

## Introduction

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

Freightliner chassis are equipped with various chassis and driver controls. The coverage in this manual applies to all recreational vehicle chassis in general and everything may not apply specifically to your vehicle, due to optional component offerings. Component coverage specific to the front-engine diesel chassis can be found in **Chapter 9**. If parts on your chassis differ from those shown, they may have been installed by the vehicle final-stage manufacturer.

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

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

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

## Environmental Concerns and Recommendations

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

## Event Data Recorder

This vehicle is equipped with one or more devices that record specific vehicle data. The type and amount of data recorded varies depending on how the vehicle is equipped (such as the brand of engine,

if an air bag is installed, or if the vehicle features a collision avoidance system, etc.).

## Customer Assistance Center

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

## Reporting Safety Defects

If you believe that your vehicle has a defect that could cause a crash or could cause injury or death, you should immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying Freightliner Custom Chassis Corporation.

If the NHTSA receives similar complaints, it may open an investigation, and if it finds that a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you, your dealer, or Freightliner Custom Chassis Corporation.

To contact NHTSA, you may call the Vehicle Safety Hotline toll-free at 1-888-327-4236 (TTY: 1-800-424-9153); go to [www.safercar.gov](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/menu.htm](http://www.tc.gc.ca/roadsafety/menu.htm).

# Foreword

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# 1

## Vehicle Identification

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# Vehicle Identification

## INCOMPLETE VEHICLE COMPONENT INFORMATION

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

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

PAINT MFR :  
PAINT NUMBER :



A Subsidiary of FREIGHTLINER LLC

USE VEHICLE ID NUMBER (VIN)  
WHEN ORDERING PARTS.

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






FOR COMPLETE PAINT INFORMATION  
SEE VEHICLE SPECIFICATION SHEET.

FREIGHTLINER CUSTOM CHASSIS CORPORATION

GAFFNEY, SOUTH CAROLINA, USA

12/04/2001 f080122

Fig. 1.3, Vehicle Identification Number (VIN) Label, Typical

<b>EXHAUST AFTERTREATMENT SYSTEM INFORMATION</b>					
INDICATOR LAMP(S)	 (Solid) Level 1	 (Flashing) Level 2	 (Flashing) Level 3	 (Flashing) Level 4	 <b>WARNING</b>
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>
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>
For a driver Parked Regeneration there must be a dash mounted Regeneration Switch.					
<b>See Engine Operator's Manual for complete Regeneration Instructions.</b>					

24-01583-000B

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Fig. 1.4, EPA07 Warning Label

# 2

## Instruments

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# Instruments

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## Light Bar Control Unit (LBCU)

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

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

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

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

## Audible Alarms

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

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

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

## Emergency Shutdown

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

## Information Center

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

## Power Initialization

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

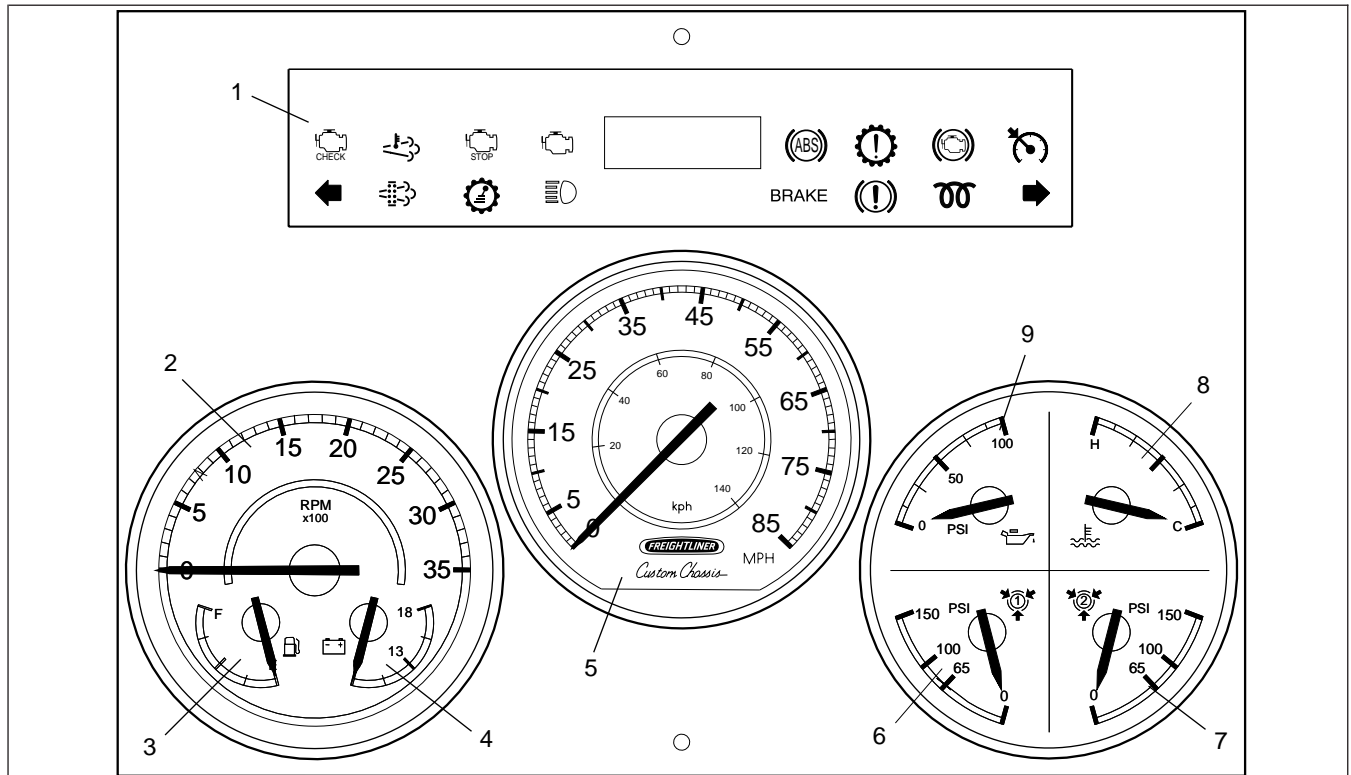
## Navigating the Menu Screen

Navigate the menu structure using the toggle switch, located in the driver's area. The "up" arrow of the toggle switch is yellow. See [Fig. 2.3](#).

## Menu Structure

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



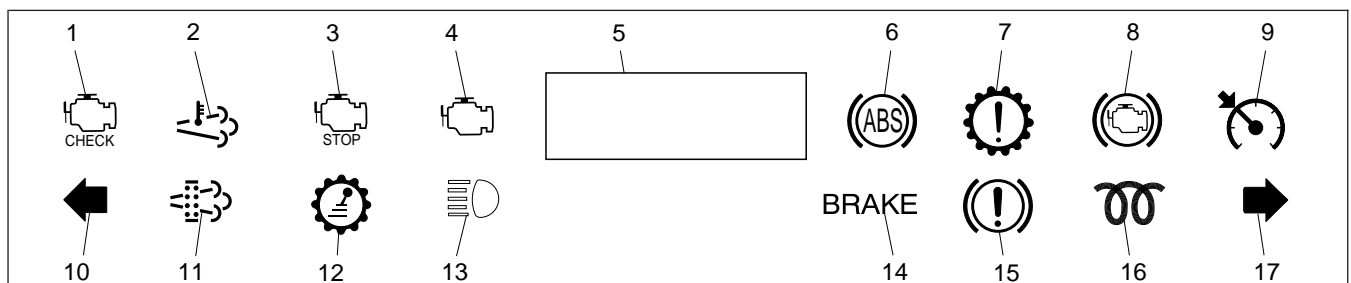


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- |                           |                      |                              |
|---------------------------|----------------------|------------------------------|
| 1. Light Bar Control Unit | 4. Voltmeter         | 7. Secondary Air Gauge  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

**Fig. 2.1, Typical Instrument Panel, EPA07 Compliant**



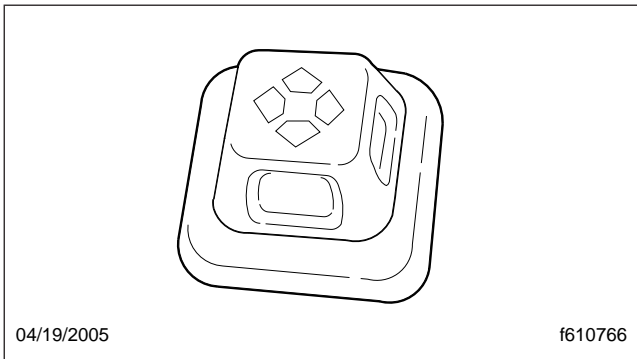
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- |  |  |                                   |
|--|--|-----------------------------------|
| 1. Check Engine Indicator                      | 7. Check Transmission Indicator          | 12. Shift Inhibit Indicator       |
| 2. High Exhaust System Temperature (HEST) Lamp | 8. Engine Brake Engaged Indicator        | 13. Headlight High-Beam Indicator |
| 3. Stop Engine Warning                         | 9. Cruise On Indicator                   | 14. Parking Brake Indicator       |
| 4. Malfunction Indicator Lamp                  | 10. Left-Turn Signal Arrow               | 15. Low Air Pressure Indicator    |
| 5. Dash Driver Display Screen                  | 11. Diesel Particulate Filter (DPF) Lamp | 16. Wait to Start Indicator       |
| 6. ABS Indicator                               |  | 17. Right-Turn Signal Arrow       |

**Fig. 2.2, LBCU Message Center, EPA07 Compliant**

# Instruments



**Fig. 2.3, Toggle Switch**

## Ignition Off Screen

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

## Home Screen

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

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

- A pretrip inspection checklist that includes 19 items and 10 driver-entered options. Once each item has been reviewed, click the right arrow of the toggle switch to place a check by the item. Click the left arrow to exit the checklist.
- Driver's Favorite Categories—There are nine categories that the driver can select from; three can be viewed at one time. Select the category desired by using the up/down toggle switch. Then, click the right arrow of the toggle switch for three seconds to access the sub-menus within each category. Finally, click the left arrow of the toggle switch to exit.
- Setup/Maintenance/Diagnostics screen is actually three different categories for the driver to use. They are as follows:
  1. Setup—Includes set time and date, configure checklist, select metric/english, set LCD properties.

2. Maintenance—Includes engine oil, engine air filter, engine fuel filter, transmission oil, generator oil, generator fuel filter, generator use time.

3. Diagnostics—Includes check gauges, check icons, check inputs, check outputs, engine diagnostics, ABS diagnostics, hardware/software version, and software debug display (this menu is used by the gauge manufacturer only).

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

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

## Menu Structure

The menu structure road map is provided to illustrate the screens that are available in the information center and the path to specific screens. Refer to the road maps to set the time and date, view engine diagnostics, etc. See [Fig. 2.4](#), [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](#), [Fig. 2.17](#), [Fig. 2.18](#), [Fig. 2.19](#), [Fig. 2.20](#), [Fig. 2.21](#), [Fig. 2.22](#), [Fig. 2.23](#), and [Fig. 2.24](#).

## Warning and Indicator Lights

There are 17 warning and indicator lights installed in the LBCU message center. These indicator lights are listed by their position in the dash message center.

The lights on the left-hand side of the driver display screen are described first, followed by those on the right-hand side. See [Fig. 2.25](#).

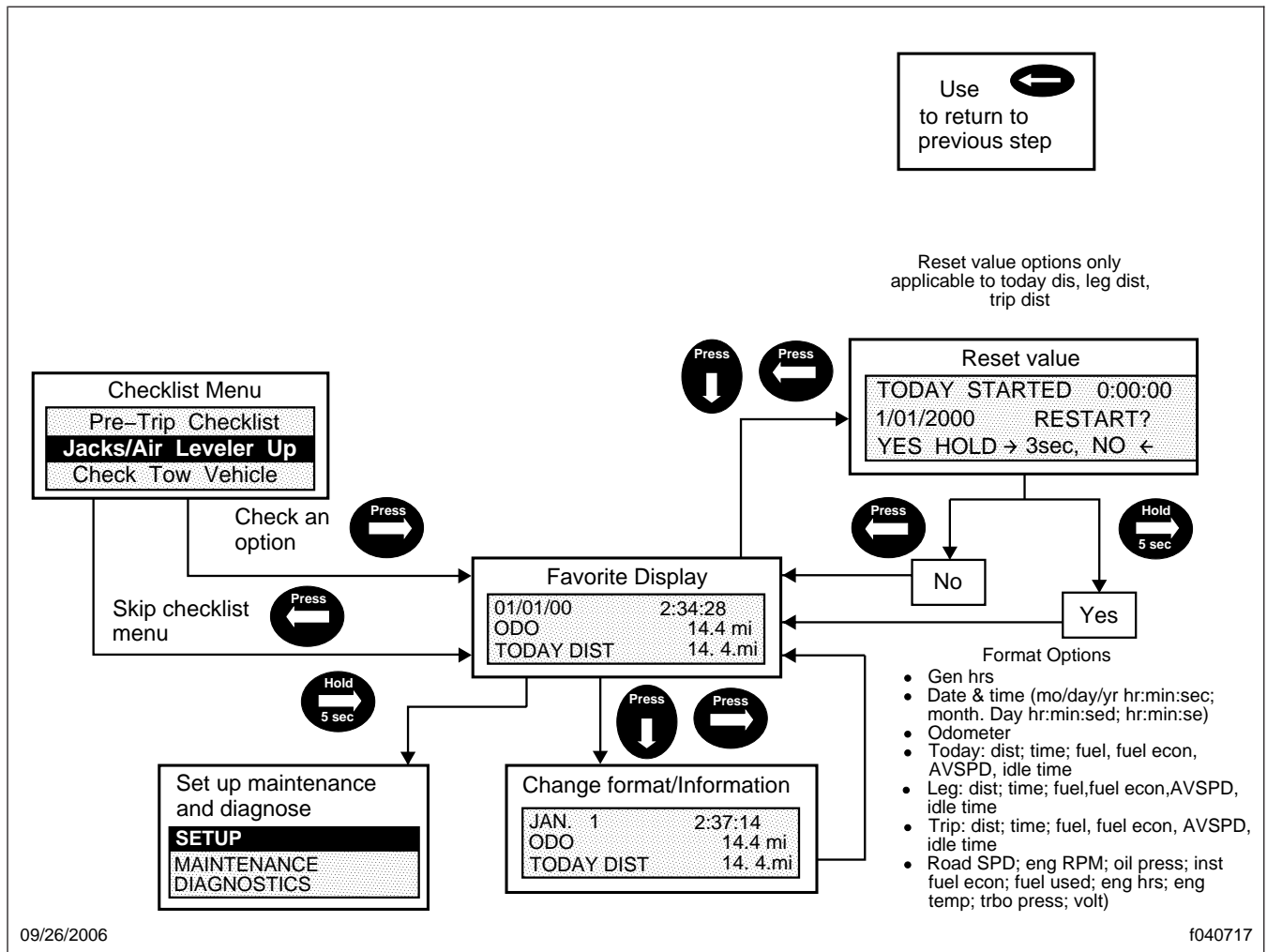


Fig. 2.4, Favorite Display

## Check Engine Indicator

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

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

## High Exhaust System Temperature (HEST) Lamp

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

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

# Instruments

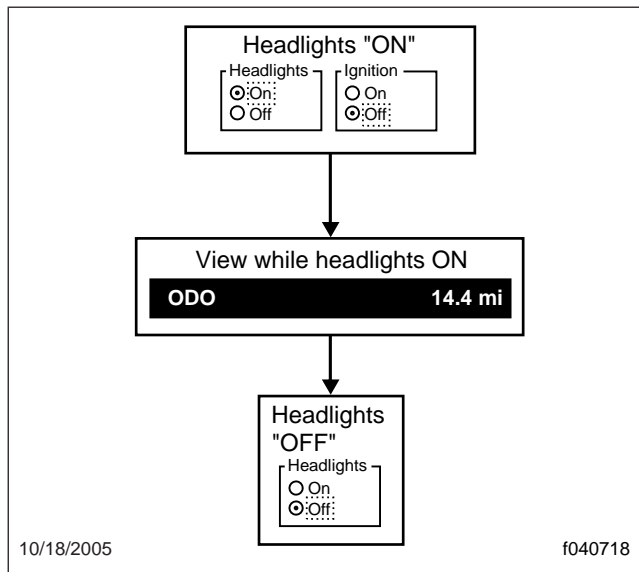


Fig. 2.5, View Odometer Value

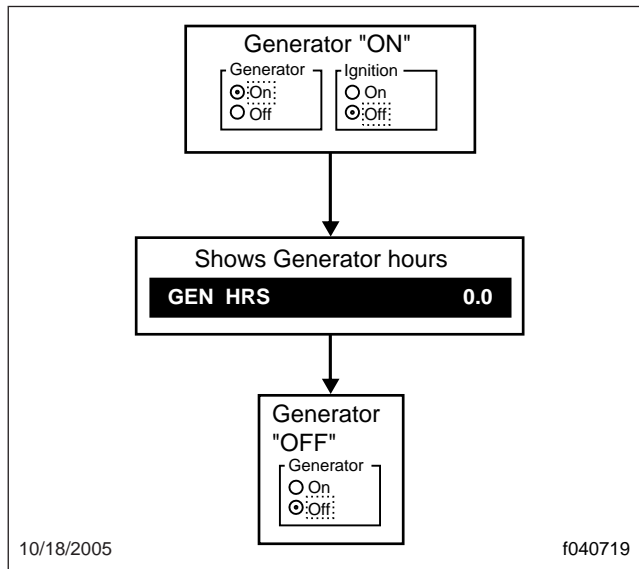


Fig. 2.6, View Generator Hours

## Stop Engine Warning

A red Stop Engine Warning Light indicates a serious fault that requires the engine be shut down immediately. The driver must safely bring the vehicle to a stop on the side of the road and shut down the engine as soon as the red light is seen. If the engine shuts down while the vehicle is in a hazardous location, the engine can be restarted after turning the key

to the OFF position for a few seconds. See the **Cummins or Mercedes-Benz Operation and Maintenance Manual** for more information.

## Malfunction Indicator Lamp

A Malfunction Indicator Lamp (MIL) indicates an engine emissions-related fault, including, but not limited to, the aftertreatment system. The MIL applies to the Mercedes-Benz engine only. See the engine operation manual for details.

## Dash Driver Display Screen

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

## ABS Indicator

The ABS indicator illuminates when a problem is detected.



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

## Check Transmission

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

## Engine Brake Engaged Indicator

A green engine brake indicator illuminates when the engine brake is applied. Wait until the indicator light goes off to start the engine.

## Cruise-On Indicator

A green indicator illuminates when the cruise control is on.

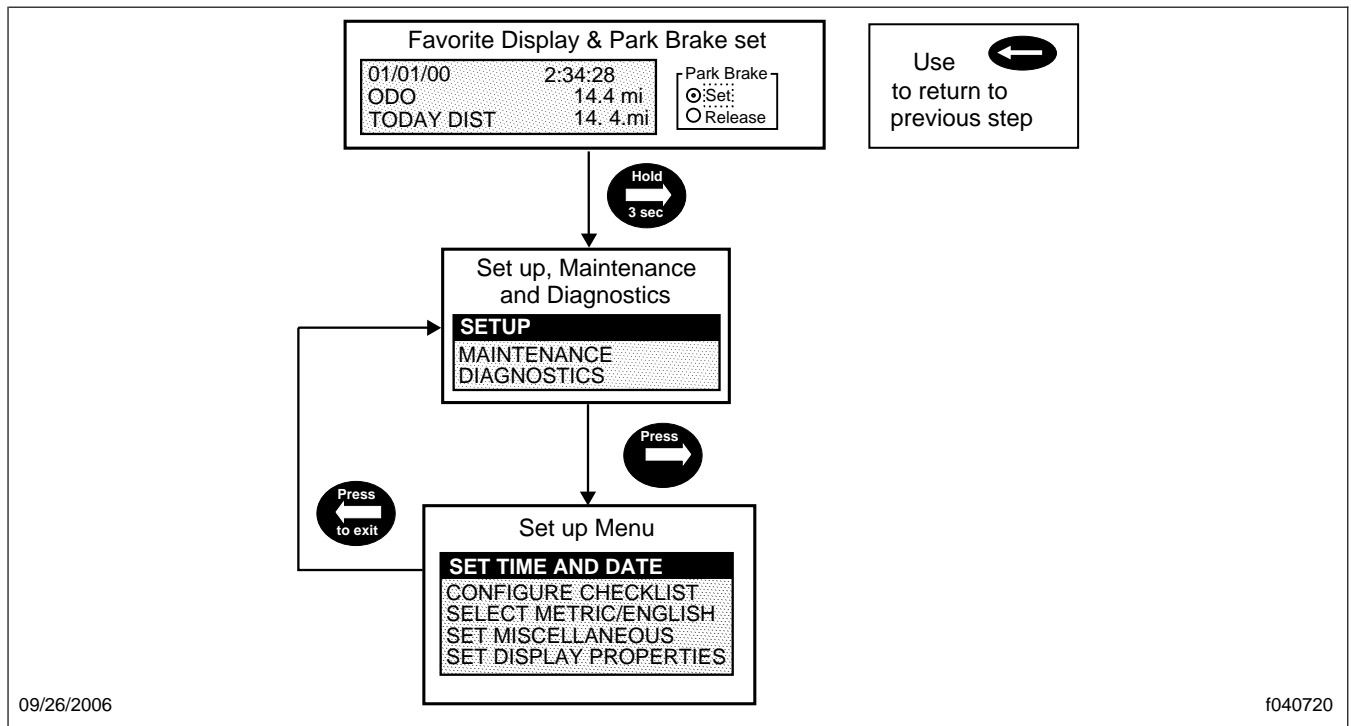


Fig. 2.7, Set Up Menu

## Left-Turn Signal Arrow

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

## Diesel Particulate Filter (DPF) Lamp

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

## Shift Inhibit Indicator Lamp

A yellow Shift Inhibit Indicator illuminates when the transmission ECU is prohibiting shifting.

## Headlight Hi-Beam Indicator Lamp

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

## Parking Brake Indicator

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

## Low Air Pressure Indicator

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

## Wait to Start Indicator

A yellow wait-to-start indicator light illuminates when the intake heater is active.

## Right-Turn Signal Arrow

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

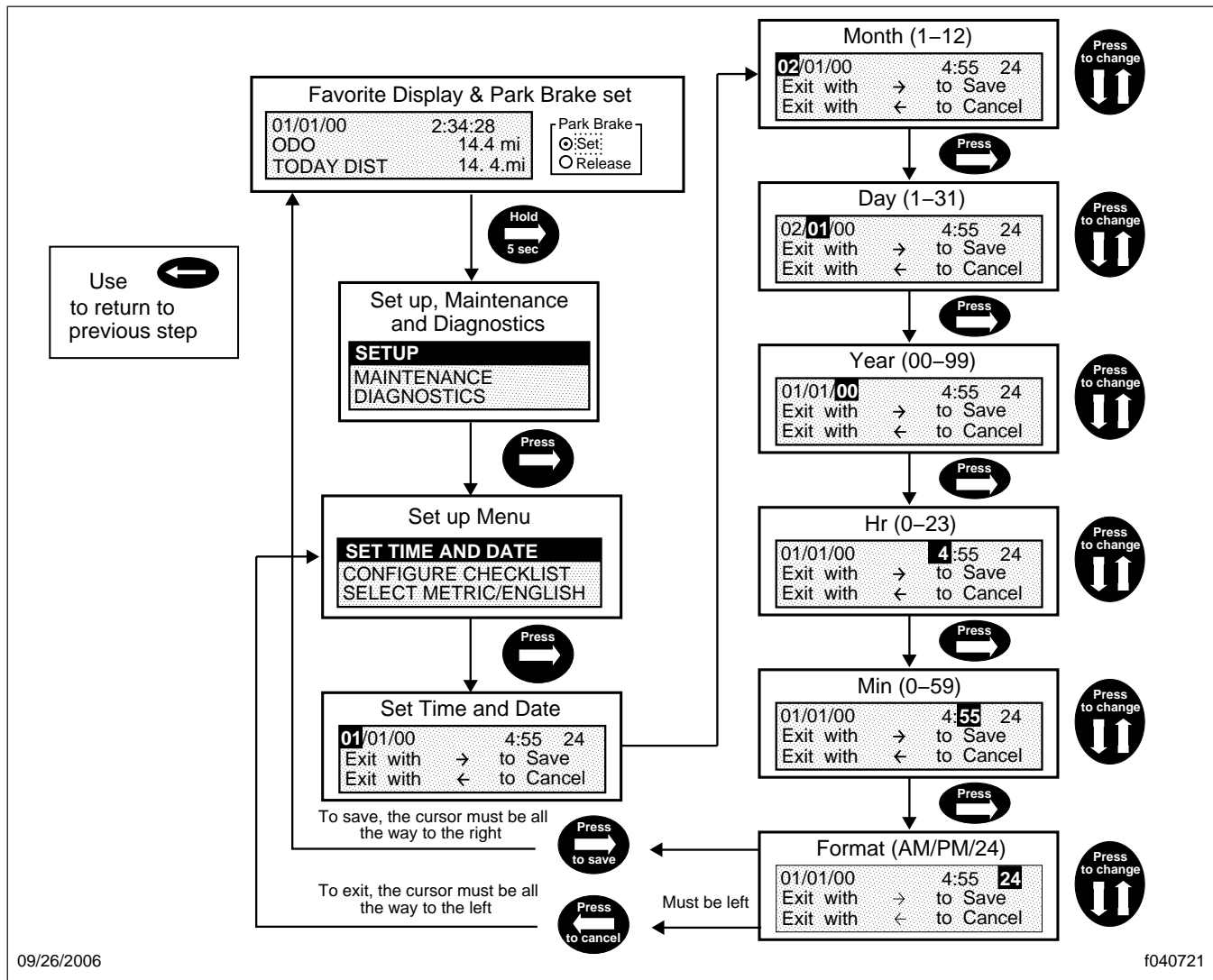


Fig. 2.8, Set Time and Date

## Speedometer and Tachometer

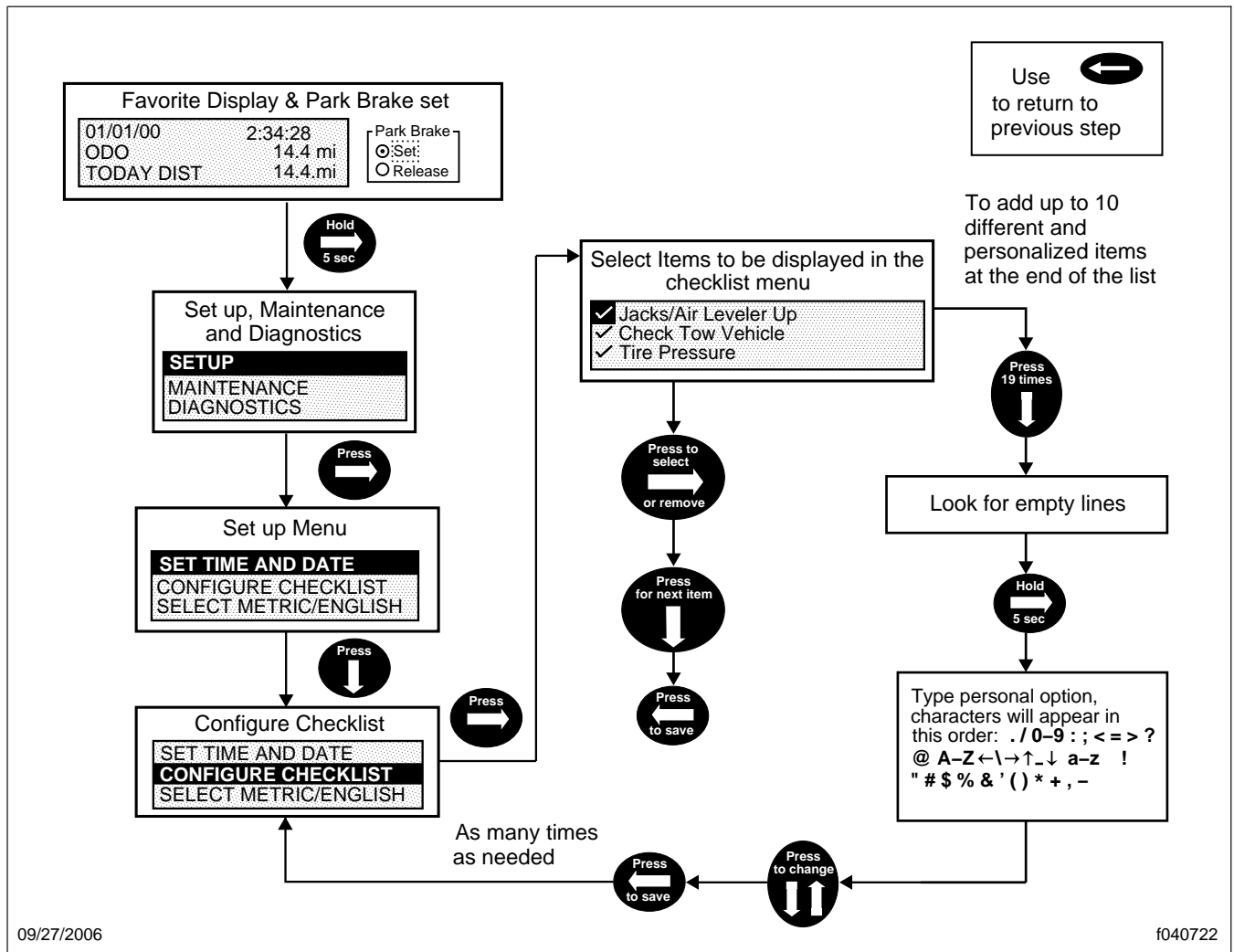
### Speedometer

The speedometer indicates vehicle speed in miles per hour (mph) or kilometers per hour (km/h). See Fig. 2.26.

### Tachometer (Three-in-One Gauge)

This gauge serves 3 functions as follows. See Fig. 2.27.

- Tachometer; indicates the revolutions per minute (rpm) of the engine.
- Fuel Gauge; indicates the amount of fuel in the fuel tank.
- Voltmeter; indicates the vehicle charging system voltage when the engine is running, and battery voltage when the engine is stopped. By monitoring the voltmeter, the driver can be aware of potential charging system problems and have them repaired before the batteries discharge enough to create starting difficulties.



**Fig. 2.9, Configure Checklist**

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

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

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

## Standard Instruments

Standard instruments are equipped with the instrument cluster and should be present on every vehicle. See [Fig. 2.28](#).



