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

Freightliner chassis are equipped with various chassis and cab components; not all of the information contained in this manual applies to every vehicle. 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 your selling dealer before making any alterations to the vehicle or chassis.

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

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

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

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

This vehicle is equipped with an event data recorder (EDR). The main purpose of an EDR is to record data in certain crash or near-crash situations, such as air bag deployment or hitting a road obstacle, that will assist in understanding how a vehicle’s systems performed. The EDR is designed to record data related to vehicle dynamics and safety systems for approximately 60 seconds. This data can help provide a better understanding of the circumstances in which crashes and injuries occur. Data recorded includes the following items:

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

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

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

Emissions and Fuel Efficiency Compliance
This vehicle must be regularly inspected and maintained as indicated in the S2 Chassis Maintenance Manual, and in the Pre- and Post-Trip Inspections and Maintenance chapter in this manual, in order to continue satisfactory performance and ensure coverage of the vehicle under the manufacturer’s warranty. Many maintenance procedures ensure that the vehicle and engine continue to comply with applicable emissions standards. Maintenance procedures, using components engineered to comply with greenhouse
gas emissions and fuel efficiency regulations, may be performed by an authorized Daimler Trucks North America dealer, an independent outlet, or the vehicle owner or operator.

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

Customer Assistance Center

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

Reporting Safety Defects

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

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

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

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

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

Component Information Label .......................................................... 1.1
Vehicle Identification Number .......................................................... 1.1
Emissions Labels ............................................................................. 1.1
Component Information Label

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

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

Incomplete chassis intended for service in the U.S. have an incomplete vehicle certification label attached by the final-stage manufacturer. This label will be attached to the incomplete vehicle document included with the vehicle, and certifies that the vehicle conforms to all applicable FMVSS regulations in effect on the date of completion.

Vehicle Identification Number

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

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

Emissions Labels

Aftertreatment System Indicators Label

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

A reference label included with the driver’s documentation package contains important warning indicators in the instrument cluster that pertain to the ATS. See Fig. 1.4.

It is a violation of U.S. federal law to alter exhaust plumbing, ATS, or other components in any way that would bring the engine/vehicle out of compliance with
certification requirements (Ref: 42 U.S.C. §7522(a) (3)). It is the owner’s responsibility to maintain the vehicle so that it conforms to EPA regulations.

Vehicle Emission Control Information Label

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

A Vehicle Emission Control Information Label indicates compliance with GHG14 regulations. See Fig. 1.5. It is the owner’s responsibility to maintain the vehicle so that it conforms to EPA and NHTSA regulations.

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

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

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

Battery Access ................................................................. 2.1
Hood Opening and Closing ............................................. 2.1
Battery Access
Battery Compartment
The battery compartment is located behind the driver’s area, attached to the frame rail. To open the battery access door, insert and turn the key, then pull the access door open. Pull the pull-pin spring latches out to slide the battery tray forward. See Fig. 2.1.

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

To return the battery to the compartment, slide the battery tray in until the pin spring latch is in the locked position. Lock the battery access door with the key.

Battery Disconnect Switch, Optional
A battery disconnect switch, if so equipped, cuts off all battery power to the vehicle. It is also used whenever the vehicle is placed out of service for extended periods to prevent battery discharge. The battery disconnect switch is located on the side of the battery box. See Fig. 2.2.

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

Hood Opening and Closing
A torsion spring helps to raise and lower the hood. Hood restraint cables prevent the hood from over-travel. An optional hood damper limits the closing speed. In the operating position, the hood is secured to the half-fenders by a hold-down latch on each side.

Tilting the Hood
1. Apply the parking brakes.
2. Release both hood hold-down latches by pulling the ends outward. See Fig. 2.3.
NOTICE

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

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

Closing the Hood

1. Push the hood over center.

2. As the hood goes over center, the damper (if equipped) automatically slows its rate of descent. If needed, you can also slow the rate of descent with your hand.

3. Make sure the hood is flush with the cowl, then secure the hood by engaging both hood hold-down latches.

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

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</table>
Instrumentation Control Unit

Figure 3.1 and Fig. 3.2 show a typical set of instruments for vehicles equipped with the S2 Chassis ICU3 instrument cluster.

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

The ICU3 instrument cluster receives information from the datalink and sensors installed on the vehicle, and sends that information to electronic gauges.

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

The S2 Chassis instrument clusters have the capability to drive independent stand-alone gauges such as those installed on the auxiliary dash panel.

Dash Message Center

The dash message center houses all of the standard and optional warning and indicator lamps. Warning messages and diagnostic fault codes will appear in the driver display screen.

Ignition Sequence

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

NOTE: The air gauges do not sweep.

