove the rear driveshaft.

IMPORTANT: Cover the ends of the hubs with metal plates or plywood cut to fit the axle opening, and drilled to fit the axle shaft studs. This prevents lubricant from leaking out, and will keep contaminants from getting into the axle lubricant and damaging the wheel bearings.

4. If additional clearance is needed for towing, remove the bumper.
5. Attach the towing device. Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the towing-vehicle operator.

————— **NOTICE** —————

**Failure to protect the frame rails from the chains could cause damage, leading to eventual frame failure.**

6. Lift the vehicle and secure the safety chains. If extra towing clearance is needed, remove the front wheels.
7. Connect the clearance lights, taillights, and signal lights. Connect any special towing lights required by local regulations.

 **WARNING**

Failure to chock the tires or connect the tow truck's air brake system before releasing the spring parking brakes could allow the disabled vehicle to suddenly roll. This could cause property damage or personal injury.

————— **NOTICE** —————

Before attempting to tow a vehicle with an air suspension (and during the towing operation), ensure that the air suspension is properly charged. Charge the suspension through the Schrader valve on the air dryer. Attempting to tow a vehicle with an improperly charged air suspension may result in damage to the chassis and body.

8. Chock the tires on the disabled vehicle and connect the towing vehicle's air brake system to the vehicle being towed. Then, release the spring parking brake and remove the chocks.
9. On vehicles equipped with hydraulic disc brakes be sure the parking brake is released before starting the towing process.

## Rear Towing Hookup

1. Position the front tires pointing 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.

# 15

## GM Gasoline Engine

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# GM Gasoline Engine

## Starting the Engine

**IMPORTANT:** For service issues and questions, call 1-800-FTL-HELP and follow the prompts for gasoline engines. Representatives will be able to answer questions and diagnose mechanical issues, as well as provide detailed service repair information.

### General Information

**NOTE:** Before starting the engine, read **Chapter 2** and **Chapter 3** in this manual for detailed information on how to read the instruments and operate the controls.

Before operating the vehicle, perform the engine pretrip inspection and daily maintenance checks in **Chapter 10** and **Chapter 11** of this manual.

### NOTICE

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

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

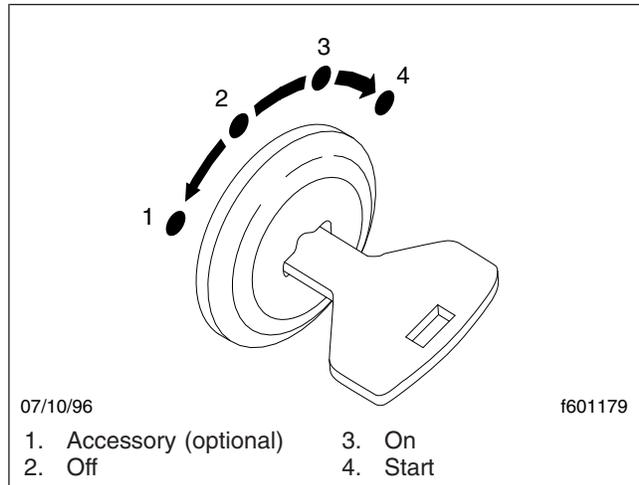
### NOTICE

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

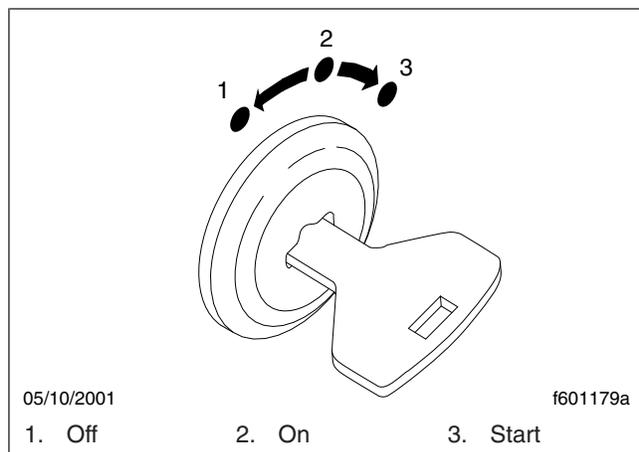
1. Set the parking brake.
2. Turn the ignition switch to the ON position. See **Fig. 15.1** for the four-position ignition switch and **Fig. 15.2** for the three-position ignition switch.
3. Make sure that the transmission shift control is in Neutral (N) or Park (P), and that the park brake is set.

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

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



**Fig. 15.1, Four-Position Ignition Switch**



**Fig. 15.2, Three-Position Ignition Switch**

### NOTICE

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

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

**IMPORTANT:** When the engine is started, it takes a short time to build up a lubricating oil film between the shafts and bearings, and between the pistons and cylinder walls. The oil pressure gauge indicates any drop in lubricating

oil pressure within 15 seconds of engine start-up.

6. If the engine does not start after 5 to 10 seconds, especially in very cold weather below 0°F (−18°C), it could be flooded with too much gasoline. Try pushing the throttle pedal all the way to the floor and holding it there as you hold the key in the START position for up to 15 seconds

## 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.**

7. If the vehicle starts briefly but then stops again, repeat the process. This will clear the excess gasoline from the engine.
8. Do not race the engine immediately after starting it. Operate the engine and transmission gently until the oil warms up and lubricates all of the moving parts.

## MIL Lamp

## NOTICE

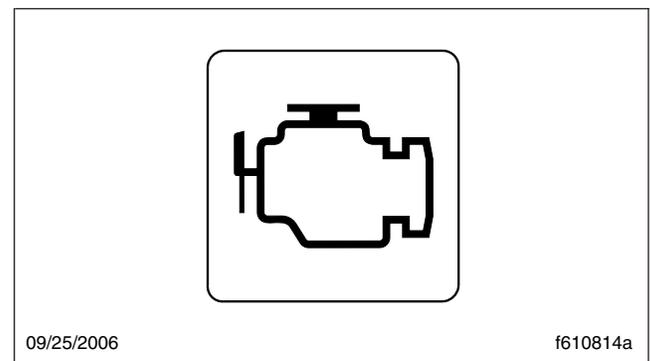
**If the vehicle is continually driven when the MIL lamp is activated, the emission controls may not work as well, the vehicle fuel economy may not be as good, and the engine may not run as smoothly. This could lead to costly repairs that may not be covered by the vehicle warranty.**

**Modifications made to the engine, transmission, exhaust, intake, or fuel system of the vehicle, or replacing the original tires with tires that do not meet the same tire performance criteria, can affect the vehicle's emission controls and can cause the MIL lamp to activate. Modifications to these systems could lead to costly repairs not covered by the vehicle warranty. This could also result in a failure to pass required emission inspection and/or maintenance tests.**

When the MIL lamp activates, it can either flash on and off, or remain on with a constantly illuminated lamp.

## MIL Lamp Flashes

**IMPORTANT:** If the MIL lamp flashes on and off while driving the vehicle, the driver should find a safe place to park and stop the vehicle immediately. See [Fig. 15.3](#) for an example of the MIL lamp. The vehicle should be taken to an authorized Freightliner dealer as soon as possible for service. Continued driving with an illuminated MIL lamp could damage the emission system and void the warranty.



**Fig. 15.3, MIL Lamp**

The MIL lamp illuminates to indicate a fault that affects the emission system; a misfire condition is one example. Diagnosis and service may be required. To prevent serious damage to the vehicle, observe the following guidelines:

- Reduce vehicle speed.
- Avoid hard accelerations.
- Avoid steep uphill grades.

Once the MIL lamp begins flashing, the driver should find a safe place to stop. Turn the vehicle off, wait at least 10 seconds, and then restart the vehicle. If the MIL lamp continues to flash, observe the guidelines listed above and see a dealer for service as soon as possible.

## MIL Lamp is on Constant (steady)

A constant (steady) MIL lamp indicates that an emission system malfunction has been detected on the vehicle. Diagnosis and service may be required. The following information may correct an emissions system malfunction.

# GM Gasoline Engine

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- Make sure the fuel cap is fully installed. The diagnostic system can determine if the fuel cap has been left off or is incorrectly installed. A missing or loose fuel cap allows fuel to evaporate into the atmosphere. A few driving trips with the fuel cap properly installed should turn the MIL lamp off.
- If the vehicle has been driven through a deep puddle of water, the system could be wet. Inspect the electrical system and make sure it is not wet. This condition is usually corrected when the electrical system dries out. A few driving trips should turn the MIL lamp off.
- Make sure to fuel the vehicle with quality fuel. Poor fuel quality causes the engine not to run as efficiently as designed and can cause—
  - stalling after start-up;
  - stalling when the vehicle is changed into gear;
  - misfiring;
  - hesitation on acceleration; or
  - stumbling on acceleration.

If one or more of these conditions occur, change the fuel brand used. At least one full tank of the proper fuel will be required to turn the MIL lamp off. See **Fuel** in this chapter for information on the proper fuel to use.

If the MIL lamp will not go off after performing the above steps, your dealer can check the vehicle. The dealer has the proper test equipment and diagnostic tools to fix any mechanical or electrical problems that may have developed. A GM dealership can also check gasoline engines.

## Engine Break-In

The engine will perform better over time if the guidelines below are followed.

- Keep the vehicle speed at 55 mph (88km/h) or less for the first 500 miles (805 km).
- Do not drive at one constant speed, either fast or slow, for the first 500 miles (805 km). Do not make full-throttle starts. Avoid downshifting to brake or slow the vehicle.
- Avoid making hard stops for the first 200 miles (322 km). During this time, the new brakes are

not yet broken in. Making hard stops with new brakes can lead to premature wear and early replacement. This guideline should be followed each time new brakes are installed.

- Do not tow a trailer during the break-in period.

Once the break-in period has been met, engine speed and load can be gradually increased.

## Fast Idle System

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

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

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

## Fast Idle Operation

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

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

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

- Applying the brake.
- The transmission shifter is moved out of Park (P) or Neutral (N); this will engage the transmission.
- Selecting the cruise control ON/OFF switch when it was previously on.

## Engine Coolant

### NOTICE

**If an improper coolant mixture is used, the engine could overheat and be damaged. The repair cost would not be covered by the warranty. Too much water in the mixture can freeze and crack the engine, radiator, heater core, and other parts.**

For the gasoline engine, a 50/50 mixture of clean water and DEX-COOL® coolant should be used. If this mixture is used, nothing else needs to be added. This mixture will—

- give freezing protection down to  $-34^{\circ}\text{F}$  ( $-37^{\circ}\text{C}$ );
- give boiling protection up to  $265^{\circ}\text{F}$  ( $129^{\circ}\text{C}$ );
- protect against rust and corrosion;
- not damage aluminum parts;
- help keep the proper engine temperature.

### NOTICE

**If extra inhibitors and/or additives are used in the vehicle's cooling system, the cooling system could be damaged. Use only the proper mixture of the engine coolant and water listed here for the cooling system.**

## Fuel

**IMPORTANT:** Using the recommended fuel (gasoline) is important for proper maintenance of the engine. To help keep the engine clean and maintain optimum vehicle performance, General Motors recommends the use of gasoline advertised as TOP TIER detergent gasoline. Any resulting engine damage due from the use of unapproved fuel (gasoline) would not be covered by the vehicle warranty.

### NOTICE

**Do not use ethanol fuel (E85) in the vehicle. The engine is not designed for this fuel, and serious engine damage will result if it is used.**

## Gasoline Octane

Use regular unleaded gasoline with a posted octane rating of 87 or higher. If the octane rating is less than 87, an audible knocking noise may occur. If this happens, use a gasoline rated at 87 octane or higher as soon as possible. If gasoline rated at 87 octane or higher is being used and a heavy knocking is heard, the engine needs service.

## Gasoline Specifications

Gasoline should meet the American Society for Testing and Materials (ASTM) specification D4814 in the United States or CAN/CGSB-3.5 or 3.511 in Canada. Some gasolines contain an octane-enhancing additive called methylcyclopentadienyl manganese tricarbonyl (MMT). General Motors does not recommend the use of gasolines containing MMT. Gasoline containing MMT can reduce the life of spark plugs and the performance of the emission control system could also be affected. The malfunction indicator lamp (MIL) might come on if gasoline with MMT is used. If this happens, take the vehicle to a dealer for service.

## Additives

To provide cleaner air, all gasoline in the United States is now required to contain additives that help prevent engine and fuel system deposits from forming, allowing the emission control system to work properly. In most cases, you should not have to add anything to the fuel. However, some gasolines contain only the minimum amount of additive required to meet EPA regulations. To help keep fuel injectors and intake valves clean, or if the vehicle experiences problems due to dirty injectors or valves, look for gasoline that is advertised as TOP TIER detergent gasoline.

For those who do not use TOP TIER detergent gasoline regularly, one bottle of GM Fuel System Treatment Plus, added to the fuel tank at every engine oil change, can help clean deposits from fuel injectors and intake valves. GM Fuel System Treatment Plus is the only gasoline additive recommended by General Motors.

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## Engine Oil

### NOTICE

Use engine oil that is identified as meeting GM standard GM6094M and showing the American Petroleum Institute (API) starburst symbol. Failure to use the recommended oil can result in engine damage and will void the engine warranty.

When determining the type of engine oil to use, look for three things.

- Use only an oil that meets GM standard GM6094M.
- Oil grade SAE 5W–30 is best for the engine. Do not use SAE 10W–40 or 20W–50.
- The API starburst symbol. See [Fig. 15.4](#).



Fig. 15.4, API Symbol

If the vehicle is being operated in an area of extreme cold, the use of SAE 5W–30 oil will provide easier cold starting for the engine.

## Engine Oil Additives

Do not add anything to the oil. The recommended oils with the API starburst symbol that meet GM standard GM6094M are all that is needed for good performance and engine protection.

## Engine Oil Flushing

### NOTICE

Engine oil system flushing is not recommended and could cause engine damage not covered by the engine warranty.

## Checking the Engine Oil

It is important to check the oil regularly and keep it at the proper level. In order to get an accurate reading, the oil must be warm and the vehicle must be on level ground.

1. Turn off the engine and give the oil several minutes to drain back into the oil pan. If this is not done, the oil dipstick may not show the actual level.
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 level.
3. If the oil is below the cross-hatched area at the tip of the dipstick, add at least one quart (liter) of the recommended oil. See [Fig. 15.5](#).

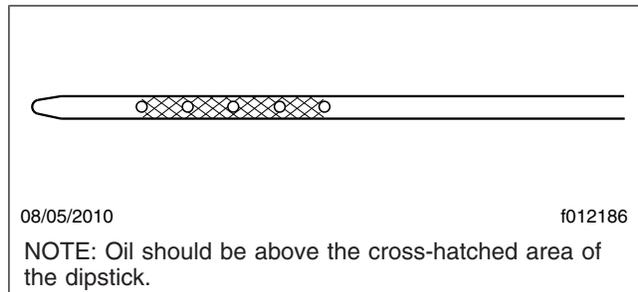


Fig. 15.5, Oil Dipstick

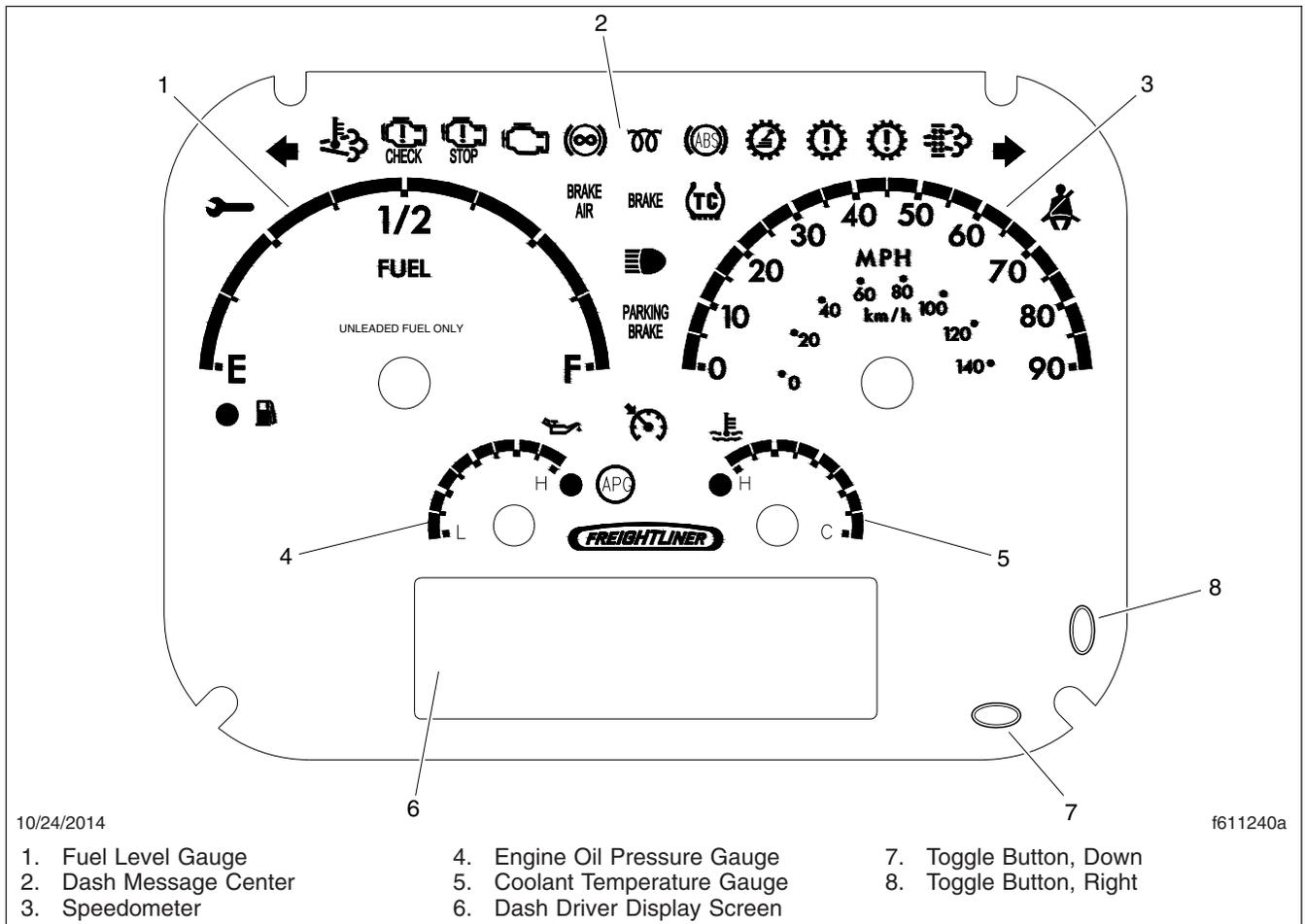
## Changing the Engine Oil

The engine oil must be changed every 3000 miles (4827 km). See maintenance operation **01–03** in the *Walk-In Van Chassis Maintenance Manual* for detailed instructions.

## Ametek Instrument Panel

The following information describes the Ametek instrument panel, used with gasoline engines. The instrument panel is shown in [Fig. 15.6](#).

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



**Fig. 15.6, Gauge Layout (typical, U.S.)**

## Message Display Center

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

- Odometer
- Trip Odometer 1/Trip Odometer 2
- Chassis Battery Voltage
- Instantaneous Fuel Rate
- Average Fuel Rate
- Gear Attained Status
- Transmission Temperature
- Hour Meter

- Boost Pressure
- Engine Oil Pressure
- Coolant Temperature
- Fuel Level
- Percent Engine Load
- Engine RPM

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

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## 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.

## Menu System

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

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

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

arrow toggle button to go back to the main message display screen.

## Setup Menu

### Select Display Units

The set units screen allows the driver to choose between English or metric units of measurement for the displayed values. To navigate to the set units screen, see [Fig. 15.7](#), screens H, I, and J.

### Startup Screen

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

### LCD Contrast

Select contrast from the menu to set the LCD contrast. Use the down toggle button to set the contrast to the desired level. To navigate to the contrast screen, see [Fig. 15.7](#), screen M.

### Reset Parameters

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

## Maintenance Menu

The maintenance menu has the following three sub menus:

- maintenance intervals
- transmission oil life remaining
- transmission oil filter life monitor

### Maintenance Intervals

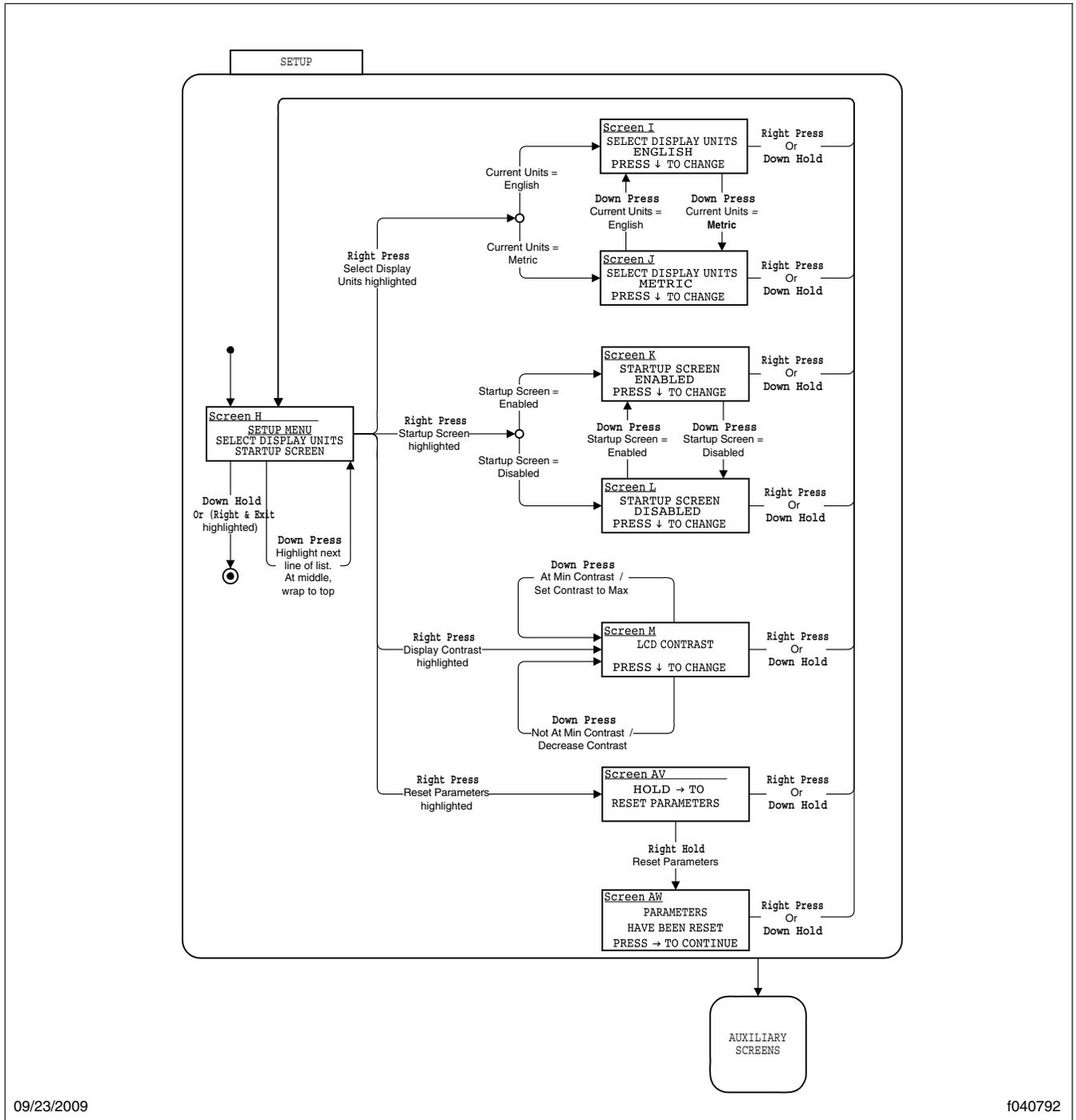
The maintenance intervals menu allows the driver to set the change intervals for engine oil and engine air filter. If the intervals are set to zero, the maintenance warnings must be disabled.

### Transmission Oil Life Remaining

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

### Transmission Oil Filter Life Monitor

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



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Fig. 15.7, Setup Menu Screens

TRANS OIL FILTER FUNCTIONAL or TRANS OIL FILTER CLOGGED.

# GM Gasoline Engine

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## Diagnostic Menu

The diagnostic menu contains the following items:

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

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

## Engine Faults

This screen displays engine fault codes that are received from the engine electronic control unit (ECU). To navigate to the engine fault screen, see [Fig. 15.8](#), screen AA.

## Transmission Faults

This screen displays transmission fault codes that are received from the transmission ECU. To navigate to the transmission fault screen, see [Fig. 15.8](#), screen AB.

## ABS Diagnostics

This screen displays Antilock Brake System (ABS) fault codes that are received from the ABS ECU. To navigate to the ABS diagnostic screen, see [Fig. 15.8](#), screen AC.

## Check Gauges

The check gauges screen allows the driver to set each gauge as a percentage of scale (either 0, 50, or 100%), as shown in the LCD. To navigate to the check gauges screen, see [Fig. 15.9](#), AG screens.

## Warning Lamp

The warning lamp screen allows the driver to test each warning lamp (not the vehicle load) on and then off, displaying the lamp name and status in the LCD. To navigate to the warning lamp screen, see [Fig. 15.9](#), screen AH.

## Check LCD

Selecting the check LCD screen displays the Freightliner Custom Chassis Corporation (FCCC) logo in normal and reverse video three times and then returns to the menu. To navigate to the check LCD screen, see [Fig. 15.9](#), screen AI.

## Check Binary Inputs

The check binary inputs screen displays the pin number and status of each binary input. The toggle buttons allow the driver to select each binary input. This information is continuously updated to assist in troubleshooting. To navigate to the check binary inputs screen, see [Fig. 15.9](#), 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. 15.10](#), 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. 15.10](#), screen AL.

## Menu Navigation

The menu navigation screens are provided to illustrate the menu system. The paths to specific screens are shown, along with instructions for using the toggle buttons to move from one screen to another. See [Fig. 15.77](#), [Fig. 15.8](#), [Fig. 15.99](#), [Fig. 15.10](#), [Fig. 15.1111](#), [Fig. 15.12](#), [Fig. 15.1313](#), [Fig. 15.14](#), [Fig. 15.1515](#), [Fig. 15.16](#), [Fig. 15.1717](#), [Fig. 15.18](#), and [Fig. 15.1919](#).