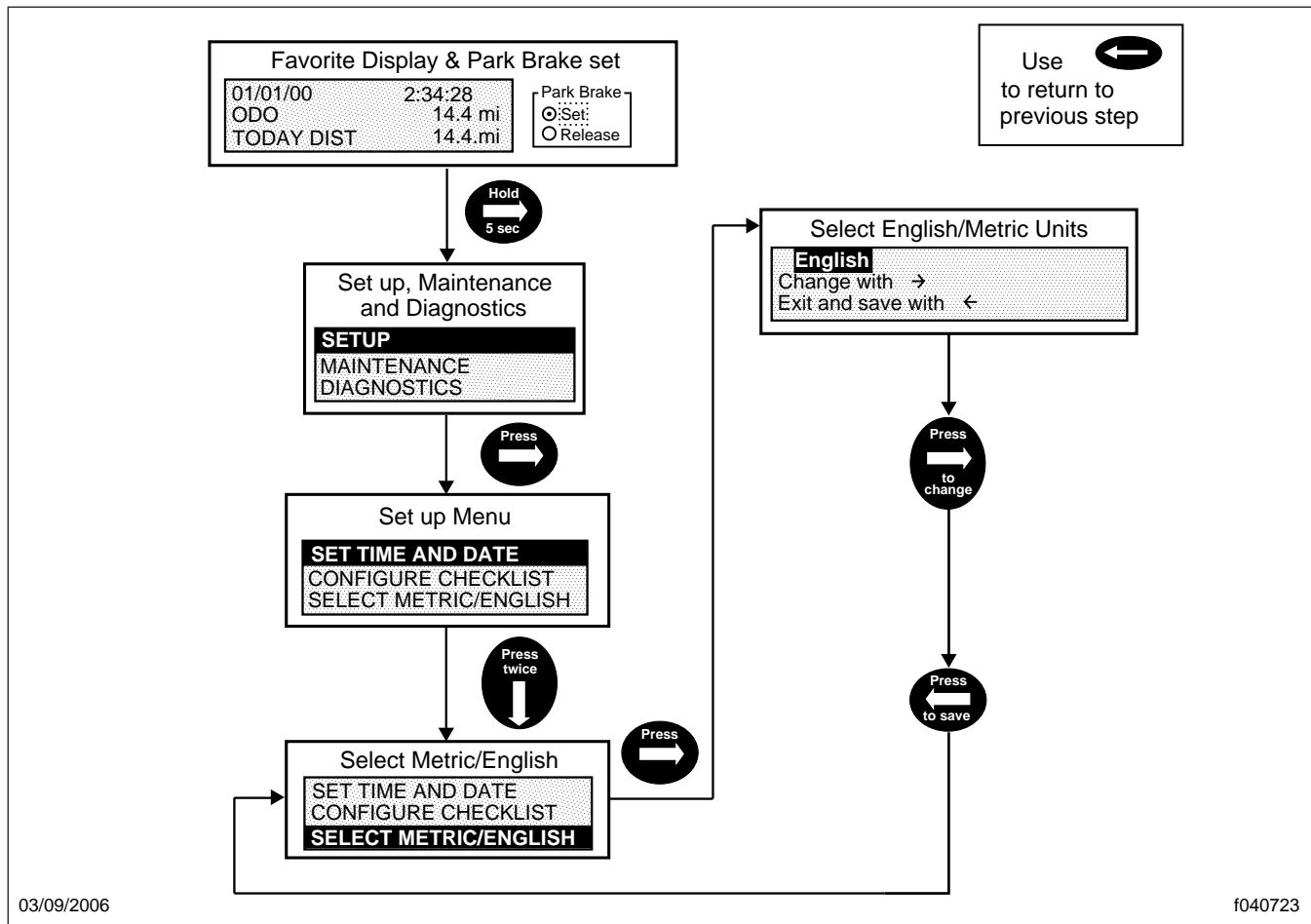


Fig. 2.10, Change Units

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

### Engine Oil Pressure Gauge

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

### CAUTION

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

## Coolant Temperature Gauge

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

## Primary and Secondary Air Pressure Gauges

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



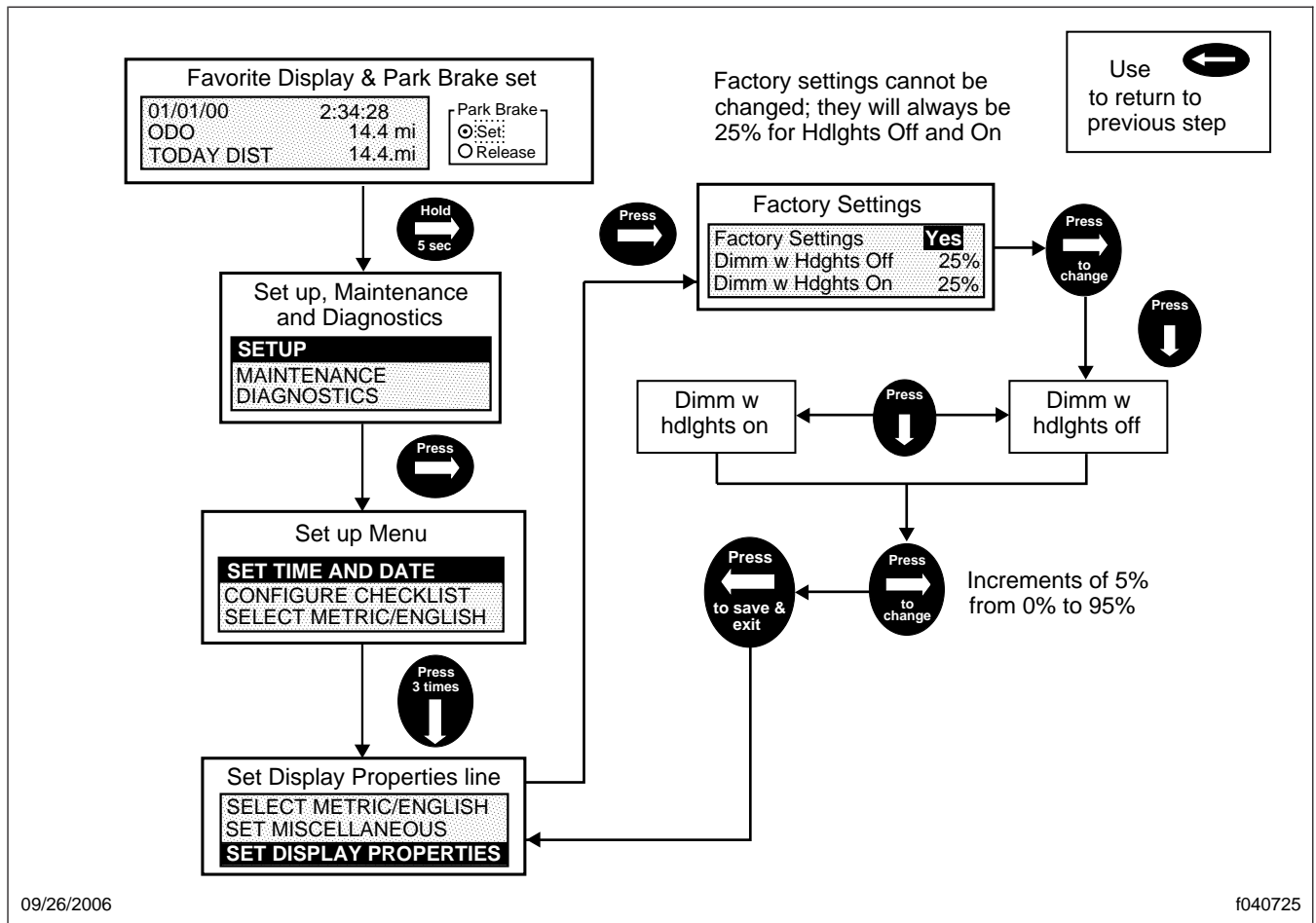


Fig. 2.11, Set Display Properties

alarm will sound if the pressure drops below a safe operating range.

## Intake-Air Restriction Indicator

An intake-air restriction indicator measures the vacuum on the engine side of the air cleaner at the air cleaner outlet. See Fig. 2.29. Replace the air cleaner element every two years, or when filter restriction reaches 25 inH<sub>2</sub>O. Reset the indicator by pressing the button on the bottom.

NOTE: A new air cleaner element will normally read 10 to 12 inH<sub>2</sub>O (254 to 305 mmH<sub>2</sub>O). Rain or snow can wet the filter and cause a higher than normal reading temporarily. See Table 2.1 for the intake-air restriction level.

Intake-Air Restriction Vacuum Readings*		
Engine Type	Initial inH <sub>2</sub> O (mmH <sub>2</sub> O)	Service inH <sub>2</sub> O (mmH <sub>2</sub> O)
Mercedes-Benz	12 (305)	20 (508)
Cummins	12 (305)	25 (635)