The following lamps illuminate during the ignition sequence:

- fasten seat belt warning
- low battery voltage warning
- high coolant temperature warning
- low engine oil pressure warning
- low air pressure warning
- parking brake on indicator
- all engine indicator/warning lights, including check engine and stop engine
- all ABS indicator/warning lights, including wheel spin, and tractor ABS (if installed)

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

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

- First line (odometer): 888888.8

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

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

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

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

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

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

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

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

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

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

Odometer

The odometer is a seven-digit display with a decimal point, until the vehicle has traveled 999,999.9 miles or kilometers (km). At one million miles (km), the odometer resets itself to 1,000,000, without the decimal point, and can continue up to 9,999,999. The odometer only displays significant figures (no leading zeros).

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

Mode/Reset Switch

The mode/reset switch, shown in Fig. 3.3, is located on the right side of the instrument cluster. The mode/reset switch is used to scroll through the displays on the message display screen, and to reset the trip distance and trip hours values to zero.

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

- Press the mode/reset switch once and the trip distance will display.
- Press the mode/reset switch a second time and the trip hours (engine hours) will display.

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

Warning and Indicator Lamps

There can be up to 27 warning and indicator lamps (telltails) installed in the dash message center. See Fig. 3.4 and Fig. 3.5.

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

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

Check Engine Warning

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

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

Stop Engine Warning

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

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

**NOTICE**

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

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

**Malfunction Indicator Lamp (MIL)**

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

**ABS Warning**

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

**NOTE:** For more information about this indicator and the ABS system, see Chapter 13.
Transmission Overheat Warning
The transmission overheat indicator illuminates when the temperature of the transmission fluid goes above the preset level set by the transmission manufacturer.

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

Low Oil Pressure Warning
The low oil pressure warning indicator and emergency buzzer activate whenever the engine oil pressure goes below the preset minimum specified by the engine manufacturer. See Table 3.1.

<table>
<thead>
<tr>
<th>Engine Model</th>
<th>Pressure at Idle RPM</th>
<th>Pressure at Rated RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercedes-Benz MBE900†</td>
<td>50 psi (345 kPa)</td>
<td>50 psi (345 kPa)</td>
</tr>
<tr>
<td>Cummins ISB</td>
<td>10 psi (69 kPa)</td>
<td>30 psi (207 kPa)</td>
</tr>
</tbody>
</table>

* Oil pressures are given with the engine at operating temperature. With the engine cold, oil pressure may be higher. Individual engines may vary from the listed pressures; observe and record pressures when the engine is new to create a guide for checking engine condition.
† EPA07 MBE900 engines are equipped with an oil pressure switch. When above minimum pressure, the dash gauge will display the values listed in this table. If below minimum oil pressure, the dash gauge will read 0 psi.

Table 3.1, Oil Pressure Specifications

High Coolant Temperature Warning
The high coolant temperature indicator and emergency buzzer activate whenever the coolant temperature goes above a preset maximum specified by the engine manufacturer. See Table 3.2.

<table>
<thead>
<tr>
<th>Maximum Coolant Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Model</td>
</tr>
<tr>
<td>Mercedes-Benz MBE900</td>
</tr>
<tr>
<td>Cummins ISB</td>
</tr>
</tbody>
</table>

Table 3.2, Maximum Coolant Temperature

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

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

Parking Brake On Warning
The parking brake on indicator activates when the parking brake is engaged.

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

Diesel Particulate Filter (DPF) Lamp
A solid illumination indicates a regeneration is required. Change to a more challenging duty cycle, such as highway driving, to raise exhaust temperatures for at least 20 minutes, or perform a stationary regeneration. See the engine operator’s manual for details.

A blinking lamp indicates that a stationary regeneration is required immediately. An engine derate and shutdown will occur. See the instructions in the engine operator’s manual to perform a stationary regeneration.

High Exhaust System Temperature (HEST) Lamp
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. 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.

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

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

Low Battery Voltage Warning
The low battery voltage warning indicator (battery icon) illuminates when the battery voltage drops below 12 volts.
Water In Fuel Indicator
The water in fuel indicator notifies the driver the fuel may contain water. Drain any water collected in the fuel/water separator.

**NOTICE**

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

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

Cruise Control Indicator
The cruise control indicator illuminates when the cruise control is activated.

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

Right-Turn Indicator
The right-turn indicator flashes on and off when the right-turn signal lights are flashing.
Both turn signal indicators flash when the hazard warning flasher is turned on.

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

- The engine oil pressure falls below the preset level shown in Table 3.1.
- The coolant temperature rises above the preset level shown in Table 3.2.
- The air pressure falls below the preset level, which is 65 psi (448 kPa).
- The parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).

Optional Warning and Indicator Lamps
A description of some commonly used optional warning and indicator lamps are listed below.