**IMPORTANT:** Follow the steps below to change the three items (also known as favorites) shown in the message display center. The message

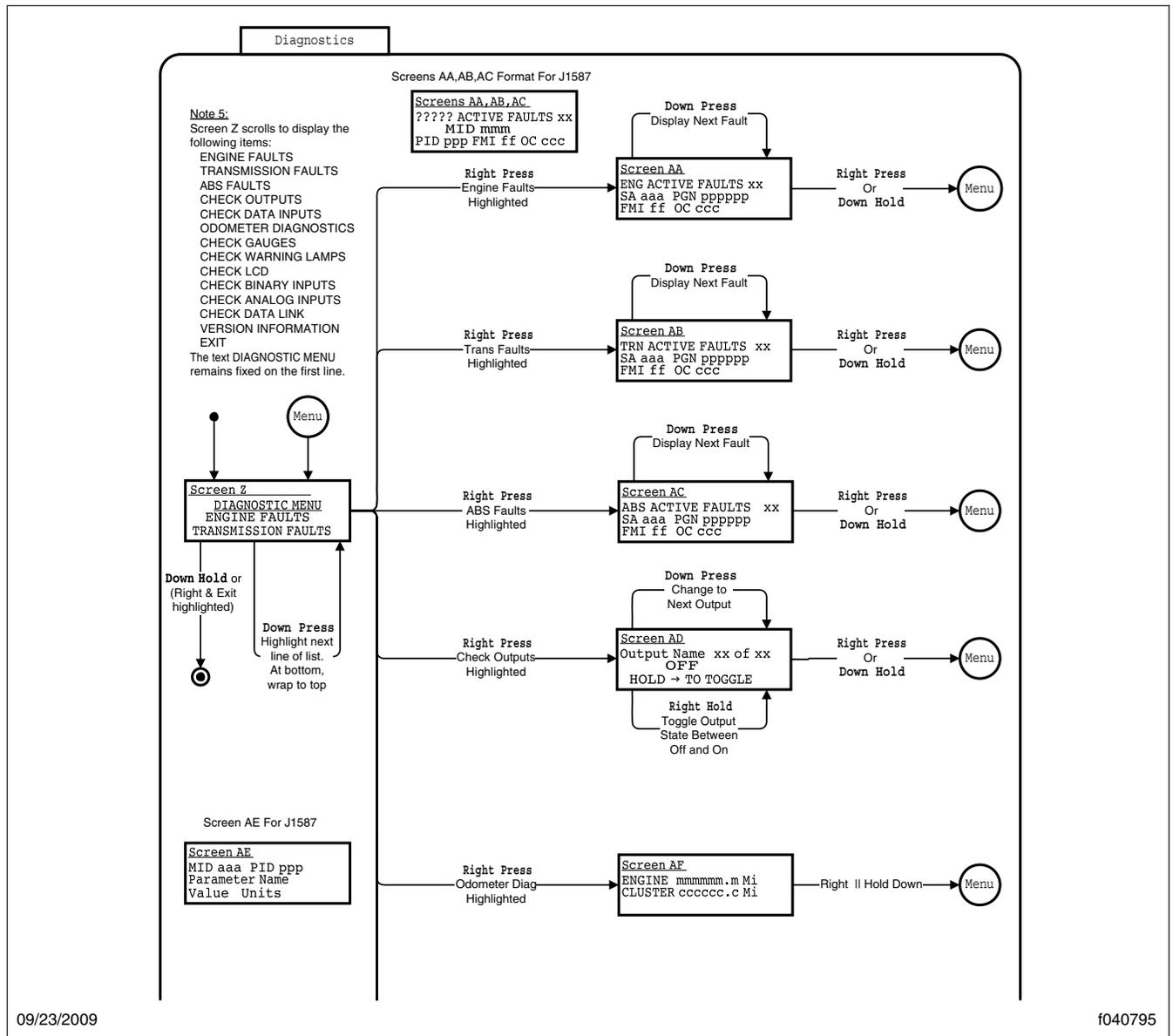
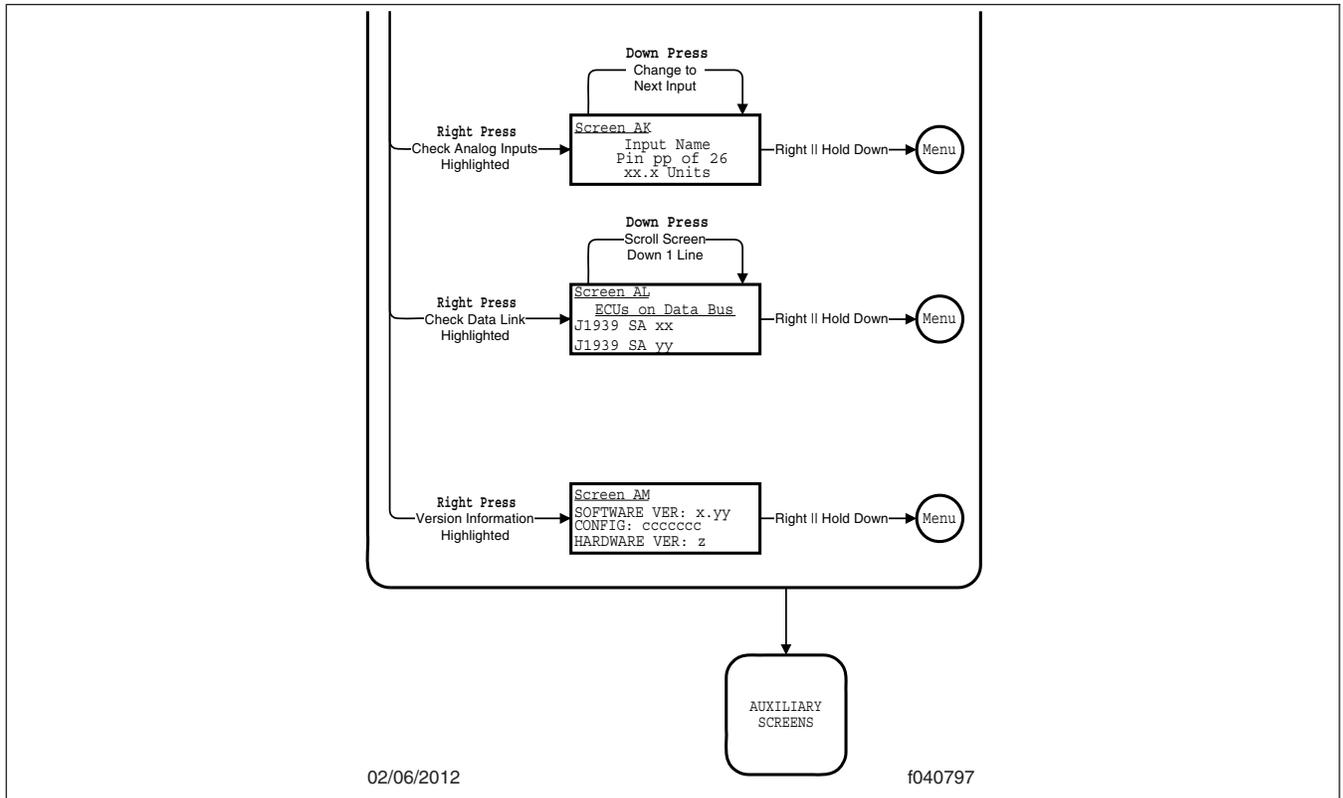


Fig. 15.8, Diagnostic Menu Screens, Screen 1

display center is referred to as screen C in **Fig. 15.13**.

1. With the vehicle in park, turn the ignition to RUN, and allow the self test to complete.
2. Press the down toggle button to select an item to change. The selected item will now be highlighted.
3. Press the right toggle button once to enter the favorites display menu, shown in **Fig. 15.13**, as screen D.
4. Use the down toggle button to scroll through the available items.
5. Highlight the new item, then press the right toggle button. The selected item will now appear in the message display center.





**Fig. 15.10, Diagnostic Menu Screens, Screen 3**

- Air Filter Reminder—the air filter requires checking or replacement.
- Transmission Prognostics Warning—if the transmission has prognostics enabled.

## 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.

## Check Engine Indicator

The amber check engine indicator light 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 stop engine light will illuminate.

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

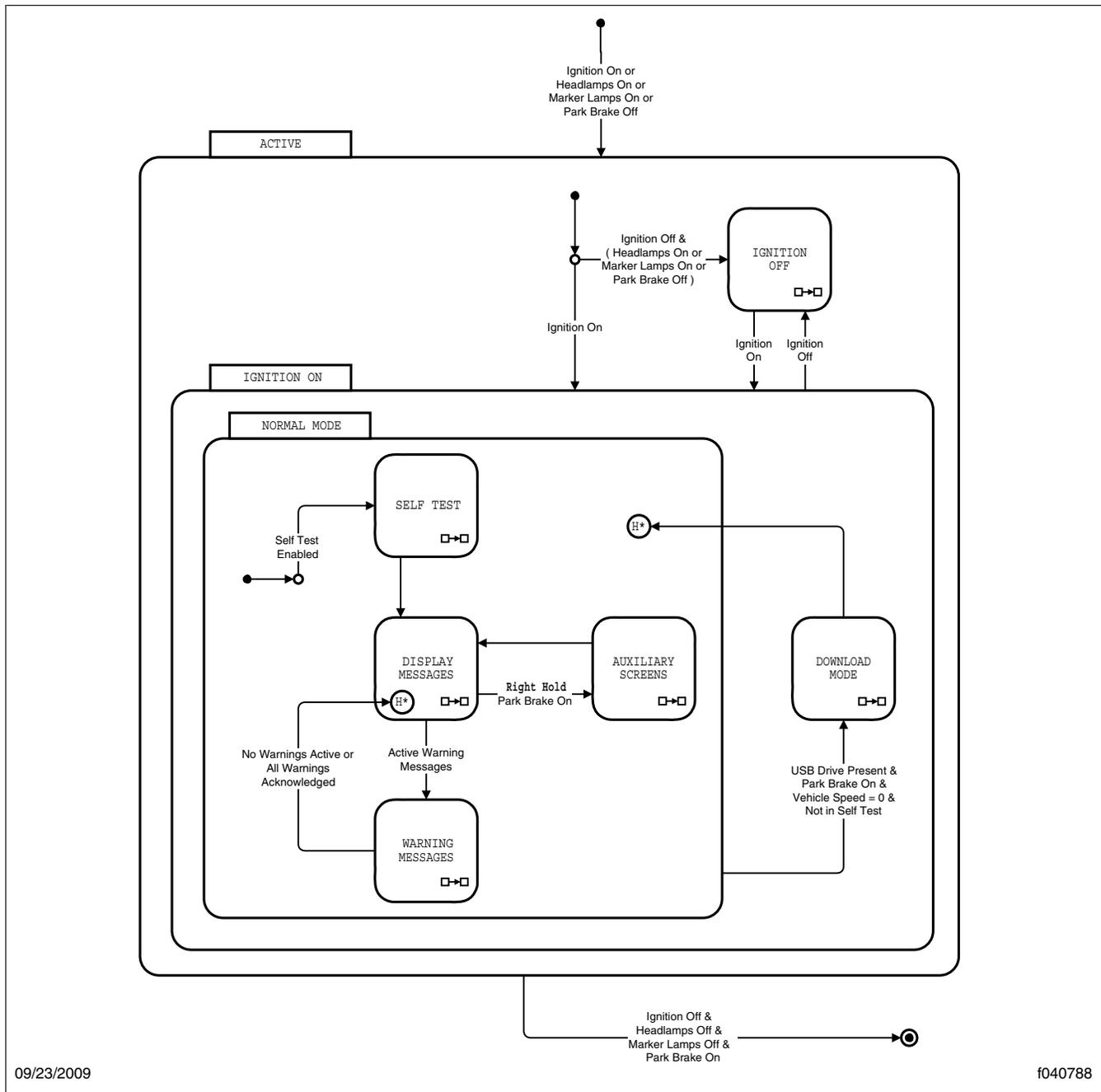
## Stop Engine Warning

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

## NOTICE

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

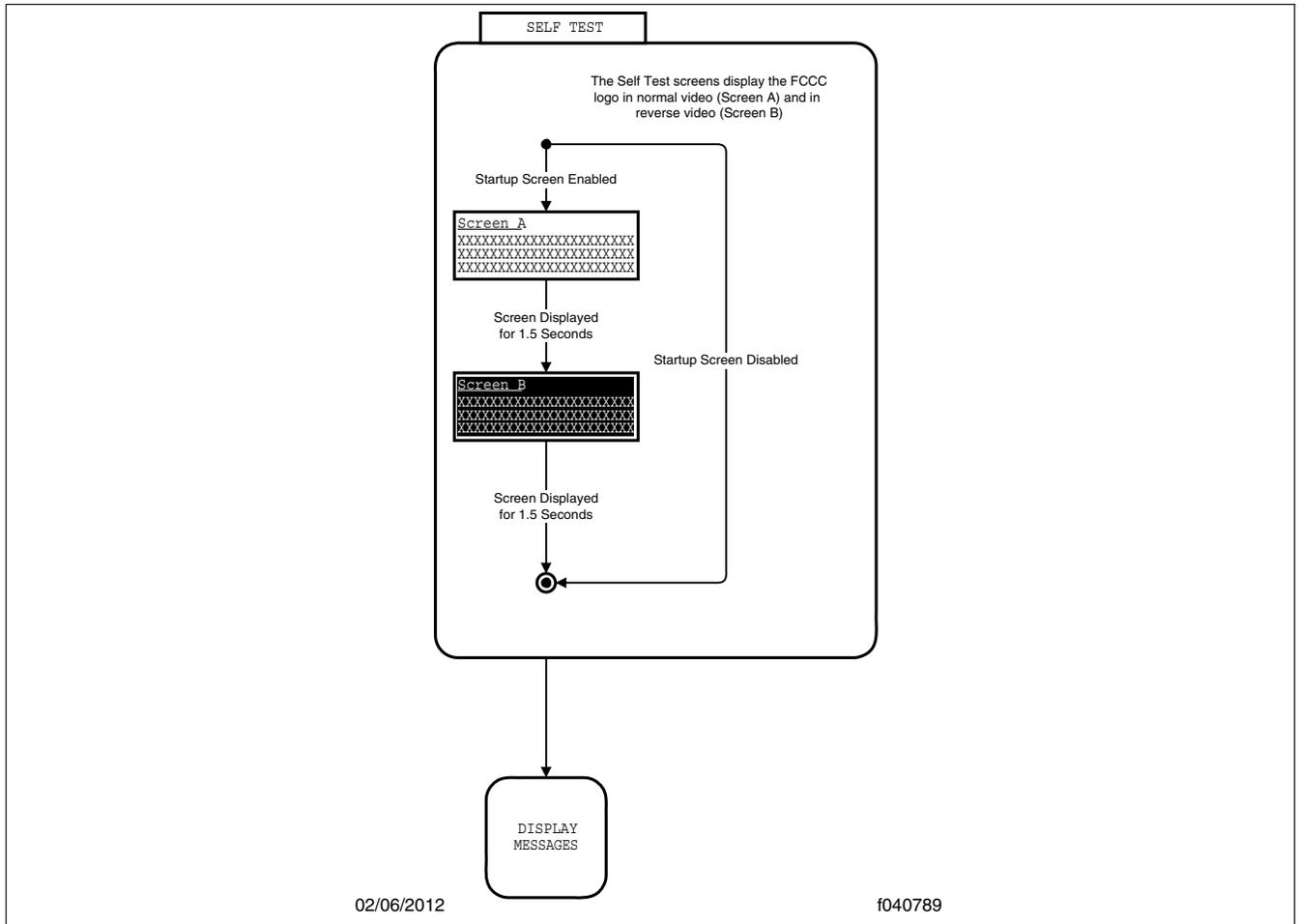
# GM Gasoline Engine



**Fig. 15.11, Ignition On, Normal Mode**

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

lamp will come on and the engine should be shut down. At this point, the vehicle is unsafe to drive and should be transported to an authorized Freightliner service facility.



**Fig. 15.12, Self Test**

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

## Malfunction Indicator Lamp (MIL)

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

## Low Air Pressure Warning

The red low air pressure warning light and emergency buzzer activate when the engine is turned on if air pressure in the primary or secondary air reservoir is below 65 to 75 psi (448 to 517 kPa), and re-

main 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).

## Wait to Start Indicator

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

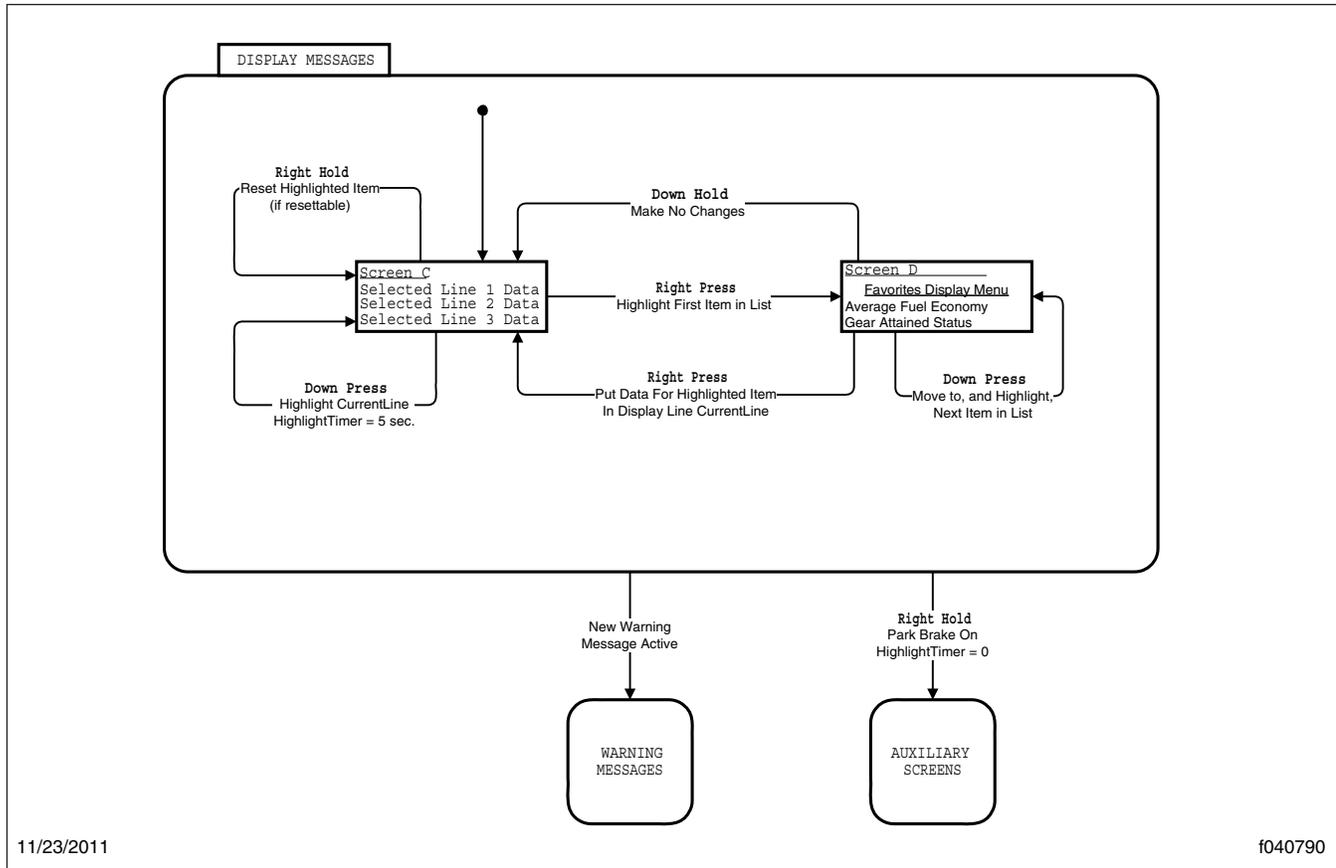


Fig. 15.13, Display Messages

## ABS Indicator

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

NOTE: For more information about this light and the ABS system, see [Chapter 7](#).

## Shift Inhibit Indicator

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

## Check Transmission Indicator

The amber check transmission indicator illuminates when the temperature of the transmission fluid goes above the preset level set by the transmission manufacturer.

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

## Stop Transmission Indicator

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

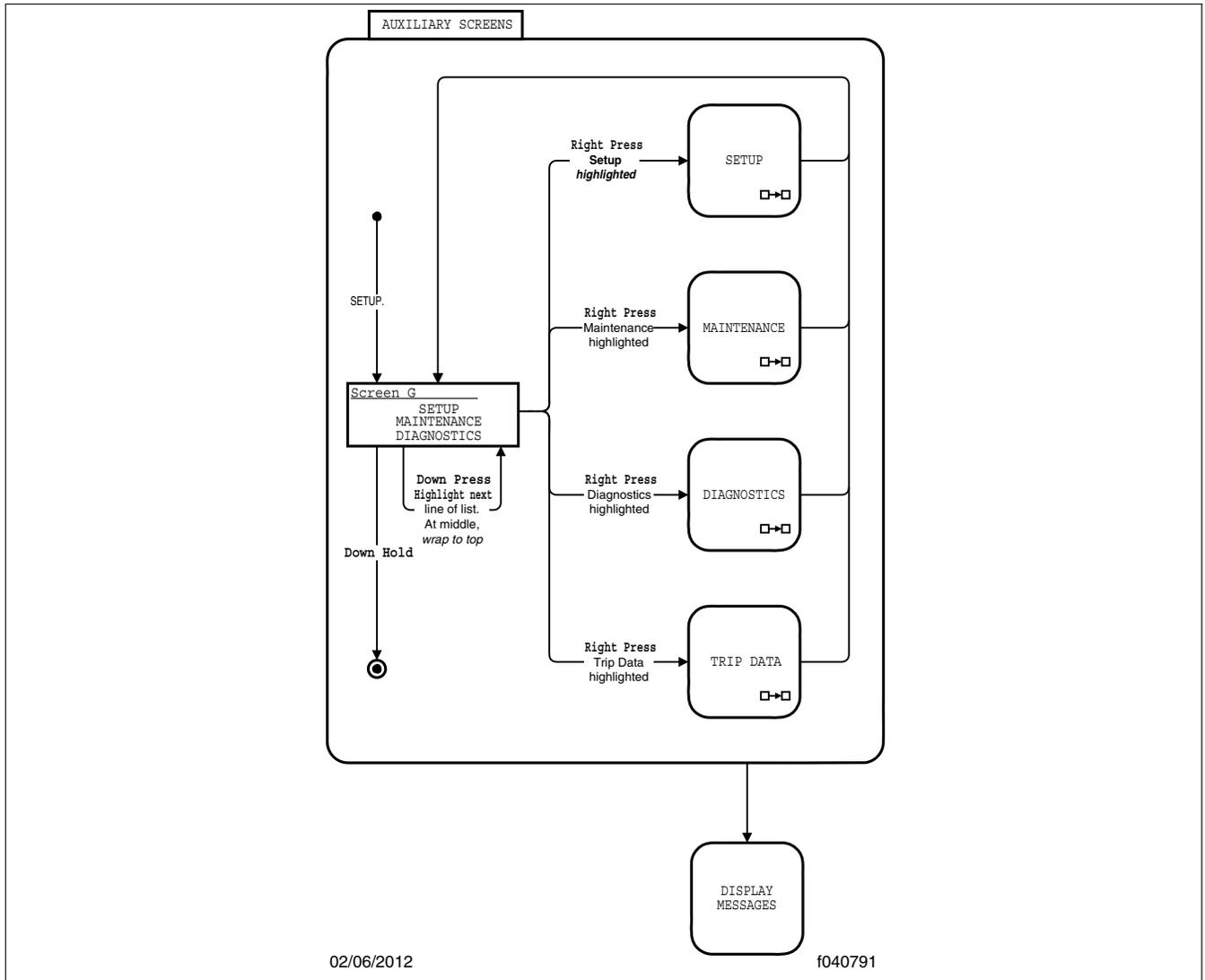
## Right-Turn Signal Arrow

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

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

## Fasten Seat Belts Warning

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



**Fig. 15.14, Auxiliary Screens**

## Hydraulic Brake System Warning

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

## Headlight High-Beam Indicator

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

## Brake System Warning/Parking Brake On Indicator

The red brake system warning/parking brake on indicator light 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.

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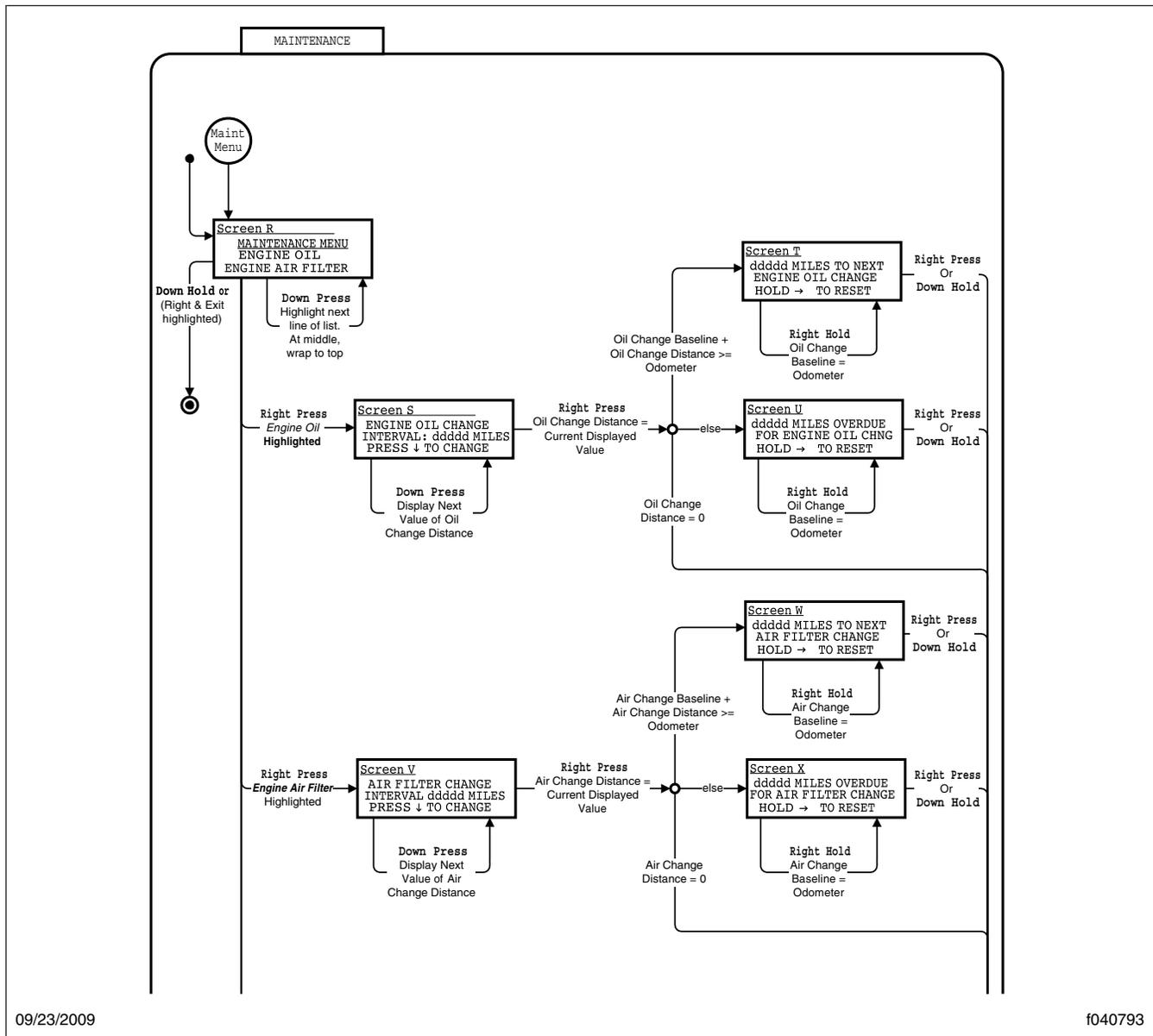


Fig. 15.15, Maintenance Menu Screens, Screen 1

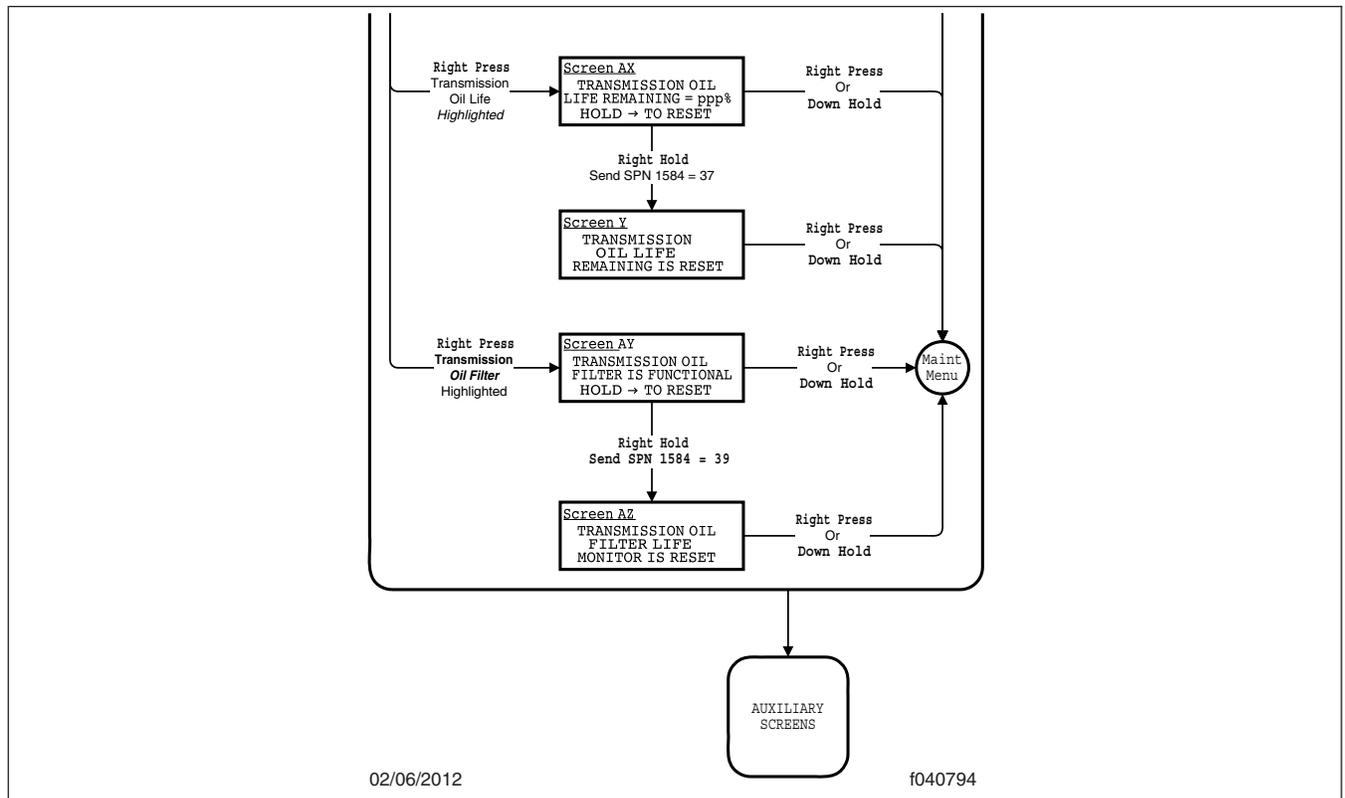
## Cruise Control Indicator

A green indicator illuminates when the cruise control is activated.