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

Table 2.1, Intake-Air Restriction Vacuum Readings

## Optional Instruments

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

# Instruments

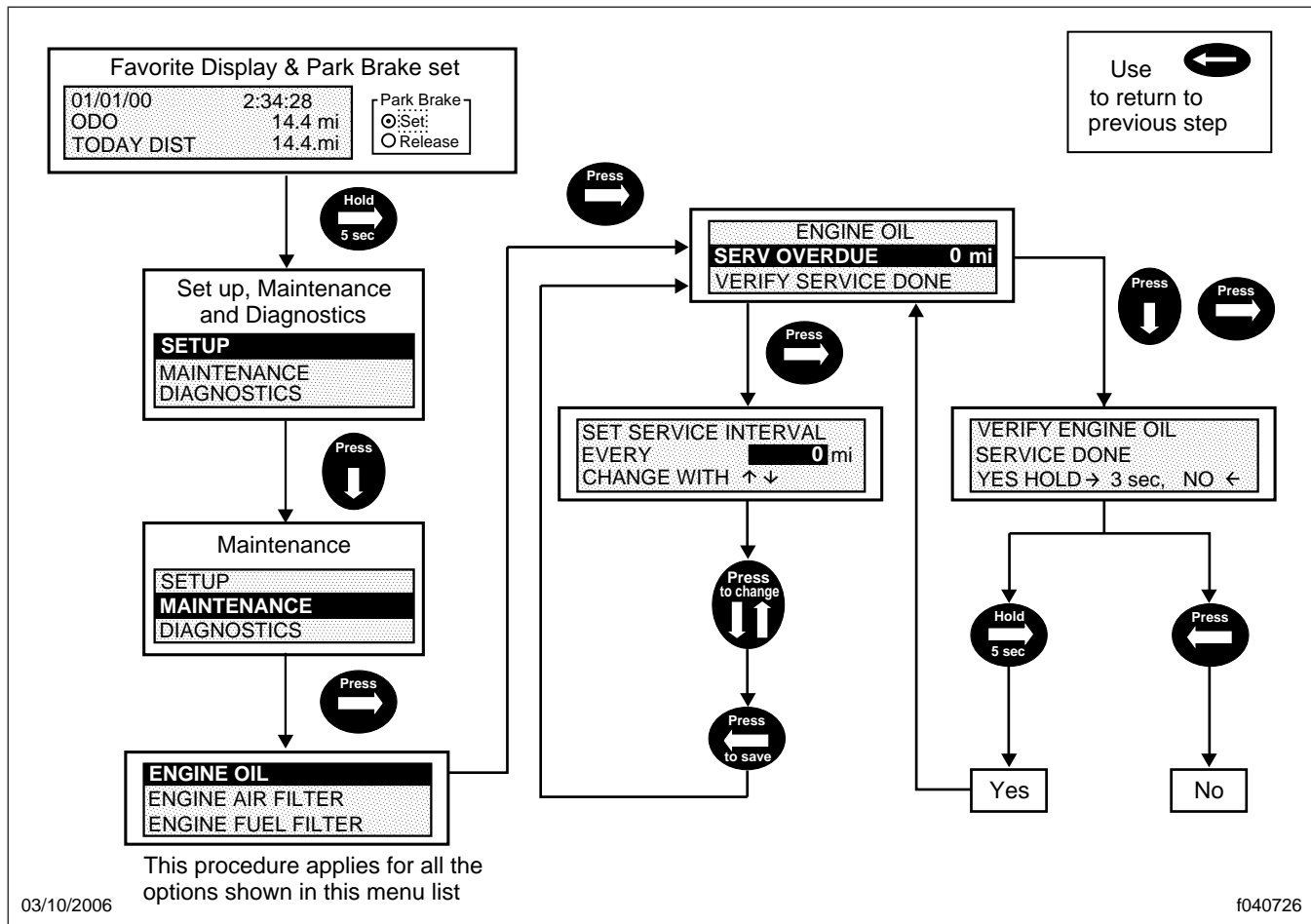


Fig. 2.12, Maintenance Menu

## Turbo Boost Gauge

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

## Transmission Temperature Gauge

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

### CAUTION

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

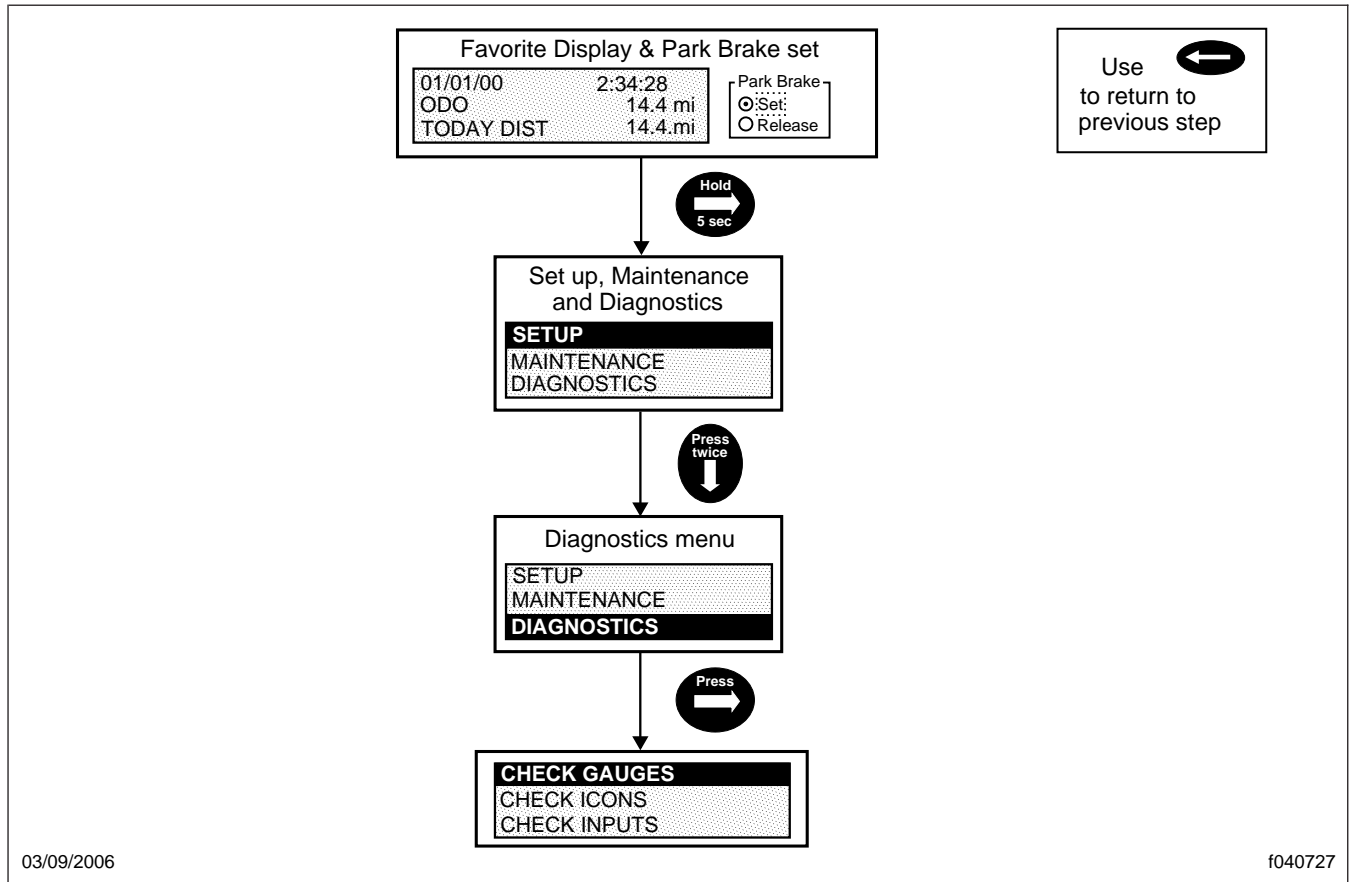


Fig. 2.13, Diagnostics Menu

# Instruments

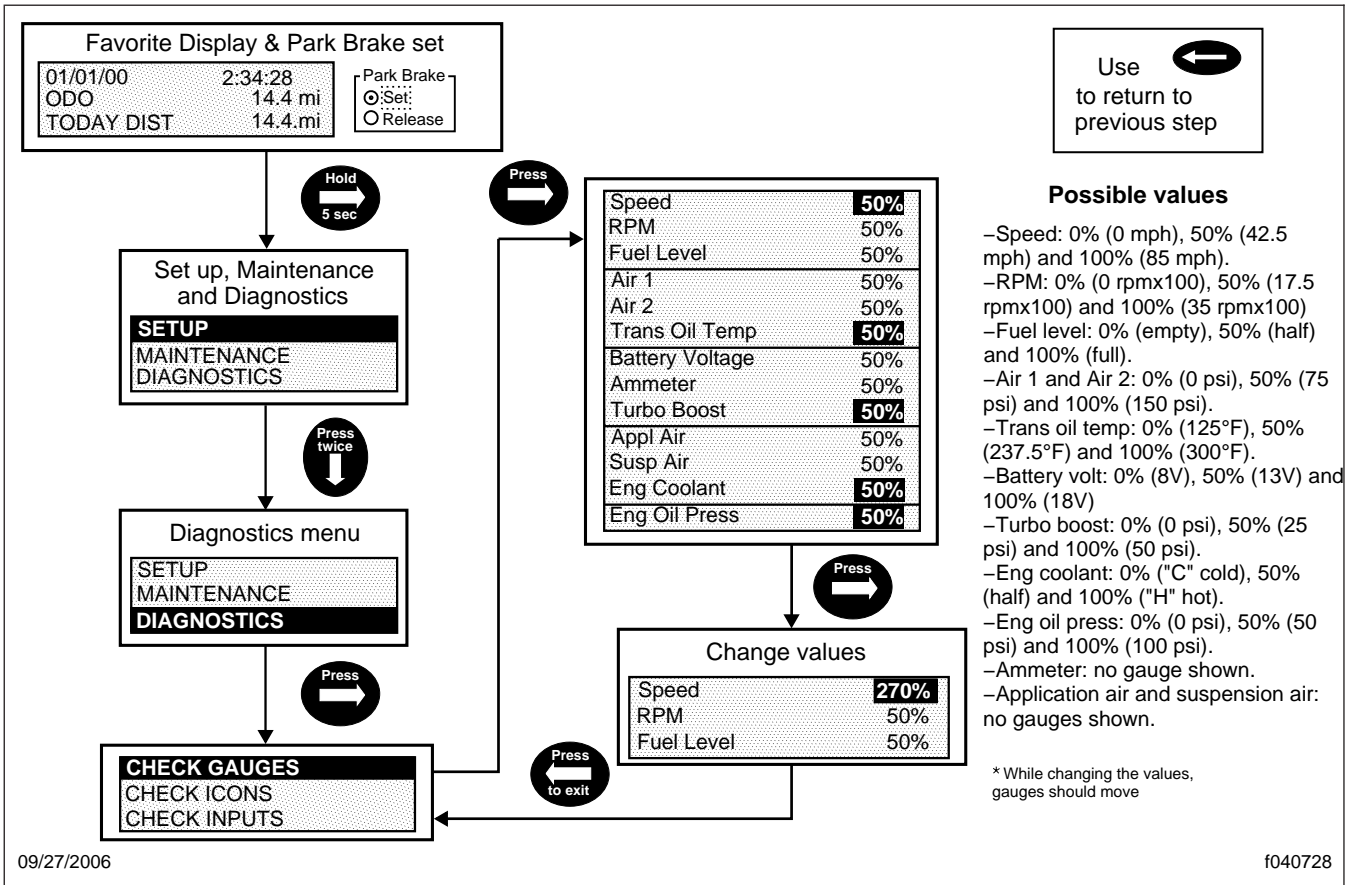


Fig. 2.14, Check Gauges and Change Values

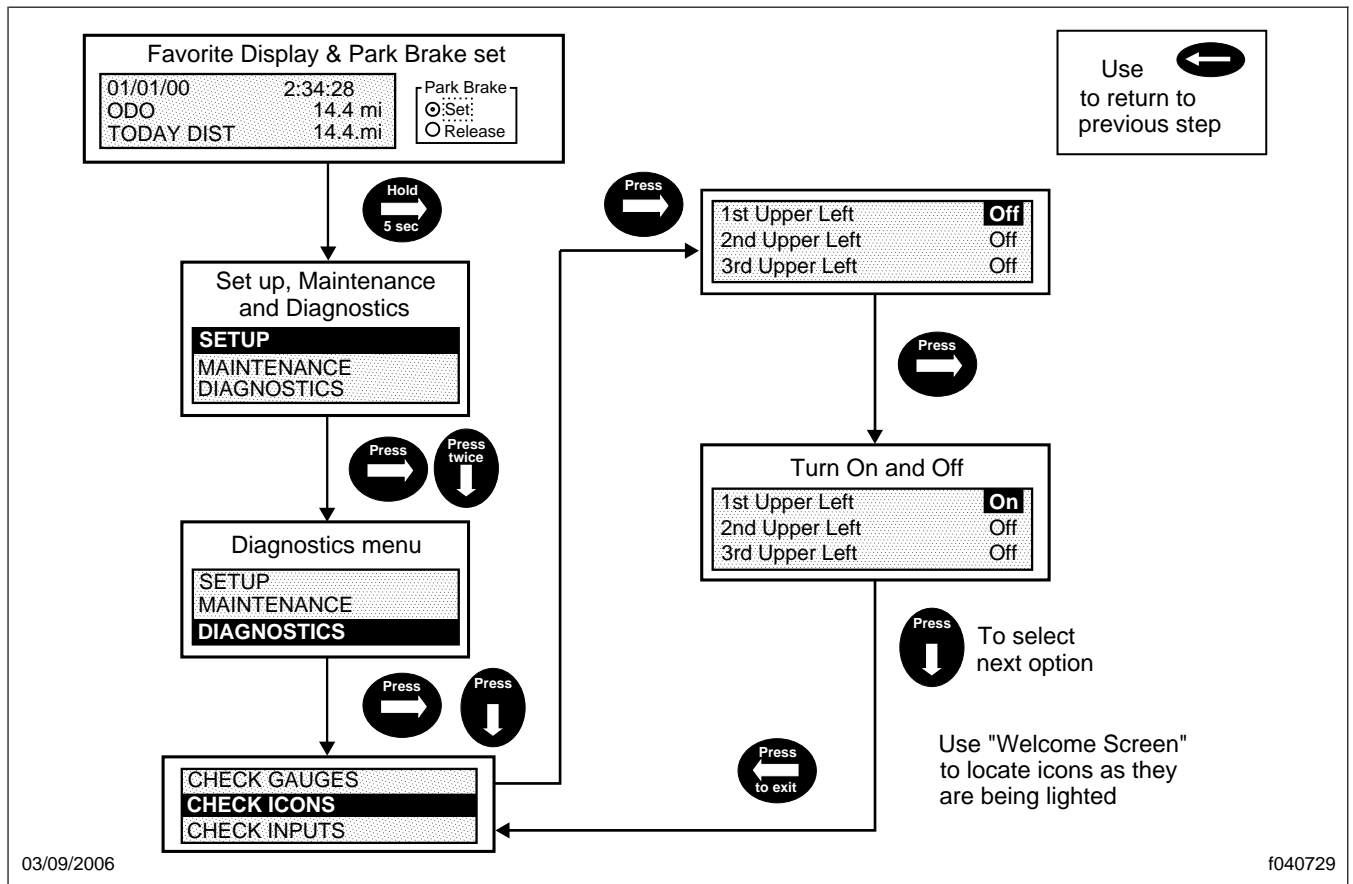


Fig. 2.15, Check Icons and Change Values

# Instruments

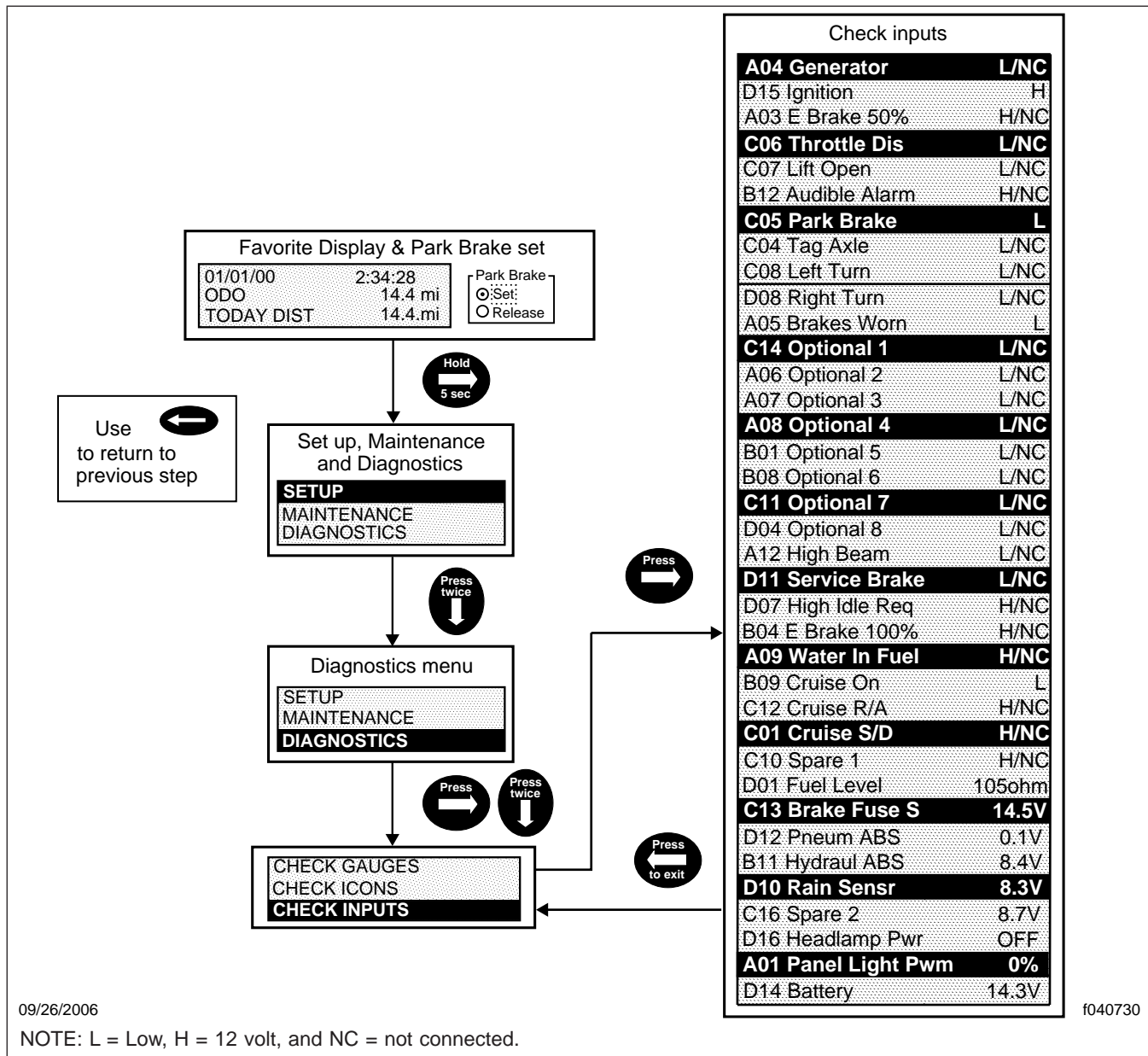


Fig. 2.16, Check Inputs

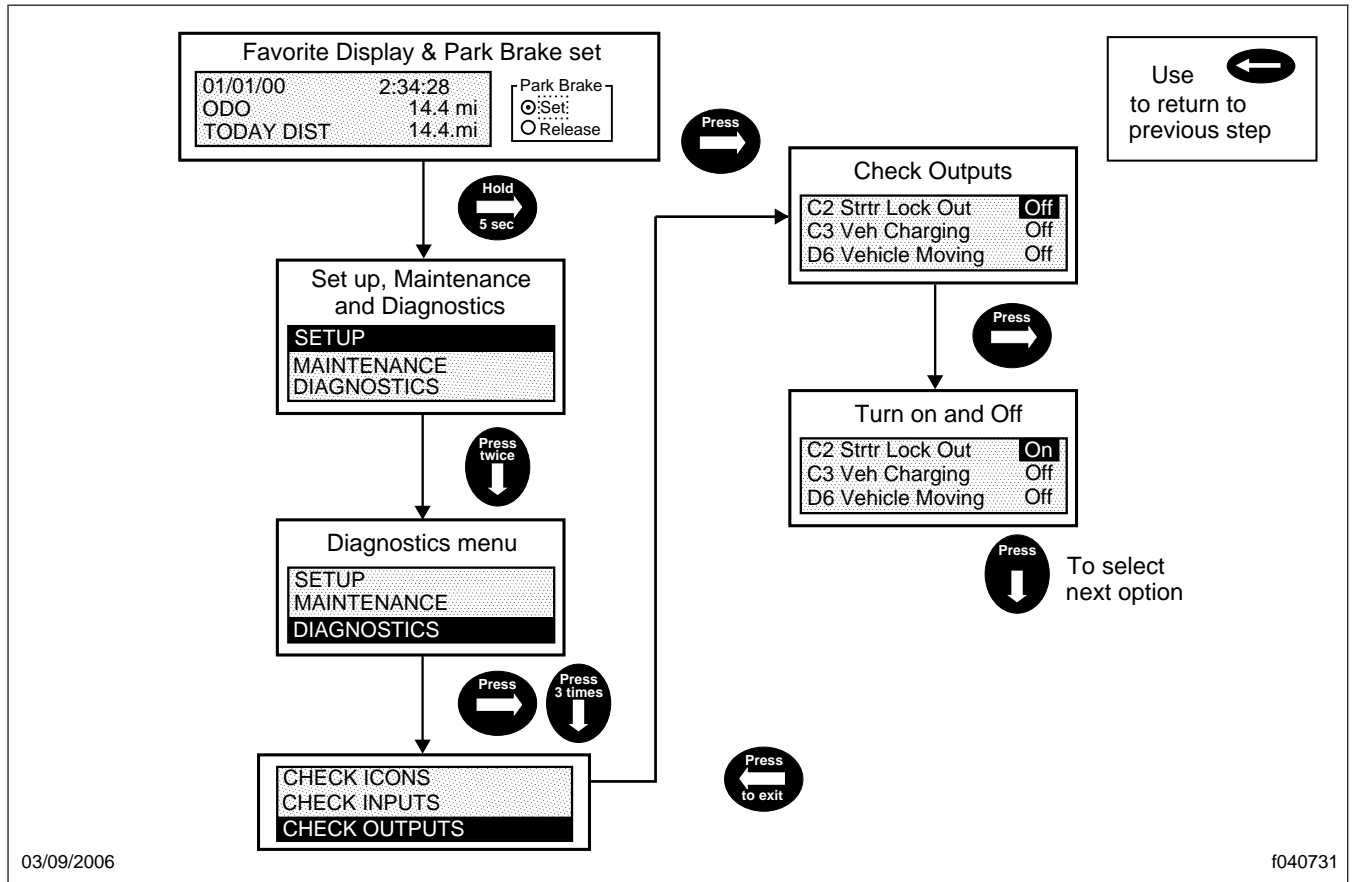


Fig. 2.17, Check Outputs

# Instruments

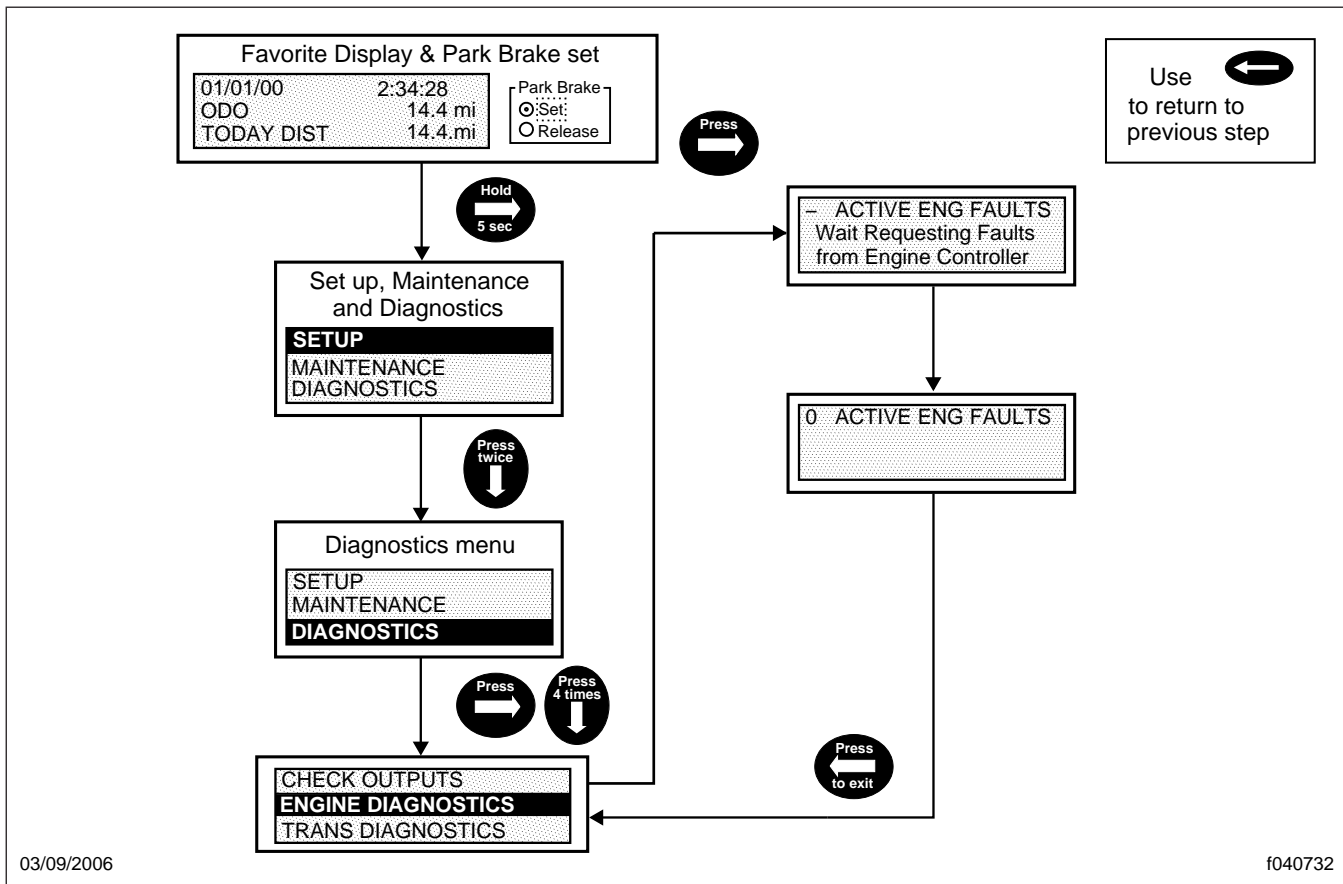


Fig. 2.18, Engine Diagnostics



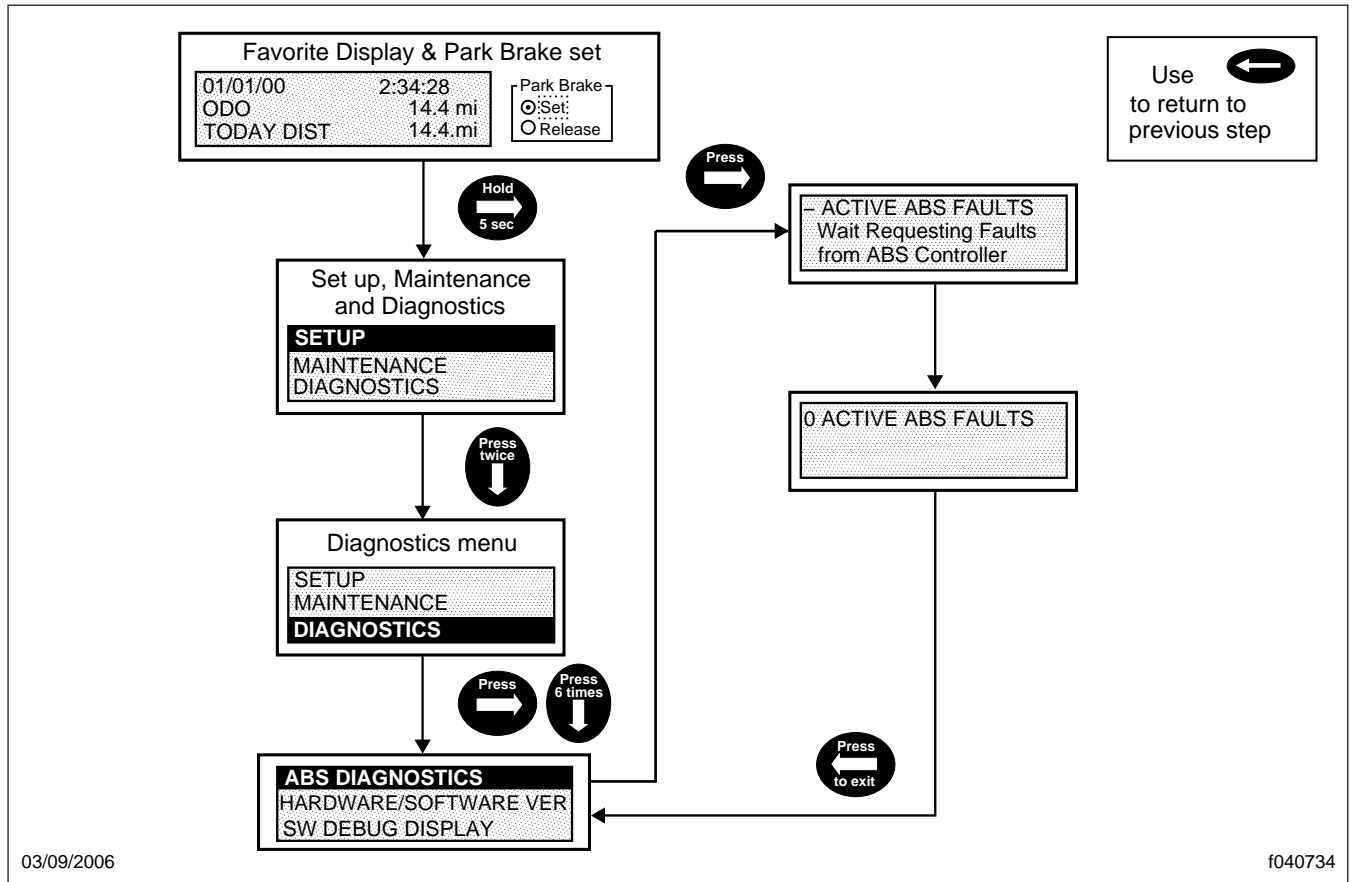


Fig. 2.19, ABS Diagnostics

# Instruments

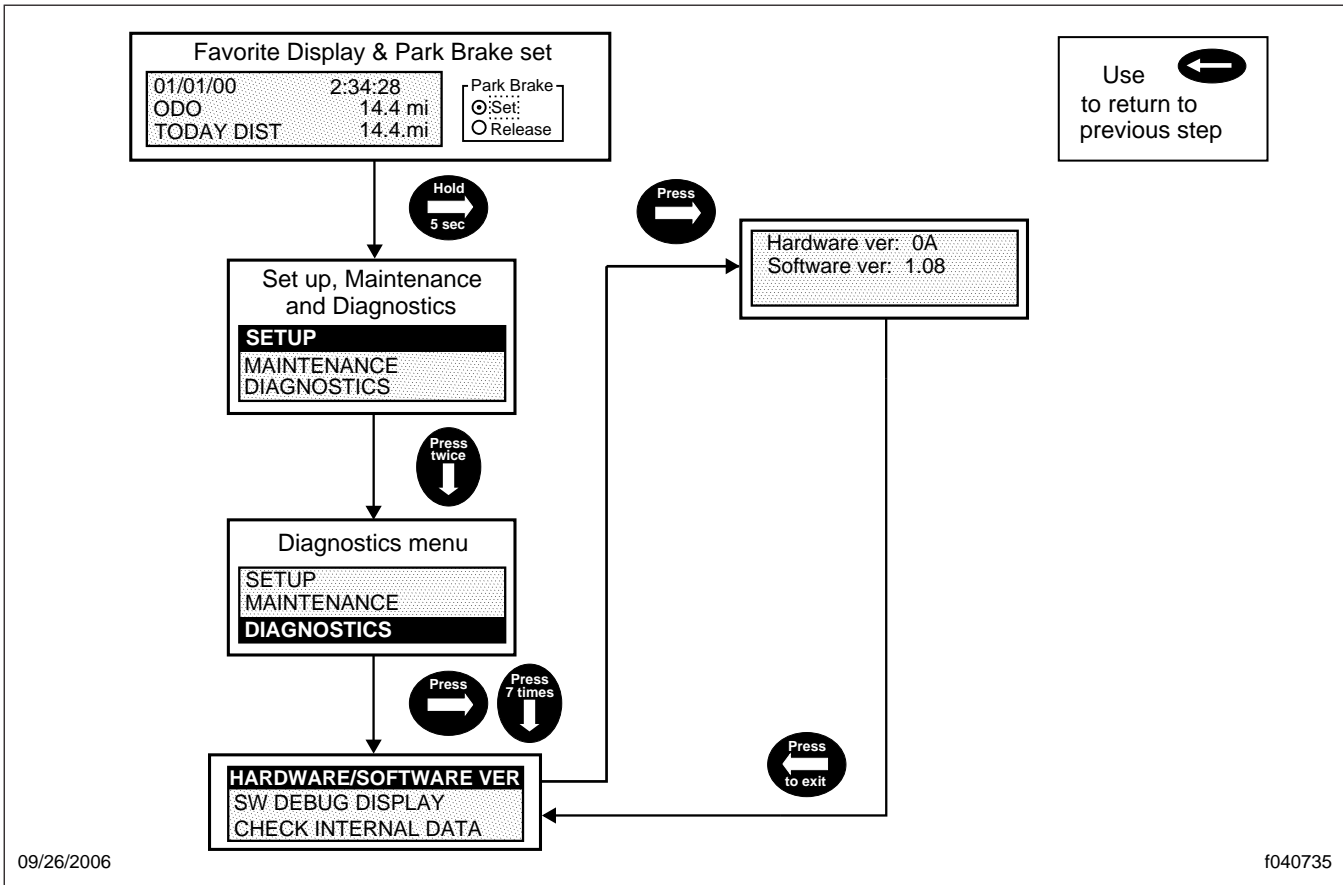


Fig. 2.20, Hardware/Software Menu

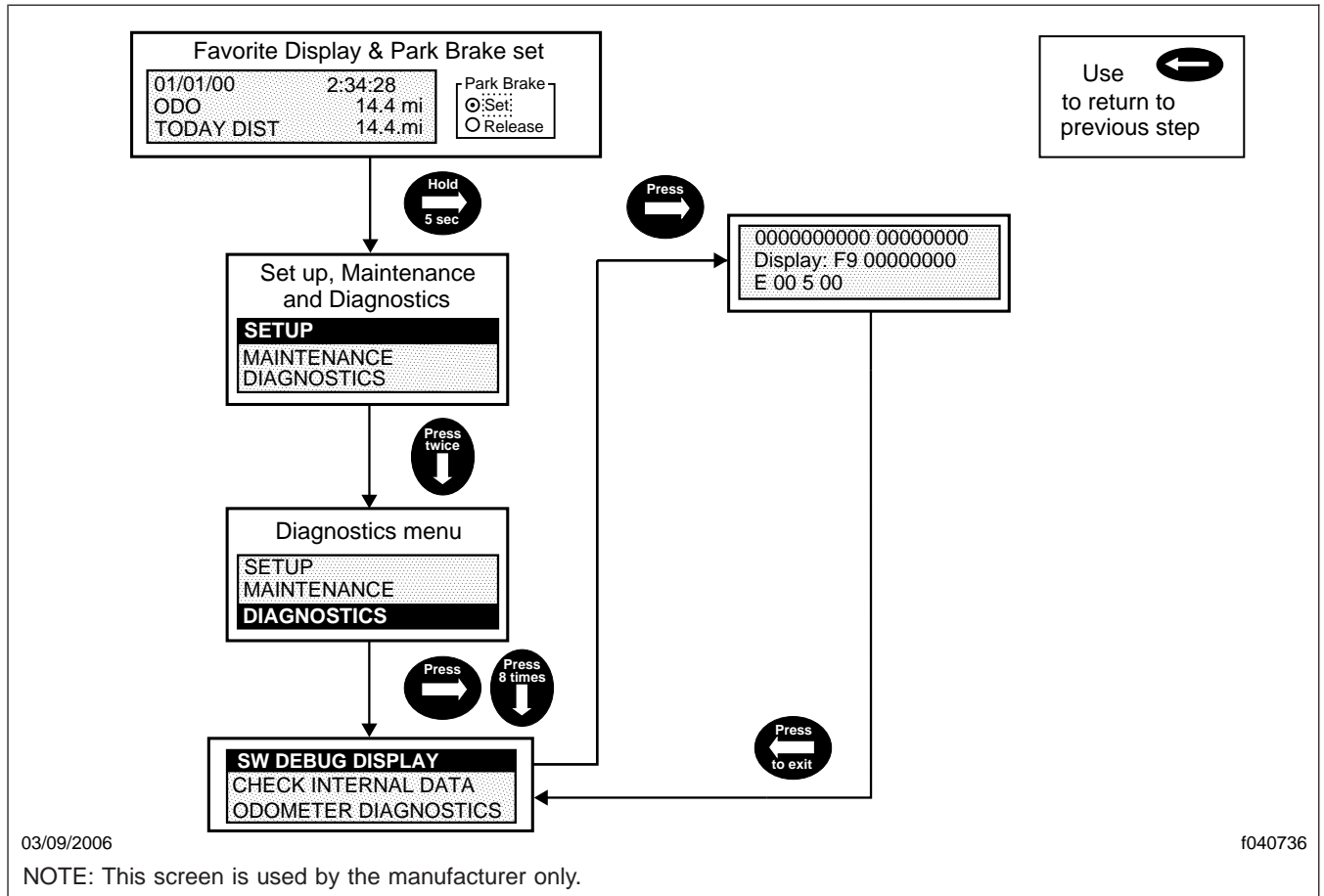


Fig. 2.21, Software Debug Display

# Instruments

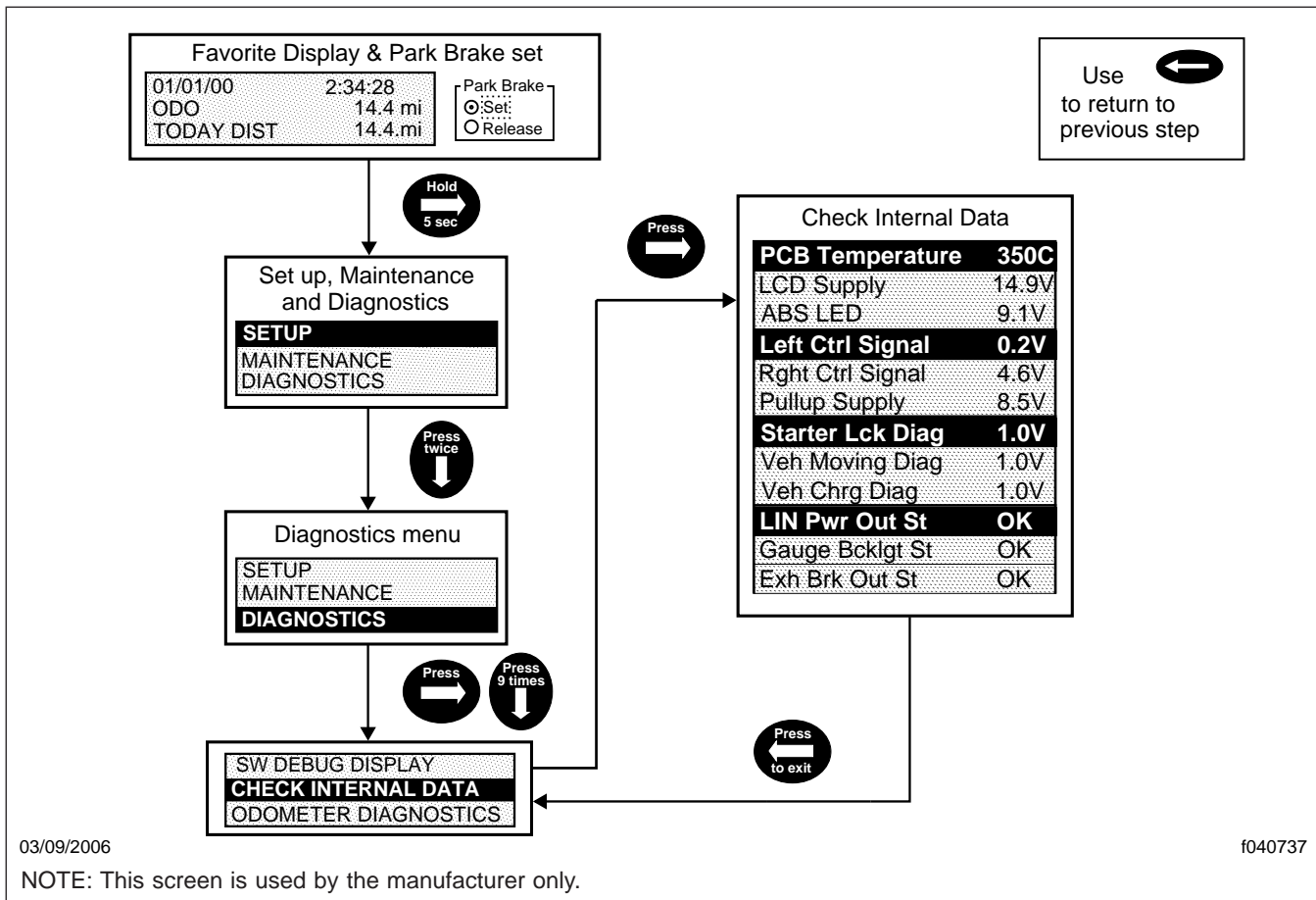


Fig. 2.22, Check Internal Data

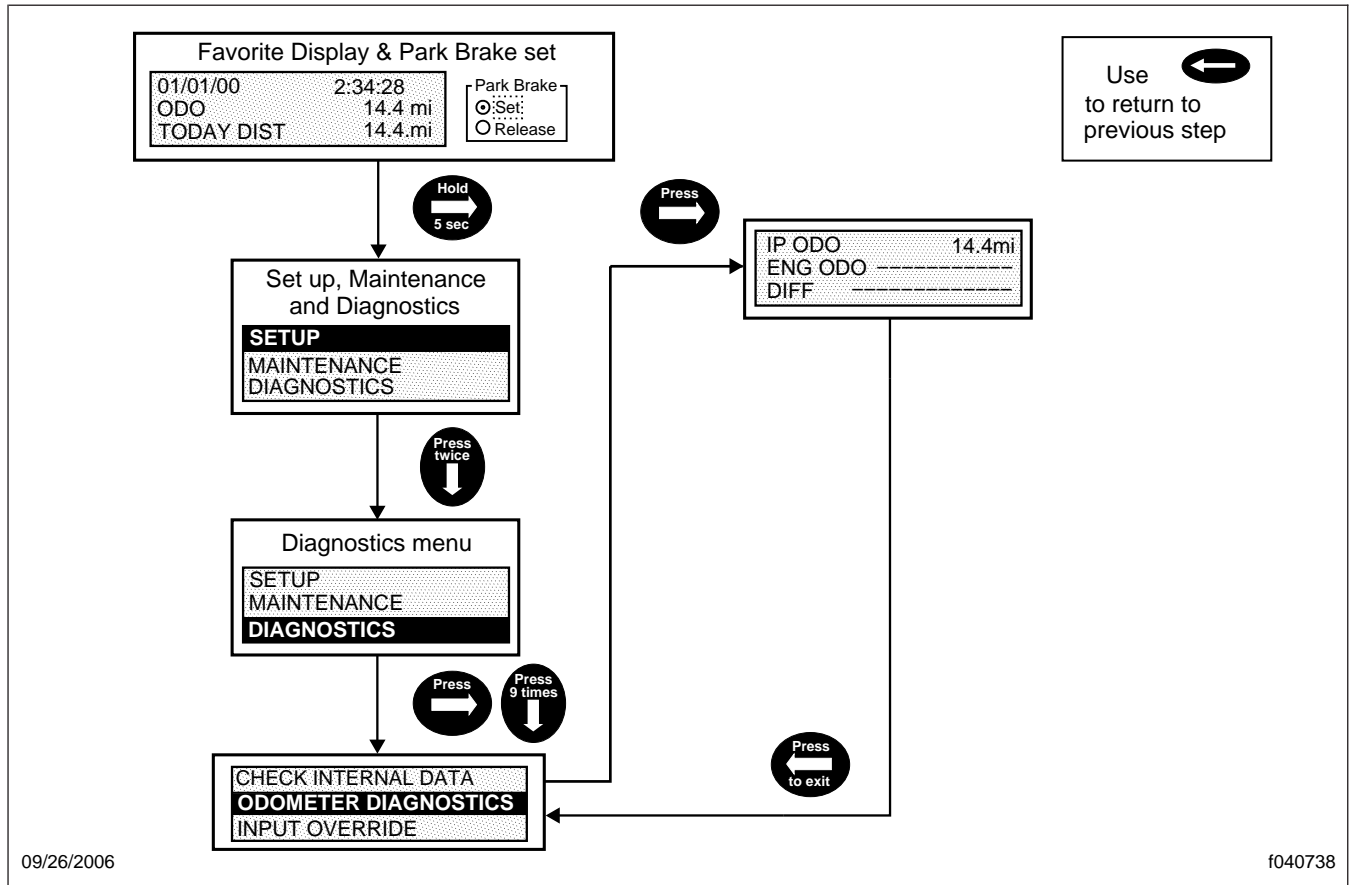


Fig. 2.23, Odometer Diagnostics

# Instruments

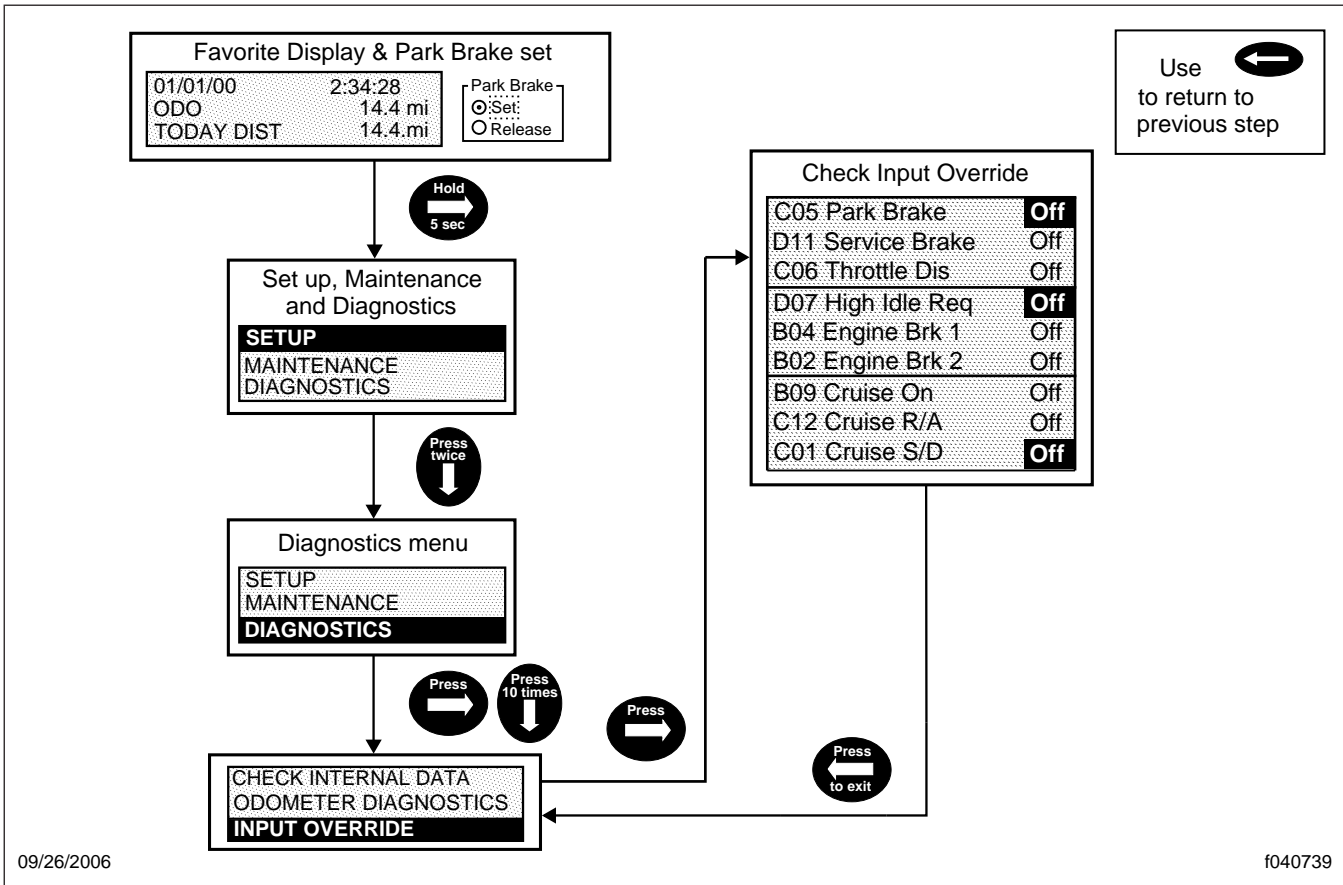


Fig. 2.24, Check Input Override

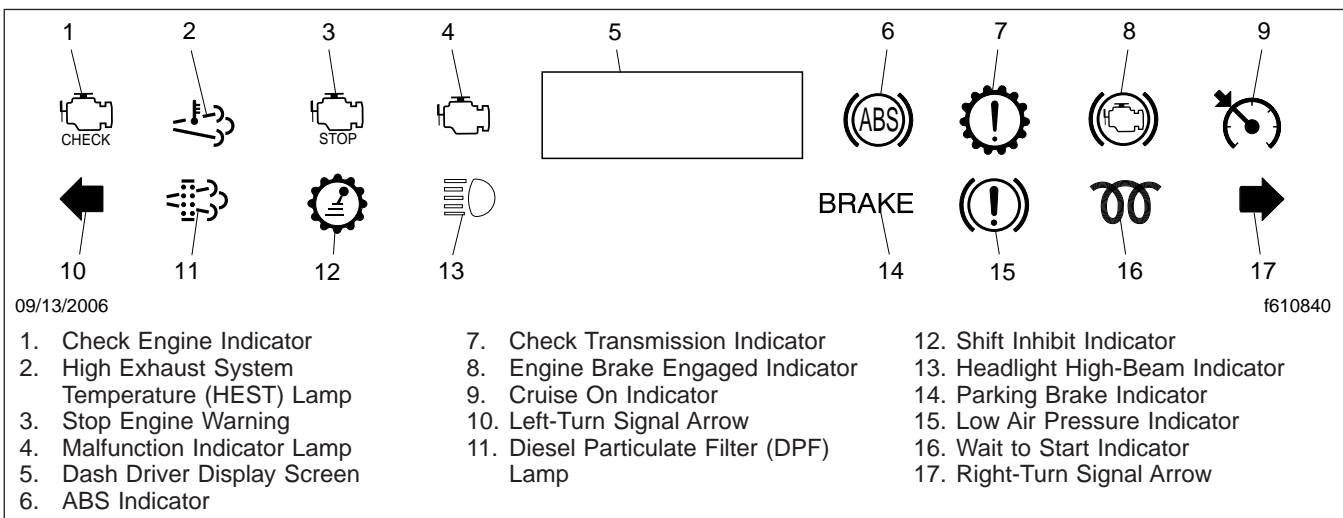
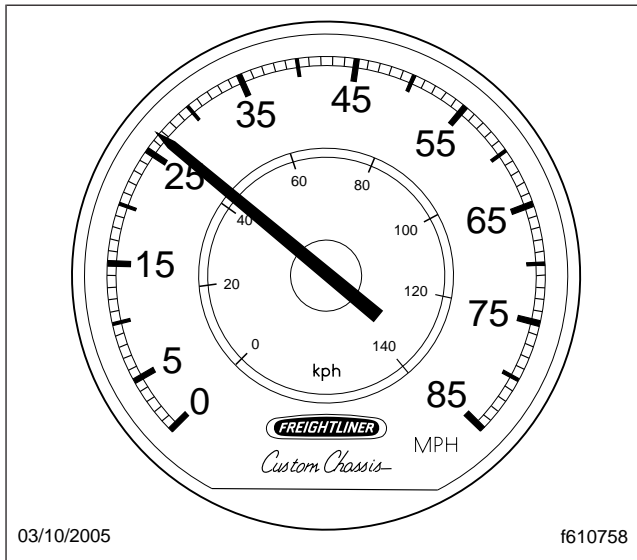
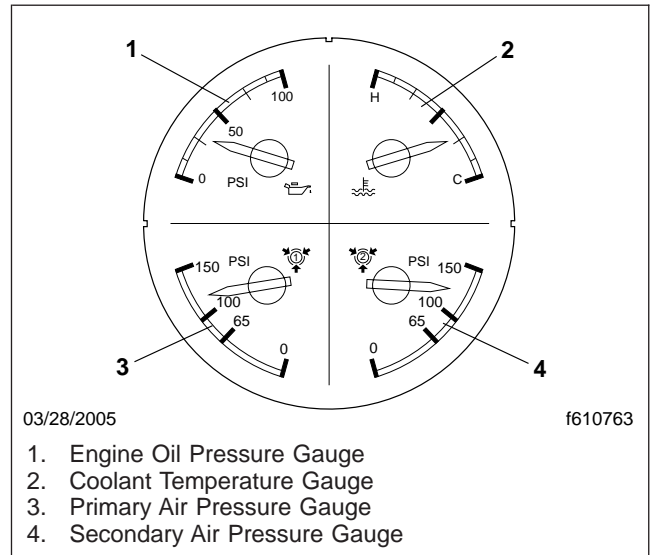


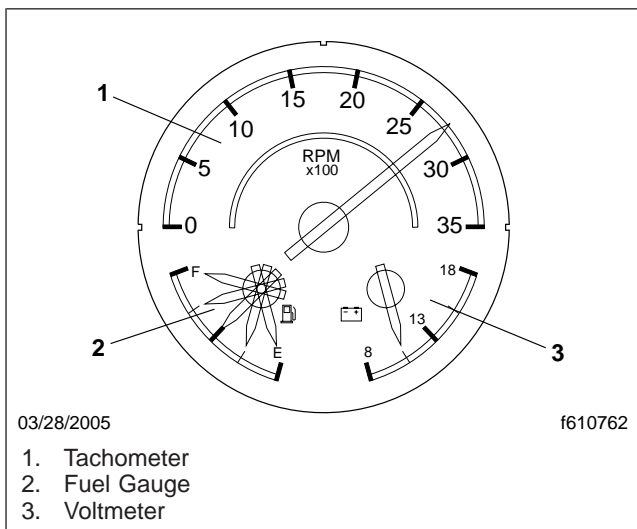
Fig. 2.25, LBCU Message Center, EPA07 Compliant



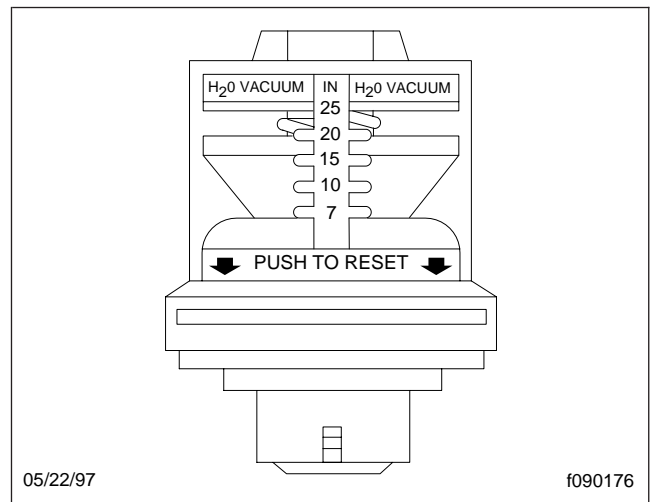
**Fig. 2.26, Speedometer**



**Fig. 2.28, Pressure/Temperature Gauges**



**Fig. 2.27, Tachometer (Three-In-One Gauge)**



**Fig. 2.29, Intake-Air Restriction Indicator**

# 3

## Controls

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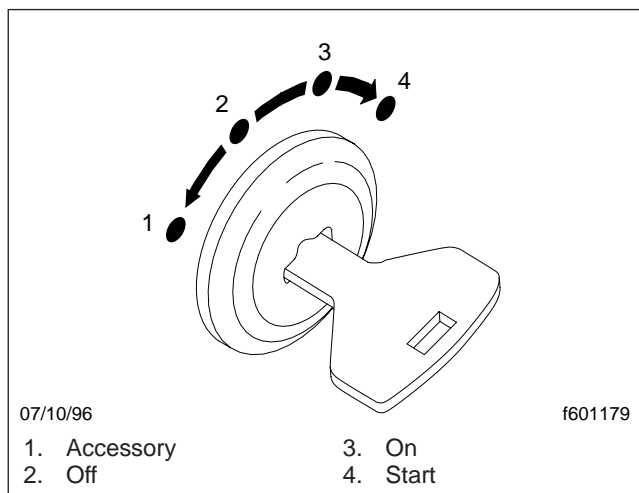
Ignition Switch and Key .....	3.1
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# Controls

## Ignition Switch and Key

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



**Fig. 3.1, Ignition Switch**

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

**NOTE:** In the ACCESSORY position (the key is turned fully counterclockwise) the electric gauges will not operate.

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 air pressure and low oil pressure operate until the engine is started and minimum pressures are built up.

## Electrical System General Information

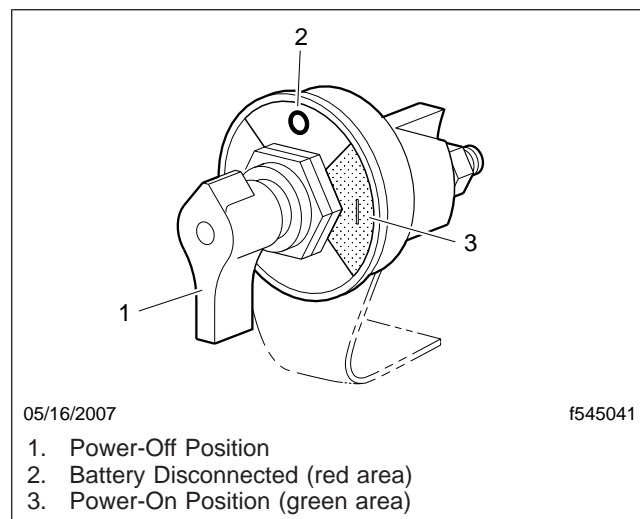
The Recreational Vehicle chassis uses multiple electrical signals that are carried along a simplified set of wires, reducing the size of wiring bundles. There are significantly fewer wires overall, meaning less chance of damage, shorts, and other problems. The information in this chapter is to help familiarize 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 your 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

Some Recreational Vehicle 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**

## Lighting Controls

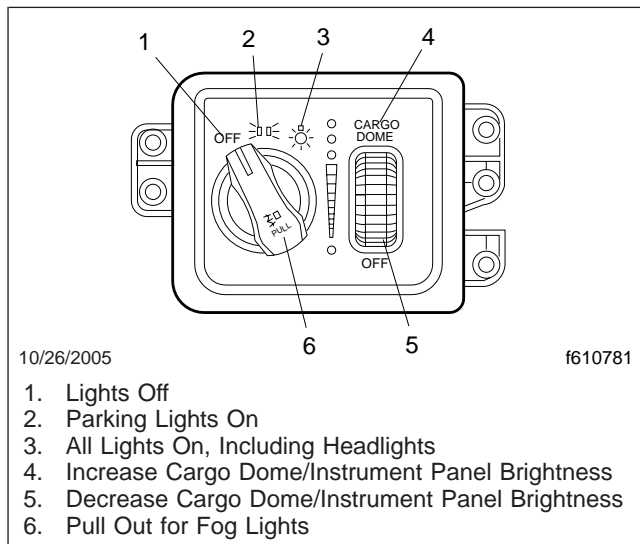
The lighting controls mentioned under this heading generally operate through switches located on the dash.

### Headlight Switches and Panel Lights

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

- All lights are OFF if the control knob is turned to the left position.
- If the knob is in the middle position, all lights are on except the headlights.
- If the knob is in the right position, all lights including the headlights are on.
- If the knob is pulled out, all lights including the fog lights are on.

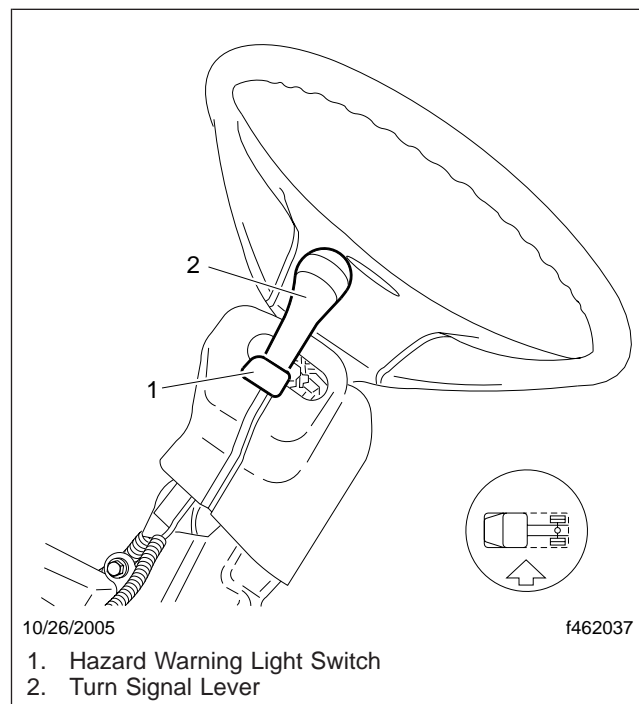
A separate dash panel dimmer control adjusts dash panel brightness. Turn the knob upwards to increase the panel brightness, and down to dim the light. See [Fig. 3.3](#).