**Air Filter Warning**
The air filter warning indicator (AIR FILTER legend) illuminates when the air cleaner filter element is clogged, restricting the intake air flow. See Table 3.3.

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

<table>
<thead>
<tr>
<th>Engine</th>
<th>Pre-EPA07 Engines</th>
<th>EPA07 and Newer Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cummins</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Mercedes-Benz</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 3.3, Air Intake Maximum Restriction Values (inH₂O)

**IMPORTANT:** Never attempt to clean the air filter.

**Alternator No Charge Indicator**
The alternator no charge indicator lamp (NO CHARGE legend) illuminates when the alternator is not charging properly.

**Check Transmission Warning (diesel engine only)**

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

The check transmission indicator, shown in Fig. 3.6, notifies the driver of three things. Any of the following items could be the cause for activating the indicator:

- the oil needs to be changed
- the filter(s) need to be changed
- clutch maintenance is required
When the check transmission indicator illuminates, refer to the Allison Operator’s Manual or contact customer support at Allison Transmission to determine the specific cause activating the indicator.

Speedometer and Tachometer

Speedometer

Three kinds of speedometer faces are available. The U.S. version of the speedometer registers speed in both miles per hour (mph) and kilometers per hour (km/h), with mph in larger numbers. See Fig. 3.7.

Tachometer

The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range. See Fig. 3.7.

Standard Instruments

Engine Oil Pressure Gauge

**NOTICE**

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

See Fig. 3.8 for an example of the engine oil pressure gauge. If the engine oil pressure falls below the preset levels shown in Table 3.1, first the check engine lamp will illuminate, and, if the condition does not improve, the stop engine lamp will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

Coolant Temperature Gauge

**NOTICE**

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

During normal engine operation, the coolant temperature gauge should read 175 to 195°F (79 to 91°C). See Fig. 3.9. If the temperature remains...
below 160°F (71°C), or exceeds the maximum temperature shown in Table 3.2, inspect the cooling system to determine the cause. See Group 20 of the S2 Chassis Workshop Manual.

![Coolant Temperature Gauge](image)

**Fig. 3.9, Coolant Temperature Gauge**

If the coolant temperature rises above the preset levels shown in Table 3.2, first the check engine warning indicator will illuminate, and, if the condition does not improve, the stop engine warning indicator will also illuminate and the buzzer will sound. At this point, the engine will derate or shut down, depending on the type of engine protection system installed.

**Fuel/Diesel Exhaust Fluid (DEF) Gauge**

For engines that are EPA10-compliant or newer, the fuel and DEF levels are measured in a dual purpose fuel/DEF gauge. See Fig. 3.10.

The diesel fuel level is indicated at the top of the gauge, with a low-level warning lamp that illuminates when the diesel fuel level registers 1/8th of capacity. One fuel gauge is standard. If equipped with a second (optional) fuel gauge, each fuel tank level is indicated on a separate gauge.

The DEF level is indicated in the lower portion of the gauge. There is a low DEF level warning lamp that illuminates when the DEF level reaches 10% of capacity. See Chapter 9 for details of the DEF gauge functions.

**Figure 3.11** shows a fuel gauge installed on EPA07 vehicles.

![Fuel/DEF Gauge, EPA10](image)

**Fig. 3.10, Fuel/DEF Gauge, EPA10**

![Fuel Level Gauge, EPA07 Vehicles](image)

**Fig. 3.11, Fuel Level Gauge, EPA07 Vehicles**

**Primary and Secondary Air Pressure Gauges**

**WARNING**

If air pressure falls below minimum pressure, the braking ability of the vehicle will be limited. Slow the vehicle down and bring it to a gradual stop. Do not attempt to move the vehicle until air pressure has risen above the minimum level. Moving a vehicle without adequate braking power could cause an accident resulting in property damage, personal injury, or death.

Air pressure gauges register the pressure in the primary and secondary air systems. Normal pressure...
with the engine running is 100 to 120 psi (690 to 827 kPa) in both systems. See Fig. 3.12.

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

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

Voltmeter

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

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

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

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

Optional Instruments

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

Air Intake Restriction Gauge

The air intake restriction gauge indicates the vacuum on the engine side of the air cleaner. On standard installations, it is mounted on the air intake duct in the engine compartment. See Fig. 3.13. As an option for easier viewing, the intake-air restriction indicator can be mounted on the dash, usually on the right-hand control panel.

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

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

Ammeter

An optional ammeter measures current flowing to and from the battery. See Fig. 3.14. When the batteries are being charged, the meter needle moves to the plus side of the gauge; when the batteries are being discharged, the needle moves to the minus side. A consistent negative reading when the engine is running indicates a possible problem with the charging system.