## Emergency Buzzer

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

- The engine oil pressure falls below the preset level which is 6 psi (41 kPa) at 700 rpm, or 18 psi (124 kPa) at 4400 rpm.



**Fig. 15.16, Maintenance Menu Screens, Screen 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).
- The coolant temperature rises above 253°F (123°C) and the check engine and stop engine lights illuminate. When the coolant temperature falls below 244° (118°C) the emergency buzzer and stop engine light will turn off.

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

## 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. 15.21](#).

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

### Tachometer

The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range. See [Fig. 15.21](#).

## Standard Instruments

### Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tanks. See [Fig. 15.22](#). A low-level warning light illuminates when the diesel fuel level registers 1/8th of capacity.

# GM Gasline Engine

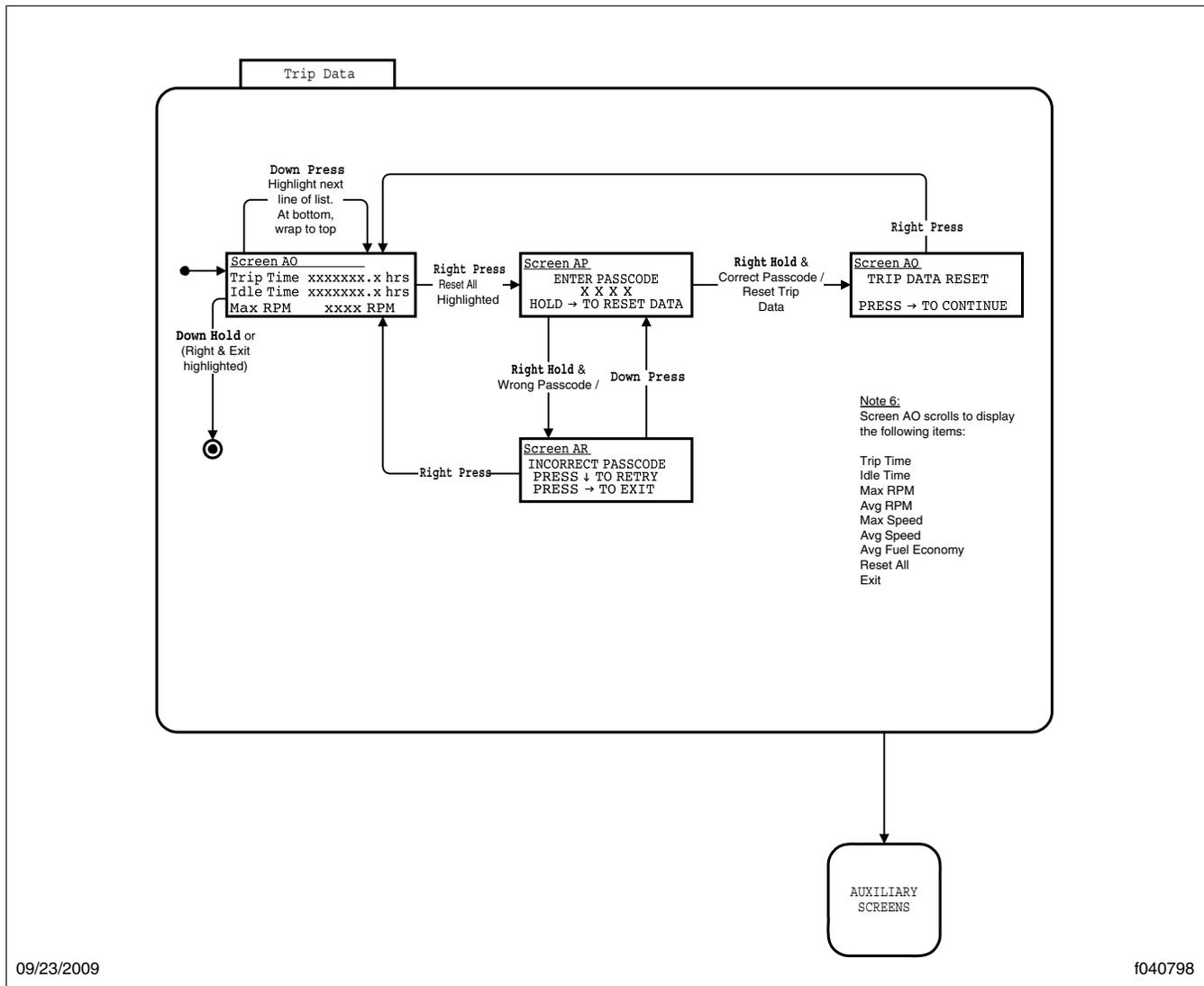


Fig. 15.17, Trip Data

## 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.**

If the engine oil pressure falls below preset levels, the check engine light will illuminate. If the condition does not improve, the CHECK engine light and low oil pressure warning light will also illuminate and the buzzer will sound. See Fig. 15.23. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

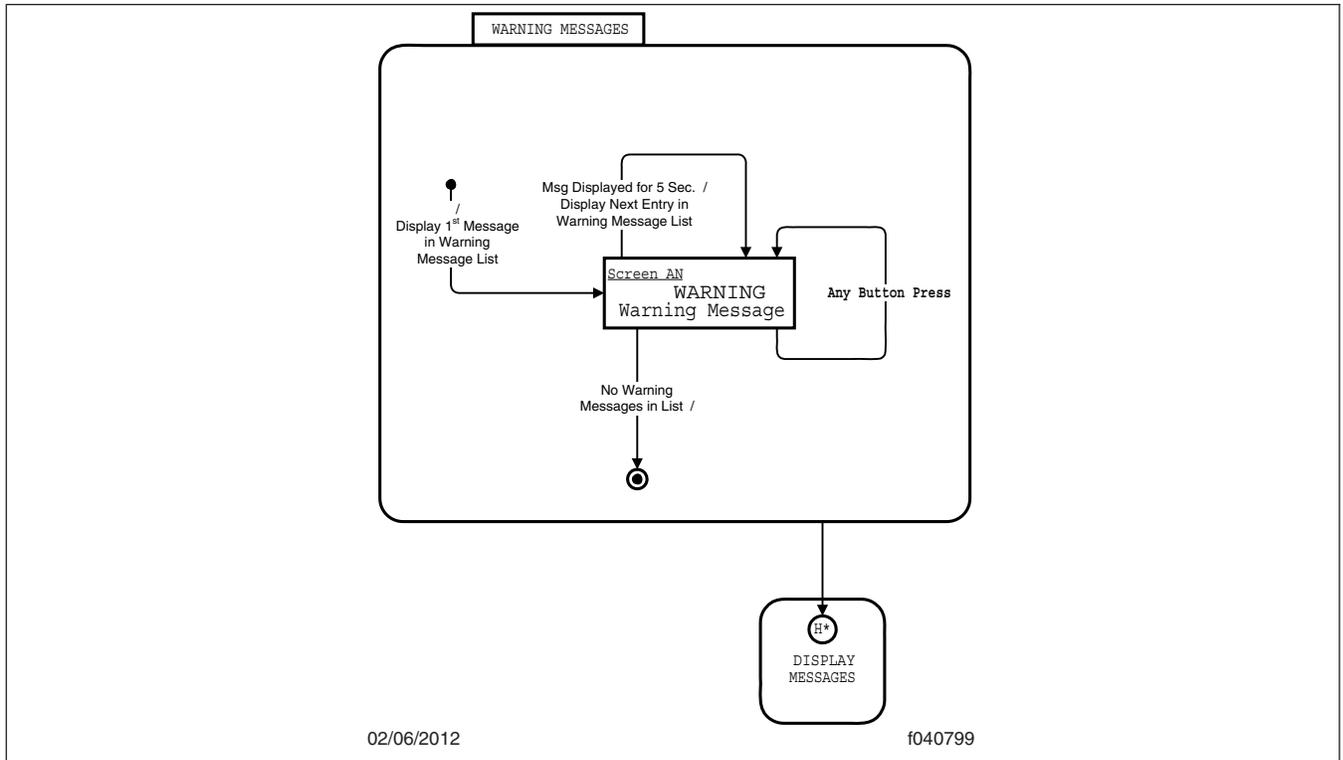


Fig. 15.18, Warning Messages

## Coolant Temperature Gauge

speed will increase, to speed up the cooling fan and water pump to cool the engine.

### NOTICE

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

During normal engine operation, the coolant temperature gauge should read 200 to 205°F (93 to 96°C). See Fig. 15.24. If the temperature remains below 160°F (71°C) or exceeds 235°F (113°C), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

The coolant temperature gauge is very important. See Fig. 15.24. If the coolant temperature rises above 253°F (123°C), the check engine and stop engine lights will illuminate, and the buzzer will sound. At this point, the engine will derate and idle

# GM Gasoline Engine

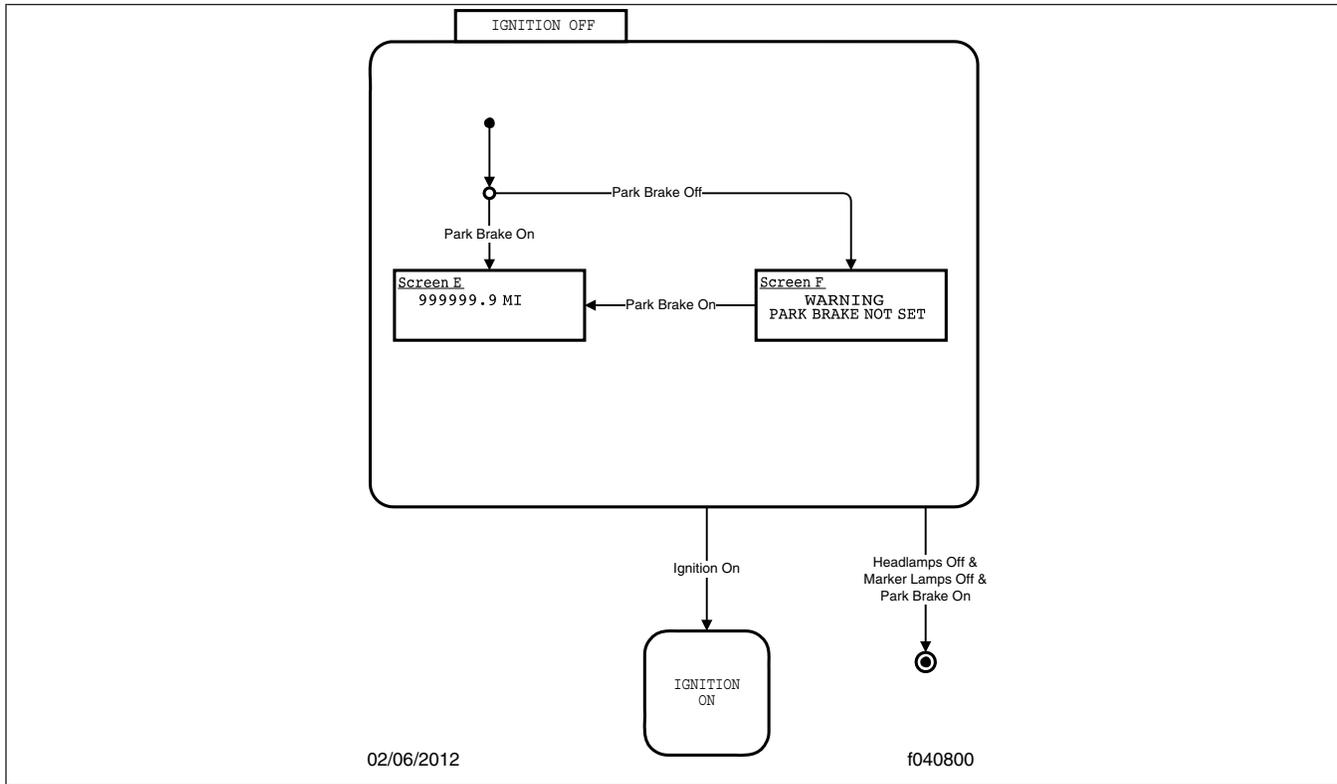


Fig. 15.19, Ignition Off (shown when ignition is keyed OFF)

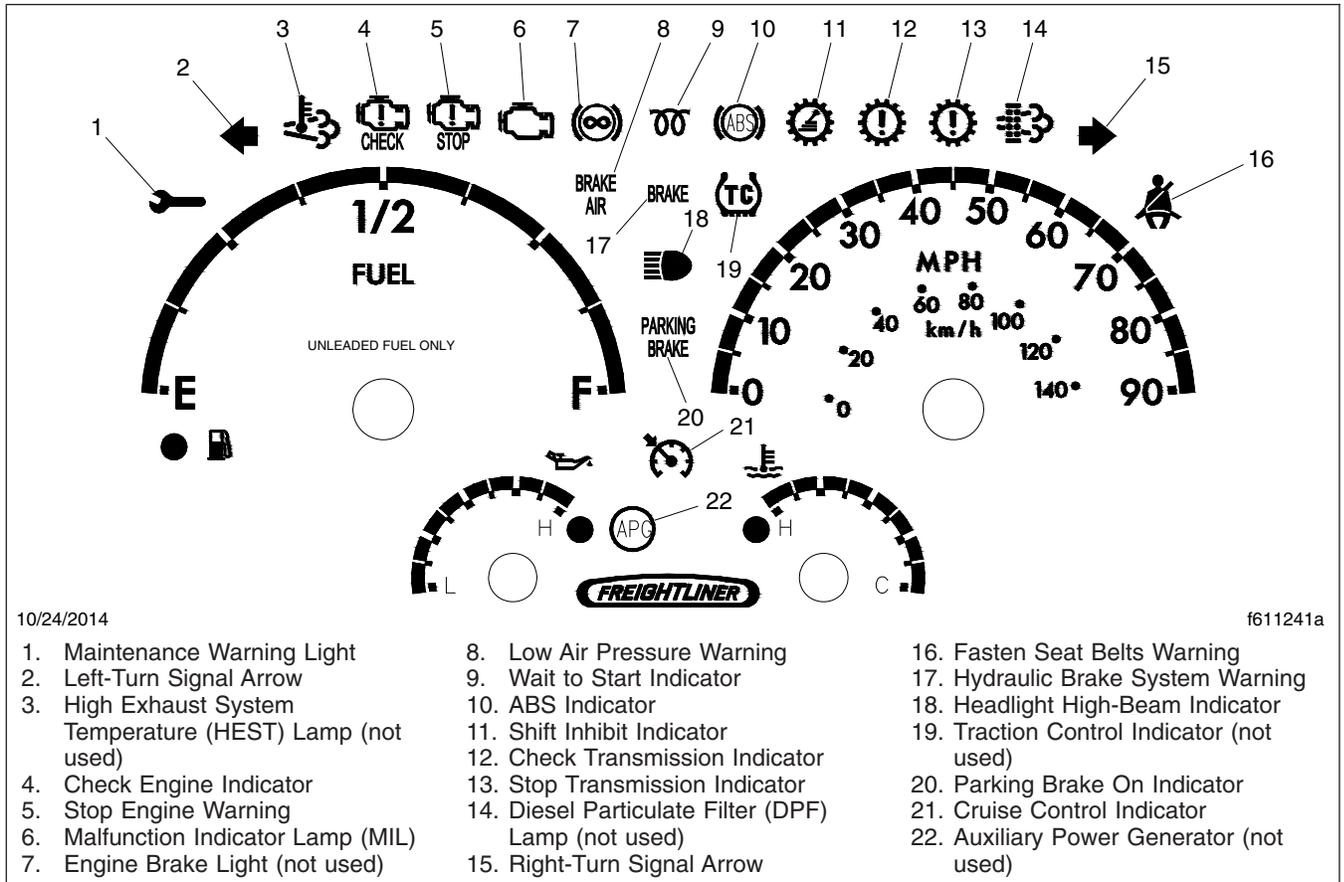


Fig. 15.20, Gasoline Engine Warning and Indicator Lights

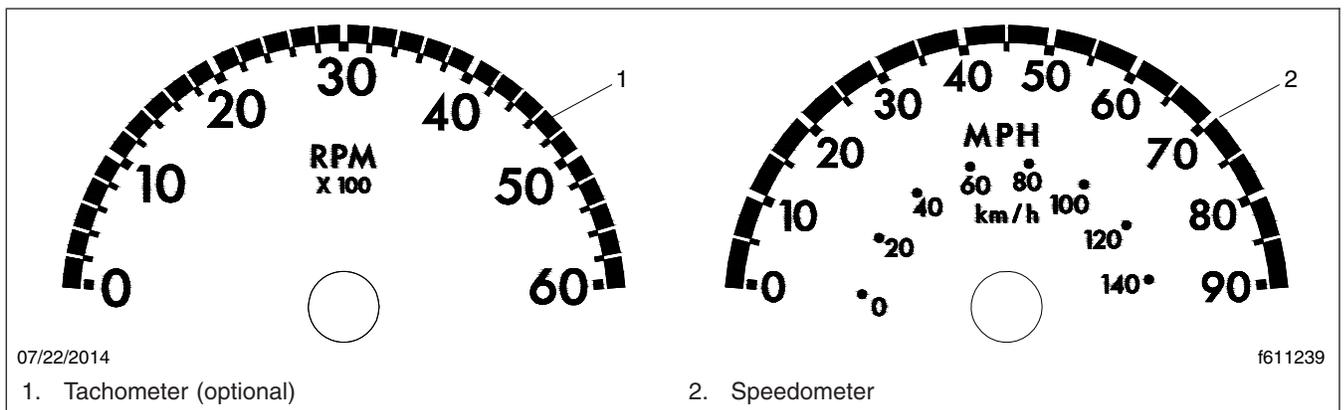
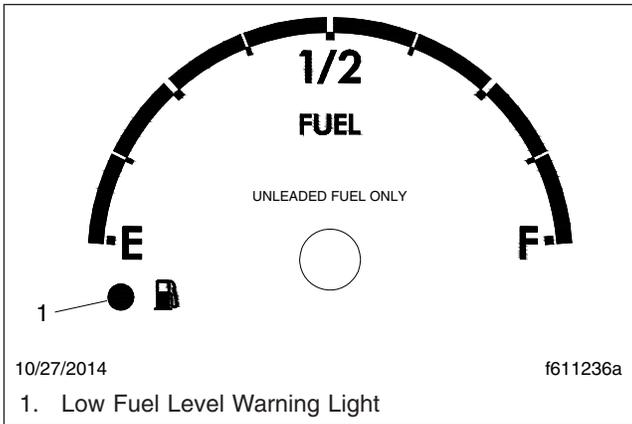


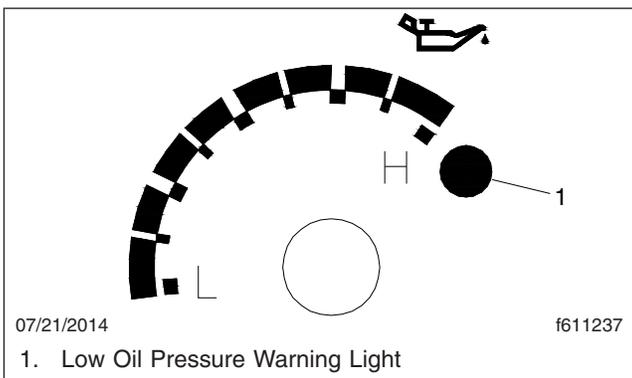
Fig. 15.21, Speedometer and Tachometer (U.S. version)

# GM Gasoline Engine

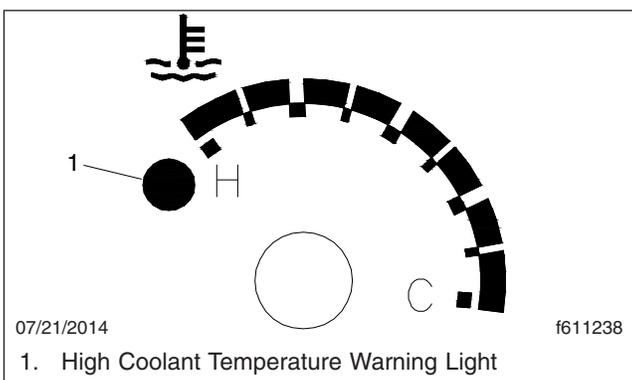
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**Fig. 15.22, Fuel Level Gauge (typical gauge shown)**



**Fig. 15.23, Engine Oil Pressure Gauge**



**Fig. 15.24, Coolant Temperature Gauge**

# 16

## Hydraulic Hybrid

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# Hydraulic Hybrid

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## Safety Precautions

To ensure the safety of the driver, read and understand the statements that follow before operating the hydraulic hybrid vehicle.



Warning labels are placed on various components of the hydraulic hybrid drive system. Failure to read and follow the directions given can lead to personal injury, loss of life, and vehicle or component damage.

Never run hands, arms, or any other part of the body over a hydraulic hose, line, fitting, or assembly to check for leaks. A pinhole leak can release toxic fluid at more than 600 ft (183 m) per second, acting as a hypodermic needle and penetrating both protective clothing and skin at short distances.

Never tighten or loosen a hydraulic connection when the system is under pressure. The connection could fail catastrophically, causing personal injury and/or damage to the vehicle. Make certain that all high pressure is bled from the hydraulic system before working on any connections.

Use extreme caution when working with hydraulic hoses, lines, fittings, or assemblies during installation, preventive maintenance, or component replacement. Fluids under high pressure can be dangerous and potentially lethal. Make sure to bleed all high pressure so that hoses and components can be examined safely.

Discharging high pressure using the manual bleed valve does not release the nitrogen gas precharge pressure within the accumulator. The nitrogen is under high pressure and can be dangerous and potentially lethal if the accumulator is punctured.

It takes approximately 10 minutes for high-pressure fluid to discharge once the manual bleed valve has been opened. Do not attempt to work on the hybrid drive system until there is verification that the high-pressure fluid has been fully discharged.

Do not exit the vehicle before applying the park brake and shifting the transmission to neutral (N). Otherwise, the vehicle could roll, causing property damage, personal injury, or loss of life.

Failure or improper selection or use of hoses, tubing, fittings, assemblies, or related accessories can cause death, personal injury, and property damage. Possible consequences of failure or improper selection or use of these items include but are not limited to the following:

- Fittings thrown off at high speed.
- High velocity fluid discharge.
- Explosion or burning of the discharged fluid.
- Contact with suddenly moving or falling objects that are controlled by the discharged fluid.
- Injection by high-pressure fluid discharge.
- Contact with discharged fluids that may cause injury due to heat, cold, or toxicity.
- Electrocutation from electric power lines.
- Whipping hoses.
- Sparking or explosion caused by static electricity buildup or other sources of electricity.
- Sparking or explosion while spraying paint or flammable liquids.
- Injuries resulting from inhalation, ingestion, or exposure to fluids.

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## NOTICE

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When the red stop transmission indicator illuminates, the transmission control module (TCM) or hybrid control module (HCM) senses a malfunction in the hydraulic hybrid drive system and the message center will display STOP TRANS and/or STOP HYBRID. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

If the low pressure reservoir (LPR) fluid level is not even with or higher than the LOW indicator marks on the sight glass, do not start the vehicle. LPR pressure should be between 35 to 70 psi (241 to 483 kPa). Operating the vehicle with a low LPR fluid level will result in damage to the hydraulic hybrid system.

Remove the rear driveshaft before towing a vehicle equipped with the hydraulic hybrid drive system. Failure to do so will result in damage to the hybrid drive system. Once the driveshaft has been removed, do not attempt to start a vehicle

equipped with a hydraulic hybrid drive system. Doing so will damage the hydraulic hybrid system components.

NOTE: It is normal for the engine to continue running for up to 30 minutes after charging is complete, as certain parameters must be met before the hydraulic hybrid system can shut the engine off.

If the message SHIFT TO NEUTRAL OR PARK appears on the message display screen (with an audible chime) and the park brake engages automatically, the driver's seat belt is unbuckled. Fasten the driver's seat belt to release the park brake.

If the gear selection continuously flashes on the shift pad display, along with the shift inhibit warning indicator illuminated (with an audible chime) and the message center display screen showing SHIFT INHIBIT, the vehicle is in cold weather startup or slow charge mode and will not shift into drive (D) or reverse (R) until the hybrid drive system is at the proper operating temperature. Gear selection will be allowed once the warning indicator is no longer illuminated and the message does not appear on the message display screen.

SHIFT INHIBIT will also appear on the message center display screen if an attempt is made to shift the transmission from drive (D) to reverse (R) or from reverse (R) to drive (D) and vehicle speed is 5 mph (8 km/h) or higher. If this occurs, the hydraulic hybrid system will shift the transmission into neutral (N) and N will appear as the current gear on the shift pad. The SHIFT INHIBIT message will appear on the message display center and the shift inhibit indicator will illuminate. The selected gear will continue to flash on the shift pad until the previous gear or neutral (N) is selected. The message and the indicator will turn off and the transmission shift will be allowed when vehicle speed is less than 5 mph (8 km/h).

## Hydraulic Hybrid Drive System

Vehicles equipped with the hydraulic hybrid drive system can be identified by the access hole on the driver's side of the vehicle, shown in [Figure 16.1](#). Some units may have a door to cover the access hole. This opening allows the driver to view the LPR pressure gauge and fluid level sight glass.