**Fig. 3.3, Light Control Knob**

### Hazard Warning Lights

To activate the hazard warning lights, pull out the hazard warning light switch located under the turn signal switch. See [Fig. 3.4](#). When the switch is pulled out, all of the turn control lights will flash. To cancel the hazard warning lights, move the turn signal switch up or down.



**Fig. 3.4, Hazard Warning Light Switch Location**

### SmartWheel (optional)

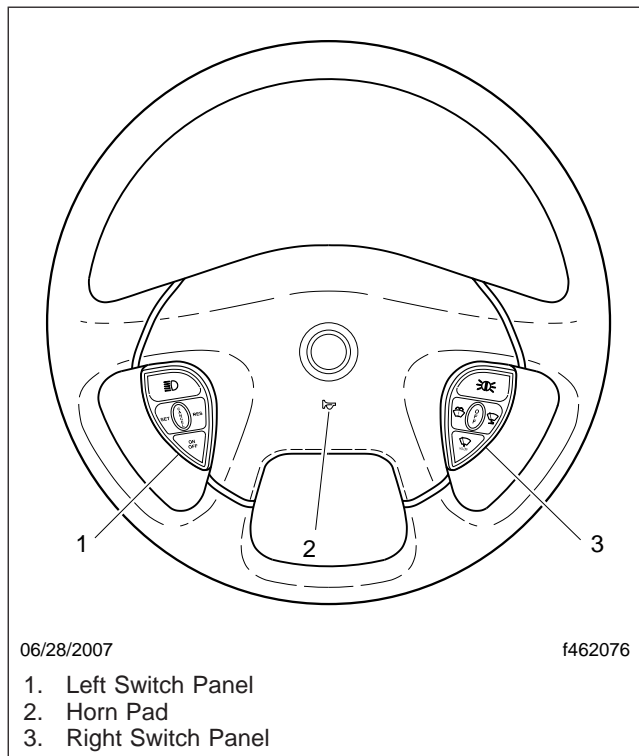
The optional SmartWheel steering wheel control system allows control of the horn, headlamp and marker lamp interrupt, cruise control functions, and windshield wiper functions from steering-wheel-mounted switch panels. See [Fig. 3.5](#) and [Fig. 3.6](#).

### Cruise Control

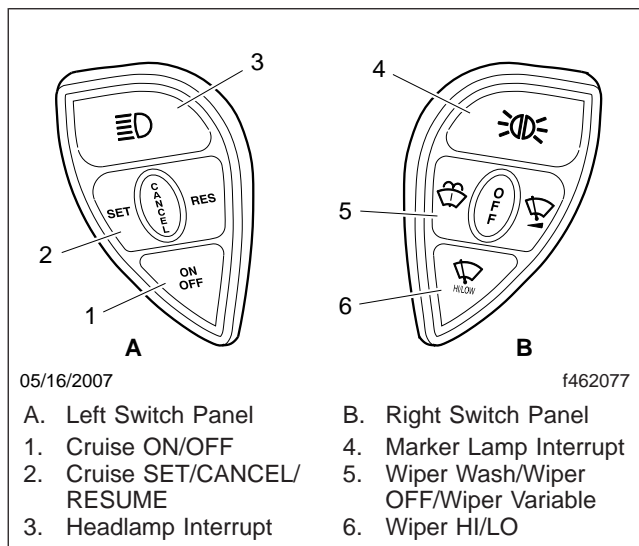
If your vehicle is equipped with a Cummins engine, see [Chapter 4](#) for detailed operating instructions.

If your vehicle is equipped with a Mercedes-Benz engine, see [Chapter 5](#) for detailed operating instructions.

# Controls



**Fig. 3.5, SmartWheel**



**Fig. 3.6, SmartWheel Switch Panels**

## Horn

The horn pad extends across the center of the steering wheel. Press the horn pad to sound the horn.

## Headlamp Interrupt

If the headlamps are on, press and hold the headlamp interrupt switch to turn them off. If the headlamps are off, press and hold the switch to turn them on.

**NOTE:** The headlamps will remain off or on only as long as the switch is being pressed.

## Marker Lamp Interrupt

If the marker lamps are on, press and hold the marker lamp interrupt switch to turn them off. If the marker lamps are off, press and hold the switch to turn them on.

**NOTE:** The marker lamps will remain off or on only as long as the switch is being pressed.

## Windshield Wipers

**NOTE:** Activating any of the wiper switches causes the headlamps to come on. To turn the headlamps off, turn the ignition off.

## Wiper Wash

Press the wiper wash switch to activate the wiper wash pump.

**NOTE:** The pump will operate only as long as the switch is pressed. If you selected either the HI/LO or variable switch previously, the wipers will continue to run in that mode when you release the switch.

## Wiper HI/LO

Press the wiper HI/LO switch to activate the wipers at low speed. Press the switch again to activate the high speed. Pressing the switch once again will cause the wipers to cycle between high and low speed with each press of the switch.

## Wiper Variable

Press the wiper variable switch to activate the wipers for one low-speed wipe.

**NOTE:** Press the switch again within approximately 30 seconds and a second low-speed wipe will occur. The low-speed wipers will continue to activate the interval determined by the time between the last two presses of the switch.

Additional presses of the switch will shorten the interval. The variable mode will cancel if you select any other wiper mode.

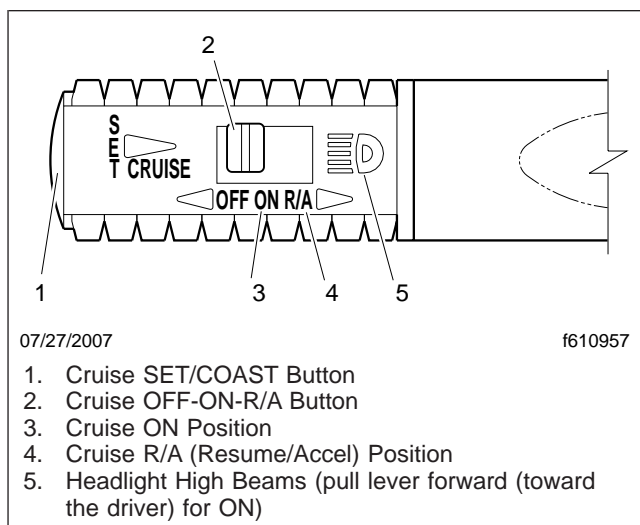
## Wiper OFF

Press the wiper OFF switch to cancel all operations of the wipers. Turning the ignition switch to the OFF position has the same effect of cancelling all wiper operations.

## Multifunction Turn Signal Switch

The multifunction turn signal switch is attached to the steering column, just below the steering wheel, on the left-hand side. See [Fig. 3.7](#). This switch has the following functions:

- turn signals
- headlight high beams
- cruise control



**Fig. 3.7, Multifunction Turn Signal Switch**

## Turn Signals

Moving the lever down turns on the left turn signal lights; moving it up turns on the right turn signal lights.

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

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

## Headlight High Beams

Pull the turn signal lever forward, toward the driver, to turn on the high-beam headlights. Pull the lever back to its original position to turn them off.

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

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

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

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

## Cruise/RPM Controls

An OFF/ON/ R/A (resume-accel) button allows the driver to select cruise control, drive with the pedal, accelerate while in cruise control, or resume cruise speed after slowing down. A SET/COAST switch allows the driver to select the cruise speed or temporarily disable the cruise control to reduce speed.

## Master Toggle Switch, Required (Mercedes-Benz Engines Only)

If the cruise control switch is left in the ON position when the ignition is turned OFF, then the switch must be cycled from ON to OFF, then, back ON in order to operate the cruise control.

## Horn

The horn button is located under the horn icon at the center of the horn pad. To sound the horn, press down on the horn icon. See [Fig. 3.8](#).

# Controls

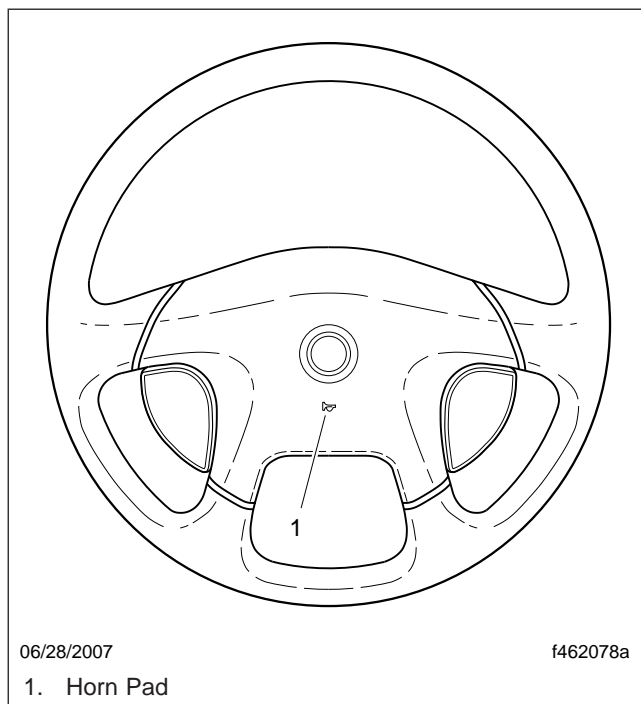


Fig. 3.8, Horn Control

## Powertrain Controls

### Allison Automatic Transmissions

Allison automatic transmissions are controlled by an electronic control unit (ECU). The ECU processes information from sensors, pressure switches, and the shift selector to automatically control the transmission according to programmed specifications. See [Fig. 3.9](#) and [Fig. 3.10](#). See [Chapter 7](#) for complete transmission operating instructions.

### Cruise Control System

#### **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.**

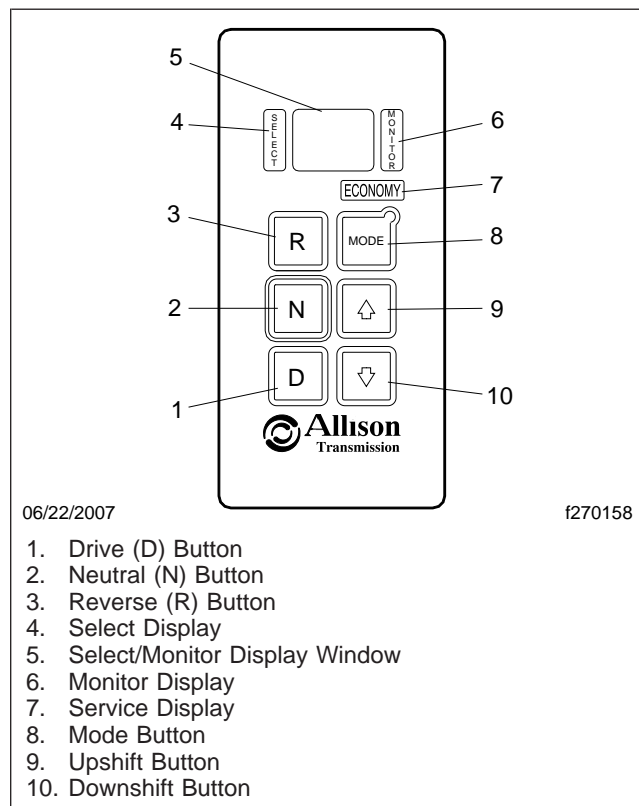
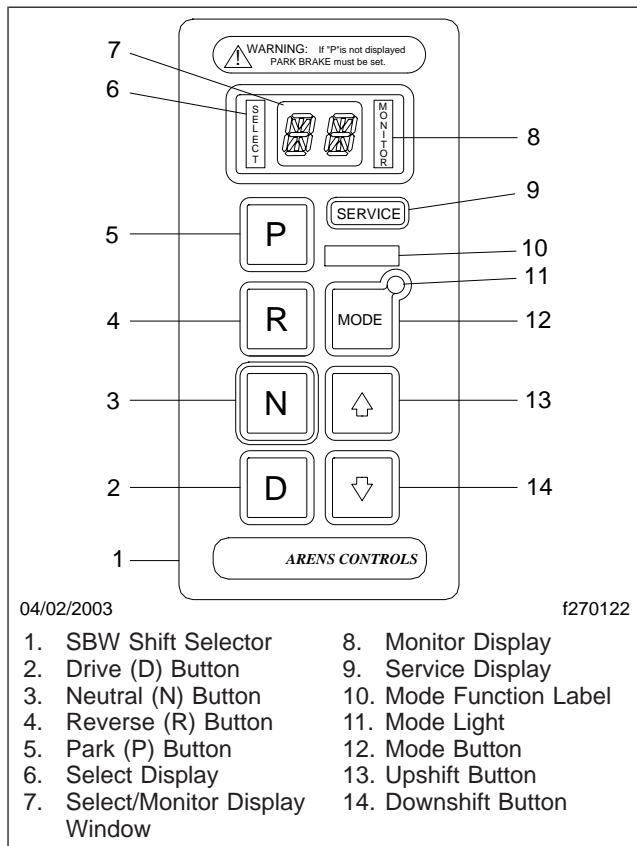


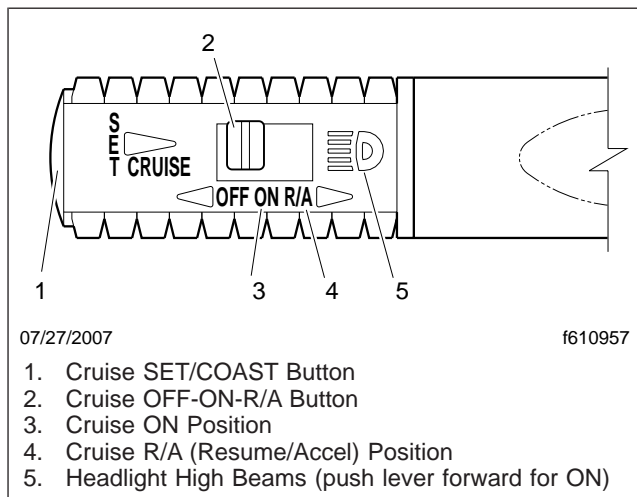
Fig. 3.9, GEN IV Shift Selector

If the cruise control is column-mounted, it is operated by two switches on the turn signal lever. See [Fig. 3.11](#). An OFF-ON-R/A (resume-accel) switch allows the driver to select cruise control, drive with the pedal, accelerate while in cruise control, or resume cruise speed after slowing down. A SET/COAST switch allows the driver to select the cruise speed or temporarily disable the cruise control to reduce speed.

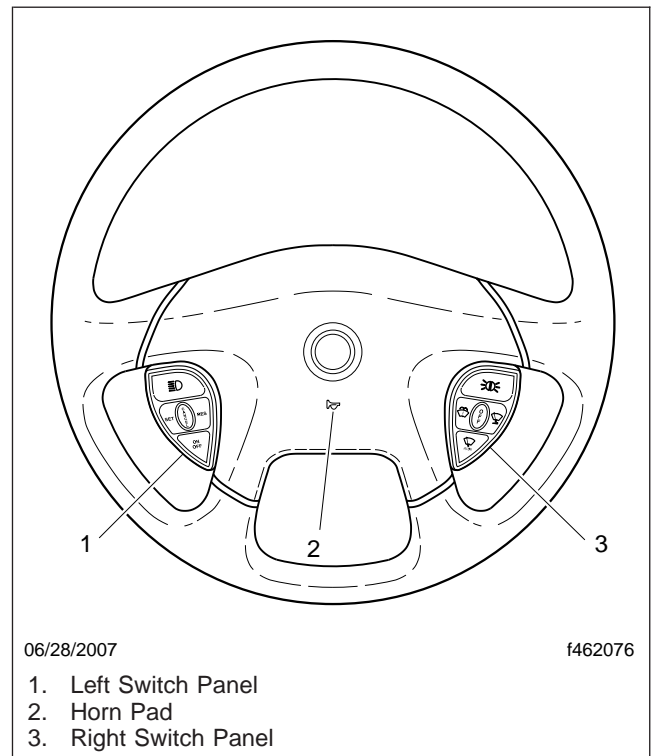
If equipped with a SmartWheel, the cruise control is operated by two switches on the steering wheel. See [Fig. 3.12](#). A SET/CANCEL/RES switch located on the left switch panel, allows the driver to select cruise control, accelerate while in cruise control, temporarily disengage cruise control, or resume cruise speed after slowing down. The On/Off switch located on the left-side switch panel activates or turns off the cruise control function. See the "SmartWheel" heading in this chapter for more information.



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



**Fig. 3.11, Multifunction Turn Signal Switch**



**Fig. 3.12, SmartWheel**

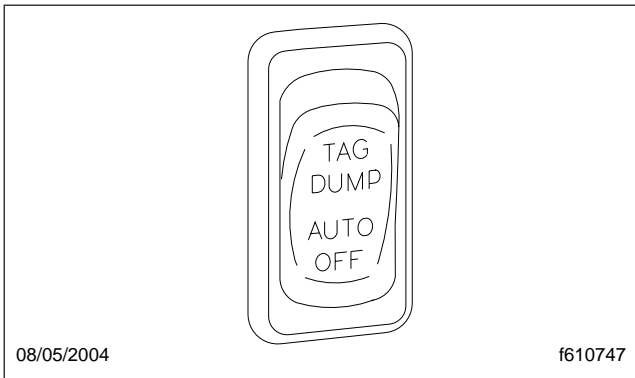
## Tag-Axle Suspension Dump Switch (optional)

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

The tag-axle suspension dump switch is operated by a three-position, dash-mounted rocker switch. See [Fig. 3.13](#). The manual TAG DUMP mode is activated by pressing and holding the rocker switch all the way in. The AUTO DUMP mode is activated automatically during reverse gear applications when the rocker switch is placed in the middle (level) position. When you depress and hold the bottom of the rocker switch, the tag-axle suspension dump switch is placed in the OFF (down) position, and the TAG DUMP mode is inactive.



# Controls



**Fig. 3.13, Tag-Axle Suspension Dump Switch**

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

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

## Backup Alarm (optional)

An optional backup alarm, supplied with the chassis and installed by the body builder, sounds when Reverse (R) gear is engaged. Check the operation of the backup alarm daily (if so equipped).

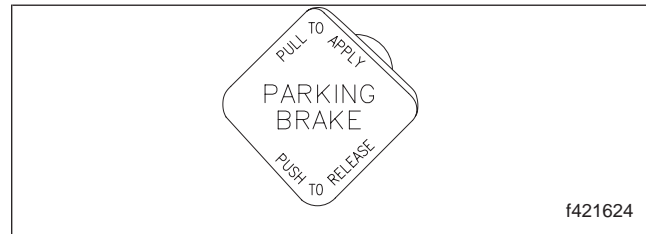
## Braking and Steering Controls

### Parking Brake Control Knob

All pneumatic-braked vehicles are equipped with a diamond-shaped parking brake control knob. See [Fig. 3.14](#). Pull the knob to apply the parking brake. In air brake systems, before the parking brake can be released, the air pressure in either brake system must be at least 65 psi (448 kPa). See [Chapter 6](#) for detailed operating instructions.

### **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**



**Fig. 3.14, Parking Brake Control Knob**

**of vehicle control, possibly causing personal injury and property damage.**

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

## Dash-Mounted Controls

### Windshield Wiper Controls

On some vehicles, if equipped with a standard steering wheel, the windshield wiper control is mounted on the dash. Check your body builder for more details.

# 4

## Cummins Engines

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## EPA07 Aftertreatment System (ATS)

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

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

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

Vehicles with EPA07-compliant engines, are equipped with an aftertreatment system that has a diesel particulate filter in place of a muffler. Particulate matter is collected in the filter, then reduced to ash in a process called regen (regeneration). Regen usually occurs during the normal operation of the vehicle, and the operator should see no difference in vehicle performance. However, a vehicle that performs mainly short trips, may not sustain exhaust temperatures sufficiently high for an automatic regen to occur. In that case it may be necessary to perform a manual regen. See the engine operation manual for complete details and operation of the aftertreatment system.

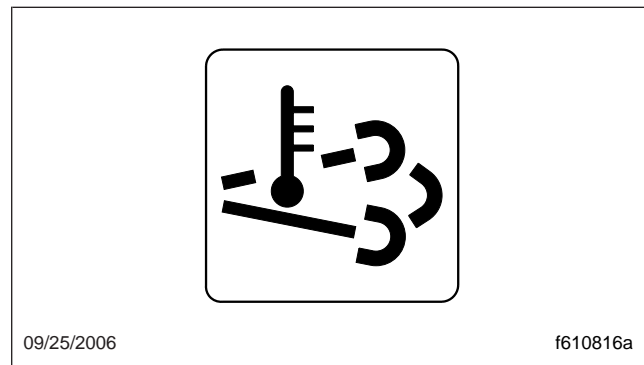
The Powerliner chassis has a Cummins 500HP ISM engine. It is not equipped with an aftertreatment device, however, it is EPA2010-compliant, and uses ultralow-sulfur diesel fuel and low-ash engine oil.

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

### WARNING

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

The High Exhaust System Temperature (HEST) lamp alerts the operator of high exhaust temperature during the regen process when the speed is below 5 mph (8 km/h), or during a manual regen. See [Fig. 4.1](#). The HEST lamp does not signify the need for any kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or explode.



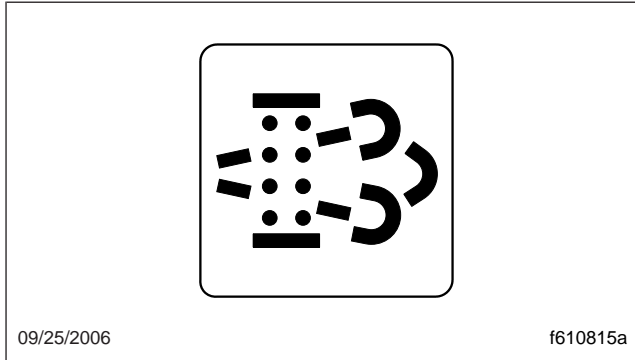
**Fig. 4.1, High Exhaust System Temperature (HEST) Lamp**

### WARNING

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

A solid yellow Diesel Particulate Filter (DPF) lamp indicates that a manual regen is required soon, and should be scheduled for the earliest convenient time. A blinking yellow DPF lamp indicates that a manual regen is required immediately, or an engine derate may occur. See [Fig. 4.2](#).

A solid yellow Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the emissions. The

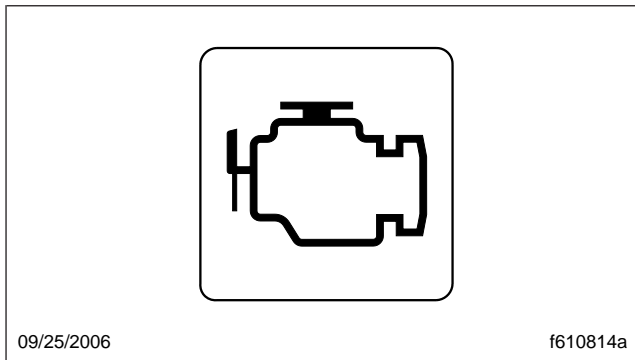


**Fig. 4.2, Diesel Particulate Filter (DPF) Status Lamp**

MIL lamp applies to the Mercedes-Benz engine only. See [Fig. 4.3](#).

Diesel particulate filter servicing must be performed by an authorized technician, and a record must be maintained for warranty purposes. The record must include:

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



**Fig. 4.3, Malfunction Indicator Lamp (MIL)**

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

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

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

## Engine Starting

### WARNING

**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: For cold-weather starting, see "Cold-Weather Operation" in this chapter.

NOTE: Cummins electronic 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.

IMPORTANT: 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. Also, before engine start-up, perform the engine pretrip inspection and daily maintenance checks in [Chapter 10](#).

### CAUTION

**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.

# Cummins Engines

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## CAUTION

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.

## CAUTION

If the engine is equipped with a turbocharger, protect the turbocharger during start-up by not opening the throttle or accelerating the engine above 1000 rpm until normal engine idle oil pressure registers on the gauge.

1. Set the parking brake.
2. Place the transmission in Neutral (N).
3. NOTE: See the *Cummins Operation and Maintenance Manual* for detailed information on starting procedures.

## Cold-Weather Starting

The cold-start system approved for use on Cummins engines has been based upon starting aid capabilities to  $-25^{\circ}\text{F}$  ( $-32^{\circ}\text{C}$ ). For more information, see the *Cummins Operation and Maintenance Manual*. Turn the ignition switch to the on position. If the engine doesn't start after 30 seconds of cranking, turn the key to the off position and wait two minutes; then repeat the starting procedure. Run the engine slightly above idle until oil pressure shows on the gauge. If oil pressure doesn't show on the gauge within 30 seconds of starting, turn the key to the off position and wait one minute; then repeat the starting procedure.

## Starting After Extended Shutdown or Oil Change

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

1. Disconnect the electrical connector from the fuel pump solenoid valve (diesel-fuel-powered engines only).
2. Crank the engine until oil pressure shows on the gauge.

3. Connect the electrical connector to the fuel pump solenoid valve (diesel-fuel-powered engines only).
4. Start the engine. After one minute, shut down the engine and check for oil leaks.
5. Allow five minutes for the oil to settle, then check the engine oil level and add oil if needed. Do not overfill.

## Engine Braking (optional)

### Exhaust Brake

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

## WARNING

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

To get the best result from the exhaust brake, it is necessary to observe several simple operating principles.

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

1. The ON/OFF switch is in the ON position.
2. The engine is not being fueled.

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

## Engine Operation

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

The driver should be familiar with the vehicle warning system in order to bring the vehicle to a safe stop if the engine malfunctions. See [Chapter 3](#) for information on driver's controls.

1. Cummins 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.
2. Depending on the vehicle gearing, the posted speed limit can sometimes allow operation in either of the top two gears; however, for improved operating efficiency (fuel economy and engine life), operate in the top gear at reduced rpm, rather than in the next lower gear at the maximum rpm.
3. Cruise at partial throttle whenever road conditions and speed requirements permit. This driving technique permits operating within the most economical power range of the engine.
4. When approaching a hill, open the throttle smoothly to start the upgrade at full power, then shift down as desired to maintain the optimum vehicle speed. The high torque of Cummins engines may permit topping some grades without shifting.
5. Cummins engines are designed to operate over a wide speed range. More frequent shifting than necessary does not allow proper utilization of this flexibility. The driver who stays in top gear and uses the wider speed range will achieve the best fuel economy.

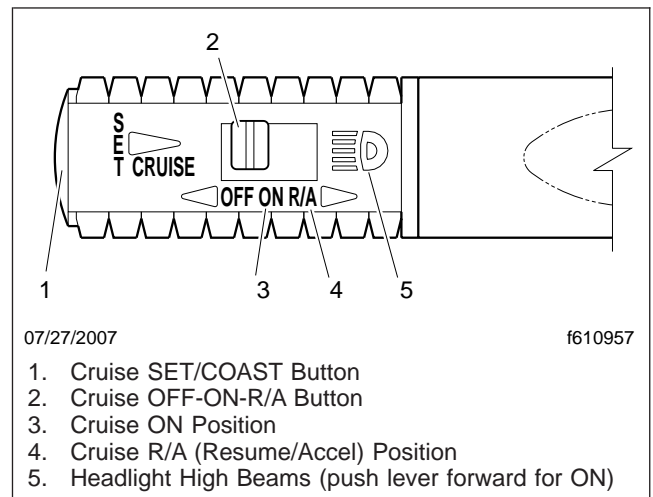
### CAUTION

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

6. The Cummins engine is effective as a brake on downhill grades, but take care not to overspeed the engine going downhill.
7. 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.

## Cruise Control

Cruise control allows you to automatically control the speed of the vehicle above 32 mph (50 km/h). The switches that operate the cruise control system are located on the turn signal lever. See [Fig. 4.4](#).



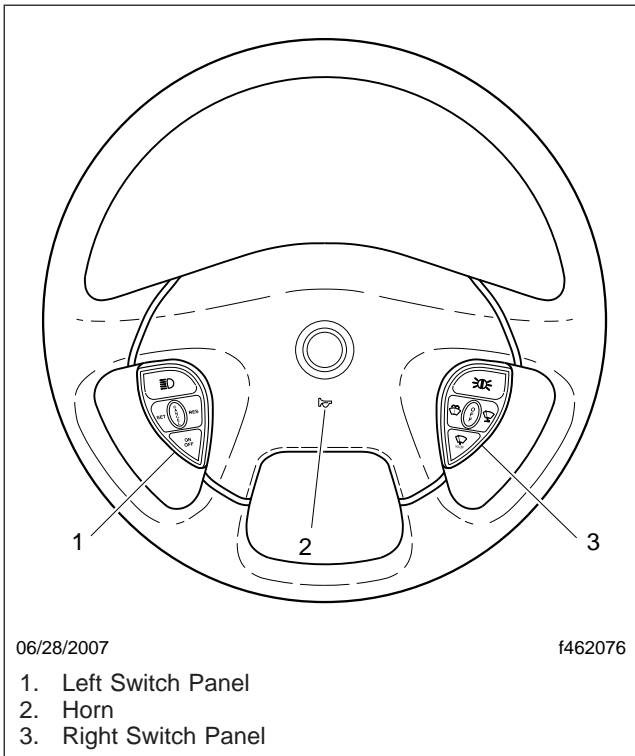
**Fig. 4.4, Multifunction Turn Signal Switch**

**NOTE:** On vehicles equipped with the optional SmartWheel, the cruise control switches are located on the left switch panel. See [Fig. 4.5](#) and [Fig. 4.6](#).

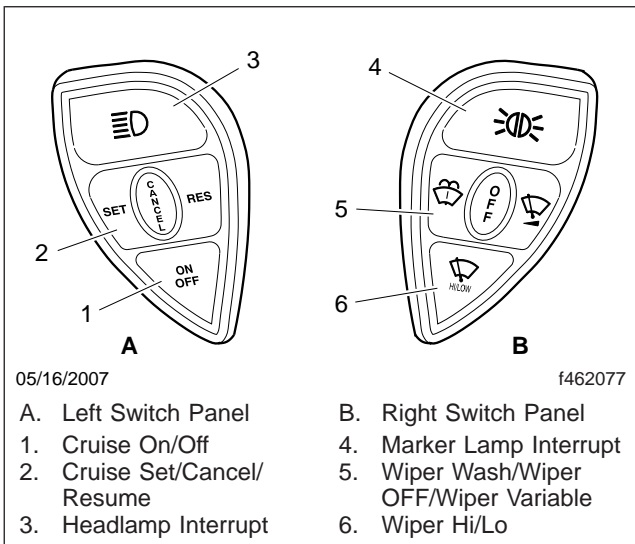
### WARNING

**Do not use the cruise control system when driving conditions do not permit maintaining a constant speed, such as in 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.**

# Cummins Engines



**Fig. 4.5, SmartWheel (optional)**



**Fig. 4.6, SmartWheel Switch Panels**

## ⚠ CAUTION

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

1. To cruise at a particular speed:
  - 1.1 Move the slide switch on the turn signal lever to the ON position or press the ON button on the steering wheel.
  - 1.2 Hold the accelerator pedal down until the vehicle reaches the desired speed. The speed must be above 32 mph (50 km/h).
  - 1.3 Press and release the SET/COAST button at the end of the turn signal lever or press the SET button on the steering wheel.
  - 1.4 One second after releasing the SET/COAST button on the lever or the SET button on the steering wheel, take your foot off of the accelerator pedal.

You can increase the vehicle speed while the cruise control is engaged by pressing on the accelerator pedal, by moving the slide switch on the turn signal lever to the RESUME/ACCEL position, or by pressing the SET button on the steering wheel. When you release the pedal, the slide switch, or the button, the vehicle will return to the set speed.

To increase the set speed, accelerate to the desired speed, then press and release the SET/COAST button on the lever or the SET button on the steering wheel.

To decrease the set speed, press and hold the SET/COAST button on the lever or the SET button on the steering wheel. When the vehicle slows to the desired speed, release the SET/COAST button on the lever or the SET button on the steering wheel.

2. To disengage the cruise control:
  - 2.1 Depress the brake pedal, *or*
  - 2.2 Move the slide switch on the turn signal lever to the OFF position or press the OFF button on the steering wheel.



If the brake pedal was used to disengage the cruise control, you can return the vehicle to the set speed with the slide switch or the steering wheel button. Accelerate to a speed above 32 mph (50 km/h), then move the slide switch to the RESUME/ACCEL position or press the RESUME/ACCEL button on the steering wheel. The cruise control will return the vehicle to the set speed.

**NOTE:** The set speed will be maintained within 4 mph (6 km/h) above or below the set speed when grades do not exceed 7 percent (most interstate highways). At higher altitudes, the set speed can vary by more than 4 mph (6 km/h).

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

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

3. To operate at high idle using the cruise control:
  - 3.1 Place the shift lever in Neutral (N).
  - 3.2 On the turn signal lever, move the slide switch to the ON position or press the ON button on the steering wheel. Accelerate to the desired rpm. Press and release the SET button on the steering wheel.
  - 3.3 Disengage by stepping on the brake pedal, by moving the ON/OFF switch to the OFF position, or by pressing the OFF button on the steering wheel.

## SmartWheel Cruise Control

### **WARNING**

**Do not use the cruise control system when driving conditions do not permit maintaining a constant speed, such as in 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.**

## Cruise On/Off

Press the cruise control ON/OFF switch to activate the cruise control or to turn it off.