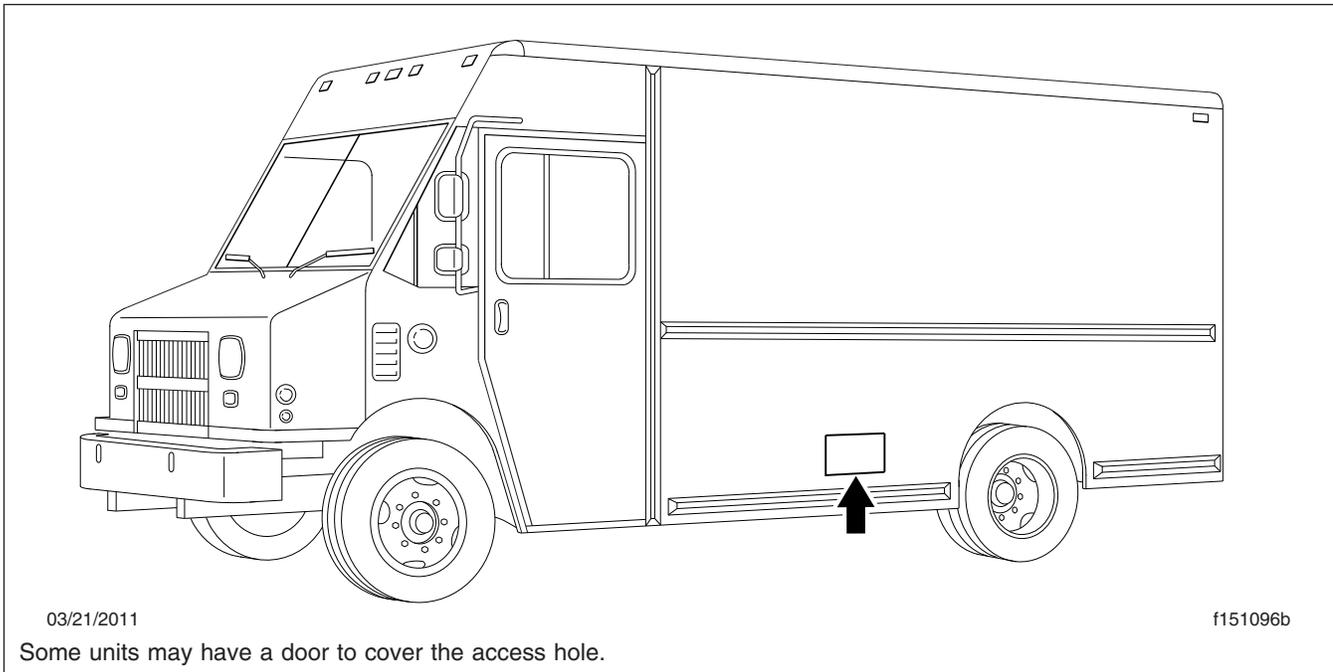
Hydraulic hybrid vehicles also utilize a hybrid performance gauge and an accumulator state-of-charge (SOC) gauge, both of which are located in the instrument cluster.

## Functional Differences

The hydraulic hybrid drive system operates similarly to a conventional drivetrain in that to move the vehicle, the proper gear is selected and the accelerator pedal is pressed, and to stop the vehicle, the brake pedal is pressed. However, the hydraulic hybrid drive system is different in the following ways:

- It utilizes hydraulic pressure to propel the vehicle at speeds up to 25–30 mph (40–48 km/h).
- Only after the vehicle reaches a speed above 25–30 mph (40–48 km/h), is the engine mechanically coupled to the rear differential.
- It captures the initial kinetic energy obtained during braking to pressurize the hydraulic system, storing the energy in the accumulator.
- Braking is a combination of brake energy recovery and the friction brakes. A small transition from brake energy recovery mode to friction braking may be when braking.
- The engine will run at a varying rpm, independent of vehicle speed, in order to run the primary pump and pressurize the accumulator. This allows for the most efficient operation of the engine.
- It can be used to start the engine while the vehicle is stopped or is in motion.
- The engine can be shut off while the vehicle is stopped or in motion, and remain off during vehicle operation, up to 25–30 mph (40–48 km/h).
- If adequate energy is in the high pressure accumulator and all requirements are met, it will

# Hydraulic Hybrid



**Fig. 16.1, Access Hole, Vehicle Equipped With a Hydraulic Hybrid Drive System**

propel the vehicle using only hydraulic pressure.

## System Components

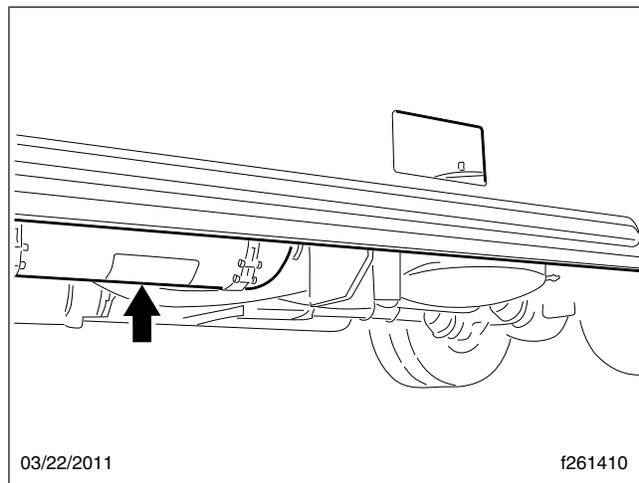
### High Pressure Accumulator

The high pressure accumulator is located under the center of the vehicle on the driver's side. See [Fig. 16.2](#). The accumulator, precharged with nitrogen gas, stores pressurized hydraulic fluid sent from the primary pump. The secondary pump also charges the accumulator during brake energy recovery.

The stored fluid is used to drive the secondary pump, which in turn drives the gearbox to propel the vehicle. Pressurized fluid can also be used to run the primary pump to start the engine.

### Hydraulic Hoses

The hydraulic hoses deliver low- and high-pressure fluid to the various components used in the hydraulic hybrid drive system. These hoses are specifically designed to withstand the extreme fluid temperature and pressure fluctuations that occur during normal operation of the hydraulic hybrid drive system. Many of the hoses have the potential to store hydraulic en-



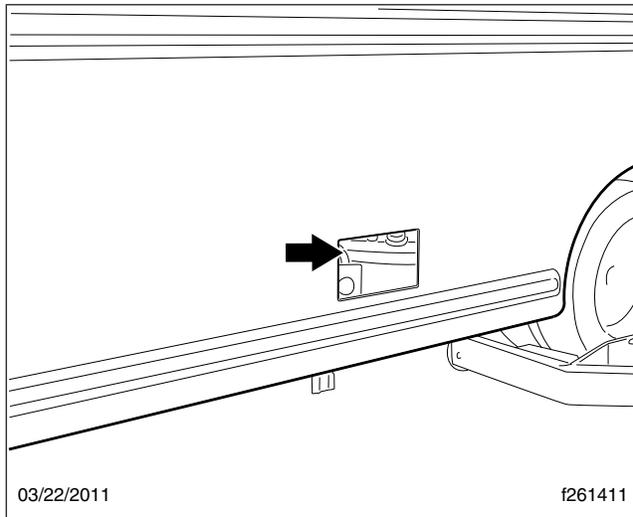
**Fig. 16.2, High Pressure Accumulator Location**

ergy of up to 5500 psi (37 923 kPa), even when the vehicle is not being operated.

The hoses are color coded to distinguish between high pressure and low pressure usage. All high pressure hoses have protective orange wrap, while the low pressure hoses have black wrap.

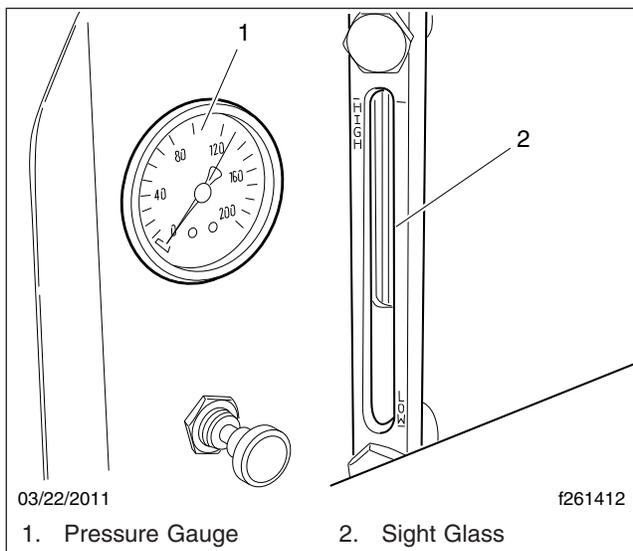
## Low Pressure Reservoir (LPR)

The LPR is located under the center of the vehicle on the driver's side, and is visible through the body opening. See **Fig. 16.3**. The LPR is precharged with nitrogen and stores hydraulic fluid.



**Fig. 16.3, Location of the LPR**

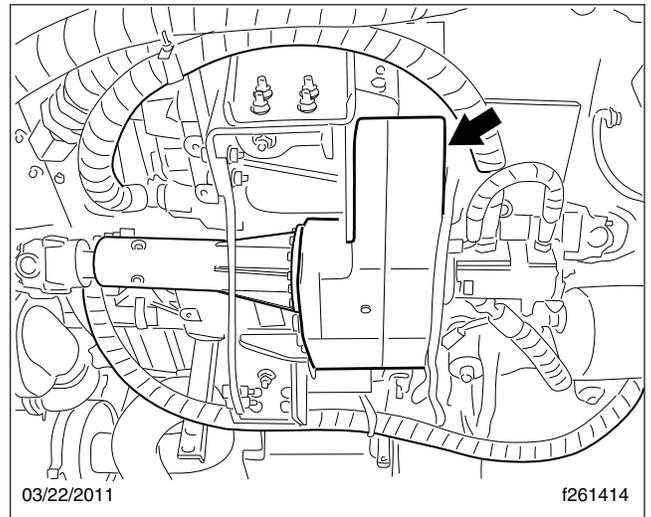
A sight glass mounted on the side of the LPR contains markings used to determine the fluid level. The pressure gauge is used to determine nitrogen gas pressure in the LPR. See **Fig. 16.4**.



**Fig. 16.4, LPR Sight Glass and Pressure Gauge**

## Gearbox

The gearbox, shown in **Fig. 16.5**, transfers power from the engine and/or the secondary pump out to the rear wheels. The gearbox can also use the power output of the primary pump to start the engine.



**Fig. 16.5, Gearbox**

## Gearbox Fluid Filter

The gearbox fluid filter, shown in **Fig. 16.6**, removes contaminants that occur normally as a result of the heat and friction generated by the movement of the internal components in the gearbox. Removing these particles allows the fluid to lubricate and cool the components, preventing premature wear and potential damage.

## Gear Pump

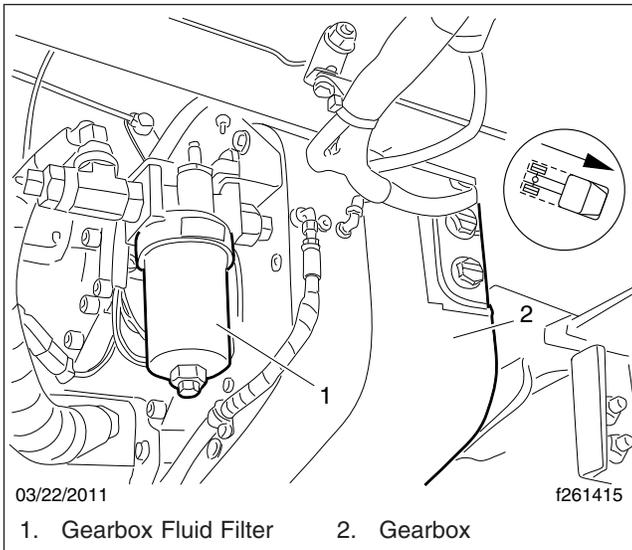
The gear pump is mounted on the back of the gearbox and is driven by the engine. See **Fig. 16.7**. It circulates hydraulic fluid through the system cooling and filtration loop, and gearbox fluid through the gearbox filtration loop.

## Primary and Secondary High Pressure Pumps

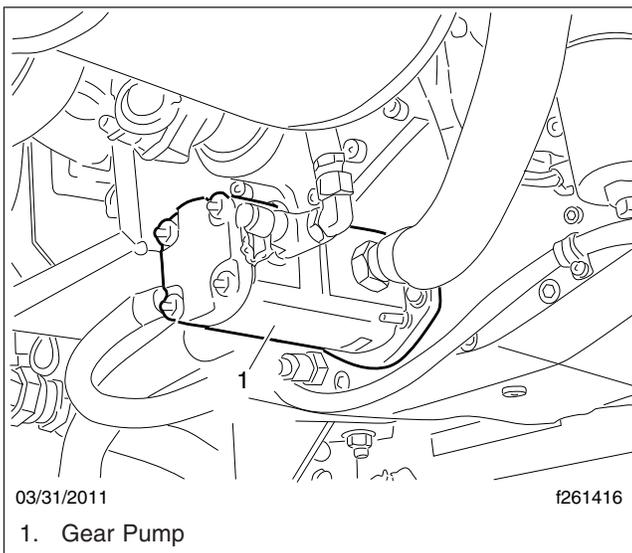
The primary and secondary high pressure pumps are mounted on the front of the gearbox as shown in **Fig. 16.8**.

The primary pump is used either as a pump or motor. In pumping mode, the pump is driven by the

# Hydraulic Hybrid



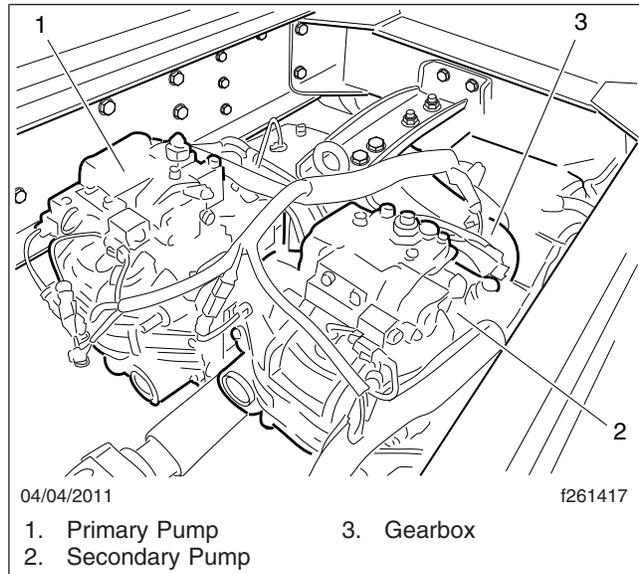
**Fig. 16.6, Gearbox Fluid Filter**



**Fig. 16.7, Gear Pump**

engine, through the gearbox, to pressurize hydraulic fluid for storage in the accumulator, and maintain the desired state-of-charge. The primary pump is also used to transfer fluid to the secondary pump to propel the vehicle.

In motoring mode, the pump is driven by the high-pressure fluid stored in the accumulator to drive the gearbox to start the engine.



**Fig. 16.8, Location of the Primary and Secondary High Pressure Pumps**

The secondary pump is also used as either a pump or motor. In motoring mode, the pump is driven by high-pressure fluid from the primary pump or the fluid stored in the accumulator to drive the gearbox to propel the vehicle.

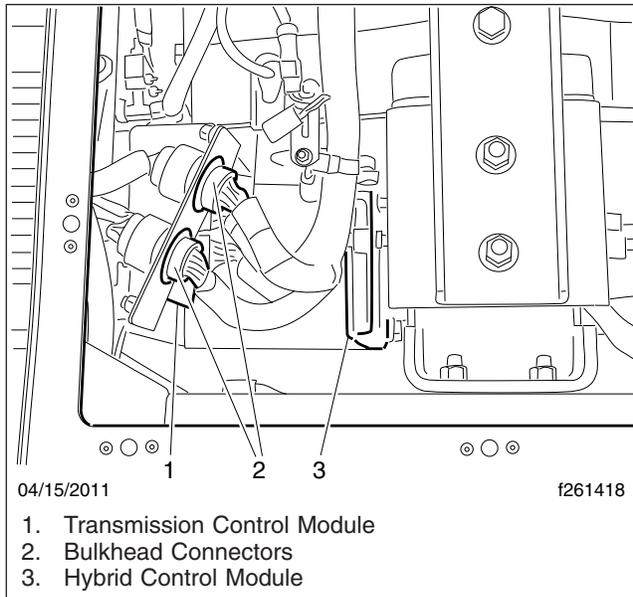
During regenerative braking, the rear wheels drive the secondary pump to pressurize fluid for storage in the accumulator. This action works to slow the vehicle.

## Hybrid Control Module (HCM)

The HCM, shown in [Fig. 16.9](#), is located below the service panel in the floor of the cargo area, and controls all hybrid drive system functions.

## Transmission Control Module (TCM)

The TCM is located below the service panel in the floor of the cargo area. It is situated underneath the bulkhead connector and interfaces with most of the vehicle's electronics. See [Fig. 16.9](#).



**Fig. 16.9, Floor Panel Access**

## Hydraulic Gauges, Warning Indicators, and Message Displays

### Gauges

The hybrid performance gauge and the state-of-charge (SOC) gauge are two hydraulic hybrid system gauges located in the instrument panel. See [Fig. 16.10](#).

### Hybrid Performance Gauge

The hybrid performance gauge displays how efficiently the vehicle is being driven. The green ECON area, which is the target range, represents when the vehicle is operating in the most economical range. When normal acceleration and braking occur, brake energy recovery maintains a high state-of-charge in the accumulator for maximum hydraulic hybrid drive performance.

The red BRAKE area indicates an aggressive braking occurrence. Aggressive braking uses more friction braking than regenerative braking to slow the vehicle, which results in less energy captured for storage in the accumulator.

The red ACCEL area indicates when the accelerator is fully depressed, which depletes the energy stored

in the accumulator in two ways. First, the engine would restart sooner than normal, and reduce the amount of engine-off time. Second, if the engine is already running, the engine's energy is used in a less efficient manner to further accelerate the vehicle.

If the hybrid performance gauge does not remain within the ECON area, regardless of how efficiently the brakes or accelerator are applied during operation, contact a certified hydraulic hybrid drive service technician to determine if there is a problem with the gauge or the system.

### State-of-Charge (SOC) Gauge

The SOC gauge displays the available fluid pressure (energy) in the accumulator for use by the hydraulic hybrid drive system.

Slower vehicle speeds require less energy use by the hydraulic hybrid drive system to propel the vehicle, allowing it to maintain a higher percentage of stored fluid pressure in the accumulator.

The state-of-charge can also be maintained through normal braking, where brake energy recovery is enabled, allowing the rear wheels to drive the secondary pump to pressurize the accumulator. Light to moderate braking will increase the state-of-charge more for a given event.

The higher the state-of-charge, the more energy there is to propel the vehicle with the hydraulic hybrid drive system rather than the engine. This results in fuel savings and less wear on the engine.

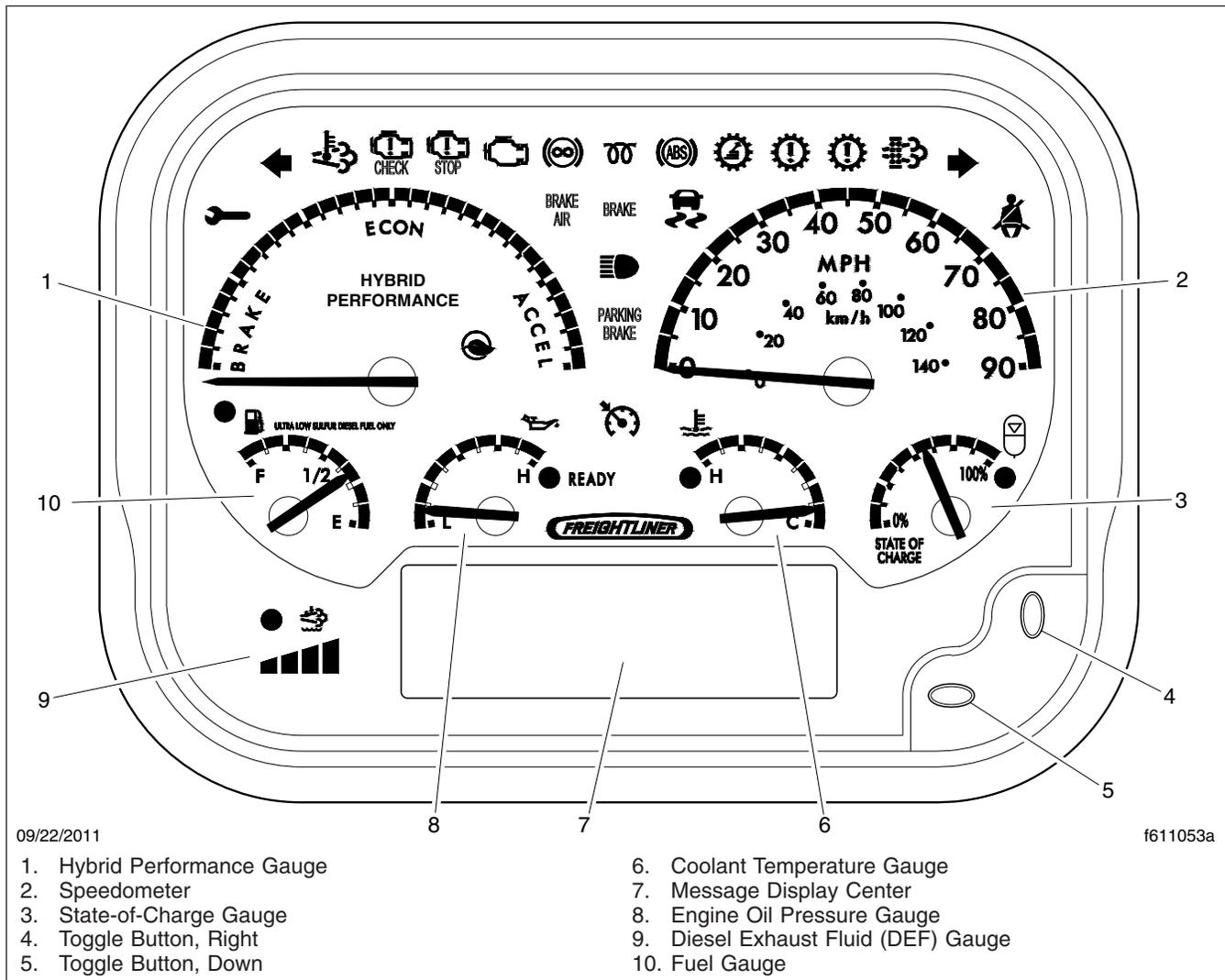
The state-of-charge can also be increased by aggressive acceleration. However, this type of increase in the state-of-charge will decrease fuel economy and should be avoided.

If the percentage on the gauge remains in the red area regardless of how efficiently the vehicle is operated, contact a certified hydraulic hybrid drive service technician to determine if there is a problem with the gauge or the system.

### Warning and Indicator Lights

The warning and indicator lights are located in the instrument panel and contain all of the standard and optional warning and indicator lights. See [Fig. 16.11](#). When the ignition is turned to the ON position, all indicators will illuminate for a required self-test.

# Hydraulic Hybrid



**Fig. 16.10, Typical Ametek Instrument Panel (Hydraulic Hybrid), EPA10 and Newer Engines**

The hydraulic hybrid vehicle also has unique indicators that are specific to the hydraulic system. These are the propulsion system ready and low traction indicators, which are described later in this section.

If an indicator—not including the READY indicator—remains illuminated after the self-test or illuminates while the vehicle is in operation, a fault exists in the system. A warning chime will sound to alert the driver when an indicator is illuminated.

## Check Transmission and Stop Transmission Indicators

The amber check transmission indicator illuminates when a problem is detected in the hydraulic hybrid drive system. See [Fig. 16.11](#).

If the check transmission indicator illuminates, along with the message center displaying CHECK TRANS or CHECK HYBRID, have the vehicle serviced as soon as possible by a certified hydraulic hybrid drive service technician.

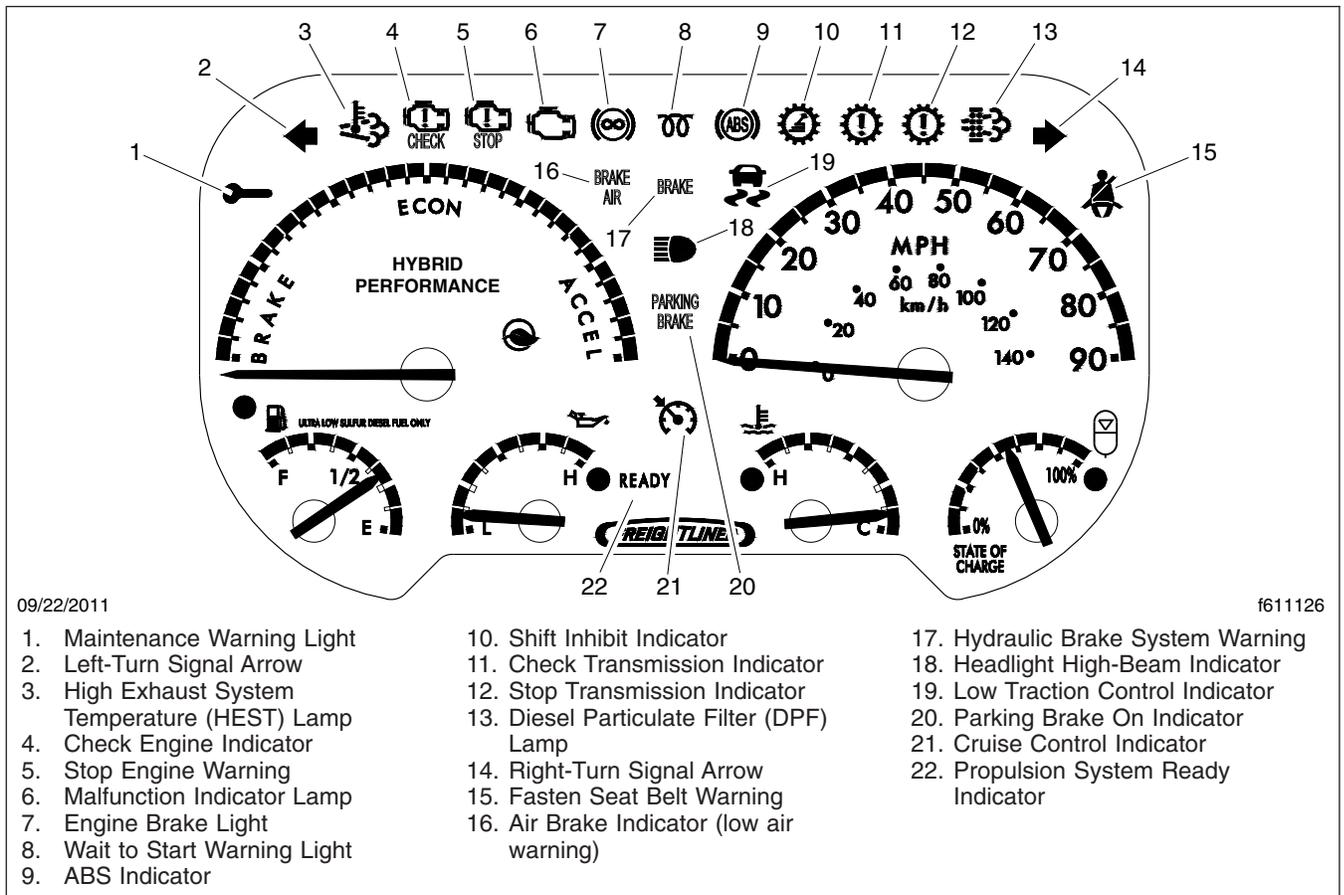


Fig. 16.11, Warning Lights, Hydraulic Hybrid Vehicle

## NOTICE

When the red stop transmission indicator illuminates, the transmission control module (TCM) or hybrid control module (HCM) senses a malfunction in the hydraulic hybrid drive system and the message center will display STOP TRANS and/or STOP HYBRID. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system. See Fig. 16.11 for an example of the stop transmission indicator.

When the red stop transmission indicator illuminates, the transmission control unit senses a malfunction in the hydraulic hybrid drive system. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

## Propulsion System Ready Indicator

NOTE: In order for the hydraulic hybrid system to power the vehicle, the propulsion system must be charged. If the propulsion system is not charged, the engine can be used to charge the system and power the vehicle.

The green propulsion system ready indicator will illuminate when the hydraulic hybrid drive system is ready to propel the vehicle. When the ignition is turned to the ON position, and the propulsion system ready indicator is illuminated, the vehicle can be driven with the engine off. See Fig. 16.11 for an example of the propulsion system ready indicator.

NOTE: To start the engine with the ready indicator illuminated, to heat the cab for example, turn the ignition to the START position and hold it for at least five seconds.

# Hydraulic Hybrid

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If the propulsion system ready indicator does not illuminate, the message START ENGINE will appear on the message display screen and the hydraulic hybrid system will not allow the transmission to shift until the system is charged. To charge the system, the engine must be running in order to drive the primary pump to pressurize fluid in the high pressure accumulator. Turn the ignition to the START position to start the engine. When the engine starts, WAIT will appear in the message display screen. The WAIT message will disappear and the propulsion system ready indicator will illuminate once the charging process is complete. The engine will turn off as long as the engine coolant is at the proper operating temperature.

## Shift Inhibit Indicator

The amber shift inhibit indicator illuminates whenever all conditions for safe transmission shifting have not been met. SHIFT INHIBIT will also appear in the message display screen when the indicator illuminates. See [Fig. 16.11](#) for an example of the shift inhibit indicator. The shift inhibit indicator will illuminate due to one or more of the following conditions:

- The propulsion system ready indicator is not illuminated.
- The temperature of the hydraulic fluid is less than 0°F (-18°C).
- A transmission shift is attempted when the vehicle's speed is above 5 mph (8 km/h). When this occurs, the gearbox will be forced to shift into neutral (N) and the current gear will display N on the shift pad. The selected gear will continue to flash on the shift pad until either the previous gear or neutral (N) is selected.

The indicator and message will turn off, and the transmission can be shifted when all of the following conditions are met:

- The propulsion system ready indicator illuminates.
- The temperature of the hydraulic fluid is 0°F (-18°C) or higher.
- Vehicle speed is below 5 mph (8 km/h).

## Low Traction Control Indicator

The amber low traction indicator illuminates when wheel slippage is detected by the HCM. See

[Fig. 16.11](#) for an example of the low traction control indicator. LOW TRACTION will appear on the message display screen. The hybrid system will reduce power output until slippage is no longer detected.

## Message Displays

The hydraulic hybrid vehicle uses the same instrument panel, by Ametek, as the standard diesel Walk-In Van. The panel operates the same way unless noted otherwise here. See [Chapter 2, Instruments](#) for a detailed description of the Ametek instrument panel.

The following messages can appear on the message display screen. Brief descriptions for the various messages follow.

- low pressure reservoir (LPR) air pressure
- check transmission/check hybrid
- stop transmission/stop hybrid
- hood open
- hybrid communication fault
- hydraulic oil filter monitor
- low traction
- shift to neutral or park
- shift inhibit
- low vehicle battery voltage

## Low Pressure Reservoir (LPR) Air Pressure

LOW LPR AIR PRESSURE will appear on the message display screen when LPR pressure falls below 35 psi (241 kPa) and a warning chime will sound.

## Check Transmission/Check Hybrid

A message will appear along with the check transmission warning indicator when the transmission control module (TCM) or the hybrid control module (HCM) detects a fault in the hydraulic hybrid system.

When the red stop transmission indicator illuminates, the message center will display STOP TRANS and/or STOP HYBRID, due to a malfunction in the hydraulic hybrid system. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system. Contact a certified hydraulic hybrid service technician to determine the corrective action to take.

## NOTICE

**When the red stop transmission indicator illuminates, the TCM or HCM senses a malfunction in the hydraulic hybrid drive system and the message center will display STOP TRANS and/or STOP HYBRID. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.**

### Stop Transmission

If the TCM or HCM detects a serious fault within the hydraulic hybrid drive system, both the STOP TRANS and STOP HYBRID messages will appear on the message display screen and the stop transmission indicator will illuminate. When this occurs, the vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

### Hood Open

The message HOOD OPEN will appear on the message display screen and a chime will sound to warn the driver if the hood is open.

When the engine is off and the hood is open, the hydraulic hybrid system will prevent the engine from starting until the hood is closed.

### Hybrid Communication Fault

If there is a loss of communication between the HCM and the instrument panel, an HHV COMM FAIL message will appear on the message display screen.

### Hydraulic Oil Filter Monitor

When the hydraulic fluid filter needs to be changed, REPLACE SYSTEM OIL FILTER will appear on the message display screen and a chime will sound.

### Low Traction

When wheel slippage is detected by the HCM, LOW TRACTION will appear on the message display screen and the amber low traction indicator illuminates. The hybrid system will reduce power output until slippage is no longer detected.

### Shift to Neutral or Park

The message SHIFT TO NEUTRAL OR PARK will appear on the message display screen if the driver's seat belt is unbuckled and the brake pedal is re-

leased while the ignition switch is in the ON position, the engine is OFF, and the vehicle is in drive (D) or reverse (R) and moving less than 1 mph (2 km/h). When these conditions occur, the park brake will automatically engage to prevent the vehicle from accidentally moving without the driver. A warning chime will sound while the message is displayed.

The park brake will not release until either the engine is started, the ignition is in the OFF position, the driver's seat belt is fastened, the brake pedal is depressed, or the vehicle is placed in neutral (N). Once the park brake is released, the message will disappear.

### Shift Inhibit

Whenever all conditions for safe transmission shifting have not been met, SHIFT INHIBIT will appear on the message display screen and the amber shift inhibit indicator illuminates on the instrument panel. Once the indicator and message turn off, the gearbox will be allowed to shift into the desired gear. For additional information, see **Shift Inhibit Indicator** in this section.

### Low Vehicle Battery Voltage

When battery voltage is less than or equal to 11.9V, LOW VOLTAGE will appear on the message display screen. The message will only be activated if the engine rpm has been above 500 rpm for five seconds, or if the engine rpm is 0.

### Stop Hybrid

## NOTICE

**When the red STOP HYBRID message appears on the display screen, the TCM or HCM senses a malfunction in the hydraulic hybrid drive system. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.**

The message STOP HYBRID will appear on the message display screen when the hydraulic hybrid system senses a malfunction. When the message appears, the vehicle will shut down immediately to avoid damaging the hydraulic hybrid system.

### Menu System

The hydraulic hybrid drive system has several unique menus available. As with the diesel operated Walk-In

# Hydraulic Hybrid

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Van, 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 driver uses the toggle buttons to move from one menu screen to another. See **Fig. 16.10**, Item 4 and Item 5 for the location of the toggle buttons. See **Chapter 2, Instruments** for further information on the Ametek menu system.

The following menus are specific to the hydraulic hybrid vehicle:

- system oil pressure
- gear attained
- hydraulic oil temperature
- high pressure accumulator (HPA) gas pressure
- low pressure reservoir (LPR)
- transmission temperature
- primary/secondary air tank pressure
- applied air brake pressure 1 and 2

## System Oil Pressure

The system oil pressure menu shows the hydraulic fluid pressure within the high-pressure accumulator.

## Gear Attained

The gear attained menu lists the selected gear on the display screen.

## Hydraulic Oil Temperature

The hydraulic oil temperature menu will display the current temperature of the fluid in the hydraulic hybrid drive system. If the system reaches 170°F (77°C), power output from the hydraulic system is reduced to allow the hydraulic fluid to cool down. The check transmission indicator will illuminate and the CHECK HYBRID message will appear on the display screen. The driver should find a safe place to pull over and shut down the vehicle, then contact a certified hydraulic hybrid drive service technician to determine the corrective action to take before proceeding.

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## NOTICE

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**When the red stop transmission indicator illuminates, the TCM or HCM senses a malfunction in the hydraulic hybrid drive system and the message center will display STOP TRANS and/or STOP HYBRID. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.**

If the hydraulic oil temperature exceeds 180°F (82°C), power output is reduced to zero. The stop transmission indicator will illuminate and the STOP TRANS or STOP HYBRID message will appear on the display screen. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

## High Pressure Accumulator (HPA) Gas Pressure

The HPA gas pressure menu will display the nitrogen pressure within the high pressure accumulator.

## Low Pressure Reservoir (LPR)

The LPR menu will display the nitrogen gas pressure within the LPR.

## Transmission Temperature

The transmission temperature menu will display the current temperature of the transmission fluid in the gearbox.

If the temperature exceeds 190°F (88°C), power output from the hydraulic system is reduced to allow the fluid in the gearbox to cool down. The check transmission indicator will illuminate and the CHECK TRANS message will appear on the display screen. The driver should find a safe place to pull over and shut down the vehicle, then contact a certified hydraulic hybrid drive service technician to determine the corrective action to take before proceeding.

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## NOTICE

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**When the red stop transmission indicator illuminates, the TCM or HCM senses a malfunction in the hydraulic hybrid drive system and the message center will display STOP TRANS and/or**

**STOP HYBRID.** The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

If the transmission fluid temperature exceeds 230°F (110°C), power output is reduced to zero. The stop transmission indicator will illuminate and the STOP TRANS message will be displayed. The vehicle will shut down immediately, in order to avoid damaging the hydraulic hybrid system.

## Primary/Secondary Air Tank Pressure

Pressure in the primary and/or secondary air tank turns the engine on and off when air brake pressure drops below 90 psi (621 kPa). PRIM AIR TANK or SEC AIR TANK will appear on the message display screen.

## Applied Air Brake Pressure 1 and 2

If brake pedal pressure exceeds 65 psi (448 kPa), brake energy recovery is disabled and the vehicle's friction brakes slow the vehicle. APP BRAKE 1 or APP BRAKE 2 will appear on the message display screen.

## Transmission Shift Pad

The transmission shift pad is mounted on the dash near the driver, as shown in [Fig. 16.12](#).

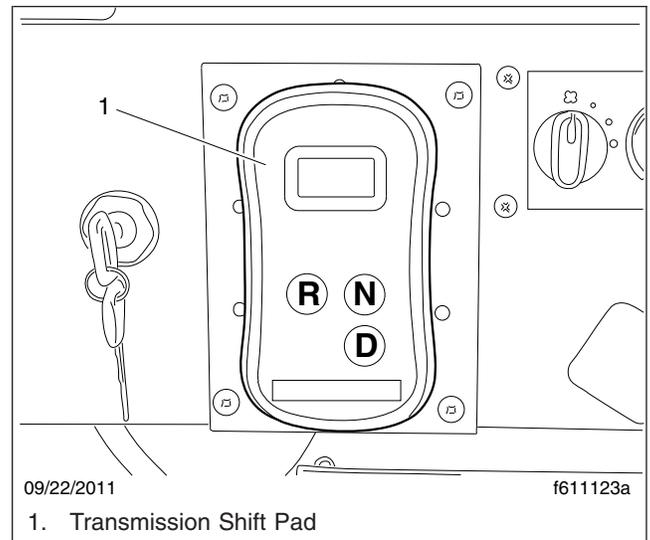
## Gear Selection

The gear selected will appear in the shift pad display screen. The left character will display the gear selected on the shift pad and the right character will display the gear that the vehicle is currently in. See [Fig. 16.13](#) for an example of the gear selection. The left character will flash until the current gear matches the requested gear.

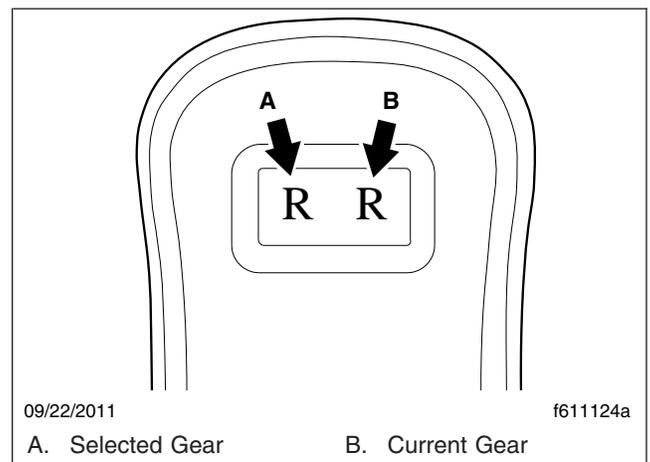
## Pretrip Inspection

### Daily Pretrip Inspections/Checks

In addition to the pretrip checklists and inspection items listed in [Chapter 10](#) and [Chapter 11](#), there are also specific pretrip inspection items for the hydraulic hybrid vehicle that must be performed before operating the vehicle.



**Fig. 16.12, Transmission Shift Pad**



**Fig. 16.13, Gear Selection**

The additional pretrip inspection items for the hydraulic hybrid vehicle are listed in [Table 16.1](#). Use the pretrip inspection checklist to ensure that vehicle components are in good working condition before each trip. Numbers within the checklist reference the corresponding detailed instructions.

# Hydraulic Hybrid

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
Inspect _____	hydraulic system for fluid leaks	D1
Inspect _____	hydraulic system hose(s) and fitting(s)	D2
Check _____	LPR fluid level and pressure	D3
Check _____	active warning indicators	D4
Check _____	system faults on the message display screen	D5
Inspector _____ Date _____		

Table 16.1, Hydraulic Hybrid Daily Pretrip Inspection and Maintenance Checklist

NOTE: To help ensure that the hydraulic hybrid vehicle delivers safe and reliable service, regularly scheduled maintenance must be performed by a certified hydraulic hybrid service technician.

Failure to follow a regular maintenance program will result in inefficient operation, unscheduled down-time, and will void the warranty.

Refer to the *Walk-In Van Chassis Maintenance Manual* for more information concerning maintenance intervals and the operations to be performed.

## Daily Pretrip Inspection and Maintenance Procedures



Warning labels are placed on various components of the hydraulic hybrid drive system. Failure to read and follow the directions given can lead to personal injury, loss of life, and vehicle or component damage.

Never run hands, arms, or any other part of the body over a hydraulic hose, line, fitting, or assembly to check for leaks. A pinhole leak can release toxic fluid at more than 600 ft (183 m) per second, acting as a hypodermic needle and penetrating both protective clothing and skin at short distances.

Never tighten or loosen a hydraulic connection when the system is under pressure. The connection could fail catastrophically, causing personal injury and/or damage to the vehicle. Make certain that all high pressure is bled from the hydraulic system before working on any connections.

Use extreme caution when working with hydraulic hoses, lines, fittings, or assemblies during installation, preventive maintenance, or component replacement. Fluids under high pressure can be dangerous and potentially lethal. Make sure to bleed all high pressure so that hoses and components can be examined safely.

Discharging high pressure using the manual bleed valve does not release the nitrogen gas precharge pressure within the accumulator. The nitrogen is under high pressure and can be dangerous and potentially lethal if the accumulator is punctured.

It takes approximately 10 minutes for high-pressure fluid to discharge once the manual bleed valve has been opened. Do not attempt to work on the hybrid drive system until there is verification that the high-pressure fluid has been fully discharged.

Do not exit the vehicle before applying the park brake and shifting the transmission to neutral (N). Otherwise, the vehicle could roll, causing property damage, personal injury, or loss of life.

Failure or improper selection or use of hoses, tubing, fittings, assemblies, or related accessories can cause death, personal injury, and property damage. Possible consequences of failure or improper selection or use of these items include but are not limited to the following:

- Fittings thrown off at high speed.
- High velocity fluid discharge.
- Explosion or burning of the discharged fluid.
- Contact with suddenly moving or falling objects that are controlled by the discharged fluid.
- Injection by high-pressure fluid discharge.

- Contact with discharged fluids that may cause injury due to heat, cold, or toxicity.
- Electrocutation from electric power lines.
- Whipping hoses.
- Sparking or explosion caused by static electricity buildup or other sources of electricity.
- Sparking or explosion while spraying paint or flammable liquids.
- Injuries resulting from inhalation, ingestion, or exposure to fluids.

1. With the ignition switch in the OFF position, visually inspect the hydraulic system for fluid leaks.

If any leaks are found, contact a certified hydraulic hybrid service technician to determine the corrective action to take.

2. Inspect the hydraulic system hose(s) and fitting(s).

High pressure hoses used on the hydraulic hybrid system can be identified by their orange wrapping. Low pressure hoses are wrapped in black.

If any of the following conditions are found, contact a certified hydraulic hybrid service technician to complete a system pressure bleed-down of the hydraulic hybrid system, and replace the hose assembly:

- fitting slippage on the hose
- exposed reinforcement
- damaged, cracked, cut, or abraded cover
- hard, stiff, heat cracked, or charred hose(s)
- leaks at the fitting(s) or in the hose(s)
- kinked, crushed, flattened, or twisted hose(s)
- blistered, soft, degraded, or loose cover
- bulges in the hose(s)

## NOTICE

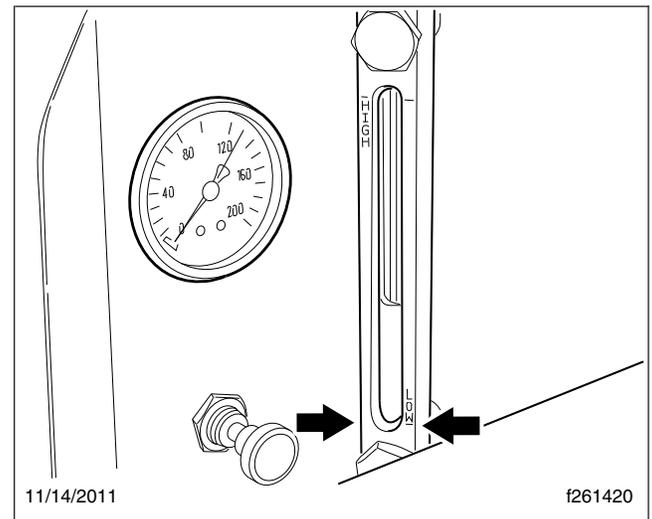
**If the low pressure reservoir (LPR) fluid level is not even with or higher than the LOW indicator marks on the sight glass, do not start the vehicle. LPR pressure should be between 35 to 70 psi**

**(241 to 483 kPa). Operating the vehicle with a low LPR fluid level will result in damage to the hydraulic hybrid system.**

3. Check the LPR fluid level and pressure.

With the ignition switch in the OFF position, verify that the LPR fluid level and pressure are correct. The fluid level should be even with or higher than the LOW indicator marks on the sight glass, as shown in **Fig. 16.14**. If the fluid level is not even with or higher than the LOW indicator marks, contact a certified hydraulic hybrid service technician to determine the corrective action to take before proceeding.

Press the valve below the gauge, shown in **Fig. 16.15**, to read the LPR pressure. The pressure should be between 35 to 70 psi (241 to 483 kPa). If the pressure is not within this range, contact a certified hydraulic hybrid service technician to determine the corrective action to take before proceeding.



**Fig. 16.14, LPR Fluid Level**

4. Check the active warning indicators.

When the ignition switch is turned to the ON position, the warning indicators in the instrument panel will illuminate for a self-test and then turn off. If the check transmission or stop transmission indicator(s) remain illuminated after the self-test has completed, contact a certified hydraulic hybrid technician to determine the corrective action to take before starting the vehicle.

# Hydraulic Hybrid

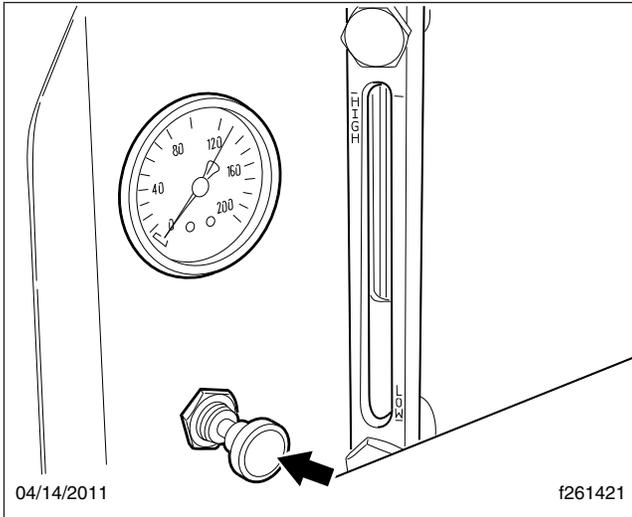


Fig. 16.15, LPR Pressure Valve

5. Check for system faults on the message display screen.

With the ignition switch in the ON position, check for any system faults that appear on the message display screen. If a message appears and does not turn off, contact a certified hydraulic hybrid technician to determine the corrective action to take before starting the vehicle.

## Engine Starting and Shutdown

### Engine Starting

NOTE: Before starting the vehicle, read [Chapter 2](#) and [Chapter 3](#) in this manual for detailed information on how to read the instruments and operate the controls. Also read **Hydraulic Gauges, Warning Indicators, and Message Displays** in this chapter.

Before operating the vehicle, perform the engine pretrip inspection and the daily maintenance checks in [Chapter 10](#) and [Chapter 11](#) of this manual. Also perform the daily maintenance checks listed under **Pretrip Inspection** in this chapter.

### NOTICE

Moving a vehicle with the starter and/or using the starter to bump the engine for maintenance pro-

cedures 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

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

1. Fasten the driver's seat belt.
2. Verify that the parking brake is set.
3. Turn the ignition switch to the ON position. See [Fig. 16.16](#) for the four-position ignition switch. If the yellow WAIT TO START indicator light illuminates or WAIT appears on the display screen, leave the ignition switch in the ON position until either the WAIT TO START light goes out or WAIT no longer appears on the display screen. See [Table 16.2](#) for further information concerning the hydraulic hybrid wait to start status.

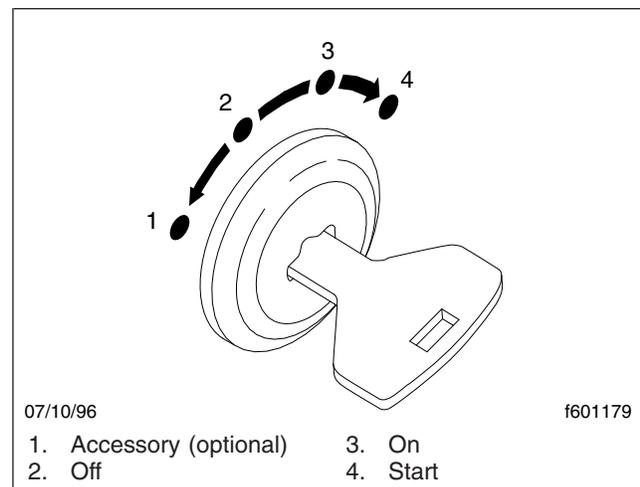


Fig. 16.16, Four-Position Ignition Switch

Hydraulic Hybrid Wait to Start Status				
Key Switch Status	Ready Lamp Status	Wait to Start Lamp Status	Engine State	Message Displayed
Off	—	—	—	—
On	Off	On	Off	WAIT TO START
On	Off	Off	Off	START ENGINE
On	On	On	Off	WAIT
On	On	Off	Off	—
On	Off	On	Running	WAIT
On	Off	Off	Running	WAIT
On	On	On	Running	—
On	On	Off	Running	—

Table 16.2, Hydraulic Hybrid Wait to Start Status

4. Make sure that the transmission is in the Neutral (N) position on the shift pad display. If NN is not displayed, press N on the shift pad.
5. Verify that the green propulsion system ready indicator is illuminated.

If the indicator is illuminated, the hydraulic hybrid system is ready to propel the vehicle. Go to **Driving the Vehicle** in this chapter.

If the indicator is not illuminated, the hydraulic hybrid system will not allow the vehicle to shift into drive (D) or reverse (R) until the high pressure accumulator is sufficiently charged. The engine must be started to allow the secondary pump to build up fluid pressure in the accumulator. Perform the following substeps.

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

- 5.1 Turn the ignition switch to the START position. After the engine starts, release the key in the ON position.

## NOTICE

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

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

**IMPORTANT:** When the engine is started, it takes a short time to build up a lubricating

oil film between the shafts and bearings, and between the pistons and cylinder walls. The oil pressure gauge indicates any drop in lubricating oil pressure within 15 seconds of engine start-up. See the *Cummins Operation and Maintenance Manual* for minimum idle oil pressure specifications.

**NOTE:** It is normal for the engine to continue running for up to 30 minutes after charging is complete, as certain parameters must be met before the hydraulic hybrid system can shut the engine off.

- 5.3 Once the system is pressurized, the engine will shut itself off and the propulsion system ready indicator will illuminate to indicate that the hydraulic hybrid system is ready.

6. Go to **Driving the Vehicle** in this chapter.

## Engine Shutdown

### Emergency Engine Shutdown

If any of the following occur, shut down the engine immediately:

- The oil pressure gauge needle swings back and forth or falls sharply.
- The exhaust pipe gives off heavy smoke.
- The coolant and/or oil temperature climb abnormally.
- Abnormal sounds suddenly occur in the engine or turbocharger.

# Hydraulic Hybrid

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## Normal Engine Shutdown

 **WARNING**

**Do not exit the vehicle without setting the parking brake and placing the transmission in neutral (N). Otherwise, the vehicle could roll forward or backward, causing property damage, personal injury, or loss of life.**

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

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

**NOTE:** SHIFT INHIBIT will appear on the message center display screen if an attempt is made to shift the transmission from drive (D) to reverse (R) or from reverse (R) to drive (D) and vehicle speed is 5 mph (8 km/h) or higher. If this occurs, the hydraulic hybrid system will shift the transmission into neutral (N) and N will appear as the current gear on the shift pad. The SHIFT INHIBIT message will appear on the message display center and the shift inhibit indicator will illuminate. The selected gear will continue to flash on the shift pad until the previous gear or neutral (N) is selected. The message and the indicator will turn off and the transmission shift will be allowed when vehicle speed is less than 5 mph (8 km/h).

2. The engine will automatically stop when the transmission is in neutral (N).

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

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## NOTICE

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

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

## Driving the Vehicle

1. Press the brake pedal and select the appropriate gear on the transmission shift pad.

If the message SHIFT TO NEUTRAL OR PARK appears on the message display screen (with an audible chime) and the park brake engages automatically, the driver's seat belt is unbuckled. Fasten the driver's seat belt to release the park brake.

2. Release the parking brake.
3. Release the brake pedal and then press the throttle.
4. Monitor all gauges, warning indicators, and the message display screen. If any of these indicate a system issue, refer to the appropriate section of this manual.

## Fuel Economy

To get the best fuel economy and use of the hydraulic hybrid system, observe the following guidelines:

- During acceleration and braking, try to stay within the ECON area of the high performance gauge.
- Reduce harsh acceleration. Aggressive acceleration causes the engine to start sooner and reduces fuel economy. Maintaining throttle pedal positions below 50% will improve overall fuel economy.
- Reduce harsh braking. The state of charge (SOC) gauge will show that light to moderate brake applications, where brake pedal travel is between 0 to 15%, allow for more brake energy recovery to charge the accumulator.

Charging the accumulator means that after each braking event, the vehicle can be accelerated by the hydraulic hybrid system rather than

by the engine. This results in fuel savings and less engine wear.

- Lower highway speed promotes greater fuel economy.
- Follow the vehicle maintenance schedule to keep the vehicle in good working condition.
- Maintain proper tire pressure. Refer to the tire manufacturer for correct tire pressure.

## Safety Features

The hydraulic hybrid has built-in safety features to prevent personal injury or component damage in the event of system pressure leaks or electrical failure.

## Brake Energy Recovery Bypass

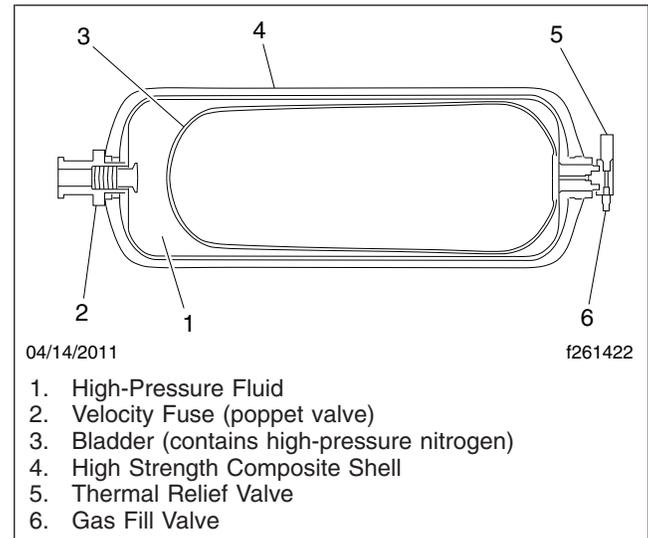
Brake energy recovery is disabled and the vehicle's air brakes are enabled to allow normal friction braking when any of the following conditions occur:

- The ignition switch is in the OFF position or there is a loss of electrical power to the HCM and/or TCM.
- The vehicle's speed is less than 2 mph (3 km/h).
- The accumulator reaches the maximum state-of-charge.
- The brake pedal is pressed greater than 65%.
- There is an antilock brake system (ABS) event.
- ABS communication is lost.
- There is not enough regenerative torque to accommodate the driver's torque request because of system limits such as pump temperatures, pump pressure, etc.
- There is a fault in the hydraulic hybrid system.