## Cruise Set

Press the cruise control SET switch to set the desired cruising speed.

## Cruise Resume

Press the cruise control RESUME switch to resume cruise control activation.

## Cruise Cancel

Press the cruise control CANCEL switch to disengage cruise control without losing the current speed setting.

## Cold-Weather Operation

See the *Cummins Operation and Maintenance Manual* for cold-weather procedures.

## High-Altitude Operation

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

## Engine Shutdown

### **CAUTION**

**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 shift lever in the Neutral (N) position and set the parking brake using the parking brake control knob.
2. It is important to idle an engine for 3 to 5 minutes before shutting it down. This allows the lubricating oil and the water to carry heat away from the combustion chambers, bearings, shafts,

# Cummins Engines

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etc. This is especially important with turbo-charged engines.

3. Do not idle the engine for excessively long periods.

**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.

4. If the engine is not being used, shut it down by turning the ignition key to the OFF position.

# 5

## Mercedes-Benz Engines

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## EPA07 Aftertreatment System (ATS)

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

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

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

Vehicles with EPA07-compliant engines, are equipped with an aftertreatment system that has a diesel particulate filter in place of a muffler. Particulate matter is collected in the filter, then reduced to ash in a process called regen (regeneration). Regen usually occurs during the normal operation of the vehicle, and the operator should see no difference in vehicle performance. However, a vehicle that performs mainly short trips, may not sustain exhaust temperatures sufficiently high for an automatic regen to occur. In that case it may be necessary to perform a manual regen. See the engine operation manual for complete details and operation of the aftertreatment system.

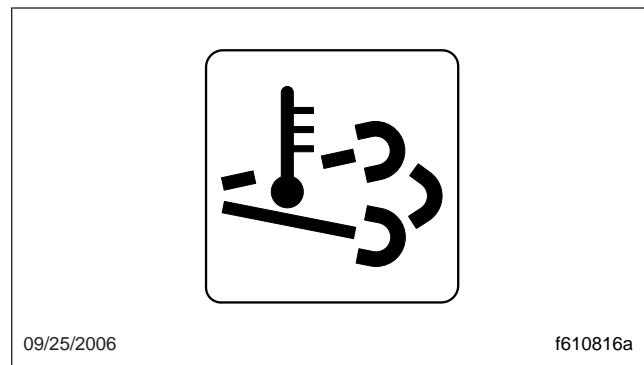
There are three warning lamps in the driver message center that alert the driver of the need to perform a manual regen, clean the filter, or of an engine fault that affects the emissions.

### **WARNING**

**When the HEST lamp is on, be certain that the exhaust pipe outlet is not directed at combustible material or toward anyone. To do so could cause**

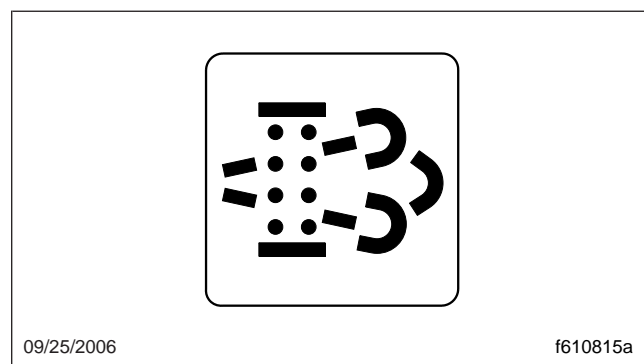
**damage to the vehicle and serious personal injury to others.**

The High Exhaust System Temperature (HEST) lamp alerts the operator of high exhaust temperature during the regen process when the speed is below 5 mph (8 km/h), or during a manual regen. See [Fig. 5.1](#). The HEST lamp does not signify the need for any kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or explode.



**Fig. 5.1, High Exhaust System Temperature (HEST) Lamp**

A solid yellow Diesel Particulate Filter (DPF) lamp indicates that a manual regen is required soon, and should be scheduled for the earliest convenient time. A blinking yellow DPF lamp indicates that a manual regen is required immediately, or an engine derate may occur. See [Fig. 5.2](#).



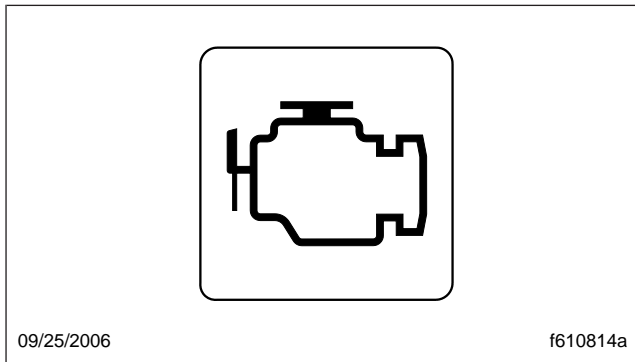
**Fig. 5.2, Diesel Particulate Filter (DPF) Status Lamp**

A solid yellow Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the emissions. The

MIL lamp applies to the Mercedes-Benz engine only. See [Fig. 5.3](#).

Diesel particulate filter servicing must be performed by an authorized technician, and a record must be maintained for warranty purposes. The record must include:

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



**Fig. 5.3, Malfunction Indicator Lamp (MIL)**

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

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

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

## Engine Starting

### ⚠ CAUTION

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

1. Turn the ignition switch to the START position. Without touching the accelerator pedal, start the engine.

2. Idle the engine for one to three minutes at 600 to 850 rpm before operating the engine under load.
3. Check the oil pressure gauge for any drop in lubricating oil pressure or mechanical malfunction in the lubricating oil system. Minimum oil pressure at idle is 7 psi (50 kPa).

### ⚠ CAUTION

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

## Cold-Weather Starting

See the *Mercedes-Benz Operation and Maintenance Manual* for cold-weather procedures.

### ⚠ CAUTION

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

## Starting After Extended Shutdown or Oil Change

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

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

1. Make sure the transmission is filled with the correct type of fluid, as recommended by the transmission manufacturer.
2. Make sure the fuel tank is full. If air has entered the fuel system, prime the fuel system, using the engine manufacturer's instructions.
3. If the engine is equipped with a fuel/water separator, drain off any accumulated water.

# Mercedes-Benz Engines

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4. Check the drive belts to make sure they are in good condition and properly adjusted. Replace any drive belts that are cracked, worn, or glazed.
5. Check the turbocharger for signs of oil or exhaust leaks. Correct any problems before starting the engine.
6. Check the engine mounting bolts for tightness. Retighten them if necessary.
7. Make sure the battery cable connections are clean and tight. Check that the batteries are charged.
8. Start the engine. See "Engine Starting".

## Engine Braking (optional)

### Constant-Throttle Valves

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



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

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

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

## Exhaust Brake

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

The exhaust brake is only active when the engine speed is between 1100 and 2700 rpm. Depressing the accelerator or clutch pedal deactivates the exhaust brake. The ABS system, when active, also deactivates the exhaust brake.

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

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

## Engine Operation

**NOTE:** Every Mercedes-Benz engine is tested on a dynamometer before shipment. Therefore, no break-in period is necessary. Before running the engine for the first time, follow the instructions in the *Mercedes-Benz Operator's Manual*.

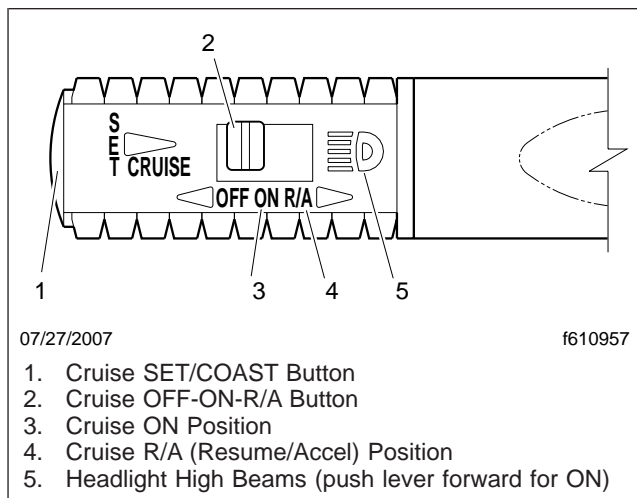
**NOTE:** Mercedes-Benz engines are equipped with the electronic engine control system, which monitors the engine as it is running. If the engine control unit (ECU) detects a fault serious enough to harm normal operation, the electronic engine system switches over to emergency running mode. When in emergency running mode, the engine operates at a maximum 1300 rpm. This allows you to move the vehicle to a service location.

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

1. 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.
2. 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.
3. Never allow the engine to exceed the high-idle governed speed (2700 rpm). Use the exhaust brake and the optional turbo or constant-throttle brake, if installed, to lower engine rpm below the high-idle governed speed.
4. Never allow the engine to idle for more than 30 minutes. Excessive idling can cause oil to leak from the turbocharger.

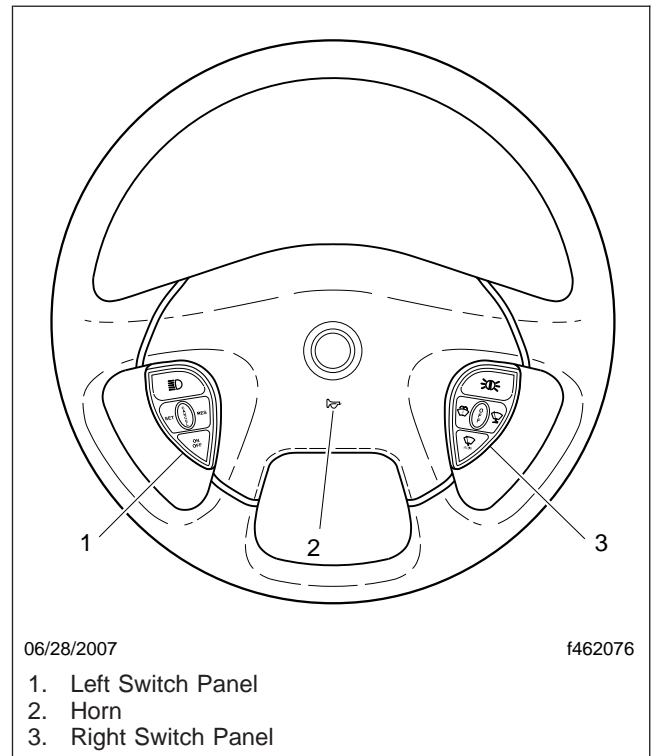
## Cruise Control

Cruise control allows you to automatically control the speed of the vehicle above 32 mph (50 km/h). The switches that operate the cruise control system are located on the turn signal lever. See [Fig. 5.4](#).



**Fig. 5.4, Multifunction Turn Signal Switch**

**NOTE:** On vehicles equipped with the optional SmartWheel, the cruise control switches are located on the left switch panel of the wheel. See [Fig. 5.5](#) and [Fig. 5.6](#).



**Fig. 5.5, SmartWheel (optional)**

### **WARNING**

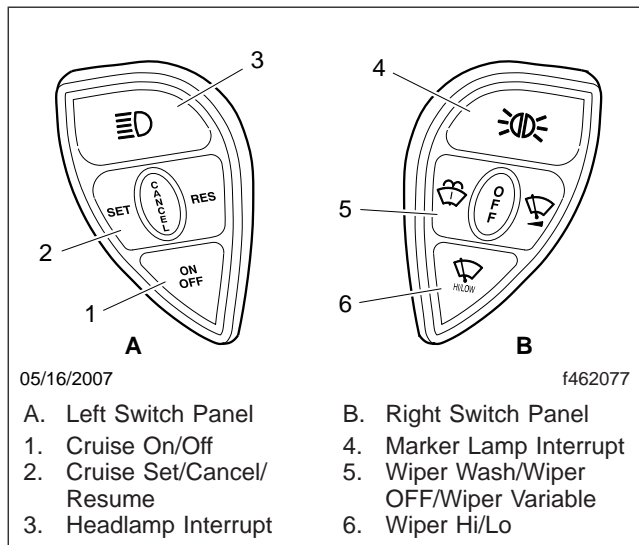
Do not use the cruise control system when driving conditions do not permit maintaining a constant speed, such as in heavy traffic or on roads that are winding, icy, snow covered, slippery, or roads with a loose driving surface. Failure to follow this precaution could cause a collision or loss of vehicle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

### **CAUTION**

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

1. To cruise at a particular speed:

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**Fig. 5.6, SmartWheel Switch Panels**

- 1.1 Move the slide switch on the turn signal lever to the ON position or press the ON button on the steering wheel.
- 1.2 Hold the accelerator pedal down until the vehicle reaches the desired speed. The speed must be above 32 mph (50 km/h).
- 1.3 Press and release the SET/COAST button at the end of the turn signal lever or press the SET button on the steering wheel.
- 1.4 One second after releasing the SET/COAST button on the lever or the SET button on the steering wheel, take your foot off of the accelerator pedal.

You can increase the vehicle speed while the cruise control is engaged by pressing on the accelerator pedal, by moving the slide switch on the turn signal lever to the RESUME/ACCEL position, or by pressing the SET button on the steering wheel. When you release the pedal, slide switch, or the button, the vehicle will return to the set speed.

To increase the set speed, accelerate to the desired speed, then press and release the SET/COAST button on the lever or the SET button on the steering wheel.

To decrease the set speed, press and hold the SET/COAST button on the lever or the SET button on the steering wheel. When the vehicle slows to the desired speed, release the SET/COAST button on the lever or the SET button on the steering wheel.

2. To disengage the cruise control:
  - 2.1 Depress the brake pedal, *or*
  - 2.2 Move the slide switch on the turn signal lever to the OFF position or press the OFF button on the steering wheel.

If the brake pedal was used to disengage the cruise control, you can return the vehicle to the set speed with the slide switch or the steering wheel button. Accelerate to a speed above 32 mph (50 km/h), then move the slide switch to the RESUME/ACCEL position or press the RESUME button on the steering wheel. The cruise control will return the vehicle to the set speed.

**NOTE:** The set speed will be maintained within 4 mph (6 km/h) above or below the set speed when grades do not exceed 7 percent (most interstate highways). At higher altitudes, the set speed can vary by more than 4 mph (6 km/h).

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

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

3. High Idle (With Cruise Control Option)
  - 3.1 Place the shift lever in Neutral (N).
  - 3.2 On the turn signal lever, move the slide switch to the ON position or press the ON button on the steering wheel. Accelerate to the desired rpm. Press and release the SET/COAST button on the turn signal lever or the steering wheel.



- 3.3 Disengage by stepping on the brake pedal, by moving the ON/OFF switch to the OFF position, or by pressing the OFF button on the steering wheel.

## SmartWheel Cruise Control

### **WARNING**

**Do not use the cruise control system when driving conditions do not permit maintaining a constant speed, such as in 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.**

### **Cruise On/Off**

Press the cruise control ON/OFF switch to activate the cruise control or to turn it off.

### **Cruise Set**

Press the cruise control SET switch to set the desired cruising speed.

### **Cruise Resume**

Press the cruise control RESUME switch to resume cruise control activation.

### **Cruise Cancel**

Press the cruise control CANCEL switch to disengage cruise control without losing the current speed setting.

## Master Toggle Switch, Required

If the cruise control switch is left in the ON position when the ignition is turned OFF, then the switch must be cycled from ON to OFF, then, back ON in order to operate the cruise control.

## Cold-Weather Operation

### **WARNING**

**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.**

See the *Mercedes-Benz Operation and Maintenance Manual* for cold-weather procedures.

## High-Altitude Operation

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

## Engine Shutdown

### Emergency Shutdown

If any of the following occur, shut down the engine immediately:

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

### Normal Engine Shutdown

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

### **CAUTION**

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

2. Allow the engine to idle one to two minutes before shutting it down. This allows the lubricating oil and the coolant to carry heat away from the combustion chambers, bearings, shafts, and seals. The extreme heat may cause bearings to seize or oil seals to leak.

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IMPORTANT: Bearing and seals in the turbo-charger 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 turbo-charger temperature may rise as much as 115°F (46°C).



## CAUTION

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

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

# 6

## Air Brake System

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Air Brake System .....	6.1
Antilock Braking System (ABS) .....	6.3



# Air Brake System

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## Air Brake System

### General Information

#### WARNING

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

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

#### WARNING

**Do not operate the vehicle with the front brakes backed off or disconnected. Backing off or disconnecting the front brakes will not improve vehicle handling and may lead to loss of vehicle control resulting in property damage or personal injury.**

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

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

#### **Air Brake System With External Fill (Schrader) Valve**

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, then 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 to 73 psi (448 to 503 kPa) with the ignition switch in the ON position.

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

### Operation

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

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

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

The yellow diamond-shaped knob on the control panel actuates the parking brake valve. See [Fig. 6.1](#). Pull out the knob to apply the parking brake.

#### 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**

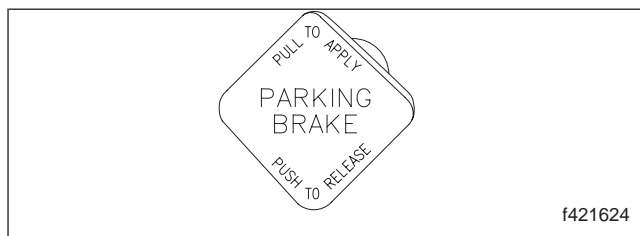


Fig. 6.1, Parking Brake Control Knob

of vehicle control, possibly causing personal injury and property damage.

## CAUTION

Do not use the spring parking brakes if the service brakes are hot, such as after descending a steep grade. Also, do not use the spring parking brakes during freezing temperatures if the service brakes are wet. To do so could damage the brakes if hot, or cause them to freeze during cold weather.

If the brakes are wet, drive the vehicle in low gear and lightly apply the brakes to heat and dry them. Allow hot brakes to cool before using the spring parking brakes. Always chock the tires.

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.

## Brake Burnishing (new vehicle)

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

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

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

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

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

5. Inspect each wheel and ensure that there is no excessive end-play.
6. Inspect the brake adjusters and air chambers and ensure that the pushrods have proper and equal stroke.
7. If the brakes pull the vehicle to one side or grab after the burnishing procedure, contact a Freightliner dealer for assistance.

## 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.

## WARNING

**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.**

# Air Brake System

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## Antilock Braking System (ABS)

### 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 air brake system. ABS passively monitors vehicle wheel speed at all times, but *controls* wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard air brake system is in effect.

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

Meritor WABCO 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. The control unit's main circuit interprets the wheel speed sensor signals and calculates wheel speed, wheel retardation, and a vehicle reference speed. If the calculations indicate wheel lockup, the main circuit signals the appropriate solenoid control valve to reduce braking pressure. During emergency braking, the solenoid control valve alternately reduces, increases, or maintains air pressure supply in the brake chamber to prevent front and rear wheel lockup.

#### **WARNING**

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

**IMPORTANT:** During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle to ensure proper ABS functioning. The required frequency of cleaning will vary with

conditions. In general, do not allow corrosive materials to remain on the underside of the vehicle for extended periods of time.

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

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

#### **WARNING**

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

During emergency or reduced-traction stops, fully depress the brake pedal until the vehicle comes to a safe stop; *do not pump* the brake pedal. With the brake pedal fully depressed, the ABS 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.**

# 7

## Transmissions

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Driving Precautions .....	7.1
Allison Automatic Transmissions .....	7.1

# Transmissions

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## 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 6](#) 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.

### CAUTION

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

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

### WARNING

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

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

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

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

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

## Allison Automatic Transmissions

### CAUTION

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

### WARNING

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

### CAUTION

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

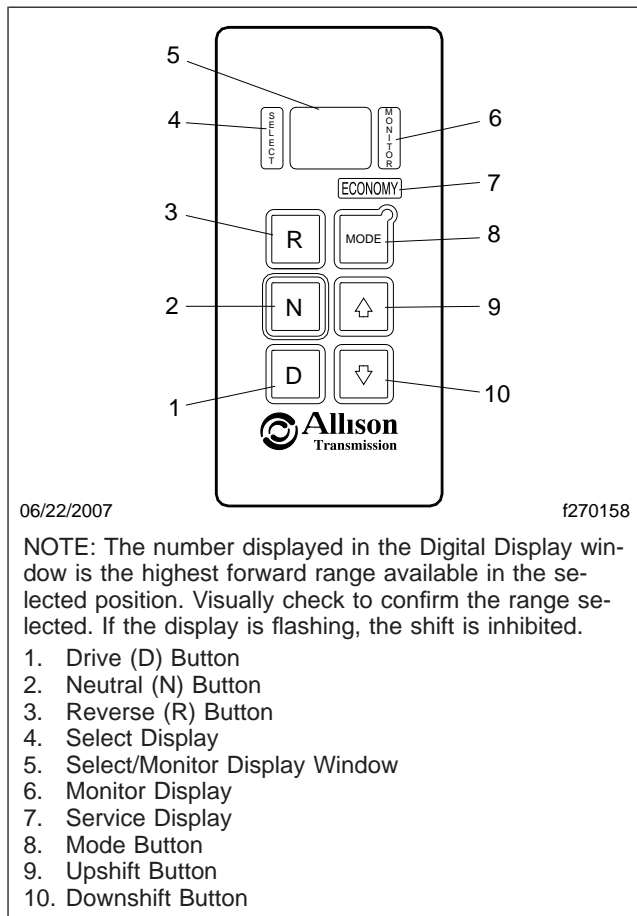
## 2500/3000/4000 MH Models

### General Information

2500, 3000, and 4000 MH series automatic transmissions have six forward speeds and one Reverse (R) speed. These transmissions have electronic shift controls that can be programmed to allow the use of different numbers of geared speeds. See [Fig. 7.1](#). For instance the transmission can be programmed to operate as a 4-speed, 5-speed, or 6-speed unit in the "primary" shift mode. If needed, a "secondary" shift mode can be programmed to provide another shift configuration to optimize vehicle use under different operating conditions. To activate a secondary shift mode, or other special function programmed into the electronic control unit (ECU), depress the Mode button. A label just above the Mode button identifies the special function.

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





**Fig. 7.1, GEN IV Shift Selector**

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

## Operation

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

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

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

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

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

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

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

## 2100/2500 Models (Arens SBW)

### General Information

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

The 2100/2500 series transmissions have a park pawl and the SBW selector has a Park (P) position. See [Fig. 7.2](#).

In case the vehicle needs to be towed and the SBW system cannot be activated to move the transmission out of Park (P), a manual procedure is provided to shift the transmission. At the actuator, on the transmission, a port is provided to insert an Allen wrench to shift the transmission manually. See [Chapter 14](#) for more information.

### Transmission Operation

1. At the top left side of the selector, is the select display. On the left side of the display window,

# Transmissions

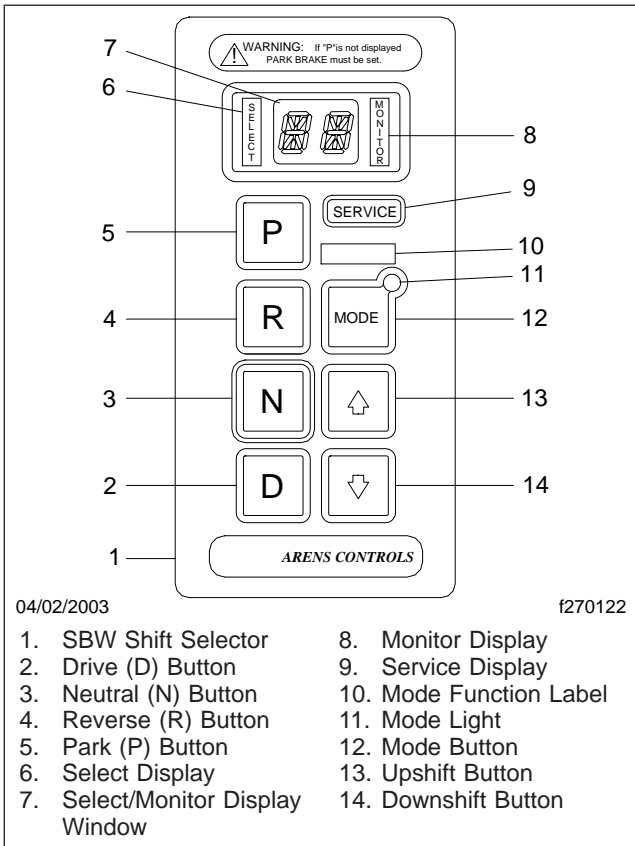


Fig. 7.2, SBW Shift Selector (2100/2500 series)

an LED character indicates which gear has been selected.

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

## WARNING

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

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

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

## WARNING

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

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

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

## WARNING

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

- Select the N button to place the transmission in Neutral (N). An N will appear on both sides of the display window. The vehicle may be started in Neutral (N).
- Select the D button to place the transmission in Drive (D). The transmission will automatically shift through the full range of First (1) through Fifth (5) gears. When Drive (D) is first selected, the display will show D1, indicating that Drive (D) was selected and that First (1) gear is engaged. As the transmission automatically upshifts and downshifts, the display will show the gear currently engaged (D1, D2, D3, D4, or D5).



7. With the transmission in Drive (D), select the downshift (down arrow) button to manually downshift one gear at a time, from Fifth (5) to First (1). The select display will show the selected gear and the monitor display will show the gear currently engaged. From D5 at the top of the Drive (D) range, the display will show 44, 33, 22, and 11 as progressively lower gears are manually selected.
12. A flashing select/monitor display indicates that the transmission (and not the SBW system) has inhibited a selected transmission operation. See the *Allison Transmission Operator's Manual* for more information.

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

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

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

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

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 **CAUTION**

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

11. The service display illuminates if a fault is detected in the SBW system. Have a qualified technician inspect the SBW system as soon as possible.

# 8

## Steering System

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Power Steering System .....	8.1
Steering Column Adjustment .....	8.1

# Steering System

## Power Steering System

NOTE: When there is no load on the vehicle and the front tires are pointed straight ahead, the steering wheel spokes should be at the 9 and 3 o'clock positions or within 10 degrees to either side. See [Fig. 8.1](#).

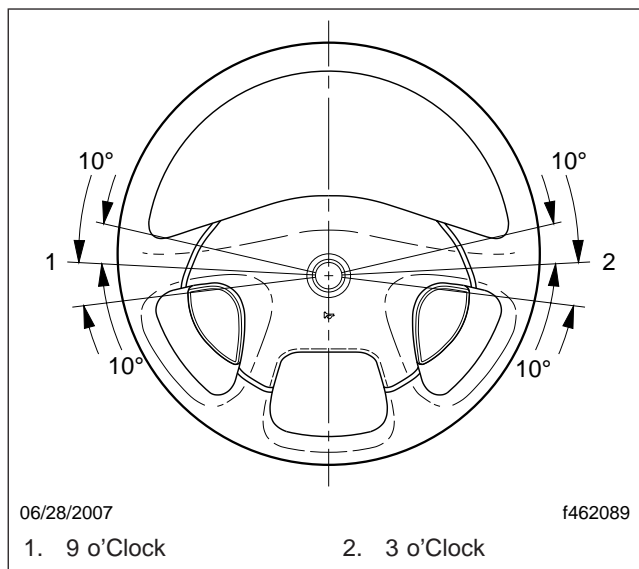


Fig. 8.1, Steering Wheel Centered

## Steering Column Adjustment

### TRW Tilt/Telescope Steering Column



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

To tilt the steering column, press down on the foot pedal (located below the steering wheel) to release the steering column lock. Adjust the column to the desired position. Release the foot pedal to lock the steering column in place. To telescope the steering column, lift up the lever on the steering column. Pull the steering wheel upward or push it downward until it is at the desired height. Release the lever to lock the steering column in place. See [Fig. 8.2](#).

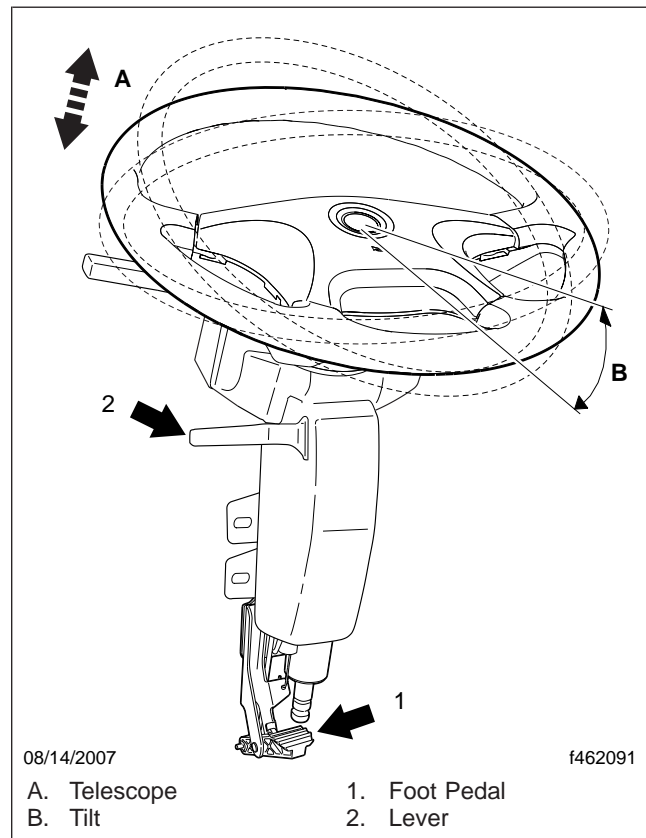


Fig. 8.2, TRW Tilt/Telescope Steering Column (typical)

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

# 9

## Front-Engine Diesel Chassis

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Instrumentation Control Unit .....	9.1
Allison Automatic Transmissions .....	9.4
Hydraulic Brake System .....	9.6

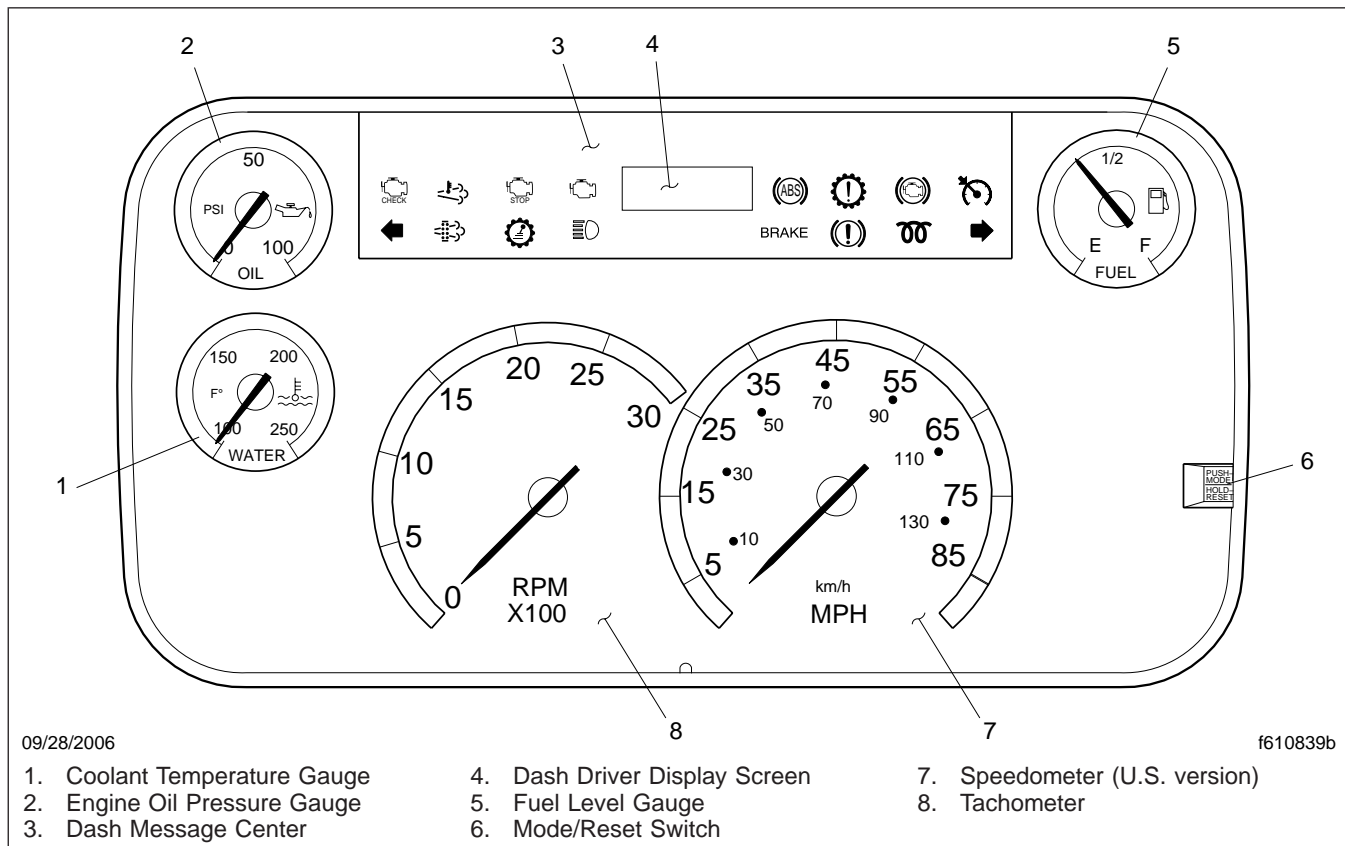
# Front-Engine Diesel Chassis

## Instrumentation Control Unit

**Figure 9.1** shows a typical set of instruments for vehicles equipped with the MC Recreational Vehicle instrument cluster (ICU3-M2).

## Dash Message Center

The dash message center is the heart of the instrument cluster. It has two parts, a set of 26 warning and indicator lights similar to those found on a con-



**Fig. 9.1, Gauge Layout (basic), EPA07 Compliant**

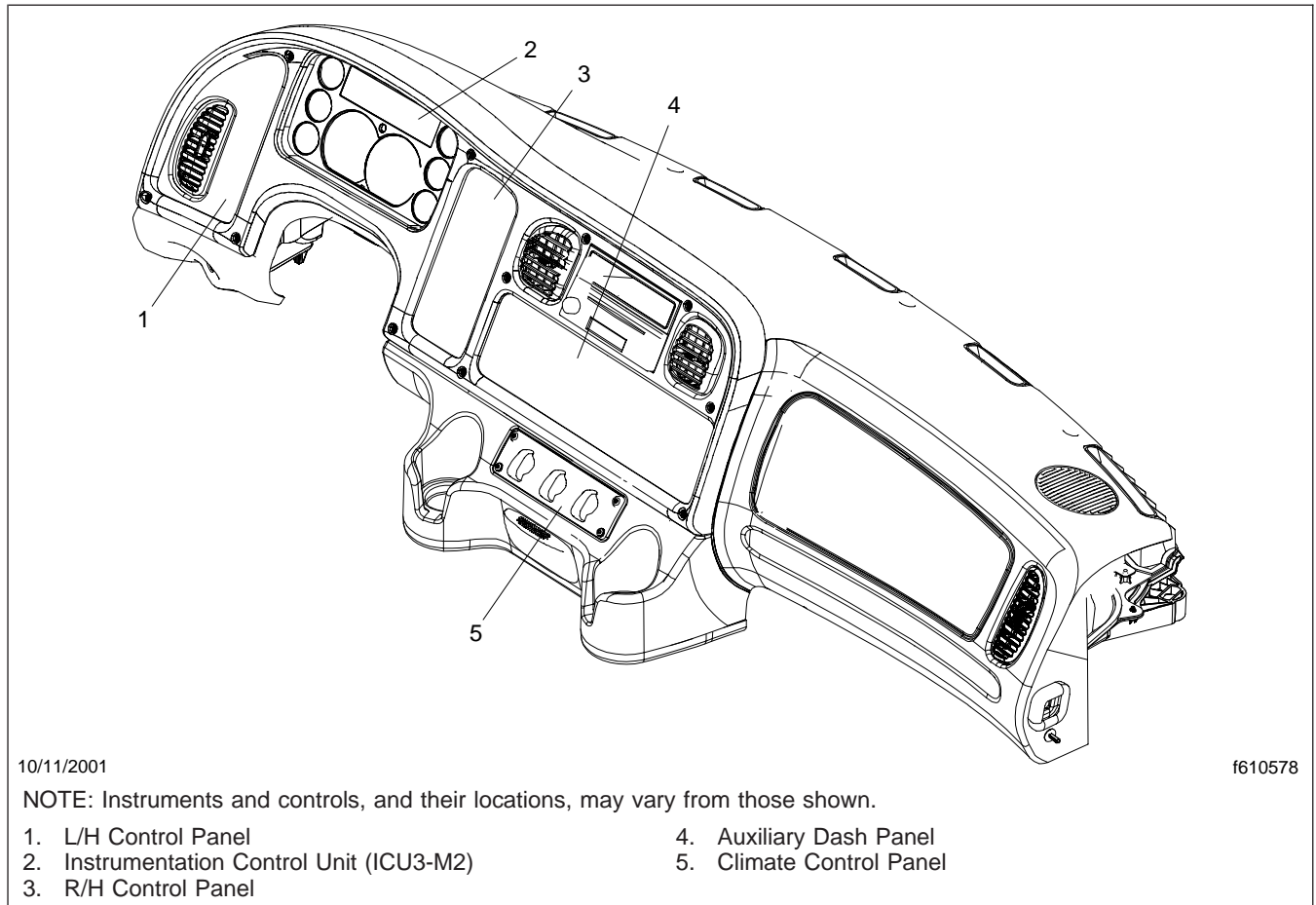
The MC Recreational Vehicle instrument cluster is an updated version of the basic electronic dashboard (ICU-3). It can accept information from the datalink and from various sensors installed on the vehicle, and deliver that information to electronic gauges.

There are six gauges on the driver's instrument panel.

The instrument cluster has the capability to drive independent stand-alone gauges such as those installed on the auxiliary dash panel. **Figure 9.2** shows a typical dash.

ventional lightbar, and a dash driver display screen. The driver display screen is a one-line by seven character liquid crystal display (LCD) that normally shows odometer readings. Below this display is a smaller one-line by three-character LCD that shows voltmeter readings.

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



**Fig. 9.2, Dash Panel Layout (typical)**

## Ignition Sequence

The dash message center goes through a prescribed ignition sequence each time the ignition switch is turned on. See [Fig. 9.3](#) for the ignition sequence.

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

The following lights illuminate during the ignition sequence:

- Fasten Seat Belt Warning
- Low Battery Voltage Warning
- High Coolant Temperature Warning
- Low Engine Oil Pressure Warning

- Parking Brake On Indicator
- All engine indicator/warning lights, including Check Engine and Engine Protection

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

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

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

# Front-Engine Diesel Chassis

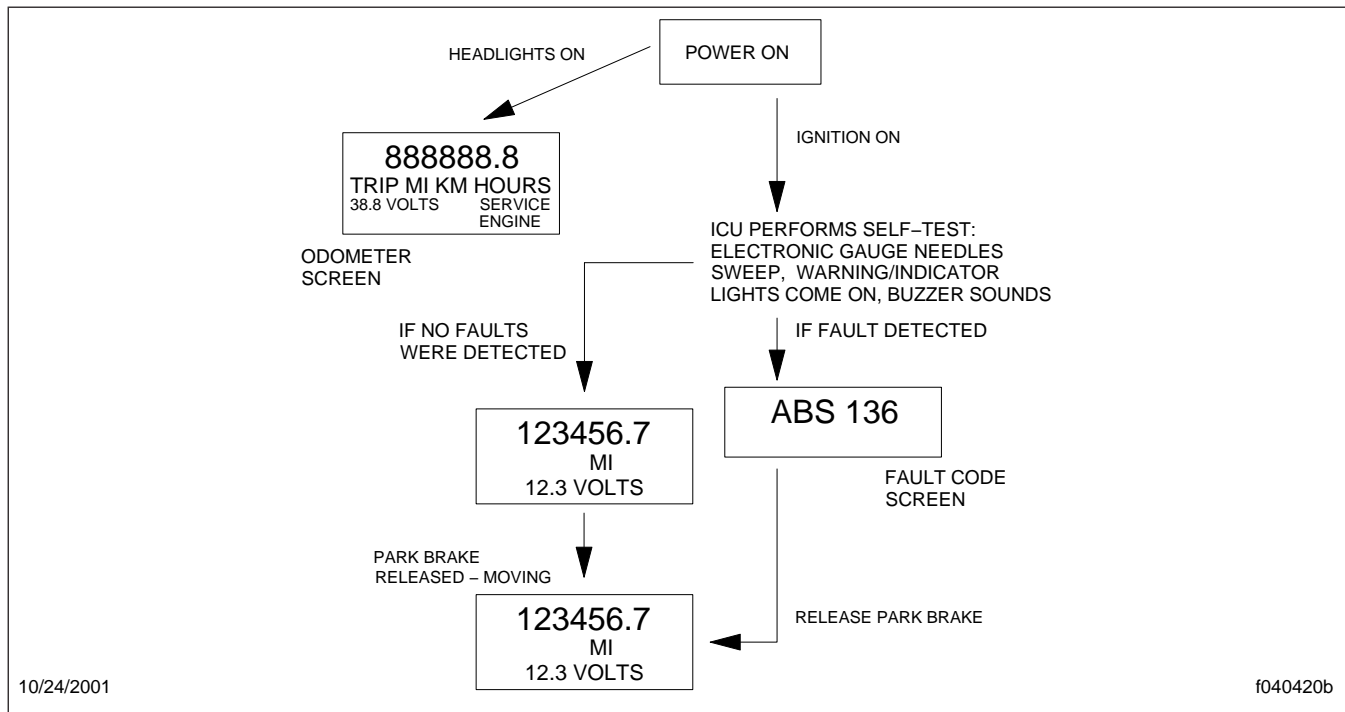


Fig. 9.3, Ignition Sequence

- Fourth line: ENGINE

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

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

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

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

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

Some examples of mission critical faults include:

- High coolant temperature
- Low coolant level

- Low engine oil pressure

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

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

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

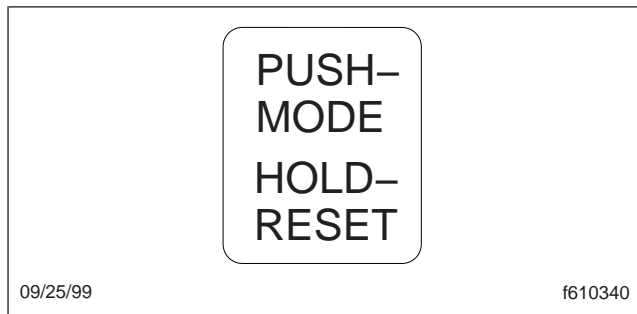
## Odometer

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

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

## Mode/Reset Switch

The mode/reset switch is located on the right side of the instrument cluster. See [Fig. 9.4](#). The mode/reset switch is used to scroll through the displays on the message display screen, and to reset the trip distance and trip hours values to zero.



**Fig. 9.4, Mode/Reset Switch**

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

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

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

## Allison Automatic Transmissions

### CAUTION

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

### CAUTION

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

## 1000/2100/2200/2350 MH Models

### General Information

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

The 1000/2200/2350 series transmission has a park pawl and the SBW selector has a Park (P) position. The 2100 series transmission has a park brake (Pb) button. See [Fig. 9.5](#) and [Fig. 9.6](#).

In case the vehicle needs to be towed and the SBW system cannot be activated to move the transmission out of Park (P), a manual procedure is provided to shift the transmission. At the actuator, on the transmission, a port is provided to insert an Allen wrench to shift the transmission manually. See [Chapter 14](#) for more information.

### Transmission Operation

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



# Front-Engine Diesel Chassis

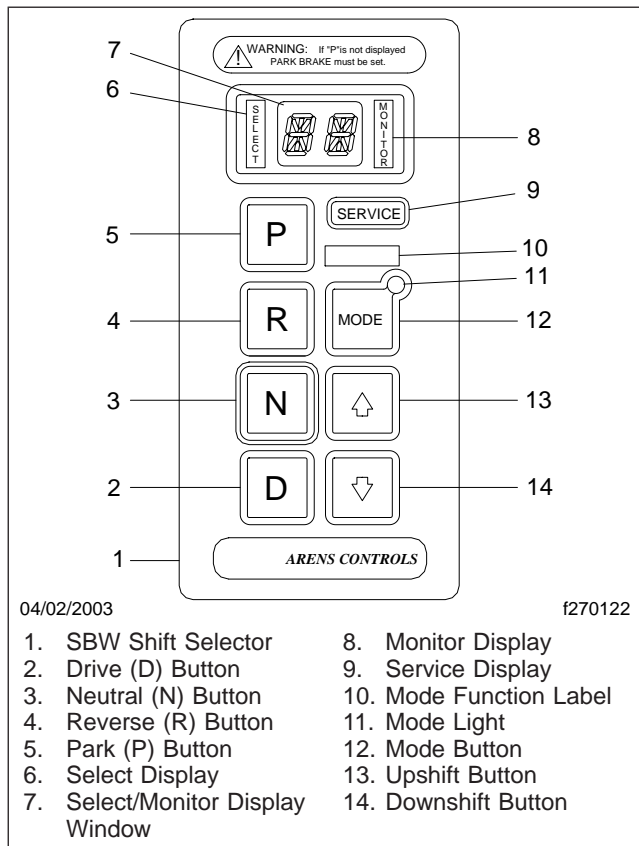


Fig. 9.5, SBW Shift Selector (1000/2200/2350 series)

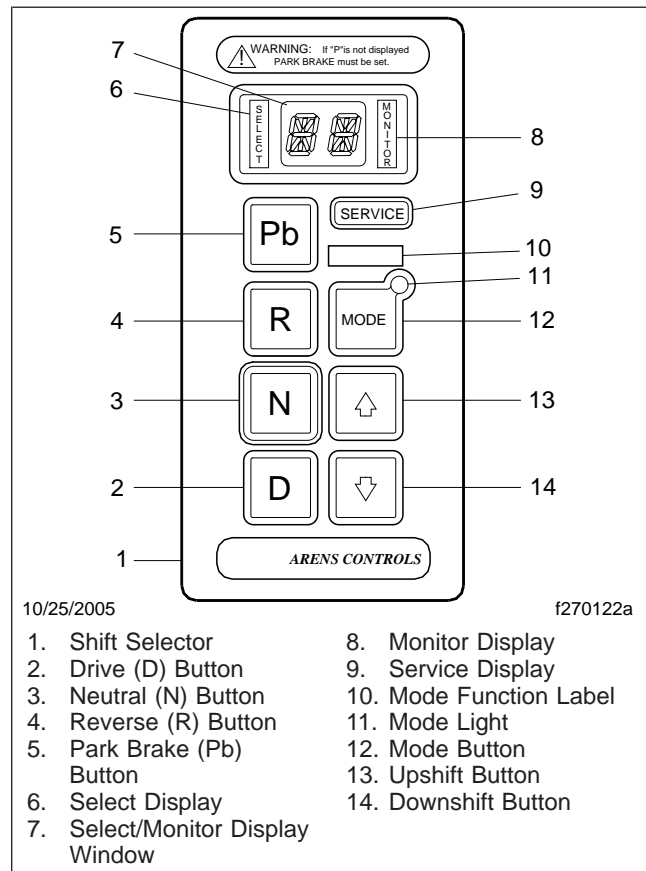


Fig. 9.6, SBW Pushbutton Shift Selector with Park Brake (Pb) Button (2100 series)

## ⚠ WARNING

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

NOTE: Only the 1000 series have a park pawl and a Park (P) button.

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

## ⚠ WARNING

**Always place the transmission in the Park (P) or Neutral (N) position and set the parking brake**

**before releasing the service brakes and exiting the vehicle. Otherwise the vehicle could move unexpectedly and cause an accident, possibly resulting in personal injury and property damage.**

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

## ⚠ WARNING

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

- Select the N button to place the transmission in Neutral (N). An N will appear on both sides of

the display window. The vehicle may be started in Neutral (N).

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

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

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

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

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

## CAUTION

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

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

## Hydraulic Brake System

### General Information

The hydraulic brake system includes a power booster, master cylinder, reservoir, hydraulic lines, a brake rotor on each wheel hub, and a brake caliper and pad assembly at each rotor. See [Fig. 9.7](#).

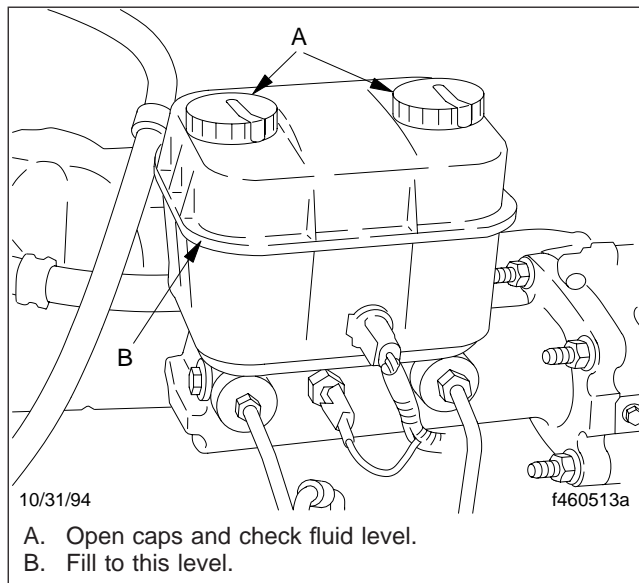
**IMPORTANT:** Make sure that the fluid level in the master cylinder reservoirs is up to the flange that surrounds the reservoir. Use only heavy-duty brake fluid, DOT 3, in the hydraulic brake system. Do not mix types and brands of fluid because of possible incompatibility.

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

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

The Meritor WABCO Antilock Braking System (ABS) is an electronic wheel speed monitoring and control

# Front-Engine Diesel Chassis



**Fig. 9.7, Hydraulic Brake Reservoir**

system that works with the hydraulic brake system. ABS passively monitors vehicle wheel speed at all times, but *controls* wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard hydraulic brake system is in effect.

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

ABS includes signal-generating tone wheels and sensors located in the wheel hubs of each sensed axle. The sensors transmit vehicle wheel speed information to an electronic control unit (located on the front-wall) which interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate wheel lockup, the appropriate control circuit signals the brake pressure modulator to increase or decrease braking pressure until wheelslip has been corrected.

The electronic control unit also has a safety circuit that constantly monitors the wheel sensors, brake pressure modulator, and the electrical circuitry. The dash warning light (ABS) comes on after the ignition

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

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

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

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

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

## Operation

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

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

## CAUTION

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

### Auto-Apply Parking Brake Operation

Use the following instructions to operate the parking brake:

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

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

# 10

## Pre- and Post-Trip Checklists

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Pretrip and Post-Trip General Information .....	10.1
Daily Pretrip Inspection and Maintenance Checklist .....	10.1
Weekly Post-Trip Inspection and Maintenance Checklist .....	10.2
Monthly Post-Trip Inspection and Maintenance Checklist .....	10.3

# Pre- and Post-Trip Checklists

## Pretrip and Post-Trip 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.

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

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

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

Numbers in parentheses within each of the checklists reference the corresponding detailed instructions found under "Daily (D), Weekly (W), or Monthly (M) Procedures" in **Chapter 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, take the vehicle to an authorized Freightliner dealer for assistance.

## Daily Pretrip Inspection and Maintenance Checklist

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

For the daily pretrip inspection and maintenance checklist see **Table 10.1**.

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
_____	Drain manually drained air reservoirs (that are not equipped with automatic drain valves)	D1
Check _____	windshield washer reservoir fluid	D2
Inspect _____	wheel seal and hub cap (for leakage)	—
Check _____	surge tank coolant level	D3
Inspect _____	radiator and charge air cooler	D4
Check _____	engine for fuel, oil, or coolant leaks	—
Inspect _____	engine and chassis wiring	D5
Inspect _____	air intake system	D6
Inspect _____	intake-air restriction indicator mounted on air intake	D6
Check _____	engine oil level	D7
Check _____	power steering fluid level	D8
Check _____	fuel tank(s), fuel lines, and connections	D9
Check _____	fuel level	D10
Inspect _____	fuel/water separator	D11
Check _____	front and rear suspension components	D12
Check _____	headlights, mirrors, and window glass, and windshield wipers	D13
Check _____	doors (open without difficulty and close securely)	—
_____	Adjust driver's seat, then align rearview and downview mirrors	—
Check _____	dash-mounted intake-air restriction indicator	D6

# Pre- and Post-Trip Checklists

Procedure Performed (check off)	Daily Pretrip Inspections/Checks	Procedure Reference
Check _____	oil- and air-pressure warning systems	D14
Check _____	LBCU warning lights	D15
Check _____	ICU fault codes (front-engine diesel chassis)	D16
Check _____	horn, windshield wipers, and windshield washer	D17
Inspect _____	heater, defroster, and optional mirror heat controls	D18
Check _____	panel lights and interior lights	D19
Check _____	exterior lights and reflectors	D20
Check _____	tire pressure	D20
Check _____	tire condition	D21
Check _____	rims and wheels	D22
Check _____	automatic transmission fluid level	D23
Inspect _____	air brake chambers and pushrods	D24
Inspect _____	air brake lines	D25
Inspect _____	slack adjusters	D26
Inspect _____	air brake system operation	—
Check _____	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 _____	Remove chocks and test service brakes	D27
Inspector _____ Date _____		

Table 10.1, Daily Pretrip Inspection and Maintenance Checklist

## Weekly Post-Trip Inspection and Maintenance Checklist

For the weekly post-trip inspection and maintenance checklist see [Table 10.2](#).

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

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

Table 10.2, Weekly Post-Trip Inspection and Maintenance Checklist



# Pre- and Post-Trip Checklists

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## Monthly Post-Trip Inspection and Maintenance Checklist

For the monthly post-trip inspection and maintenance checklist see [Table 10.3](#).

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

Procedure Performed (check off)	Monthly Post-Trip Inspections/Checks	Procedure Reference
_____	Clean the battery terminals	M1
Inspect _____	radiator hoses and heater hoses	M2
Check _____	fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 4 brake fluid)	—
Check _____	steering wheel play	M3
Check _____	outer surfaces of the body (for visible surface breaks and damage)	—
Check _____	hood tilt damper (attached at both ends)	—
Inspect _____	brake lining wear	M4
Inspect _____	driveshaft	—
Inspector _____ Date _____		

**Table 10.3, Monthly Post-Trip Inspection and Maintenance Checklist**



# 11

## Pre- and Post-Trip Inspections and Maintenance

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Daily Pretrip Inspection and Maintenance Procedures .....	11.1
Weekly Post-Trip Inspection and Maintenance Procedures .....	11.12
Monthly Post-Trip Inspection and Maintenance Procedures .....	11.12

# Pre- and Post-Trip Inspections and Maintenance

## Daily Pretrip Inspection and Maintenance Procedures

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

### 1. Drain manually drained brake system air reservoirs.

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

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

## WARNING

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

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

- 1.2 Exhaust the remaining air and moisture from the system by opening the drain cocks on the bottoms of the remaining air reservoirs. 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.
  - 1.4 If the drained water is cloudy or oily, it may indicate a problem with the compressor. If oil is allowed to contaminate the air dryer, it will not remove the water from the air brake system, which could adversely affect braking.
2. Check the fluid level in the windshield washer reservoir.
- Add washer fluid as needed.

## WARNING

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

### 3. Check the coolant level in the surge tank.

See Fig. 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. If the surge tank was empty, start the engine after refilling and check the level again when the engine is at operating temperature.

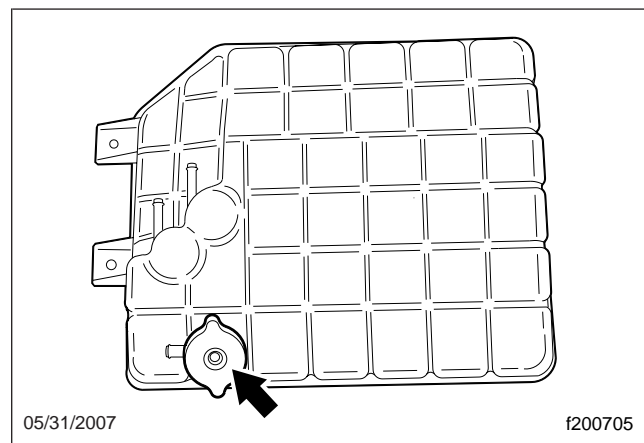


Fig. 11.1, Surge Tank Fill Cap

## CAUTION

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

### 4. Inspect the radiator and charge air cooler.

- 4.1 Inspect the radiator and charge air cooler for clogged fins. Use compressed air or water directed from the fan side of the core to backflush any material restricting airflow.
- 4.2 Inspect the radiator and charge air cooler for damage and accumulated debris. Straighten bent or damaged fins to permit airflow across all areas of the cores.

# Pre- and Post-Trip Inspections and Maintenance

NOTE: When traveling through areas of high insect concentration, it may be necessary to clean the exterior of the radiator or the charge air cooler core as often as every 200 miles (320 km).

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

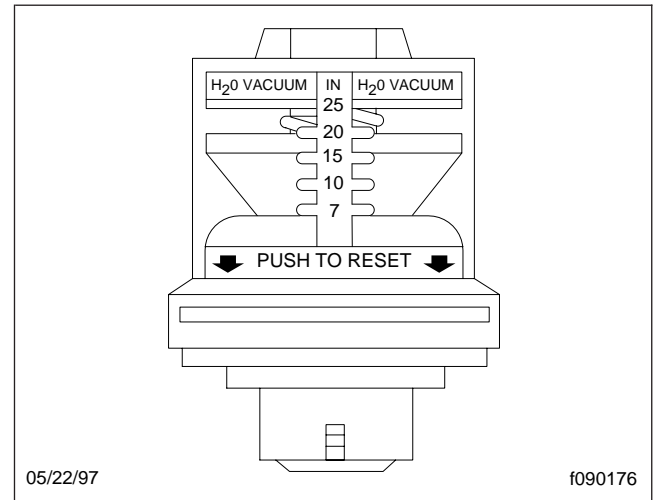
## CAUTION

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

- 6.1 Check the intake-air restriction indicator to determine if the air cleaner needs to be changed. See [Fig. 11.2](#).
- 6.2 Replace the primary filter element in the air cleaner when the yellow line reaches 25 inH<sub>2</sub>O for Mercedes-Benz engines or Cummins engines. Take the vehicle to an authorized Freightliner dealer for assistance.

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

- 6.3 Inspect the 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.



**Fig. 11.2, Air Restriction Indicator**

- 6.4 Check the engine air intake piping from the air cleaner to the engine intake. Inspect the piping for loose connections, cracks, torn or collapsed hoses, punctures, and other damage. Tighten loose connections, and have damaged components replaced. Make sure the piping system is airtight so that all intake air passes through the air cleaner.
  7. *Check the engine oil level.*  
The oil level should show between the upper and lower marks on the dipstick. Add enough oil to bring the level up to the operating range. See the *Cummins*, or the *Mercedes-Benz Operation and Maintenance Manual* for recommended lubricants and capacities.
- ## CAUTION
- Maintain the correct engine oil level. Operating the engine with the oil level below the low mark or above the high mark could result in engine damage.**
8. *Check the fluid level in the steering system hydraulic fluid reservoir. See [Fig. 11.3](#).*  
If needed, fill the reservoir to a level between the MIN and MAX marks. Use only Dexron® VI ATF, or an equivalent.

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

# Pre- and Post-Trip Inspections and Maintenance

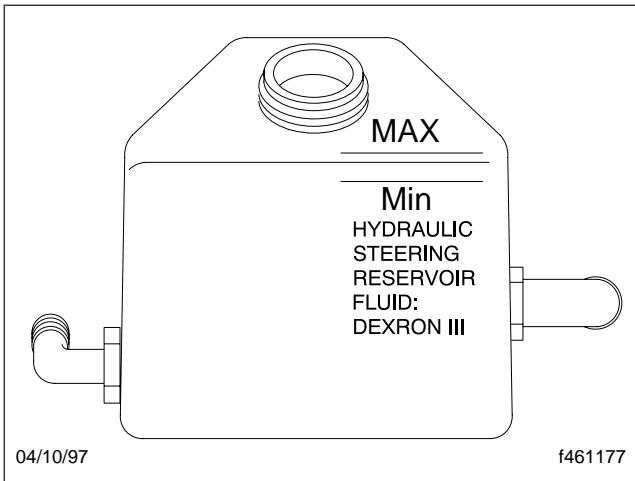


Fig. 11.3, Steering System Hydraulic Fluid Reservoir

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

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

10. *Check the fuel level in the fuel tank(s).* To keep condensation to a minimum, fuel tanks should be filled at the end of each day. Federal regulations prohibit filling a fuel tank to more than 95 percent of its liquid capacity. Select the proper grade of fuel as specified by the engine manufacturer.

## **WARNING**

**Never fill fuel tanks to more than 95 percent of their liquid capacity. This could make them more likely to rupture from impact possibly causing fire and resulting in serious personal injury and death by burning. Do not mix gasoline or alcohol with diesel fuel. This mixture could cause an explosion, possibly resulting in serious personal injury or death. Do not fill the fuel tanks in the presence of sparks, open flames, or intense heat. These could ignite the fuel, possibly causing severe burns.**

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

## **CAUTION**

**Water in the fuel/water separator will appear as beads. Drain the separator only enough to remove the water. Do not drain the separator completely or it will be necessary to prime the fuel system before the vehicle may be started again.**

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

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

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

## **WARNING**

**Do not replace individual leaves of a damaged front or rear suspension leaf spring assembly; replace the complete spring assembly. Visible damage, such as cracks or breaks, to one leaf causes hidden damage to other leaves. Replacement of only the visibly damaged part(s) is no assurance that the spring is safe. If cracks or**

# Pre- and Post-Trip Inspections and Maintenance

**breaks exist on front spring assemblies in either of the two top leaves, a loss of vehicle control could occur. Failure to replace a damaged spring assembly could cause an accident resulting in serious personal injury or property damage.**

13. Clean the windshield, side, and rear windows with a long-handled or telescoping window cleaning device and standard cleaning solutions. Stand only on the ground, on a stepladder, or an elevated walkway. The vehicle entry/exit steps and handholds are not designed for this purpose. The tires, fenders, engine, and other under-hood components do not have adequate gripping surfaces and handholds.

Check the condition of the windshield wiper arms and blades.

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

Inspect the wiper blades for damage and deteriorated rubber.

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

Replace damaged or deteriorated wiper blades.



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

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

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

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

14.1 If the warning systems do not come on when the ignition is turned on, have the systems repaired.

14.2 If the air pressure in both systems is above the preset minimum when the engine is started, test the low air pressure warning system by 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.

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

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

During the ignition sequence, if an active fault is detected in any device that is connected to the datalink, the message display screen will show the active fault codes, one after the other until the parking brake is released or the ignition switch is turned off. See [Chapter 9](#) for detailed operating instructions for the ICU.

16. *Make sure that the horn, windshield wipers, and windshield washers are operating properly. These devices must be in good working order for safe vehicle operation.*

16.1 Make sure that the horn works. If a horn is not working, have it repaired before trip departure.

16.2 Check the wiper and washer control on the multifunction turn signal switch. If the wipers and/or washers are not working, have them repaired before trip departure.

17. *During cold weather; make sure the heater, defroster, and optional mirror heat controls are operating properly. If so equipped, turn on the mirror heat switch and make sure the system is working.*

18. *Check the operation of all the panel lights and interior lights.*

Turn on the headlights, dash lights, and four-way flashers and leave them on. If any of the gauge

# Pre- and Post-Trip Inspections and Maintenance

bulbs, the dome light bulbs, or the right- and left-turn indicator bulbs are not working, replace them.

19. *Make sure all the exterior lights are working properly.* Check that all the lights and reflectors are clean.
  - 19.1 Check that the brake lights, taillights, headlights, parking lights, turn signals, road lights (if so equipped), and front clearance lights are working properly and are clean.
  - 19.2 Test the high and low beams of the headlights.
  - 19.3 Replace the light bulbs or sealed beam units that are not working.
20. Check the tire inflation pressures, and inspect each tire for bulges, cracks, cuts, and punctures.

**IMPORTANT:** The load and cold inflation pressure must not exceed the wheel manufacturer's recommendations, even though the tire may be approved for a higher load or inflation. Some wheels are stamped with a maximum load and maximum cold inflation rating. If the load exceeds the maximum wheel capacity, the load must be adjusted or reduced. See and adhere to the tire load and cold inflation pressure specifications stated on the vehicle specification label.

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

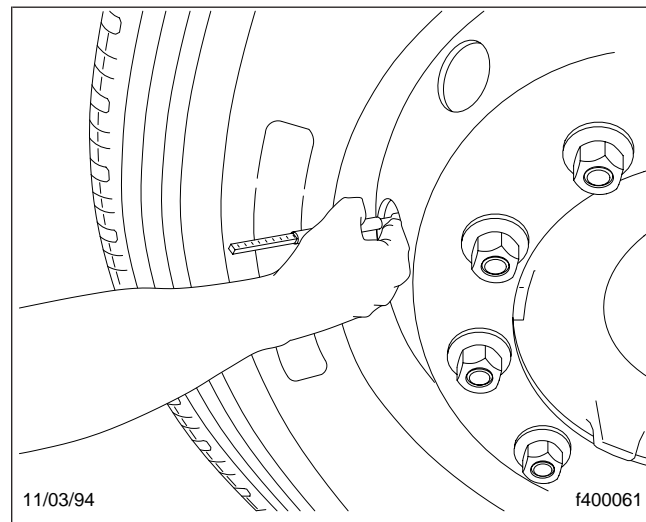
- 20.1 Check the inflation pressures of the tires before each trip, using an accurate tire pressure gauge. See [Fig. 11.4](#). Check tire pressures when the tires are cool. The maximum inflation pressure for each tire is provided on the outer wall of the tire. Inflate the tires to the applicable pressures, if needed. Be sure that valve stem caps are used on every tire, and that they are screwed on finger-tight.

When traveling at unusual speeds, use [Table 11.1](#) to adjust tire pressure.

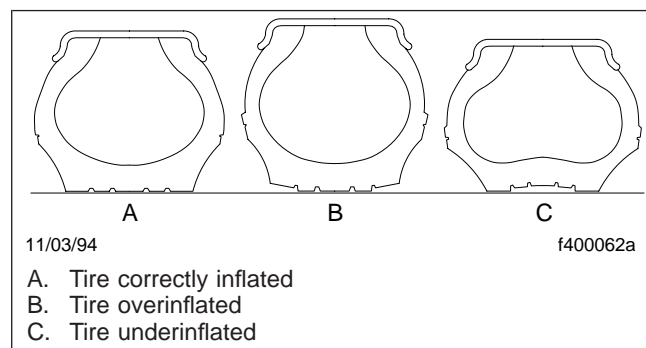
For vehicles with Michelin tires, see the *Michelin Recreational Vehicle Tire Guide* for correct tire inflation pressures for the vehicle load.

Overinflation gives the treaded surface of the tire a convex shape. See [Fig. 11.5](#). This causes premature tire wear in the middle part of the tire since this section is primarily in contact with the road.

Underinflation gives the tread surface a concave shape. See [Fig. 11.5](#). This causes excessive tire wear on the outer edges of the tire since those edges are primarily in contact with the road.