## High Pressure Safety Devices

The accumulator velocity fuse (poppet valve) is located on the high-pressure fluid side of the accumulator. See [Fig. 16.17](#). The fuse is set to block fluid flow from the accumulator in the event of a major leak anywhere in the high-pressure side of the accumulator. The velocity fuse (poppet valve) closes when the flow rate exceeds 125 gpm (473 L/min), sealing the opening to prevent further loss of high-

pressure fluid and trapping any remaining fluid in the accumulator.



**Fig. 16.17, Accumulator Safety Devices**

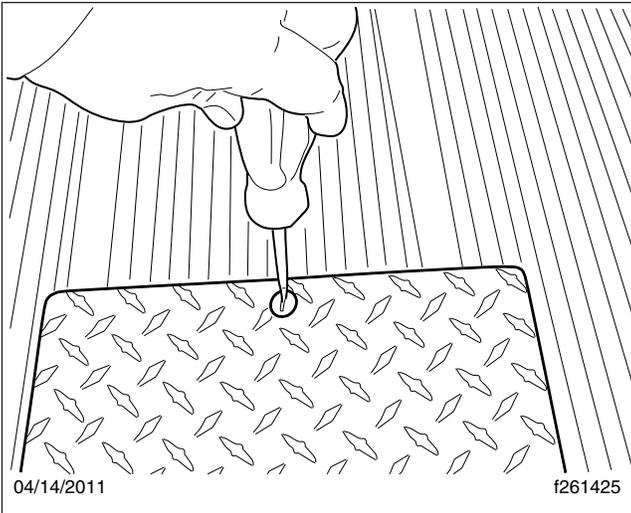
A valve block on the nitrogen side of the accumulator houses a thermal valve that opens to relieve the nitrogen gas charge if the ambient temperature reaches 219°F (104°C). See [Fig. 16.17](#). This feature prevents a rupture of the accumulator from rapidly expanding gas in the event of a fire in the cradle.

## Manual Bleed-Down Valve

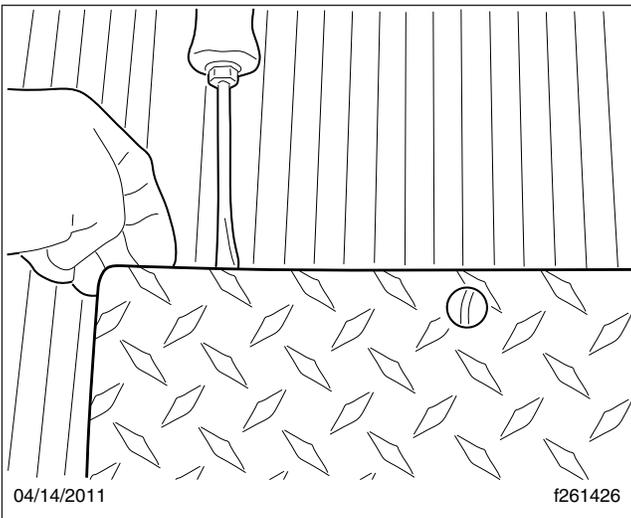
The manual bleed-down valve is located under the service panel in the floor of the cargo area. A hissing noise can be heard when the valve is opened, and high-pressure fluid is redirected back to the low pressure reservoir (LPR). Follow the steps below to access and operate the manual bleed-down valve.

1. Park the vehicle on a level surface, shift the transmission to neutral (N), shut down the engine, and set the parking brake.
2. Using a flat-blade screwdriver, remove the four screws that attach the service panel cover to the cargo floor. See [Fig. 16.18](#).
3. Use the screwdriver to pry the panel open and remove it, as shown in [Fig. 16.19](#).
4. To open the manual bleed-down valve, push in on the knurled knob, then turn the knob counter-clockwise and release it. See [Fig. 16.20](#) and [Fig. 16.21](#).

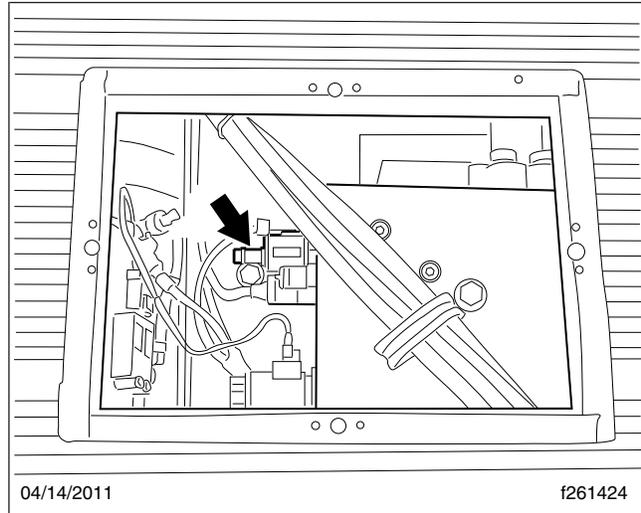
# Hydraulic Hybrid



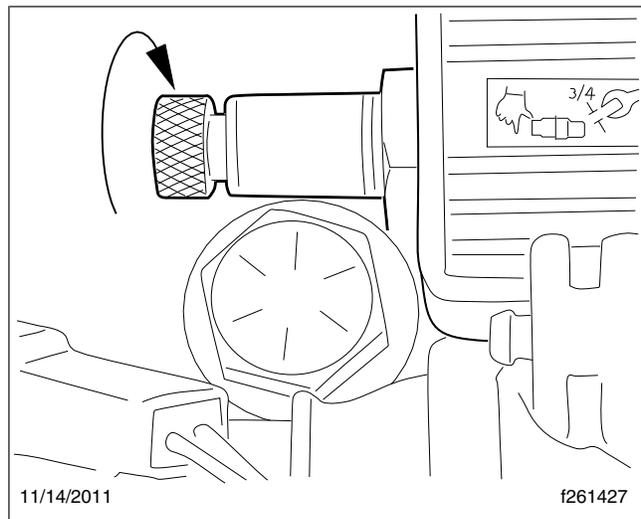
**Fig. 16.18, Removing the Service Panel Screws**



**Fig. 16.19, Removing the Service Panel**



**Fig. 16.20, Manual Bleed-Down Valve Location**



**Fig. 16.21, Opening the Manual Bleed-Down Valve**

5. Look at the LPR sight glass and pressure gauge, shown in **Fig. 16.4**, and verify that the high-pressure fluid has discharged.

The level of high-pressure fluid should be even with the HIGH indicator marks on the sight glass. Press the switch below the gauge to read the LPR pressure. It should be between 35 to 70 psi (241 to 483 kPa).

## Low Pressure Safety Devices

### LPR Rupture Disc

The LPR rupture disc, shown in **Fig. 16.22**, opens when LPR internal pressure exceeds 125 psi (862 kPa) to prevent a dangerous buildup of high-pressure fluid.

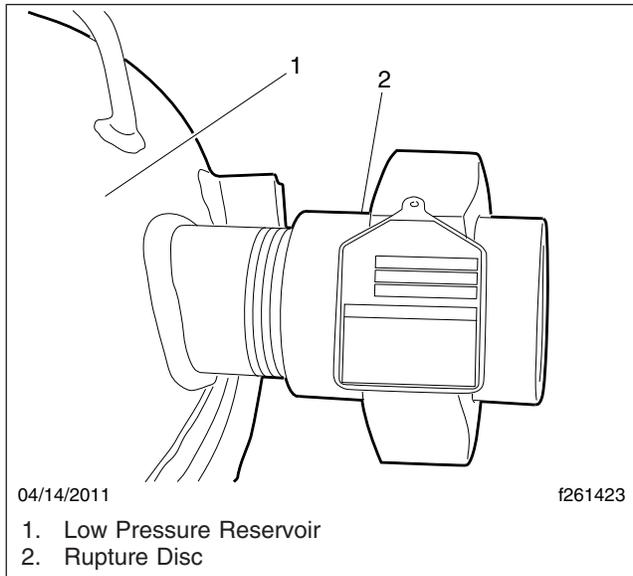


Fig. 16.22, LPR Rupture Disc

## LPR Relief Valve

The LPR relief valve opens when LPR internal pressure reaches 90 psi (621 kPa) to prevent a dangerous buildup of high-pressure nitrogen gas.

## Jumpstarting and Towing

### Emergency Starting With Jumper Cables

Using jumper cables to start a vehicle equipped with a hydraulic hybrid system is identical to a non-hydraulic vehicle, with one exception—the ignition switch must be held in the START position for up to five seconds before the engine will start. See [Chapter 13](#) for instructions when using jumper cables.

### Towing Hookup

#### NOTICE

**Remove the rear driveshaft before towing a vehicle equipped with a hydraulic hybrid system. Failure to do so will damage the hydraulic hybrid components. Once the driveshaft has been removed, do not attempt to start a vehicle equipped with a hydraulic hybrid drive system. Doing so will damage the hydraulic hybrid system components.**

For towing instructions, see [Chapter 14](#).

## Emergency Procedures

### Manual Bleed-Down

To relieve the high-pressure fluid in the hydraulic hybrid system, the manual bleed-down valve must be opened to divert fluid back to the LPR. It takes approximately 10 minutes for the system to fully discharge. See **Manual Bleed-Down Valve** in this chapter for instructions.

### Fluid Spill

The hydraulic hybrid drive system uses synthetic hydraulic and transmission fluids. In the event of a fluid spill, follow normal protocols in dealing with these fluids.

# 17

## Propane Fuel System

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Ametek Instrument Panel .....	17.5
Warning and Indicator Lights .....	17.11
Speedometer and Tachometer .....	17.18
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# Propane Fuel System

## General Information

### CAUTION

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

### DANGER

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

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

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

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

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

### NOTICE

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

HD5 grade propane is recommended for propane engines. HD5 is a heavy duty engine grade propane

with a minimum of 90% propane and a maximum of 5% propylene. This grade of propane is 100 plus octane and provides proper performance and emissions control, which the fuel system is designed to deliver.

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

### NOTICE

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

### WARNING

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

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

## Ignition Switch and Key

The ignition switch has four positions: ACCESSORY, OFF, RUN, and START. See [Fig. 17.1](#).

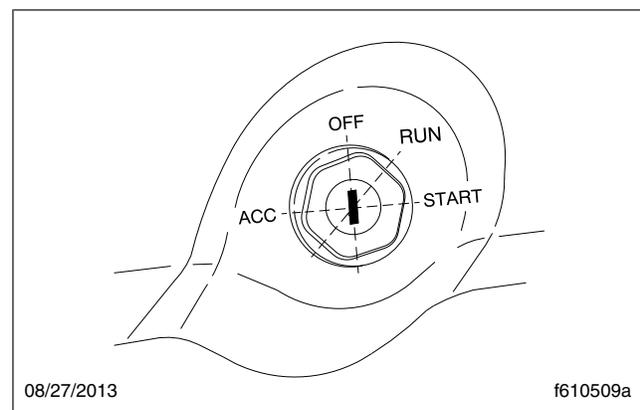


Fig. 17.1, Ignition Switch Positions

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

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

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

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

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

## Engine Operation

### General Information

**NOTE:** Before starting the engine, read the "Ametek Panel" information in this chapter and [Chapter 3](#) for detailed information on how to read the instruments and operate the controls.

Before operating the vehicle, perform the pretrip inspection and daily maintenance checks in [Chapter 10](#) and [Chapter 11](#) of this manual.

### NOTICE

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

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

## Engine Starting

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

### WARNING

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

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

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

### NOTICE

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

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

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

# Propane Fuel System

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## Engine Shutdown

Shut down the engine immediately if:

- the oil pressure gauge needle swings back and forth or falls sharply;
  - engine power and rpm fall, even though the accelerator pedal remains steady;
  - the exhaust pipe gives off heavy smoke;
  - the coolant and/or oil temperature climb abnormally;
  - abnormal sounds suddenly occur in the engine.
1. With the vehicle stopped, place the transmission in Neutral (N), or if so equipped, the Park (P) position.
  2. Set the parking brake.
  3. Idle the engine for two to three minutes before shutting it down. This allows the lubricating oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, etc.

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

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

## Propane Refueling

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

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

over the storage tank pressure; most modern stations are designed to 130 psi (896 kPa) differential pressure. It is recommended to refuel the vehicle at a modern station to prevent any customer inconvenience.

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

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### CAUTION

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

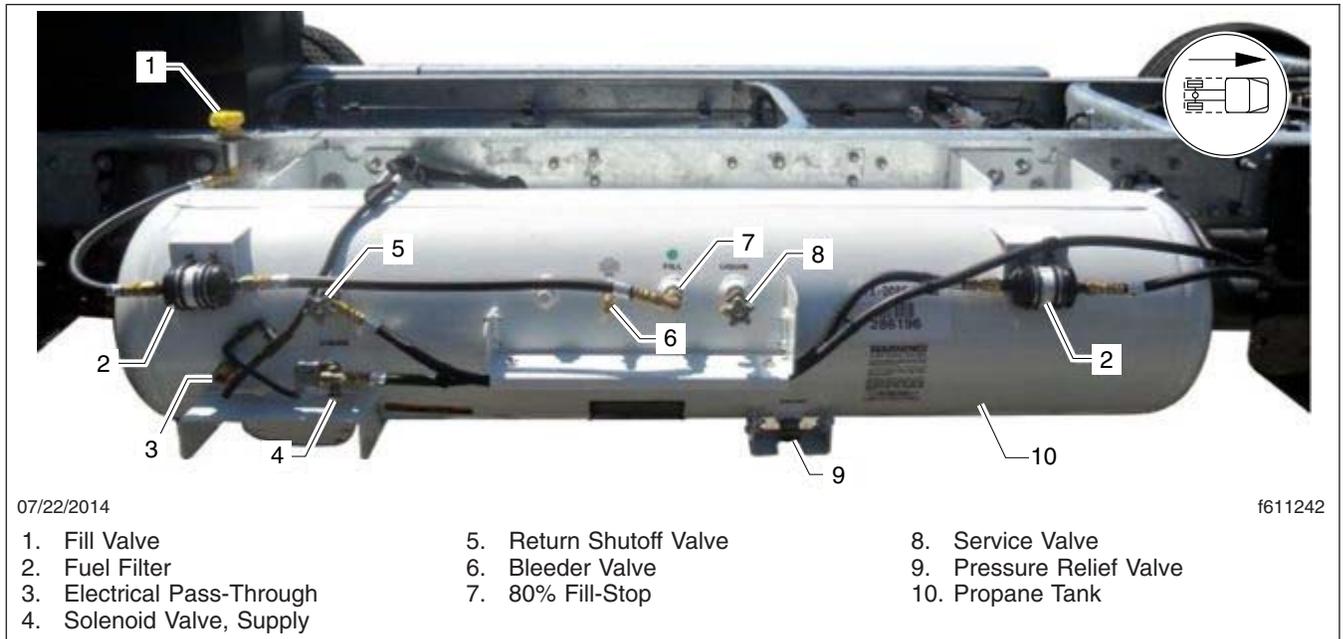
**Propane is extremely flammable, and can ignite if an ignition source is present, causing burns and other serious injuries. Keep sparks and flames away from propane. Do not smoke near propane or when refueling the vehicle.**

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

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

The following steps describe a typical refueling procedure. See **Fig. 17.2** for an example of the propane tank system.

1. Park the vehicle on level ground to ensure that the tank is properly filled.
2. Turn the vehicle ignition to OFF and set the parking brake. Chock the tires if required.
3. Ensure that there are no open flames or ignition sources in the area.



**Fig. 17.2, Propane Tank Assembly**

4. Turn the fuel tank cap counterclockwise and remove it.
5. Inspect the fill valve O-ring, making certain the O-ring is seated in the groove and is not damaged or missing.
12. When the OPD stops the flow of fuel into the tank, close the filling valve.  
If use of the 80% bleeder valve is required, stop filling when liquid from the bleeder appears in the form of a white cloudy vapor.

**CAUTION**

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

6. Connect the propane fill nozzle to the tank fill valve.
7. Rotate the propane fill valve nozzle clockwise until it is firmly attached to the tank fill valve.
8. Close the fill nozzle vent valve if so equipped.
9. Open the 80% bleeder valve only if required. CleanFuel USA does not recommend using the bleeder valve. Use of the valve in a low emission fuel station is prohibited.
10. Open the valve on the refueling nozzle.
11. Turn the propane dispenser on to begin refueling.

**CAUTION**

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

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

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

# Propane Fuel System

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

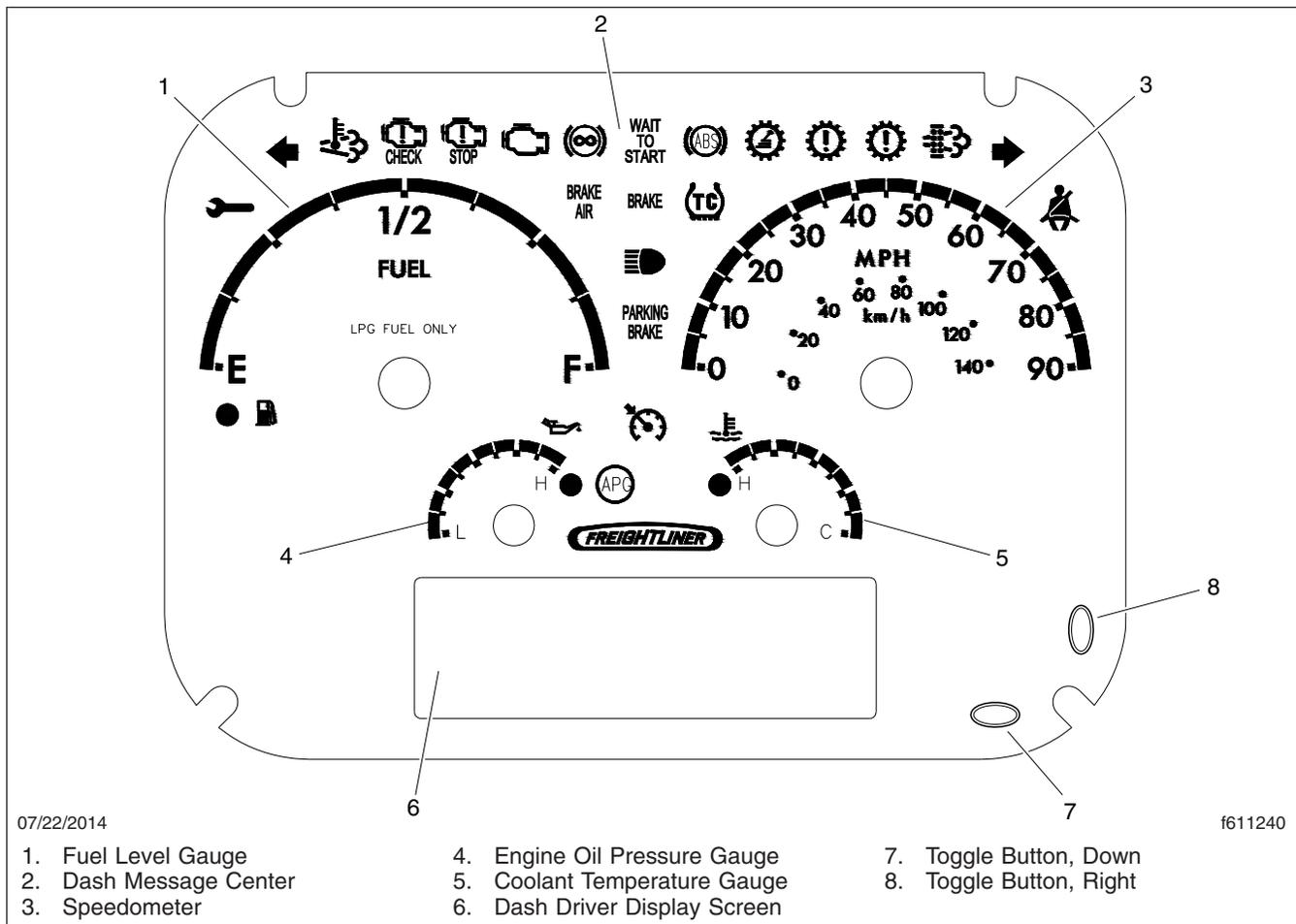
## Ametek Instrument Panel

The following information describes the Ametek instrument panel, used with liquid propane gas (LPG) engines. The instrument panel is shown in [Fig. 17.3](#).

## 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



**Fig. 17.3, Gauge Layout (typical, U.S.), LPG Engines**

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

- Average Fuel Rate
- Gear Attained Status
- Transmission Temperature

- Hour Meter
- Boost Pressure
- Engine Oil Pressure
- Coolant Temperature
- Fuel Level
- Percent Engine Load
- Engine RPM

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

## Priority Messages

Priority messages (including warning messages) are displayed in the LCD due to various inputs or data messages. Unless noted otherwise, the priority message will take over the whole screen, allowing multiple messages to be displayed in five second intervals.

## Self-Test

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

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

## Menu System

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

- Setup—this is used to set various parameters, which are saved when the ignition is turned off. Setup has select display units, startup screen, LCD contrast, and reset parameters.

- Maintenance—shows various maintenance intervals such as engine oil, air filter, etc.
- Diagnostics—this is used for setting and reading inputs and outputs and checking the gauges. It also shows the hardware and software version of the instrument panel, and has menus to retrieve active error codes from the engine, transmission, and ABS controllers.

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

## Setup Menu

### Select Display Units

The set units screen allows the driver to choose between English or metric units of measurement for the displayed values. To navigate to the set units screen, see [Fig. 17.4](#), screens H, I, and J.

### Startup Screen

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

### LCD Contrast

Select contrast from the menu to set the LCD contrast. Use the down toggle button to set the contrast to the desired level. To navigate to the contrast screen, see [Fig. 17.4](#), screen M.

### Reset Parameters

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

## Maintenance Menu

The maintenance menu has the following three sub menus:

- maintenance intervals
- transmission oil life remaining
- transmission oil filter life monitor

# Propane Fuel System

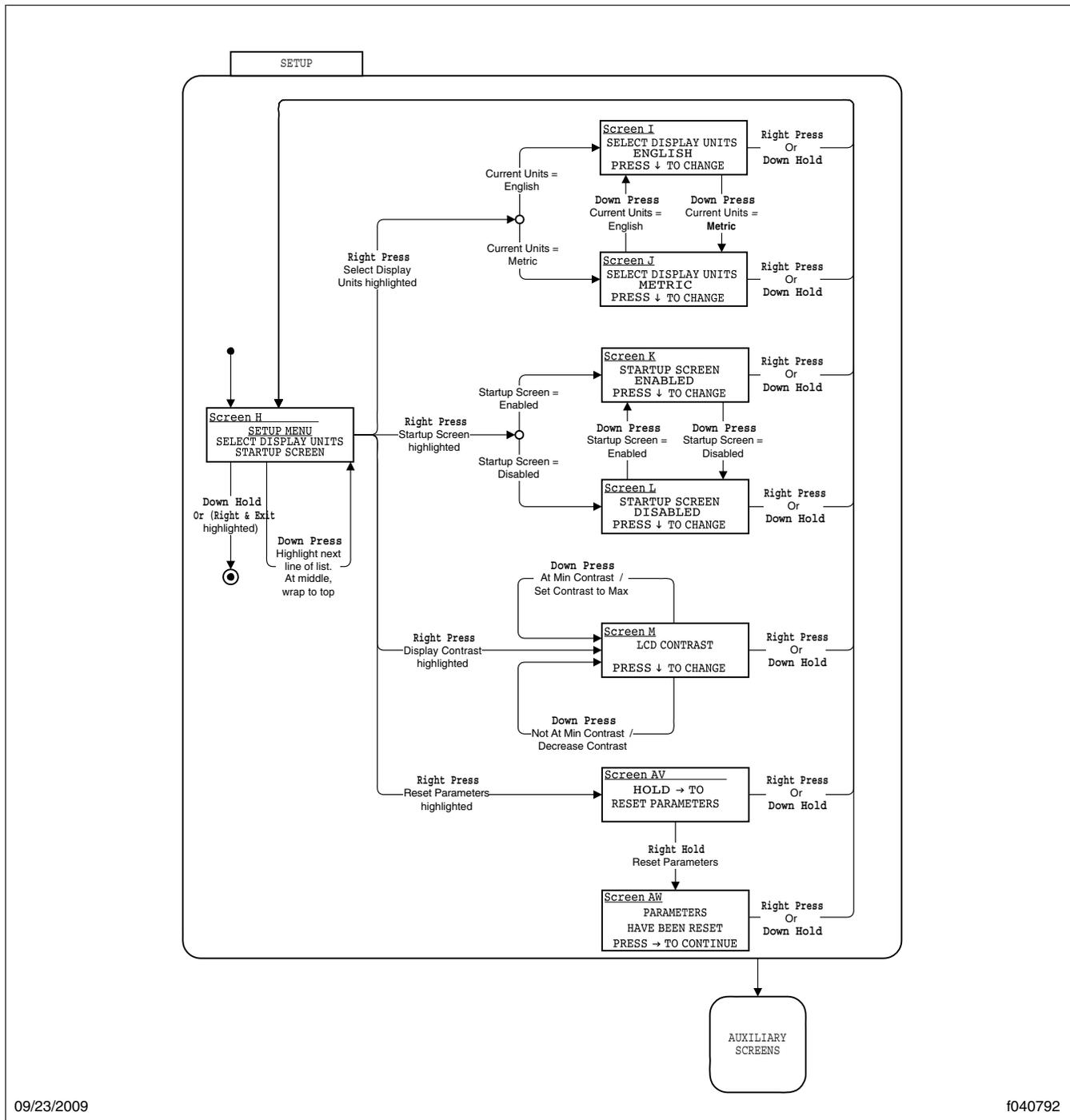


Fig. 17.4, Setup Menu Screens

## Maintenance Intervals

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

## Transmission Oil Life Remaining

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

## Transmission Oil Filter Life Monitor

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

## Diagnostic Menu

The diagnostic menu contains the following items:

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

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

## Engine Faults

This screen displays engine fault codes that are received from the engine electronic control unit (ECU). To navigate to the engine fault screen, see [Fig. 17.5](#), screen AA.

## Transmission Faults

This screen displays transmission fault codes that are received from the transmission ECU. To navigate to the transmission fault screen, see [Fig. 17.5](#), screen AB.

## ABS Diagnostics

This screen displays Antilock Brake System (ABS) fault codes that are received from the ABS ECU. To navigate to the ABS diagnostic screen, see [Fig. 17.5](#), screen AC.

## Check Gauges

The check gauges screen allows the driver to set each gauge as a percentage of scale (either 0, 50, or 100%), as shown in the LCD. To navigate to the check gauges screen, see [Fig. 17.6](#), AG screens.

## Warning Lamp

The warning lamp screen allows the driver to test each warning lamp (not the vehicle load) on and then off, displaying the lamp name and status in the LCD. To navigate to the warning lamp screen, see [Fig. 17.6](#), screen AH.

## Check LCD

Selecting the check LCD screen displays the Freightliner Custom Chassis Corporation (FCCC) logo in normal and reverse video three times and then returns to the menu. To navigate to the check LCD screen, see [Fig. 17.6](#), screen AI.

## Check Binary Inputs

The check binary inputs screen displays the pin number and status of each binary input. The toggle buttons allow the driver to select each binary input. This information is continuously updated to assist in troubleshooting. To navigate to the check binary inputs screen, see [Fig. 17.6](#), screen AJ.

## Check Analog Inputs

The check analog inputs screen displays the pin number and actual value of each analog input defined in the system. The toggle buttons allow the driver to select each analog input. This information is continuously updated to assist in troubleshooting. To navigate to the check analog input screen, see [Fig. 17.7](#), screen AK.