**Fig. 11.4, Checking Tire Pressures**



- A. Tire correctly inflated  
B. Tire overinflated  
C. Tire underinflated

**Fig. 11.5, Checking Tire Inflation**



# Pre- and Post-Trip Inspections and Maintenance

Variations in Load and Inflation Limits According to Speed		
Speed Range: mph (km/h)	Inflation Pressure: psi (kPa)	Percent Increase/Decrease in Load
70 to 75 (113 to 121)	10 (69)	(-10)
61 to 70 (98 to 113)	10 (69)	0
51 to 60 (82 to 97)	0	0
41 to 50 (66 to 80)	0	+9
31 to 40 (50 to 64)	0	+16
21 to 30 (34 to 48)	10 (69)	+24
11 to 20 (18 to 32)	15 (103)	+32

Table 11.1, Variations in Load and Inflation Limits According to Speed

## WARNING

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

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

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

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

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

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

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

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

## WARNING

**On vehicles equipped with ZF independent front suspension (IFS) and ZF SB 7000 front air disc brakes, the only approved front wheels and valve stems are those that come on the chassis as delivered from the FCCC manufacturing plant. These wheels have a special bolt pattern. Valve stems other than those delivered with the chassis may interfere with the brake calipers. The use of unapproved front wheels and/or front wheel valve stems could cause component damage and result in personal injury or death, or property damage.**

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

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

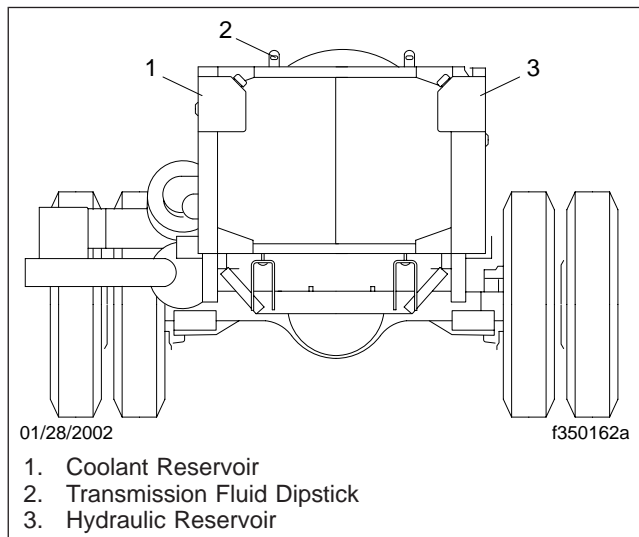
# Pre- and Post-Trip Inspections and Maintenance

Examine the wheel assembly components (including studs and nuts) for cracks or other damage.

## **WARNING**

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

22. Check the oil level in the automatic transmission. See Fig. 11.6 and Fig. 11.7.



**Fig. 11.6, Transmission Fluid Level Check**

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

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

- 22.3 Wipe the dipstick clean and check the fluid level. A safe operating level is any level within the HOT run (upper) band on the dipstick. See Fig. 11.8.
- 22.4 If the fluid is not within this range, add or drain fluid as needed to bring the level to the top of the HOT run band. See Table 11.2 for fluid types and capacities.

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

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

- 22.5 Run the engine for at least one minute to clear the fluid system of air.
- 22.6 With the engine running, wipe the dipstick clean and check the fluid level. Any level within the COLD run (lower) band is satisfactory for operating the vehicle. If the level is not within the COLD run band, add or drain fluid until it reaches the middle of the COLD run band.
- 22.7 Perform a hot check at the first opportunity after normal operating temperature, 160 to 200°F (71 to 93°C), is reached.

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

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

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

**Table 11.2, Transmission Lubricant Capacities**

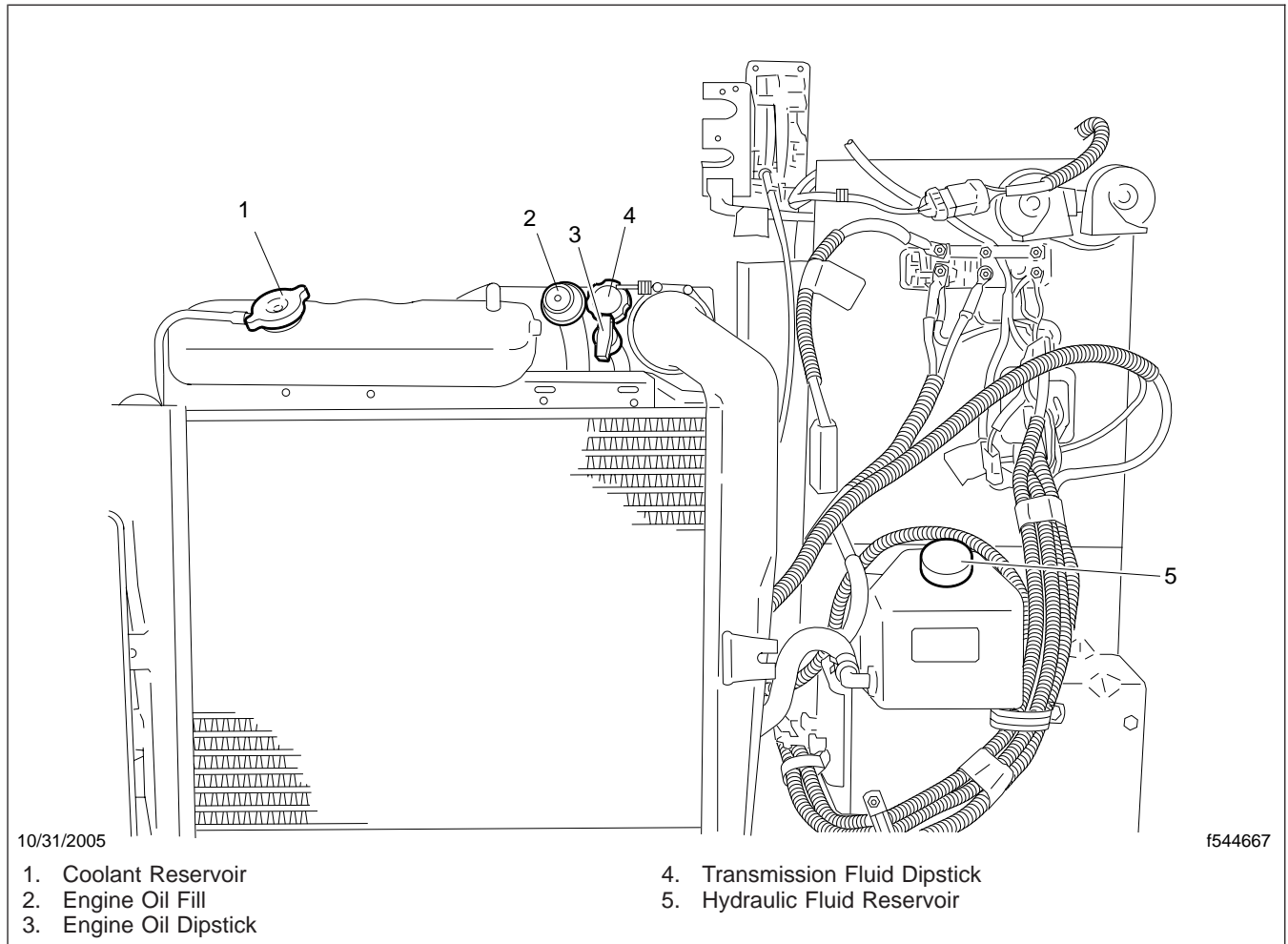
23. Inspect the air brake components including the brake chamber pushrod, air reservoirs, and air lines.

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

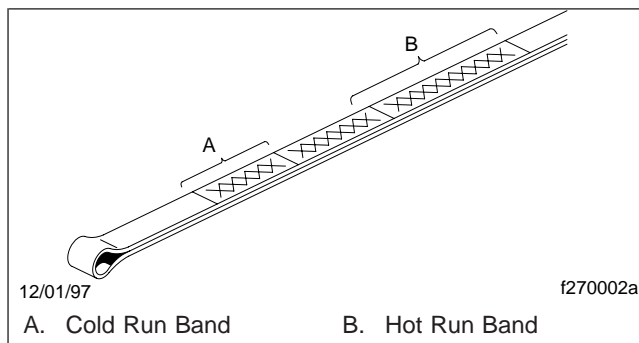
With an assistant at the front wheels to inspect the brake lines, turn the wheels to full lock in one direction. While holding the service brake pedal



# Pre- and Post-Trip Inspections and Maintenance



**Fig. 11.7, Transmission Fluid Level Check (front-engine diesel chassis)**



**Fig. 11.8, Automatic Transmission Dipstick Markings**

down, inspect the front brake air lines closely where they enter the air chambers.

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

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

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

Visually inspect the piston rod engagement with the clevis. At least 7 threads of engagement are required; there should be 1 inch (25 mm) of clearance from the centerline of the clevis pin

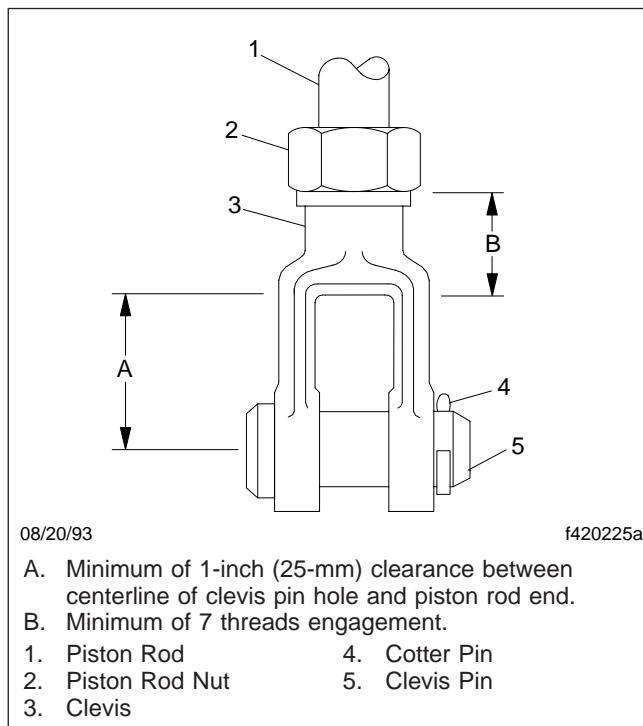
# Pre- and Post-Trip Inspections and Maintenance

hole to the end of the piston rod. See **Fig. 11.9**. Take your vehicle to an authorized Freightliner dealer for assistance.

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

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

Inspect the air lines as follows.



**Fig. 11.9, Piston Rod Engagement With the Clevis**

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

23.2 Check for kinks, dents, or swelling of the hoses. If a hose is damaged, replace it with the same size and type.

Do not route the hose on top of anything likely to be stepped on or walked on.

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

23.4 Check for hose damage caused by abrasion. If a hose is abraded, replace it. Check for the cause of abrasion, such as loose or damaged hose clamps. Repair or replace the clamps as needed.

23.5 Observe the hose cover condition, especially hoses exposed to water splash and ice. If any hose is dried out or ragged (the wire or liner is showing through the cover), replace the hose.

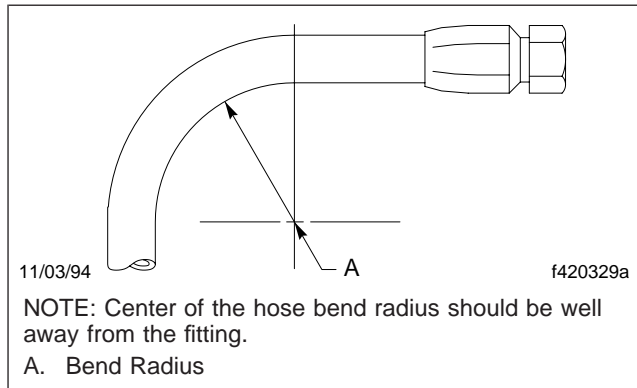
23.6 Inspect air tubing, especially tubing made of nylon. In cold weather, nylon tubing is sensitive to damage, such as nicks or cuts. Replace nicked or cut tubing, even if it is not leaking.

23.7 Check the bend radii of all hoses. See **Fig. 11.10**. The minimum bend radius of a hose is that bend which the hose will withstand without experiencing damaging stresses or kinking. For minimum bend radius values, take your vehicle to an authorized Freightliner dealer for assistance.

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

23.8 Check straight hose installations (those hoses that do not bend along their routings). Pressure changes can cause a hose to lengthen up to 2 percent, or shorten up to 4 percent. A 100-inch (2540-mm) length of hose, for example, can contract to 96 inches (2440 mm). If the hose has no slack when it is exhausted of air,

# Pre- and Post-Trip Inspections and Maintenance



**Fig. 11.10, Bend Radius**

replace it with one of adequate length to avoid a possible blow-off from the fitting during vehicle operation.

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

## 24. Inspect the air brake lines.

- 24.1 Check the clearance between the hoses and the exhaust manifold or other hot spots. Excessive heat will cause material in hoses to deteriorate rapidly or become brittle. Provide at least 6 inches (150 mm) of clearance. More clearance is recommended if the hose is located above the heat source.
- 24.2 Check for kinks, dents, or swelling of the hoses. If damaged, have the hose replaced with the same size and type.

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

- 24.3 Check for damage to hoses located near moving parts, such as drivelines, kingpins, suspensions, and axles. If moving parts are catching or pinching the lines, correct as needed.
- 24.4 Check for hose damage caused by abrasion. If abraded, have the hose replaced. Check for the cause of abrasion, such as loose or damaged hose clamps. Have the clamps repaired or replaced as needed.

- 24.5 Observe the hose cover condition, especially hoses exposed to water splash and ice. If dried out or ragged (the wire is showing through the cover), have the hose(s) replaced.
- 24.6 Inspect the air tubing, especially tubing made of nylon. In cold weather, nylon tubing is sensitive to damage, such as nicks or cuts. Have nicked or cut tubing replaced, even if it is not leaking.

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

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

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

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

**IMPORTANT:** ABS-equipped vehicles operating in regions where especially corrosive ice removal chemicals are used may experience higher than normal rotor corrosion. Tone rings should be routinely inspected for corrosion. Severe corrosion of the integral ABS tone ring may cause the ABS warning lamp in the dash to illuminate due to false wheel speed readings. If the ABS warning lamp illuminates at any time other than at vehicle start-up, have the problem repaired immediately.

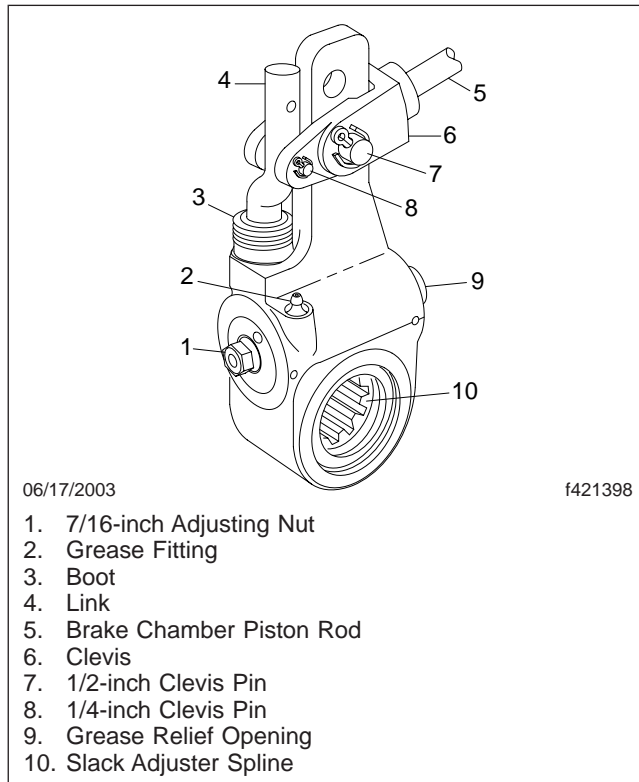
## 25. Inspect the slack adjusters.

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

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

# Pre- and Post-Trip Inspections and Maintenance

your vehicle to an authorized Freightliner dealer for assistance. See [Fig. 11.11](#).



**Fig. 11.11, Gunite Automatic Slack Adjuster**

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

## 26. Check the air brake system for proper operation.

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

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

### 26.2 Check the air pressure buildup time as follows:

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

### 26.3 Check the air pressure reserve as follows:

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

### 26.4 Check the air leakage in the system as follows:

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

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

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

If leakage exceeds the limits shown in [Table 11.3](#), repair all areas of leakage before driving the vehicle.

# Pre- and Post-Trip Inspections and Maintenance

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

**Table 11.3, Maximum Allowable Service Brake Leakage**

## 27. Test the service brakes.

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

## Weekly Post-Trip Inspection and Maintenance Procedures

### 1. Inspect the batteries and battery cables.

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

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

If the battery posts or cable terminals are corroded, disconnect the terminals from the posts. Clean them with a soda solution and a wire brush. After cleaning, connect the terminals to the battery posts, then apply a thin coat of petroleum jelly to the posts and terminals to help retard corrosion.

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

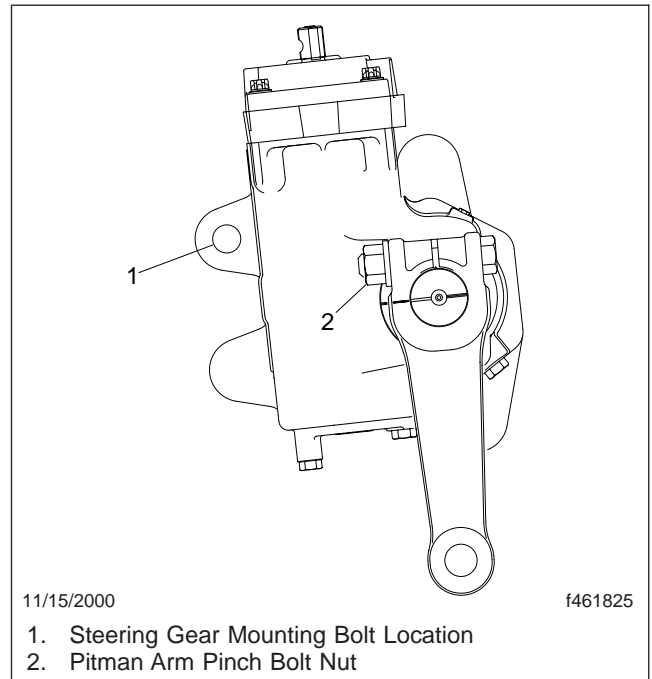
If needed, fill the hubs to the level indicated on the hub cap. See [Chapter 15](#) for recommended lubricants.

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

### 3. Examine the steering components.

See [Fig. 11.12](#). If repairs are needed, take your vehicle to an authorized Freightliner dealer for assistance.

#### 3.1 Check the mounting bolts and pitman arm nut, for tightness.



**Fig. 11.12, TRW Steering Gear Installation**

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

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

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

## Monthly Post-Trip Inspection and Maintenance Procedures

### 1. Clean the batteries.

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



# Pre- and Post-Trip Inspections and Maintenance

## CAUTION

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

- 1.2 If the battery posts or cable terminals are corroded, disconnect the terminals from the posts. Clean them with a soda solution and a wire brush. After cleaning, connect the terminals to the battery posts, then apply a thin coat of petroleum jelly to the posts and terminals to help retard corrosion.

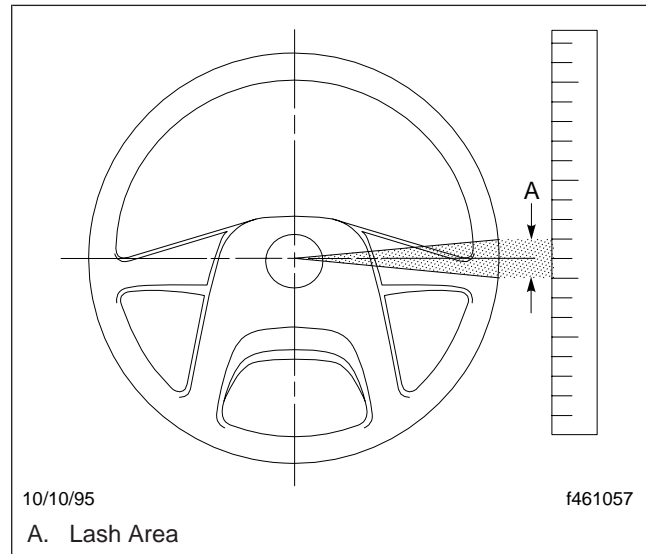
## WARNING

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

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

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

3. *Check the steering wheel for excessive play. See Fig. 11.13.*



**Fig. 11.13, Measuring Lash at the Steering Wheel**

- 3.1 With the front tires straight ahead, turn the steering wheel until motion is observed at the front wheels. Hold the steering wheel in this position.
  - 3.2 Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels.
  - 3.3 Determine the lash (free play) at the rim of the steering wheel. Excessive lash exists if steering wheel movement exceeds 2-1/4 inches (57 mm) with an 18 inch (450 mm) steering wheel.  
See local/federal regulations for acceptable ranges of lash.
4. *Check the brake lining wear on all vehicles, including those with automatic slack adjusters. Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.*
    - 4.1 Check that brake linings are free of oil and grease.
    - 4.2 Inspect the thickness of the brake linings. If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs. If *any brake linings are*

## Pre- and Post-Trip Inspections and Maintenance

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*worn to less than approximately 1/4 inch (6.4 mm) at the thinnest point, have the linings replaced on all brake assemblies on that axle. Take your vehicle to an authorized Freightliner dealer for assistance.*

- 4.3 Check the brake drums for wear and cracks.
- 4.4 Check that the inspection plugs in the dust shields or backing plates, if so equipped, are installed.

# 12

## Cleaning and Care

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Washing and Polishing .....	12.1
Wheel Cleaning .....	12.1
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# Cleaning and Care

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## Washing and Polishing

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

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

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

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

## Wheel Cleaning

### Accuride® Machined and Polished Aluminum Wheels

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

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

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

## Care of Chrome Parts

To prevent rust, keep chrome parts clean and protected at all times. This is especially important during winter driving and in coastal areas where there is exposure to salt air.

When cleaning chrome parts, use clean water and a soft cloth or sponge. A mild detergent may also be used.

Sponge gently, then rinse. If necessary, use a non-abrasive chrome cleaner to remove stubborn rust or other material. Do not use steel wool.

To help protect the chrome after cleaning, apply a coat of polishing wax to the surface. Never use wax on parts that are exposed to high heat, such as exhaust pipes.

## Dashboard Care

Periodically wipe the dashboard with a water-dampened cloth. A mild detergent can be used, but avoid using strong detergents.

—————  **CAUTION** —————

Do not use Armor-All Protectant®, STP Son-of-aGun®, or other equivalent treatments. These cleaners contain vinyl plasticizers which can cause stress crazing in the interior plastic panels which can result in cracking of the panels.

# 13

## In an Emergency

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# In an Emergency

## Freightliner Help

In the event of a vehicle emergency, call the Customer Assistance Center at 1-800-385-4357 or 1-800-FTL-HELP. Call night or day, weekdays or weekends, for dealer referral, vehicle information, or breakdown coordination.

## Hazard Warning Lights

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

## 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 vehicles to touch each other. Do not lean over the batteries when making connections, and keep all other persons away from the batteries. Failure to follow these precautions could lead to severe personal injury as a result of an explosion or acid burns.

### CAUTION

Make sure that both starting systems have the same voltage outputs and avoid making sparks. Otherwise the vehicle charging systems could be severely damaged. Also, do not attempt to charge isolated, deep-cycle batteries with jumper cables; follow the manufacturer's instructions when charging deep-cycle batteries.

1. Apply the parking brakes and turn off the lights and all other electrical loads.
2. Connect one end of a jumper cable to the positive terminal of the booster battery and connect the other end of the cable to the positive terminal of the discharged battery. See [Fig. 13.1](#).

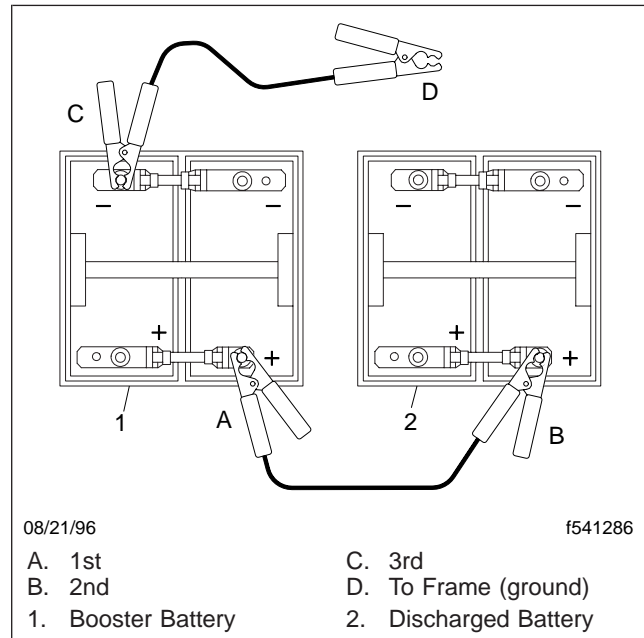


Fig. 13.1, Jumper Connections

### WARNING

Do the next step exactly as instructed and do not allow the clamps of one cable to touch the clamps of the other cable. Otherwise, a spark could occur near a battery, possibly resulting in severe personal injury from explosion and acid burns.

3. Connect one end of the second jumper cable to the negative terminal of the booster battery, then connect the other end of the cable to a ground at least 12 inches (300 mm) away from the batteries of the vehicle needing the start. The vehicle frame is usually a good ground. Do *not* connect the cable to or near the discharged batteries.
4. Start the engine of the vehicle with the booster batteries and let the engine run for a few minutes to charge the batteries of the other vehicle.

## CAUTION

**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. Attempt to start the engine of the vehicle with the batteries receiving the charge.
6. When the engine starts, let it idle for a few minutes.

## WARNING

**Do the next step exactly as instructed and do not allow the clamps of one cable to touch the clamps of the other cable. Otherwise, a spark could occur near a battery, possibly resulting in severe personal injury from explosion and acid burns.**

7. Disconnect the grounded (negative) cable from the frame or other non-battery location; then disconnect the other (negative) end of the cable.
8. Disconnect the remaining (positive) cable from the newly charged battery first; then disconnect the other (positive) end.

## Changing a Flat Tire

### WARNING

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

### WARNING

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

**IMPORTANT:** If a flat tire occurs while driving, gradually decrease vehicle speed. Holding the steering wheel firmly, move to a safe place on the side of the road.

1. If possible, stop the vehicle on a level surface, away from traffic.
2. Set the parking brake and turn the ignition switch to the OFF position.
3. Turn on the emergency flashers.
4. Remove the spare wheel, jack, jack handle, and lug wrench from storage, if so equipped.
5. Use a block to chock the wheel diagonally opposite the wheel being changed.

**NOTE:** The jacking point for the front and rear wheels is directly under the axle.

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.
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 the 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 wheel nuts to the correct torque specifications in the proper tightening sequences. See **Group 40** of the *Recreational Vehicle Chassis Maintenance Manual* for instructions.
11. Finish lowering the vehicle to the ground, then remove the jack.
12. Remove the wheel chock (the block), then stow the jack, jack handle, and lug wrench.
13. After operating the vehicle for 50 to 100 miles (80 to 160 km), retighten the nuts. Tighten the wheel nuts to the correct torque specifications in the proper tightening sequences. See **Group 40** of the *Recreational Vehicle Chassis Maintenance Manual* for instructions.

# In an Emergency

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## Running Out of Fuel

 **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 your vehicle runs out of fuel, stop the vehicle on a level location away from traffic. The engine may be restarted by adding at least two gallons (eight liters) of fuel to the fuel tank. If the vehicle is not level, up to six gallons (22 liters) of fuel may be required. Prolonged engine cranking may be required to pump fuel from the fuel tank to the engine before the engine will start.

 **CAUTION**

**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 your vehicle will not start by cranking the engine, the fuel system may need to be primed. See the *Cummins*, or the *Mercedes-Benz Operation and Maintenance Manual*.

# 14

## Towing

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Towing the Vehicle .....	14.1
Towing With the Vehicle .....	14.2

# Towing

## Towing the Vehicle

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

On vehicles equipped with an independent front suspension, do not tow the vehicle by the suspension assembly. Components of the suspension can be damaged.

When towing or pushing any vehicle equipped with an Allison transmission, disconnect the driveshaft at the rear axle and support it as necessary, regardless of the distance or speed traveled.

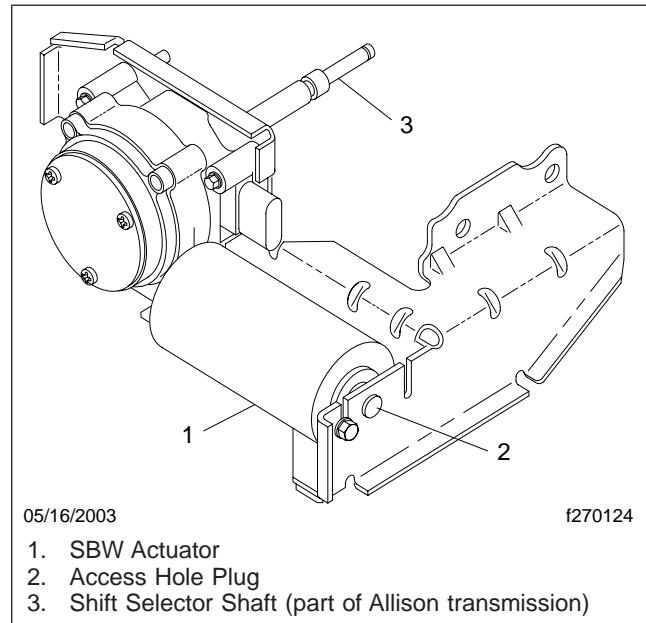
## Removing the Transmission from the Park (P) Position

If a vehicle with a shift-by-wire (SBW) system needs to be towed and the system cannot be activated to take the transmission out of Park (P), follow the steps in the procedure below.

### **WARNING**

**Do not attempt to modify the RollTek system. Doing so could change the effectiveness of the system. The RollTek system must be replaced after being activated. Failure to do so may result in personal injury or death. Infants and children must not be placed in seats equipped with the RollTek system. The RollTek system is designed for adults only. Failure to follow these instructions may result in personal injury or death.**

1. Set the parking brake on the tow vehicle.
2. Chock the tires of the tow vehicle.
3. Set the parking brake on the disabled vehicle.
4. Chock the tires of the disabled vehicle.
5. Underneath the disabled vehicle, at the transmission, remove the access hole plug at the rear of the SBW actuator. See [Fig. 14.1](#).
6. Insert a 3/16-inch allen wrench or hex key through the access hole into the rear of the actuator. Turn the allen wrench in a clockwise direction until the transmission comes out of the Park (P) position.



**Fig. 14.1, SBW Actuator (at transmission)**

7. Replace the access hole plug.
8. Remove the chocks from the tires of both vehicles.

**NOTE:** The transmission may also be placed in the Park (P) position using this procedure.

## Front Towing Hookup

1. Disconnect the battery ground cable.
2. If the vehicle is to be lifted and towed, remove the driveshaft.

### **CAUTION**

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

### **WARNING**

**Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the tow vehicle operator. The operator must be familiar with standard towing industry safety measures. Improper procedures could result in personal injury or death.**



3. Attach the towing device.
4. Lift the vehicle and secure the safety towing chains. If additional clearance is needed, remove the front wheels.
5. Connect the clearance lights, taillights, and signal lights. Connect any special towing lights required by local regulations.

## WARNING

Before releasing the parking brakes, make the connection to the towing vehicle or chock the tires on the disabled vehicle. Failure to do so could result in hazardous conditions because the vehicle could suddenly roll and injury could occur.

6. Release the parking brake.

## CAUTION

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

## Rear Towing Hookup

1. Position the front tires so that they point straight ahead and secure the steering wheel in this position.
2. Disconnect the battery ground cable.

## WARNING

Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the tow vehicle operator. The operator must be familiar with standard towing industry safety measures. Improper procedures could result in personal injury or death.

3. Attach the towing device.
4. Lift the vehicle and secure the safety towing chains. If additional clearance is needed, remove the bumper extension, if so equipped.

5. Connect the clearance lights, taillights, and signal lights. Also connect any special towing lights required by local regulations.

## CAUTION

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

## Towing With the Vehicle

### WARNING

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

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

## General Information

**IMPORTANT:** An auxiliary braking system is strongly recommended when towing. Follow your state's motor vehicle regulations and the body builder's recommendations to determine if an auxiliary system is required for towing.

Towing a load puts an additional strain on your vehicle's engine, drivetrain, brakes, tires, and suspension. For your safety and the care of your vehicle, properly match the towed load to the vehicle as follows:

1. Never load the vehicle over the Gross Vehicle Weight Rating (GVWR). Considerable damage to

# Towing

the drivetrain may result if the vehicle is over its GVWR. Check the GVWR safety compliance certification label (provided by the final manufacturer) to find the GVWR.

2. Use the Gross Combined Weight Rating (GCWR) and Gross Vehicle Weight (GVW) to determine the towing capacity. Refer to the final manufacturer for GCWR. If the GCWR is exceeded, serious damage to the drivetrain and brake system may result. Loading past the GCWR may lead to unsafe operating and braking conditions.
3. Subtract the GVW (which is the actual weight of the vehicle alone) from the GCWR (which is the total weight this vehicle can safely pull) to determine the acceptable weight this vehicle can tow.
4. Make sure that the towing equipment is properly and safely attached to your vehicle.
5. When descending a steep grade, shift the transmission into the next lower gear or use the exhaust brake to provide additional engine braking.

**NOTE:** In a high-altitude operating environment, your engine will lose power at the rate of 1 percent per 1000 feet (305 meters) of elevation. For these high-altitude operating conditions, a reduction in gross vehicle weights and gross combination weights is recommended and will result in improved vehicle performance.