# Propane Fuel System

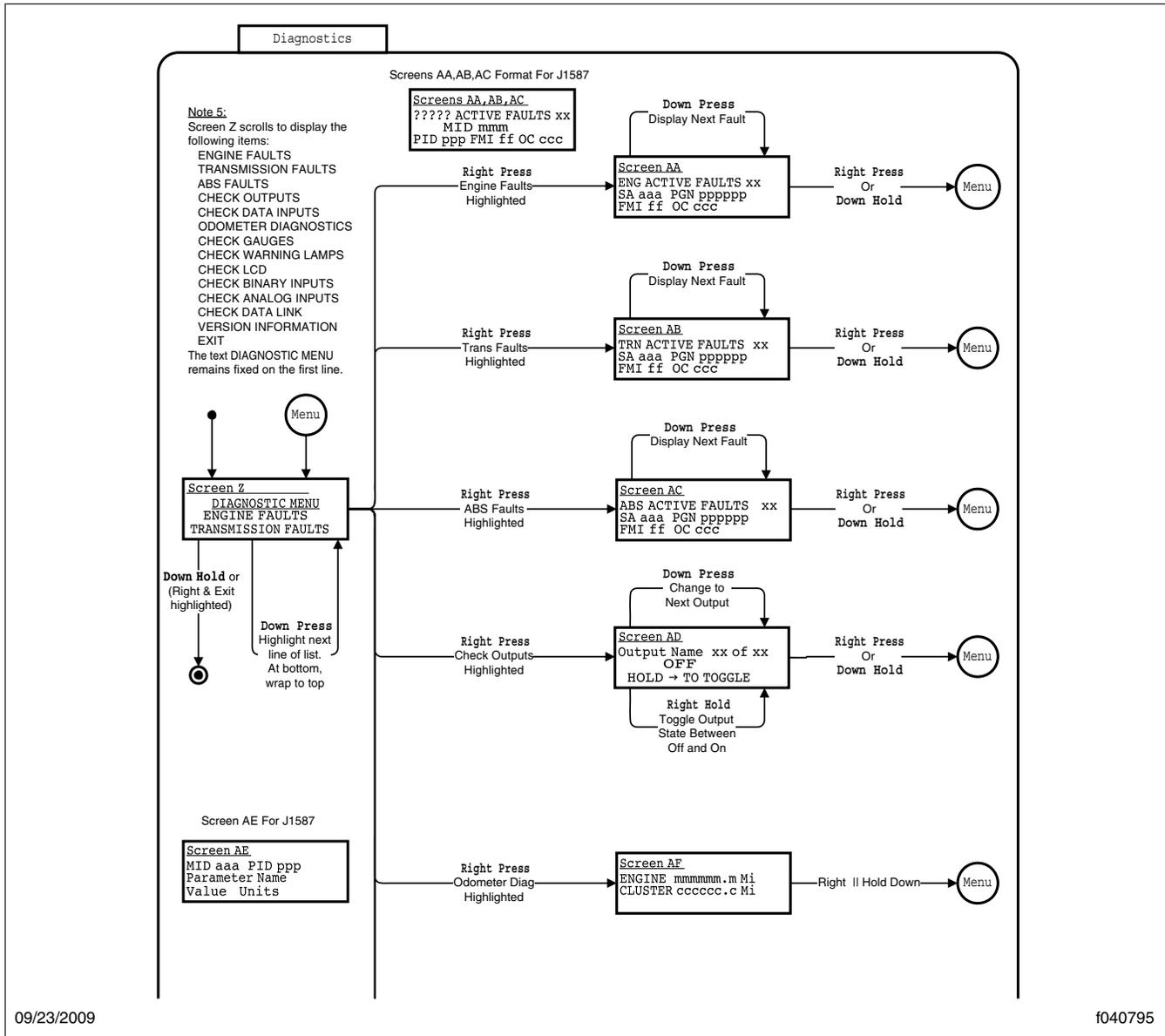


Fig. 17.5, Diagnostic Menu Screens, Screen 1

## Check Datalink

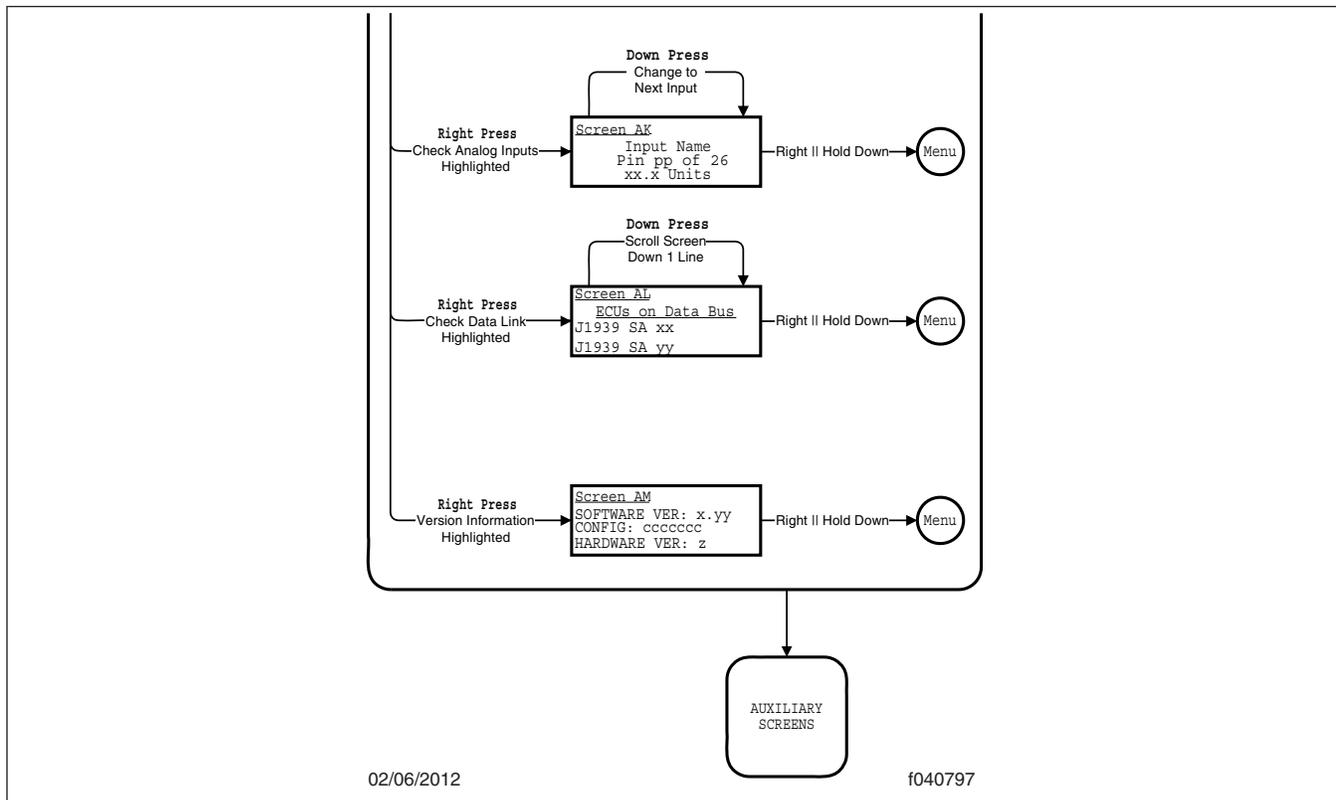
The check datalink screen allows the driver to view all devices that communicate on the J1939, J1587, and GMLAN datalinks. To navigate to the check datalink screen, see [Fig. 17.7](#), screen AL.

## Menu Navigation

The menu navigation screens are provided to illustrate the menu system. The paths to specific screens are shown, along with instructions for using the toggle buttons to move from one screen to another. See [Fig. 17.4](#), [Fig. 17.5](#), [Fig. 17.6](#), [Fig. 17.7](#), [Fig. 17.8](#), [Fig. 17.9](#), [Fig. 17.10](#), [Fig. 17.11](#),



# Propane Fuel System



**Fig. 17.7, Diagnostic Menu Screens, Screen 3**

3. Press the right toggle button once to enter the favorites display menu, shown in [Fig. 17.10](#), as screen D.
4. Use the down toggle button to scroll through the available items.
5. Highlight the new item, then press the right toggle button. The selected item will now appear in the message display center.

## Warning and Indicator Lights

There are 22 warning and indicator lights (telltales) installed in the dash message center. The warning and indicator lights are installed in fixed positions on all vehicles. Some warning and indicator lights only activate when starting the vehicle, and will not activate during vehicle operation. These lights are listed as (not used) in [Fig. 17.17](#).

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

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

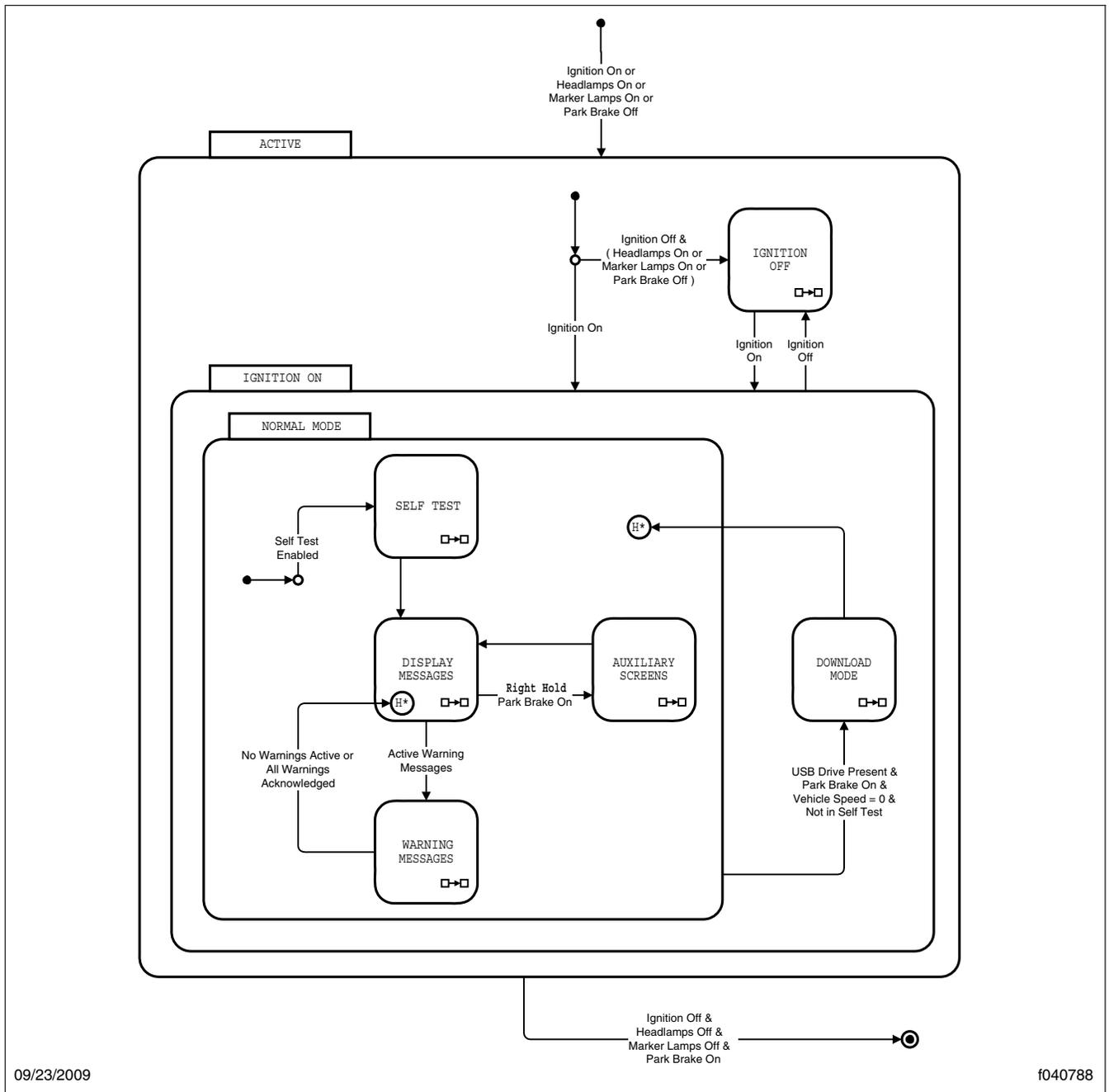
## Maintenance Warning Light

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

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

## Left-Turn Signal Arrow

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



**Fig. 17.8, Ignition On, Normal Mode**

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

## Check Engine Indicator

The amber check engine indicator light illuminates when certain faults are detected. If a critical engine condition exists (for example, low oil pressure or high

# Propane Fuel System

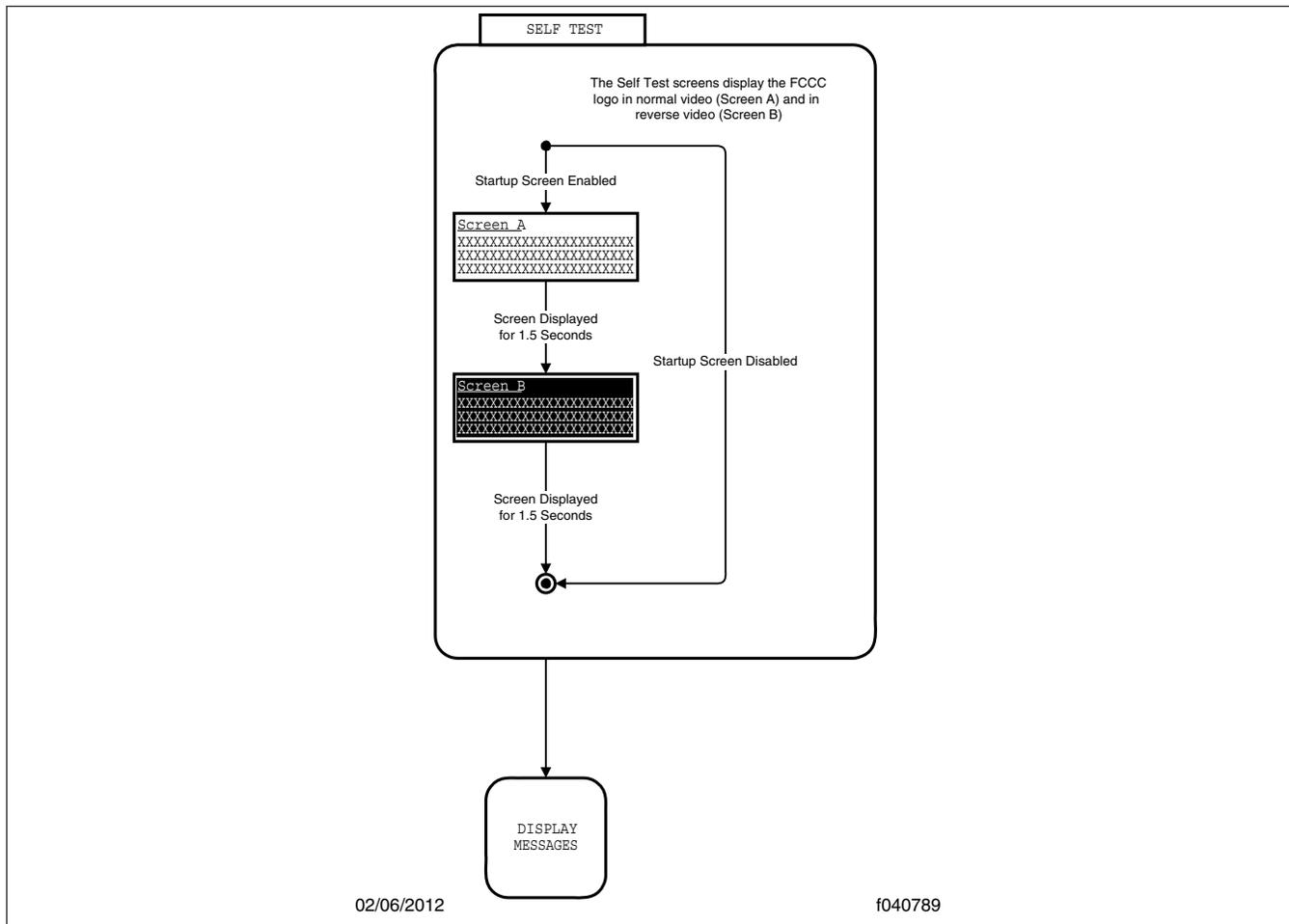


Fig. 17.9, Self Test

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 stop engine light will illuminate.

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

## Stop Engine Warning

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

## NOTICE

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

If the engine is shut down while the vehicle is in service, a single restart attempt may be performed. Depending on the nature of the fault condition, a cool-down period may be required before restarting. If, upon restarting, the fault condition still exists the lamp will come on and the engine should be shut down. At this point, the vehicle is unsafe to drive and should be transported to an authorized Freightliner service facility.

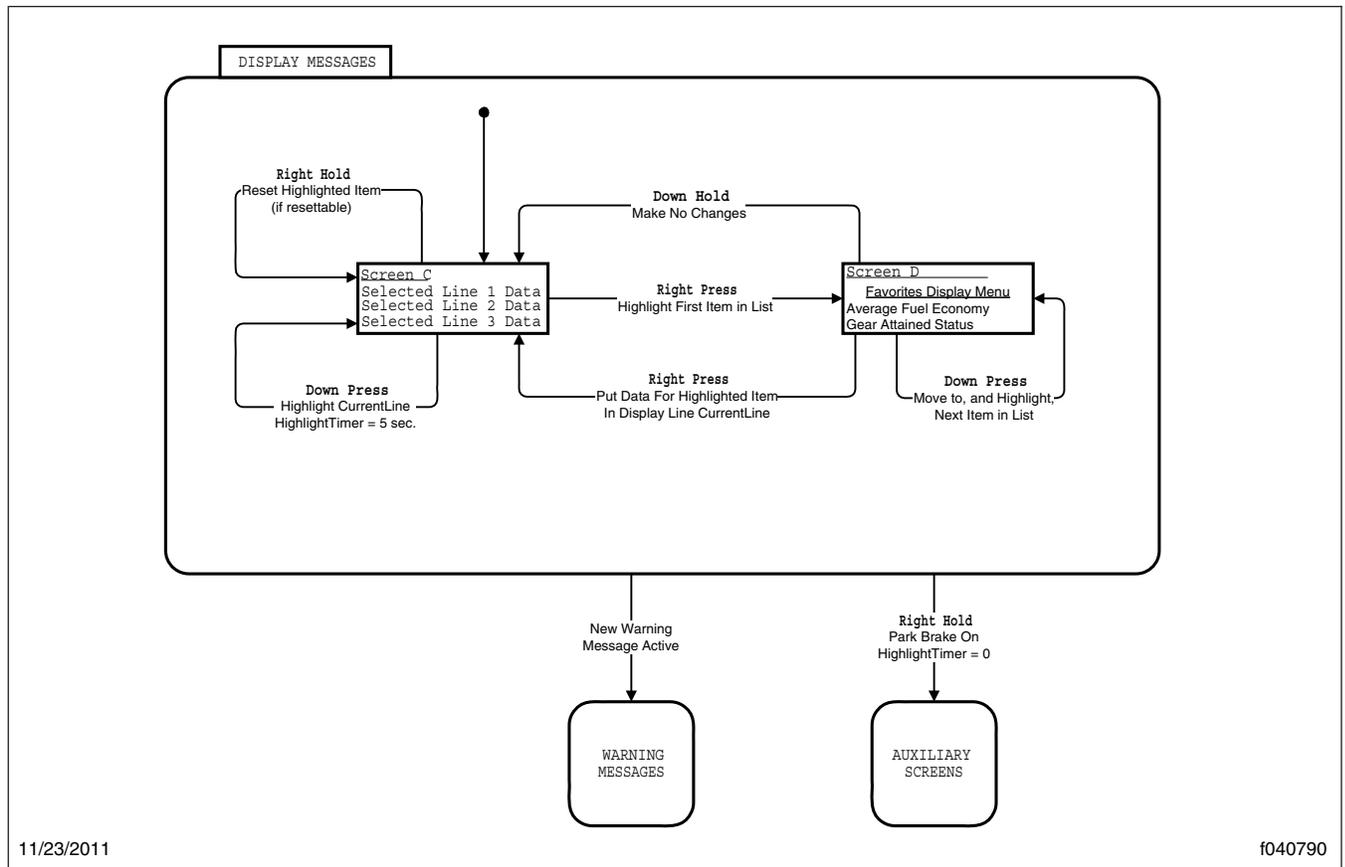


Fig. 17.10, Display Messages

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

## Malfunction Indicator Lamp (MIL)

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

## Low Air Pressure Warning

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

The warning light and buzzer also activate during operation whenever air pressure in the primary or

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

## Wait to Start Indicator

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

## ABS Indicator

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

**NOTE:** For more information about this light and the ABS system, see [Chapter 7](#).



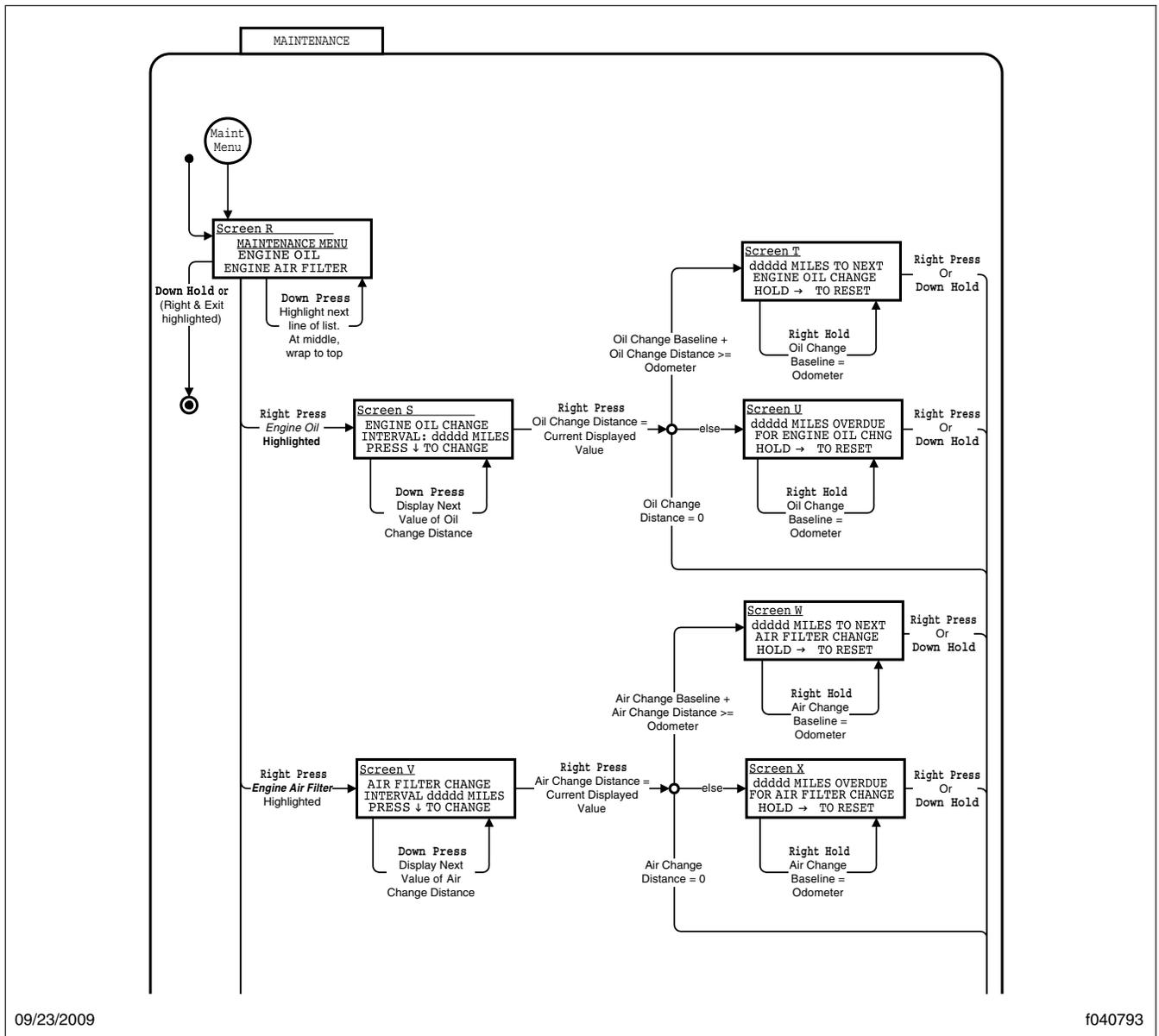


Fig. 17.12, Maintenance Menu Screens, Screen 1

## Right-Turn Signal Arrow

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

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

## Fasten Seat Belts Warning

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

# Propane Fuel System

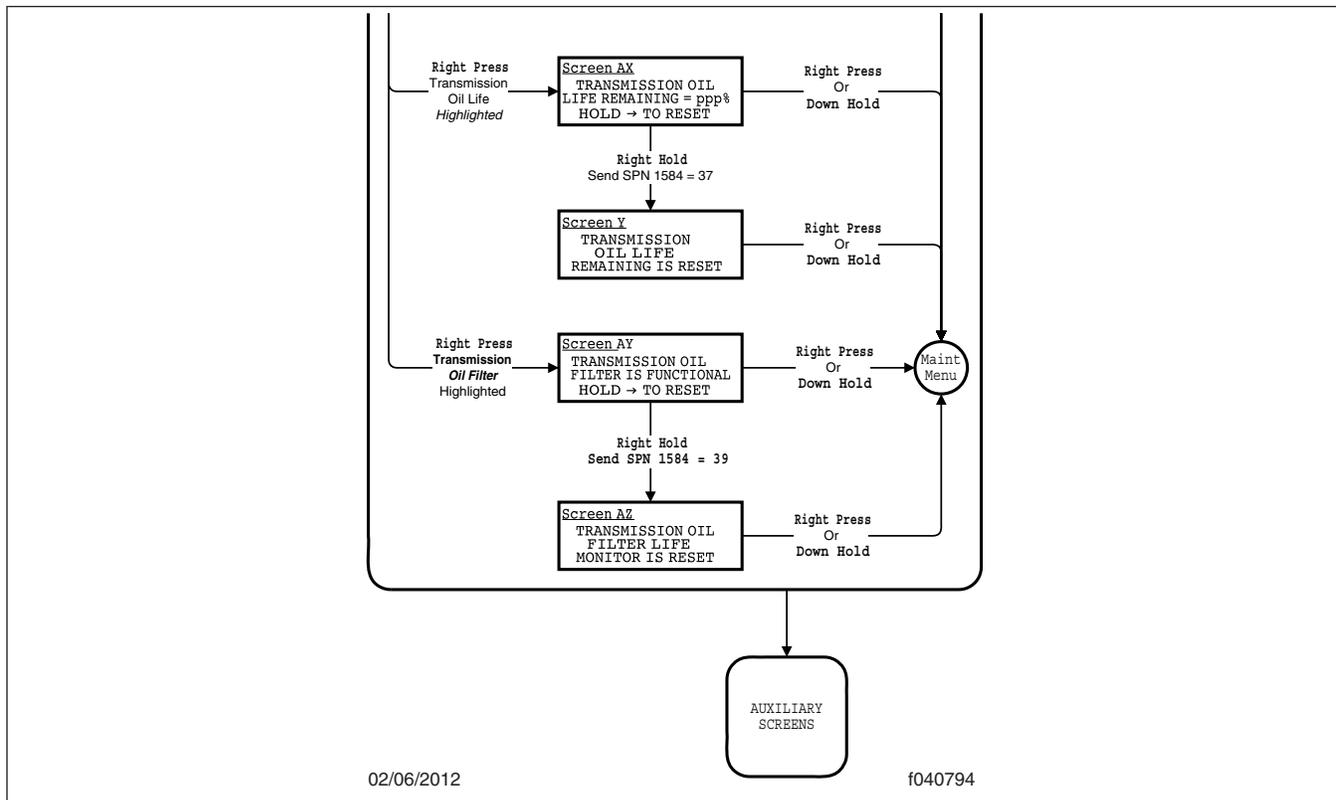


Fig. 17.13, Maintenance Menu Screens, Screen 2

## Hydraulic Brake System Warning

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

## Headlight High-Beam Indicator

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

## Brake System Warning/Parking Brake On Indicator

The red brake system warning/parking brake on indicator light 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.

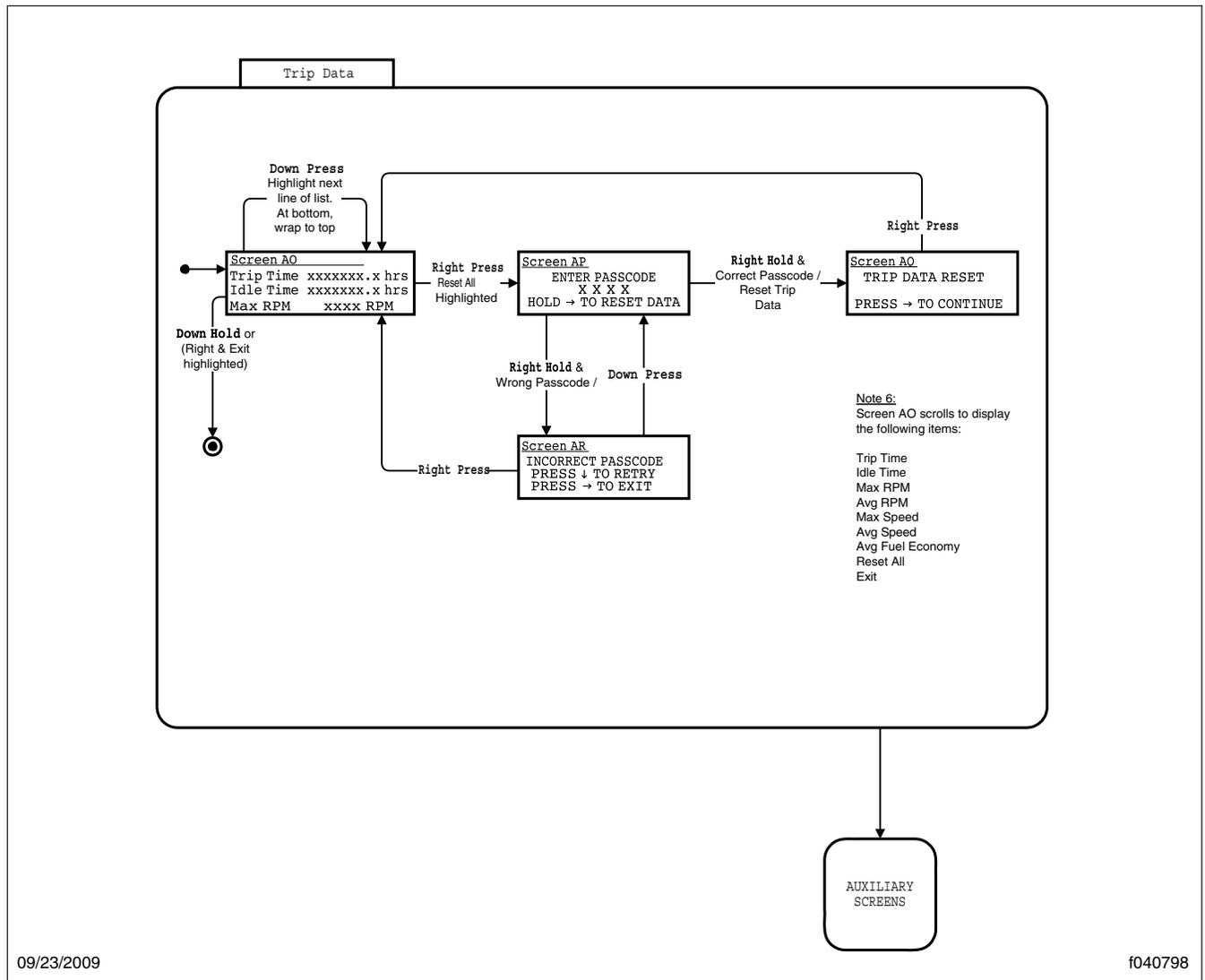
## Cruise Control Indicator

A green indicator illuminates when the cruise control is activated.

## Emergency Buzzer

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

- The engine oil pressure falls below the preset level which is 6 psi (41 kPa) at 700 rpm, or 18 psi (124 kPa) at 4400 rpm.
- The air pressure falls below the preset level, which is 65 psi (448 kPa).
- The parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).
- The coolant temperature rises above 253°F (123°C) and the check engine and stop engine lights illuminate. When the coolant temperature



**Fig. 17.14, Trip Data**

falls below 244° (118°C) the emergency buzzer and stop engine light will turn off.

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

## Speedometer and Tachometer

### Speedometer

Three kinds of speedometer faces are available. The U.S. version of the speedometer registers speed in

both miles per hour (mph) and kilometers per hour (km/h), with mph in larger numbers. See **Fig. 17.18**.

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

### Tachometer

The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting

# Propane Fuel System

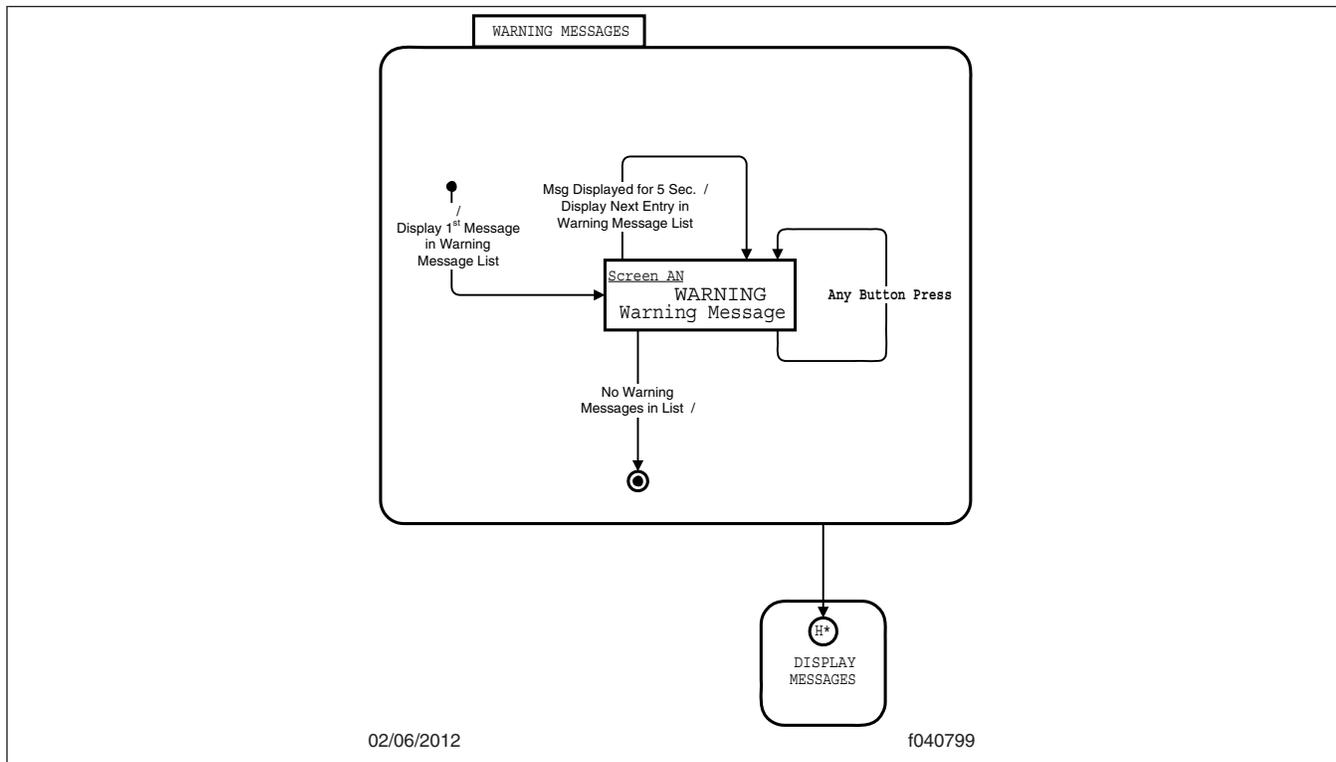


Fig. 17.15, Warning Messages

the transmission and keeping the engine in the appropriate rpm range. See Fig. 17.18.

## Standard Instruments

### Fuel Level Gauge

The fuel level gauge indicates the level of fuel in the fuel tanks. See Fig. 17.19. A low-level warning light illuminates when the diesel fuel level registers 1/8th of capacity.

### 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.**

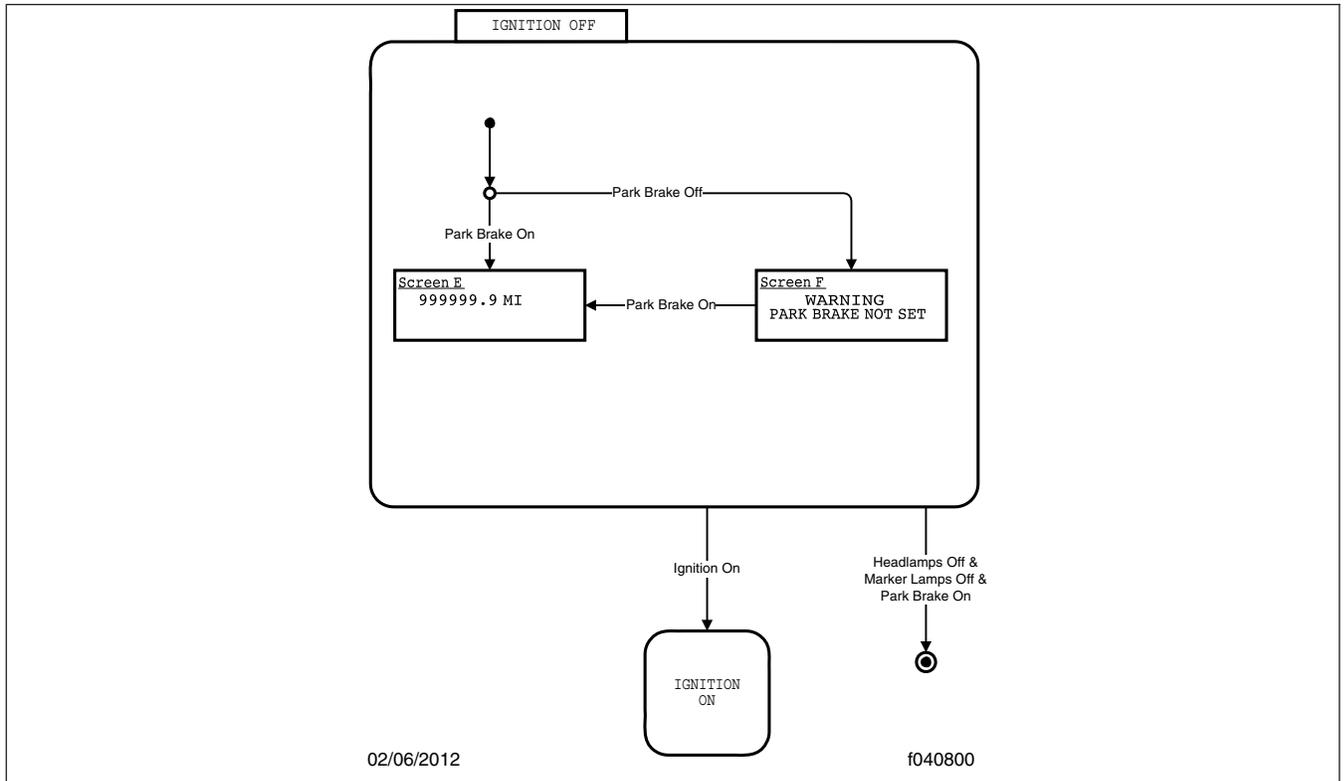
If the engine oil pressure falls below preset levels, the check engine light will illuminate. If the condition does not improve, the CHECK engine light and low oil pressure warning light will also illuminate and the buzzer will sound. See Fig. 17.20. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

### Coolant Temperature Gauge

#### NOTICE

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

During normal engine operation, the coolant temperature gauge should read 200 to 205°F (93 to 96°C). See Fig. 17.21. If the temperature remains below 160°F (71°C) or exceeds 235°F (113°C), inspect the cooling system to determine the cause.



**Fig. 17.16, Ignition Off (shown when ignition is keyed OFF)**

See the vehicle workshop manual for troubleshooting and repair procedures.

The coolant temperature gauge is very important. See **Fig. 17.21**. If the coolant temperature rises above 253°F (123°C), the check engine and stop engine lights will illuminate, and the buzzer will sound. At this point, the engine will derate and idle speed will increase, to speed up the cooling fan and water pump to cool the engine.

# Propane Fuel System

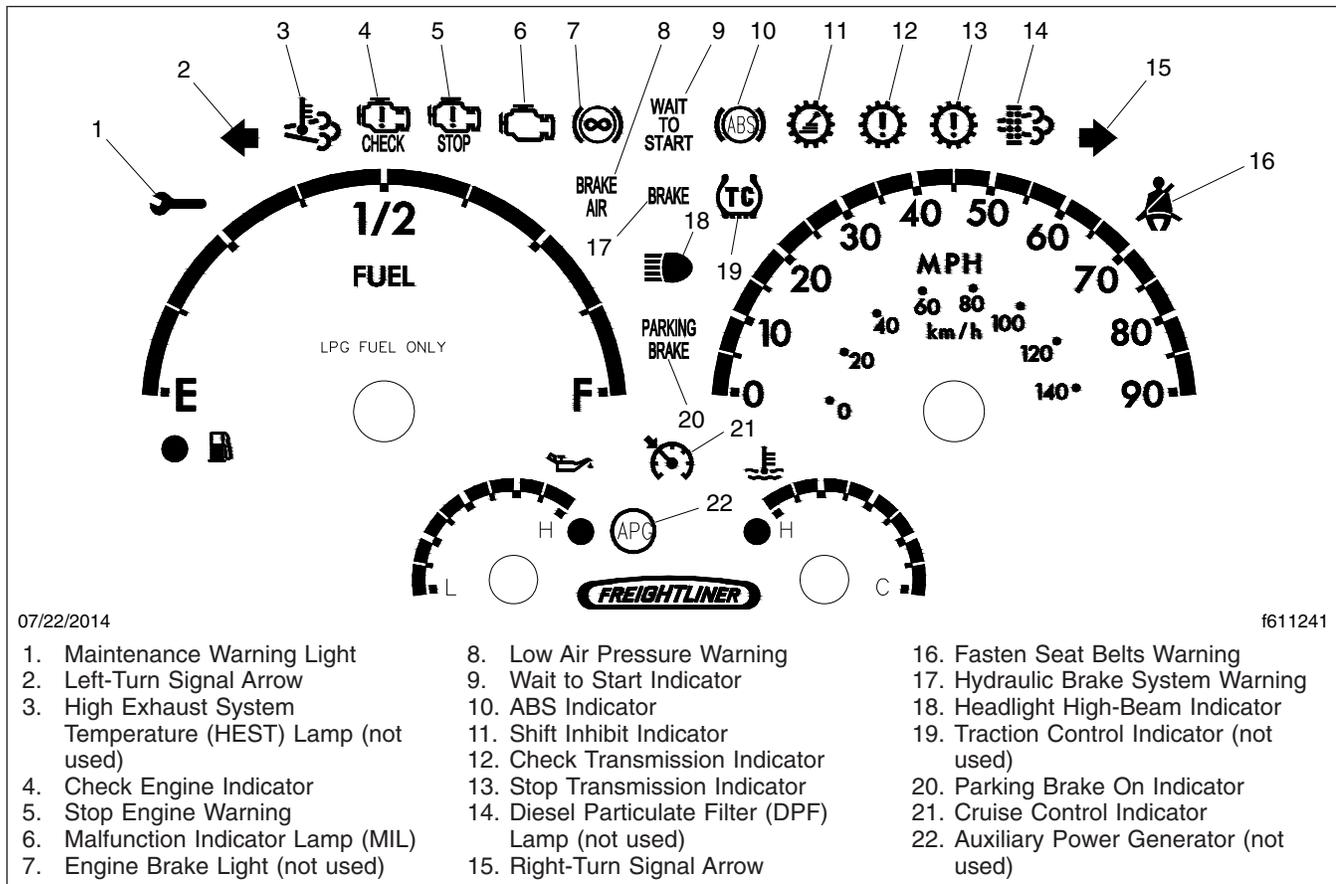


Fig. 17.17, LPG Engine Warning and Indicator Lights

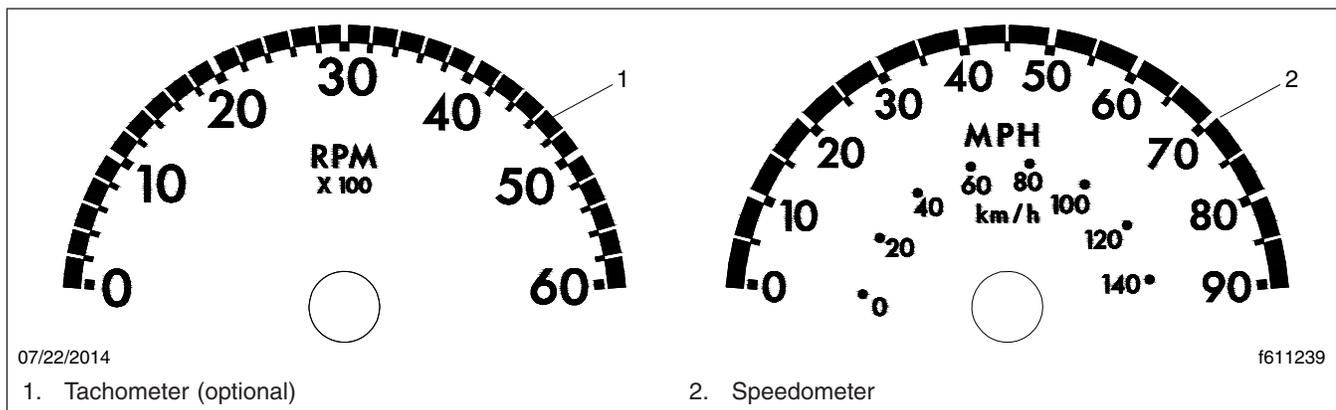


Fig. 17.18, Speedometer and Tachometer (U.S. version)

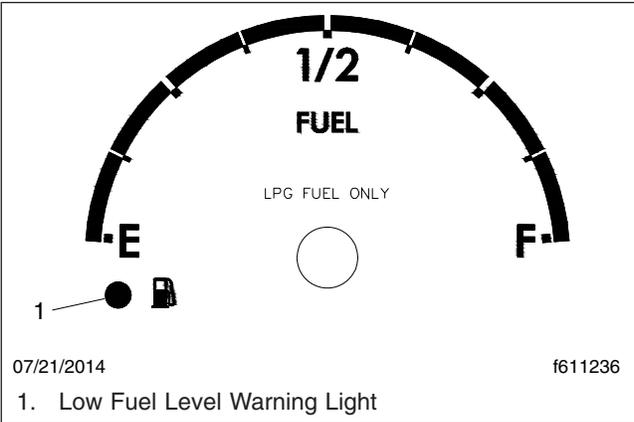


Fig. 17.19, Fuel Level Gauge (typical gauge shown)

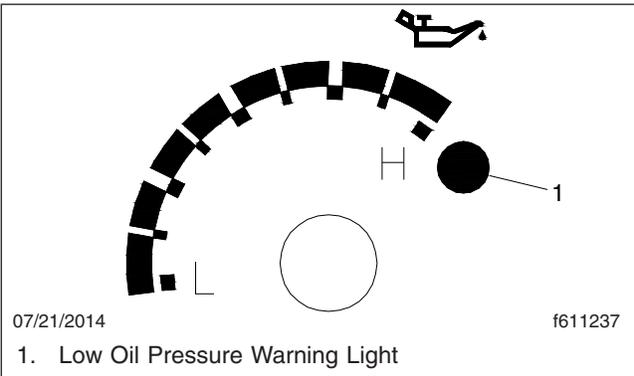


Fig. 17.20, Engine Oil Pressure Gauge

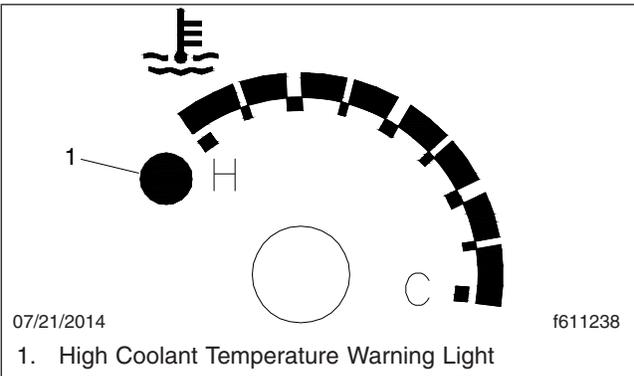


Fig. 17.21, Coolant Temperature Gauge

# 18

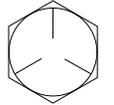
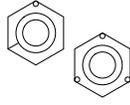
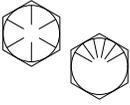
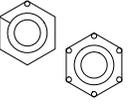
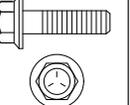
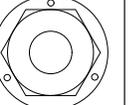
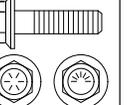
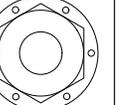
## Specifications

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Torque Charts .....	18.1
Conversion Charts .....	18.4
Fluid and Lubricant Specifications .....	18.5
Fuse/Relay/Circuit Breaker Identification .....	18.5

# Specifications

## Torque Charts

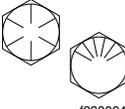
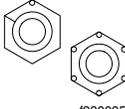
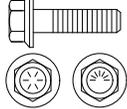
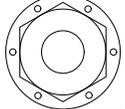
Torque Values for U.S. Customary Thread Fasteners With Lubricated* or Plated Threads†								
Thread Diameter— Pitch	Regular Hex				Flanged			
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 5 Bolt	Grade B Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft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

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

**Table 18.1, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads**

# Specifications

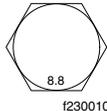
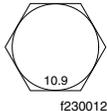
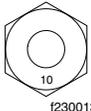
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter—Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N-m)		Torque: lbf-ft (N-m)		Torque: 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 18.1](#). FCCC recommends that all plated and unplated fasteners be coated with oil before installation.

**Table 18.2, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads**

# Specifications

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

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

**Table 18.3, 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
<b>Length</b>					
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)
<b>Area</b>					
square inches (in <sup>2</sup> )	645.16	square millimeters (mm <sup>2</sup> )		0.00155	square inches (in <sup>2</sup> )
square inches (in <sup>2</sup> )	6.452	square centimeters (cm <sup>2</sup> )		0.155	square inches (in <sup>2</sup> )
square feet (ft <sup>2</sup> )	0.0929	square meters (m <sup>2</sup> )		10.764	square feet (ft <sup>2</sup> )
<b>Volume</b>					
cubic inches (in <sup>3</sup> )	16387.0	cubic millimeter (mm <sup>3</sup> )		0.000061	cubic inches (in <sup>3</sup> )
cubic inches (in <sup>3</sup> )	16.387	cubic centimeters (cm <sup>3</sup> )		0.06102	cubic inches (in <sup>3</sup> )
cubic inches (in <sup>3</sup> )	0.01639	liters (L)		61.024	cubic inches (in <sup>3</sup> )
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 <sup>3</sup> )	28.317	liters (L)		0.03531	cubic feet (ft <sup>3</sup> )
cubic feet (ft <sup>3</sup> )	0.02832	cubic meters (m <sup>3</sup> )		35.315	cubic feet (ft <sup>3</sup> )
<b>Weight/Force</b>					
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)
<b>Torque/Work Force</b>					
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)
<b>Pressure/Vacuum</b>					
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 18.4, 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 18.5, Temperature Conversion**

# Specifications

## Fluid and Lubricant Specifications

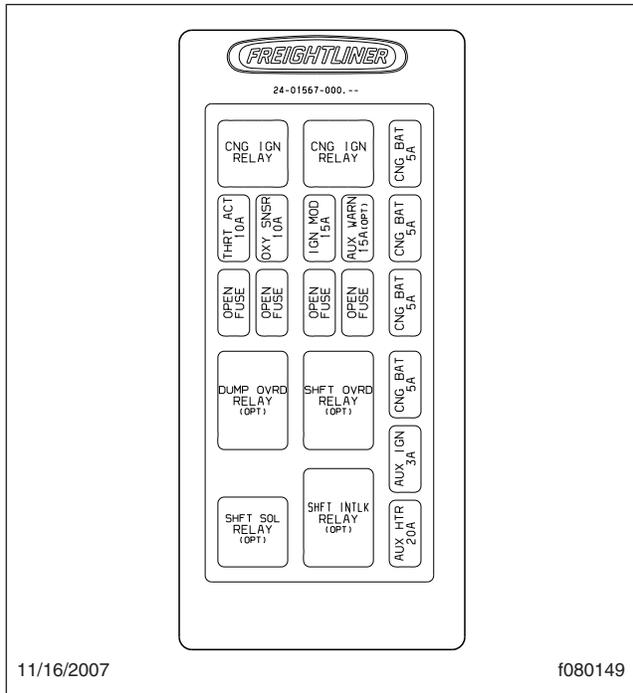
See [Table 18.6](#) for fluid and lubricant specifications.

Fluid and Lubricant Specifications	
Component	Recommended Fluid or Lubricant
Front Axle Spindle Pins, Tie Rods, Drag Link, Intermediate Steering Shaft, Front Brake and Pedal Shafts, Slip Spline and Universal Joints	Multipurpose Grease Lithium 12 Hydroxy Stearate NLGI No. 2; for temperatures below 0°F (-18°C), use MIL-G-10924B
Hydraulic Brake Master Cylinder	Heavy-Duty DOT 3 Brake Fluid
Brake and Pedal Pivots	Starplex 2 (lithium soap-based grease)
Engine	See Manufacturer's Recommendations
Transmission	See Manufacturer's Recommendations
Fuel	Ultralow-Sulfur Diesel Fuel
	CMS 20067 (CNG Engines)
	HD5 Grade Propane
Disc Brake Caliper Rails	FCCC No. 4JD623 Brake Caliper Slide Grease
Rear Axle Differential	See Manufacturer's Recommendations
Hydraulic System Reservoir	Dexron® III ATF or equivalent
Engine Coolant	50% Water/50% Ethylene Glycol Antifreeze (diesel engines)
	50% Water/50% DEX-COOL® Coolant (gasoline and propane engines only)

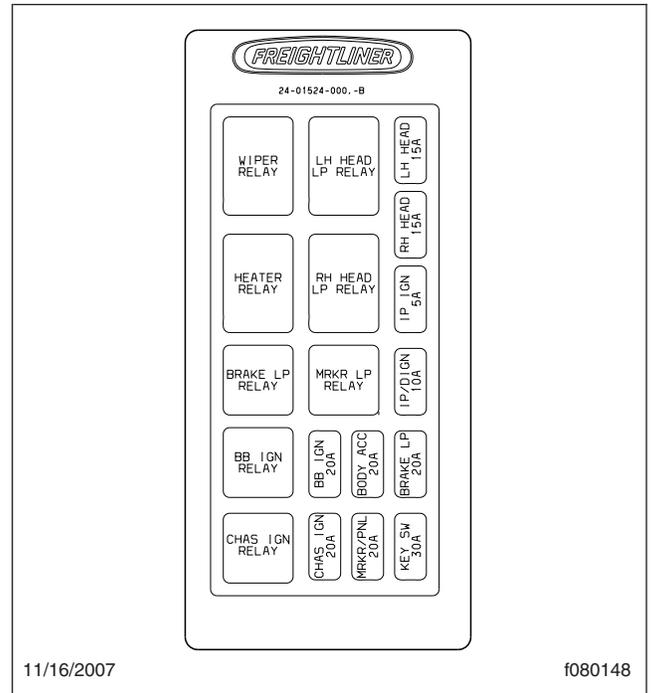
**Table 18.6, Fluid and Lubricant Specifications**

## Fuse/Relay/Circuit Breaker Identification

NOTE: The fuse/circuit breaker panel is located under the instrument panel to the left of the steering column. 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. Auto-reset breakers are installed. Depending on vehicle options, fuse/circuit breaker locations may vary from those shown. A power distribution panel may also be installed on the vehicle. This panel houses plug-in fuses and relays. See [Fig. 18.1](#) and [Fig. 18.2](#).



**Fig. 18.1, Fuse/Relay/Circuit Breaker Panels (left-side shown, typical)**



**Fig. 18.2, Fuse/Relay/Circuit Breaker Panels (right-side shown, typical)**

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