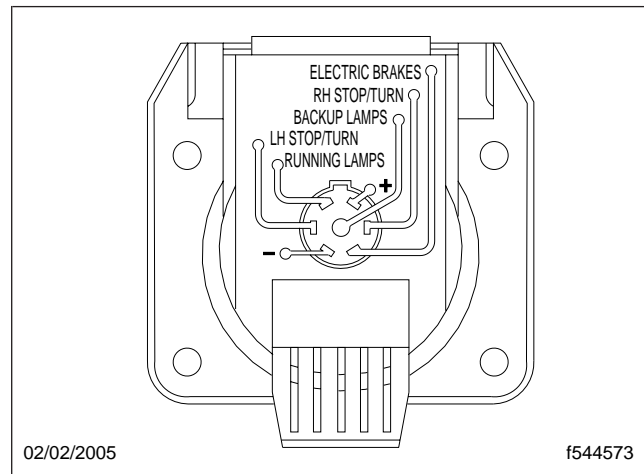
6. To avoid vehicle damage and handling difficulty, evenly distribute the trailer load. Always tie the load down securely.

## 7-Pin Connector

The following information lists the amperage (amp) load limits for each of the connections in the 7-pin connector. See [Fig. 14.2](#) for an example of the 7-pin connector.

- Electric Brakes (to brake the system) — A 12 gauge wire interfaces with the 7-pin connector trailer tow plug. See the brake manual for exact specifications.
- RH Stop/Turn — 20 amp
- Back Up Lamps — 10 amp
- LH Stop/Turn — 20 amp
- Running Lamps — 20 amp

- Ignition [+] (to charge the tow vehicle batteries) — 40 amp
- Ground [-] — for all



**Fig. 14.2, 7-Pin Connector**

## Hitches

Use a hitch and ball recommended by your vehicle manufacturer or your dealer, and make sure that its location is compatible with that of the trailer. Use a good weight-carrying hitch that uniformly distributes the trailer tongue loads through the bumper and the frame. Do not exceed the recommended towing capacity of the vehicle.

### **CAUTION**

**Always disconnect the battery and the engine ECM (electronic control module) before welding anything to the chassis frame.**

**Do not use single-clamp bumper hitches or hitches that attach to the vehicle axle. However, multi-clamp bumper hitches for occasional use of a rental trailer are acceptable if properly attached. Follow the towing instructions of a reputable rental agency. Never attach safety chains to the bumper.**

Whenever a trailer hitch is removed, be sure to have all mounting holes in the underbody properly sealed to prevent possible entry of exhaust fumes, dirt, or water.

## Trailers



**Always use safety chains between the vehicle and the trailer. Failure to do so could cause personal injury or death if the hitch fails.**

**IMPORTANT:** Before connecting a trailer lighting system directly to the lighting system of the vehicle, see your dealer or rental trailer agency for the correct type of wiring and relays for your trailer and for heavy-duty flashers.

### Parking With A Trailer

Park the vehicle on a flat surface. Chock the tires as follows:

1. Select Neutral (N) on the gear shift selector while depressing the service brake.
2. Continue depressing the service brake and have another person place wheel chocks under the trailer wheels.
3. Once the wheel chocks are in place, release the service brake, making sure that the chocks are holding the vehicle and trailer.

### Trailer Towing Tips

Towing a trailer significantly alters the manner in which the towing vehicle performs.

- Before starting on a trip, practice turning, stopping, and backing in an area away from heavy traffic to gain experience in handling the extra weight and length of the trailer. Take enough time to learn the "feel" of the vehicle/trailer combination before starting out on a trip.
- Skillful backing requires practice. Back very slowly, with someone outside at the rear of the trailer to guide your efforts. Place your hand at the bottom of the steering wheel and move it in the direction you want the rear of the trailer to swing. Make small corrections instead of exaggerated ones. A slight movement of the steering wheel will result in a much larger movement of the rear of the trailer.
- Allow considerably more room for stopping when the trailer is attached. If you have a manual brake controller, "lead" with the trailer

brakes (if so equipped) when approaching a stop, if possible. Trailer brakes are also handy for correcting trailer side-sway. Just touch them for a moment without using your vehicle brakes and the trailer should settle down and track steadily again.

- To assist in attaining good handling of the vehicle trailer combination, it is important that the trailer tongue load be maintained at approximately 10 to 15 percent of the loaded trailer weight.
- Check everything before starting out on the road. After you have traveled about 50 miles (80 km), stop in a protected location and double-check your trailer hitch and electrical connections for security. Also, examine the trailer wheel lug nuts for tightness.
- Because trailer wheels will be closer than the towing vehicle wheels to the inside of the turn, drive slightly beyond the normal turning point.
- Allow extra distance for passing other vehicles. Downshift to a lower gear for better acceleration, if necessary.
- Ahead of the vehicle, allow at least the equivalent of one vehicle and trailer length combined for each 10 mph (16 km/h) of speed.
- If your vehicle begins to lose speed as you climb a hill, downshift to a lower gear for more power at the rear wheels.
- Before descending a steep grade, slow down and shift to a lower gear. Driving with the transmission in a lower gear will assist in reducing downhill speed. If the trailer should begin to sway, touch the trailer brakes (if so equipped), not the vehicle brakes, and the trailer should settle down.

# 15

## Specifications

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Fuse/Relay/Circuit Breaker Identification .....	15.1
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# Specifications

## Fluids and Lubricants

In the engine cooling system use 50 percent water and 50 percent corrosion-inhibiting antifreeze to protect the engine to  $-34^{\circ}\text{F}$  ( $-37^{\circ}\text{C}$ ) year round.

See **Table 15.1** for engine coolant capacities.

See **Table 15.2** for approved coolants.

See **Table 15.3** for approved Allison transmission lubricants.

See **Table 15.4** for approved Allison transmission lubricant capacities.

See **Table 15.5** for approved driveline lubricants.

See **Table 15.6** for approved power steering fluids.

Coolant Capacities*	
Engine Make	Coolant Volume: qt (L)
Mercedes-Benz	37 (35)
Cummins	12 (11)

\* The total coolant volume is dependent on the number and location of optional passenger heaters.

**Table 15.1, Coolant Capacities**

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

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

**Table 15.2, Approved Coolants**

Approved Allison Transmission Lubricants	
Lubricant Type*	Temperature: °F (°C)
Castrol TranSynd™ (synthetic)	Above $-22$ ( $-30$ )
Dexron® VI	Above $-13$ ( $-25$ )

\* Lubricants listed in order of preference. Do not mix types of oil.

**Table 15.3, Approved Allison Transmission Lubricants**

Allison Transmission Lubricant Capacities	
Transmission Model	Fill Capacity:* qt (L)
1000/2000 Series (standard sump)	14.8 (14)

Allison Transmission Lubricant Capacities	
Transmission Model	Fill Capacity:* qt (L)
1000/2000 Series (shallow sump)	12.7 (12)
2100/2200/2500 Series (shallow sump)	13 (12)
3000 Series (4 inch)	29 (27)
3000 Series (2 inch)	26 (25)

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

**Table 15.4, Allison Transmission Lubricant Capacities**

Approved Driveline Lubricants	
Lubricant and Specification	Lubricant Brands
Universal joint, slip joint, and spline grease must meet ArvinMeritor Specification O-634-B (NLGI Grade No. 2, Lithium 12-Hydroxy Stearate with Molybdenum Disulfide)	Phillips Petroleum Philube MW-EP2 Grease
	Exxon 5160
	Amalie All Purpose Grease with Moly-L1-2M
	Shell Super Duty Special FF
	Marathon Maralube Molycode 529
	Shell Moly Poly Grease
	Kendall L424 Grease
	Amoco Super Chassis Grease
Ford Specification M1C-75B or part number C1AZ 19590	

**Table 15.5, Approved Driveline Lubricants**

Approved Power Steering Fluids	
Fluid Type*	Approved Fluid*
Automatic Transmission Fluid	Dexron® VI
	Dexron® II

\* Fill the power steering reservoir only with approved clean fluid. Do not mix fluid types. Wear eye protection when changing the fluid and filter.

**Table 15.6, Approved Power Steering Fluids**

## Fuse/Relay/Circuit Breaker Identification

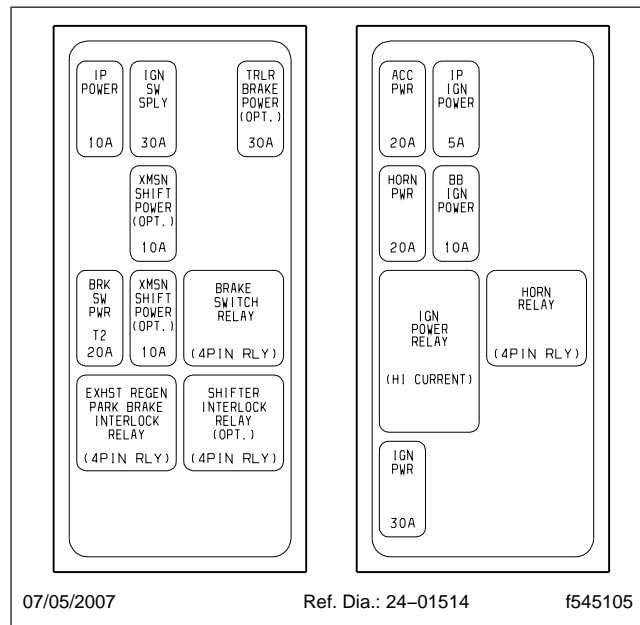
Circuit breakers protect against circuit overload. If a circuit becomes overloaded (usually caused by a short to ground), the circuit breaker opens, stopping current flow. The vehicle may be equipped with auto-reset breakers.

## Fuse/Relay/Circuit Breaker Identification (front-engine diesel chassis)

The electrical system has 5 separate power distribution modules (PDMs) containing both fuses and relays. An optional tow power PDM is also available. The PDMs are mounted in two places:

See **Fig. 15.1** and **Fig. 15.2**.

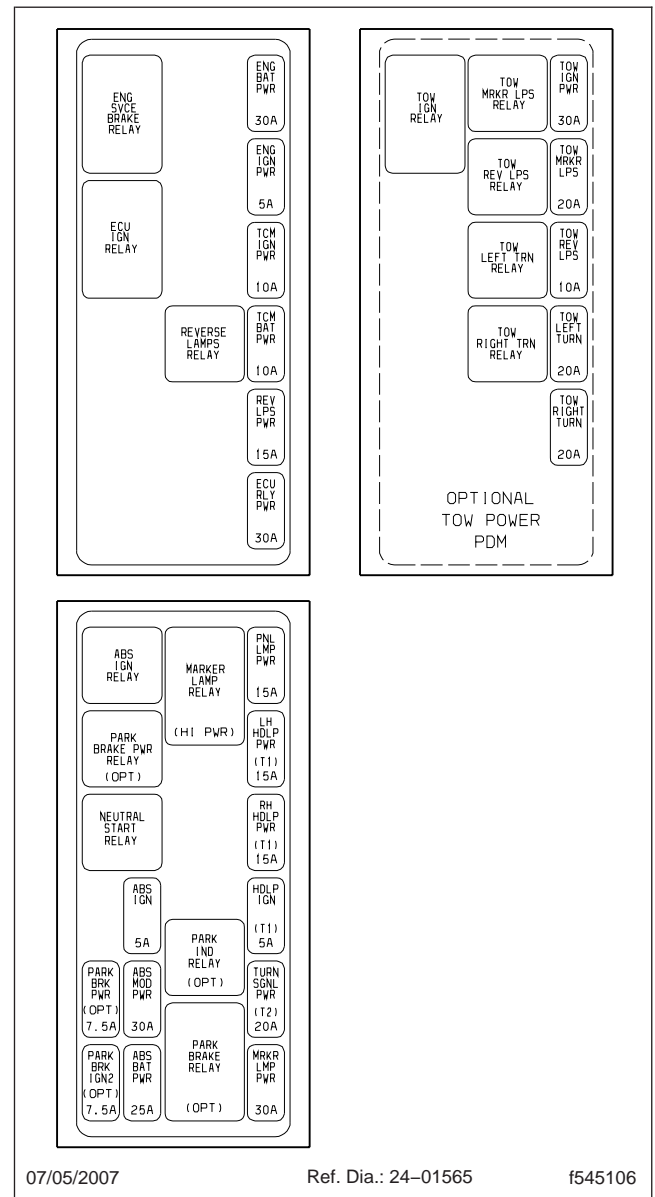
- Two inside the cab area, typically at the base of the steering column
- Three outside, typically mounted to the right of the operator's station



**Fig. 15.1, Cab PDMs (inside cab)**

## Fuse/Relay/Circuit Breaker Identification

The electrical system has a box that contains both fuses and relays. The box is mounted in varying locations (typically in the cab under the dash) depending on the design of the chassis. The fuses and relay boxes shown vary depending on chassis options. See **Fig. 15.3**, **Fig. 15.4**, **Fig. 15.5**, and **Fig. 15.6**.

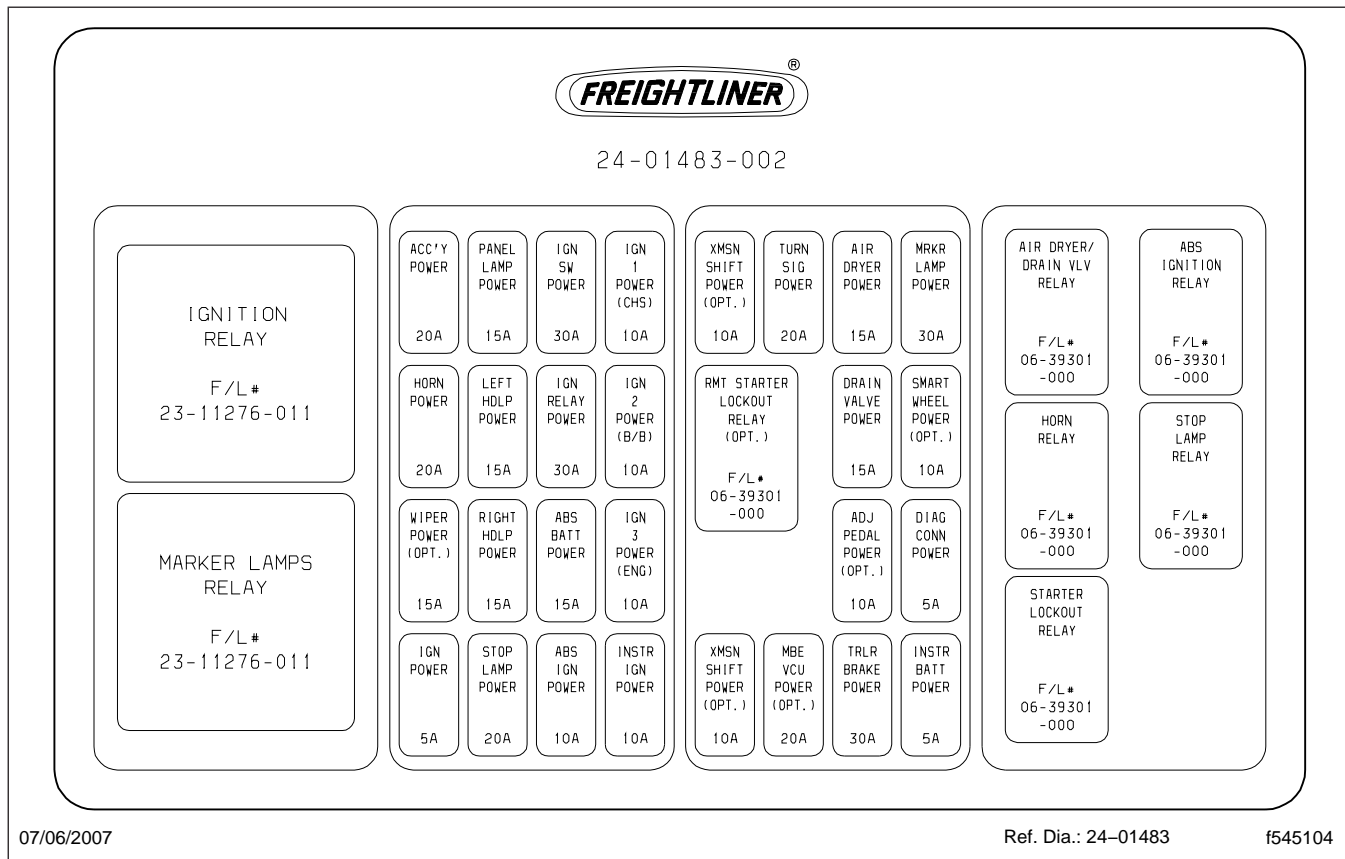


**Fig. 15.2, Chassis and Optional Tow Power PDMs (chassis mounted)**

## Electric Service Center

The information under this heading is to help familiarize the driver with the basic electrical system. Servicing the electrical system should be done only by qualified technicians. Special skills and equipment are required. Take your vehicle to an authorized

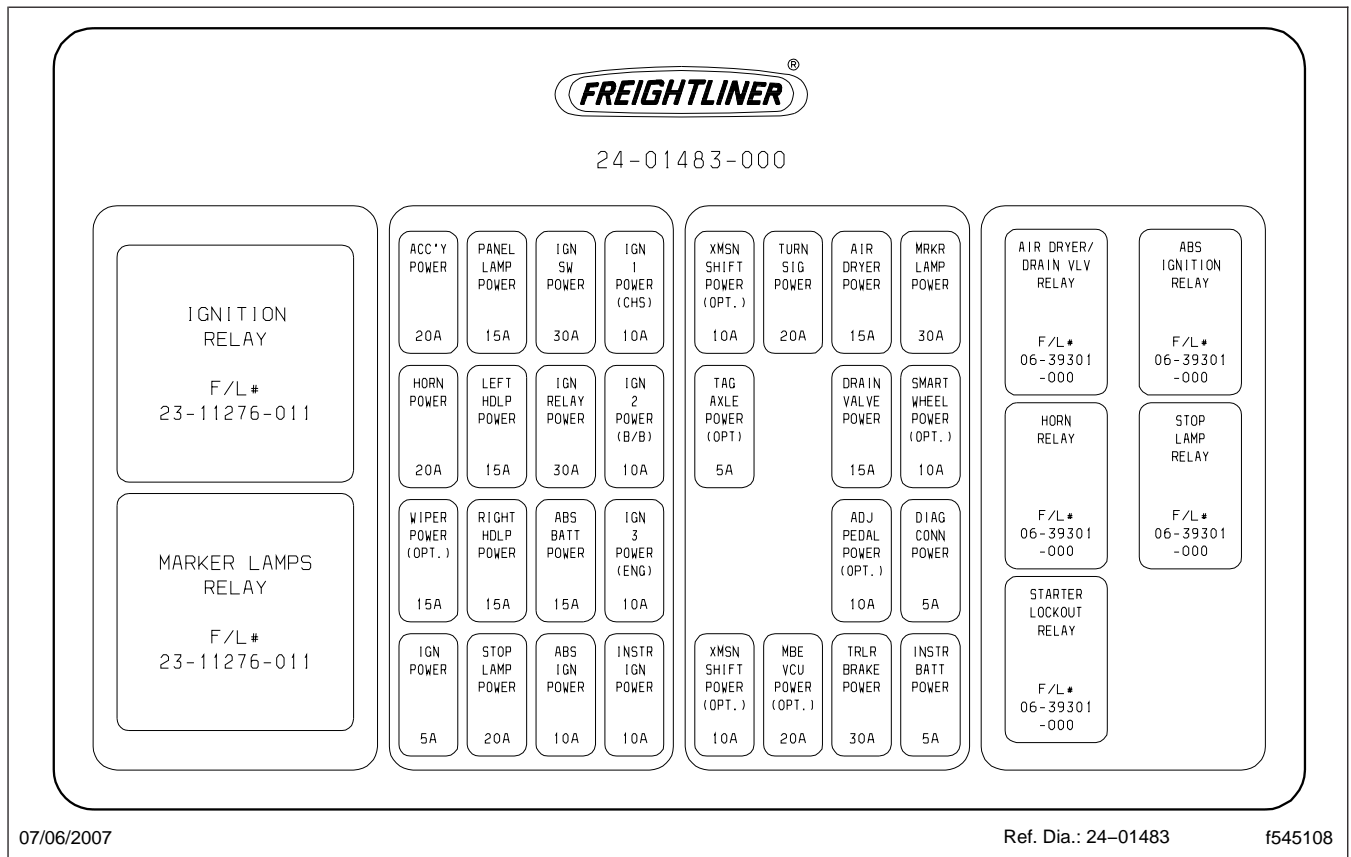
# Specifications



**Fig. 15.3, Fuse/Relay (typical install)**

Freightliner service facility for repairs. The Recreational Vehicle chassis uses multiple electrical components (and fuel and hydraulic filters) each component is mounted in varying locations on the chassis. If equipped with an Arens service center, it is mounted in one specific location, and that mounting location will vary. See [Fig. 15.7](#).





**Fig. 15.4, Fuse/Relay (typical install)**

# Specifications

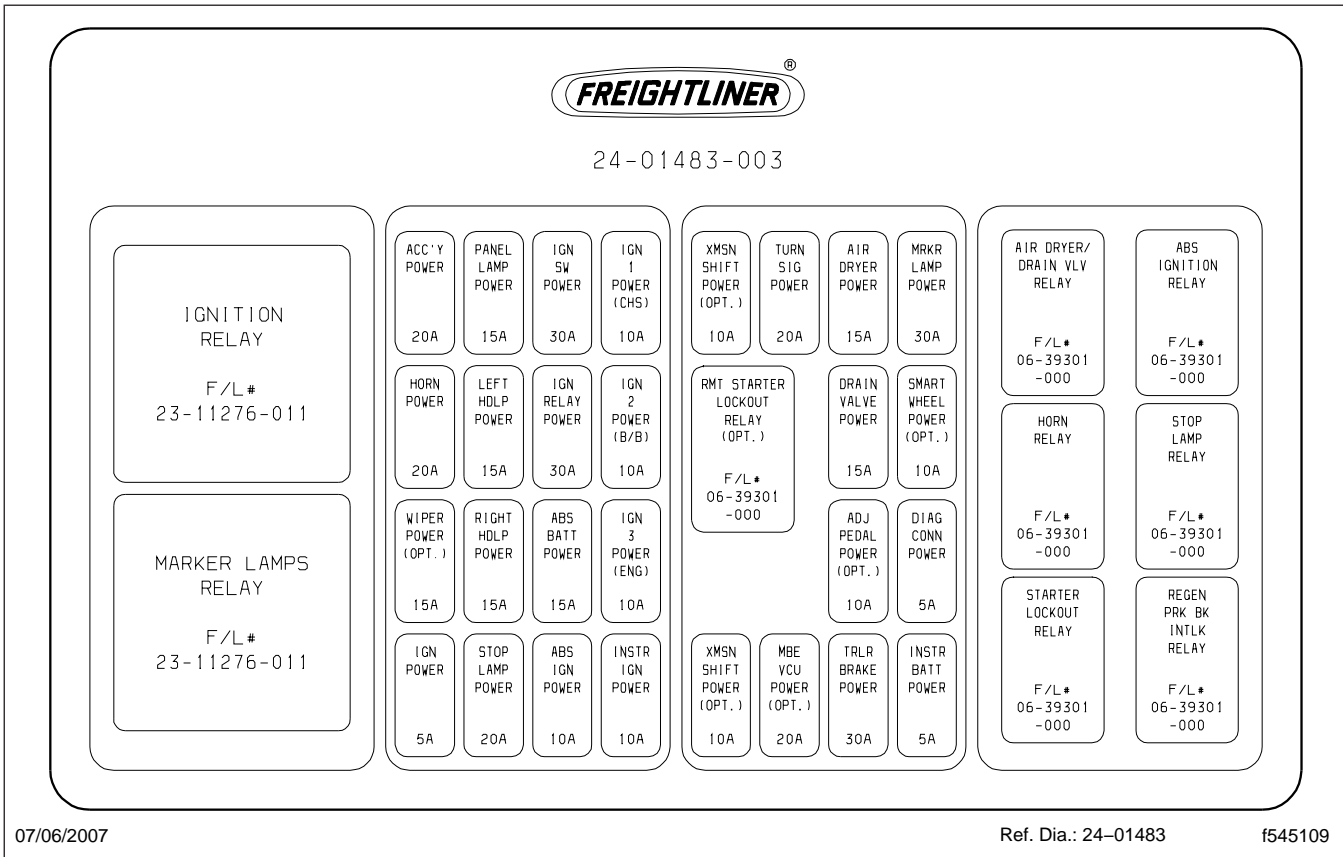
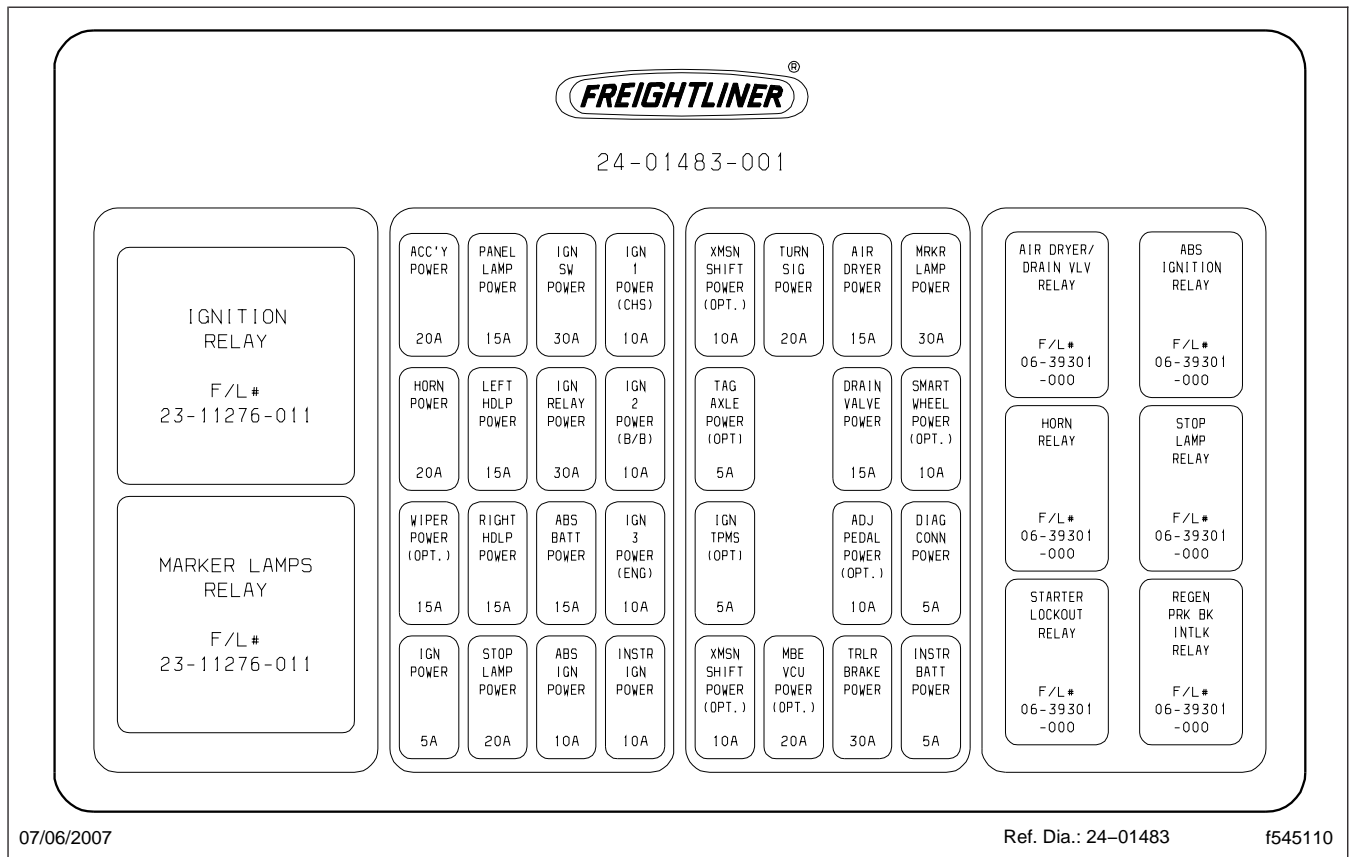
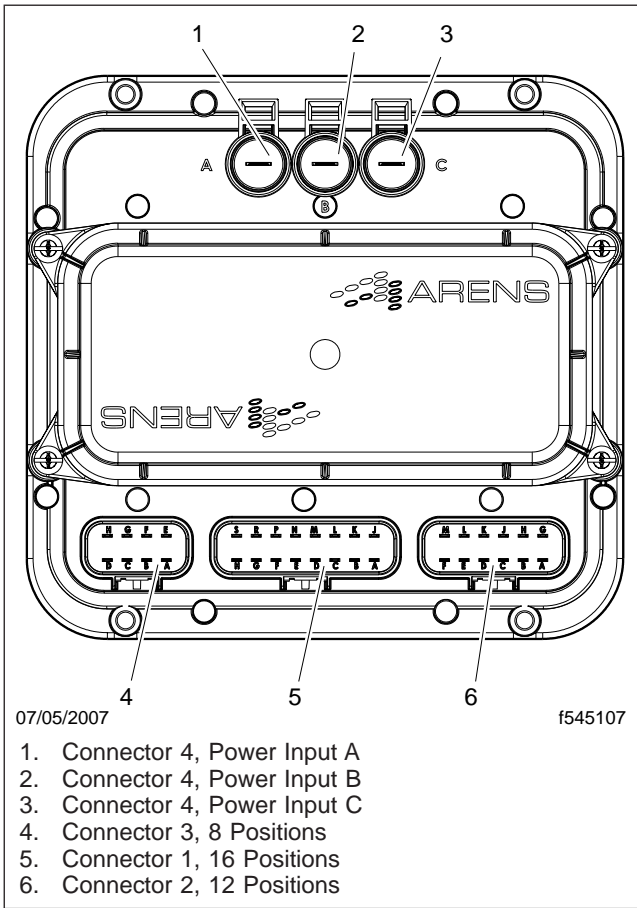


Fig. 15.5, Fuse/Relay (typical install)



**Fig. 15.6, Fuse/Relay (typical install)**

# Specifications



**Fig. 15.7, Arens Controls**

Connector 1	
Connector Position	Description
1A	ECU-IGN
1B	FAN-SIG
1C	FAN NO
1D	EXTRA
1E	ECM BATT
1F	SPARE
1G	SPARE NC
1H	DIAG PWR
1J	FAN NC
1K	FAN RTN
1L	MBE ECM BATT
1M	HYD FAN MOD
1N	SPARE COM
1P	IGN
1R	SPARE NO

Connector 1	
Connector Position	Description
1S	SPARE SIG

**Table 15.7, Connector 1**

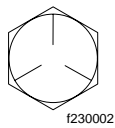
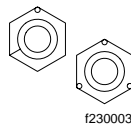
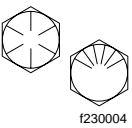
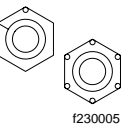
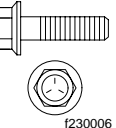
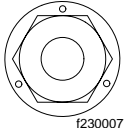
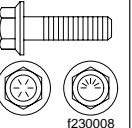
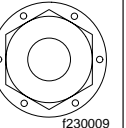
Connector 2	
Connector Position	Description
2A	IGN SW START
2B	TCM BATT
2C	TCM BATT
2D	L TURN SIG
2E	REV LPS SIG
2F	REV LPS OUT
2G	GND
2H	START OUT
2J	NEU START SIG
2K	TCM
2L	MARKER SIG
2M	R TURN SIG

**Table 15.8, Connector 2**

Connector 3	
Connector Position	Description
3A	REV TOW
3B	EXTRA
3C	EXTRA
3D	EXTRA
3E	R TURN OUT
3F	MARKER OUT
3G	L TURN OUT
3H	IGN OUT TOW

**Table 15.9, Connector 3**

## Torque Charts

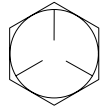
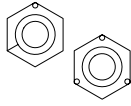
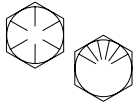
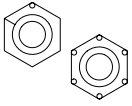
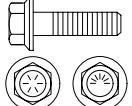
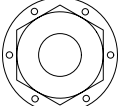
Torque Values for U.S. Customary Thread Fasteners With Lubricated* or Plated Threads†								
Thread Diameter—Pitch	Regular Hex				Flanged			
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 5 Bolt	Grade B Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (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)		—		—	

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

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

**Table 15.10, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads**

# Specifications

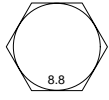
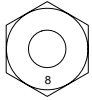
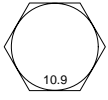
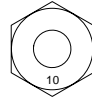
Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated)* Plain (Unplated) Threads†						
Thread Diameter—Pitch	Regular Hex				Flanged	
	Grade 5 Bolt	Grade 5 or B Nut	Grade 8 or 8.2 Bolt	Grade 8 or C Nut	Grade 8 or 8.2 Bolt	Grade G Nut
	Torque: lbf-ft (N·m)		Torque: lbf-ft (N·m)		Torque: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

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

† Male and female threads (bolt and nut) must both be unlubricated and unplated. If either is plated or lubricated, use [Table 15.12](#). Freightliner recommends that all plated and unplated fasteners be coated with oil before installation.

**Table 15.11, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads**

# Specifications

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

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

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

**Table 15.12, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads**

# Specifications

## 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 15.13, Metric/U.S. Customary Conversion

When You Know	Subtract	Then Divide By	To Get	When You Know	Multiply By	Then Add	To Get
degrees Fahrenheit (°F)	32	1.8	degrees Celsius (°C)	degrees Celsius (°C)	1.8	32	degrees Fahrenheit (°F)

Table 15.14, Temperature Conversion



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