Axle Oil Temperature Gauge, Rear

NOTICE

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

During normal operation, the optional rear axle oil temperature gauge should read between 160 and 220°F (71 and 104°C) for Detroit™ and Meritor™ drive axles. See Fig. 3.15.

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

Digital Clock

The optional digital clock has black characters on a constantly backlit green display, with a brightness that automatically adjusts for day or night. The clock has a 24-hour alarm, with a three-minute snooze feature. See Fig. 3.16.

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

NOTE: When the hour setting is for a time between noon and midnight, the small letters PM will appear in the lower left corner of the display; no PM display indicates an AM setting.
1.2 Advance the hour setting to the correct number by pushing and releasing the hour button as many times as needed. Or if the button is pressed and held in for longer than 2 seconds, the numbers will continue to advance until the button is released.

1.3 Advance the minute setting by repeatedly pushing, or pushing and holding the minute button as needed.

1.4 Push the Run/Set switch to the middle (RUN) position.

2. To set the alarm time:

2.1 Push the Run/Set switch to the left (ALARM-SET position).

2.2 Set the alarm time by using the same procedure used to set the time of day; remember to set the hour for AM (no letters in the corner of the display), or PM as desired.

2.3 Return the Run/Set switch to the middle (RUN) position; the readout will return to the time-of-day setting.

3. To operate the alarm:

3.1 With the alarm time set, push the alarm (upper) switch to the left. An alarm “wave” symbol and the letters AL will appear in the upper left corner of the display when the alarm is on.

3.2 When the displayed time of day coincides with the alarm time, the alarm will sound. If the SNOOZ button is not pushed or the alarm switch is not moved, the alarm will automatically stop sounding after 1 minute and will not sound again for 24 hours.

3.3 If desired, press the SNOOZ button while the alarm is sounding to shut the alarm off for 3 minutes. The alarm symbol will flash in the display when the button is pushed and will continue to flash until the alarm switch is moved or the alarm has sounded for one minute. The snooze procedure can be done as many times as desired.

3.4 Move the alarm switch to the right when you wish to shut off or cancel the alarm; the alarm symbol will disappear.

Engine Oil Temperature Gauge

--- NOTICE ---

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

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

- 180 to 225°F (82 to 107°C) for Cummins ISB engines
- 177 to 203°F (81 to 95°C) for Mercedes-Benz MBE900 engines

NOTE: Under heavy loads, such as when climbing steep grades, temperatures that exceed the normal oil temperature range for a short period are not unusual. If the temperature returns to normal when the load decreases, there is no problem. See Fig. 3.17.

Transmission Fluid Temperature Gauge

During normal operation, the transmission fluid temperature gauge reading should not exceed 250°F (121°C) at the sump. See Fig. 3.18.
NOTICE

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

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

Turbocharger Boost Pressure Gauge

A turbocharger boost pressure gauge measures the pressure in the intake manifold, in excess of atmospheric pressure, being created by the turbocharger. See Fig. 3.19.
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Ignition Switch and Key

The ignition switch can be turned to four positions: ACCESSORY, OFF, ON, and START. See Fig. 4.1.

![Fig. 4.1, Ignition Switch Positions](image)

The key can be inserted and removed only in the OFF position. The headlights (low beams), taillights, brake lights, road lights, clearance lights, turn signals, hazard warning lights, horn, CB radio, clock, and electric oil pan heater operate with the ignition switch in the OFF position, regardless of whether the key is inserted.

All of the components that are operable in the OFF position are operable in the ACCESSORY position, as well as the radio (if so equipped), mirror heat, air dryer, and backup lights.

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

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

Lighting Controls

The lighting controls are operated with two types of switches located on the dash:

- Paddle switches—a single paddle located in the center of the switch that can be raised or lowered to perform a function.
- Rocker switches—can be pressed up or down to perform a function. Certain rocker switches are guarded to prevent them from being switched on or off accidentally.

Headlight/Parking Light Switch

The headlights and parking lights are operated with a paddle switch, shown in Fig. 4.2. When the paddle is lowered, the parking lights (front turn signals, marker and identification lights, and the taillights) illuminate. When the paddle is raised, the low-beam headlights illuminate, along with all of the parking lights. To turn off all lights, return the paddle to the center position.

![Fig. 4.2, Headlight/Parking Light Switch](image)

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

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

Daytime Running Lights

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

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

Panel Light Increase/Decrease Switch

When the panel lights are on, they can be brightened or dimmed by using the INCR/DECR switch, just below the headlight switch. When the panel lights are on, both legends of the switch are backlit. See Fig. 4.3. Push the top of the switch to increase the panel brightness. Push the bottom of the switch to dim.

![Fig. 4.3, Panel Light Increase/Decrease Switch](image)
**Marker Lamp Interrupt Switch**

The optional marker lamp interrupt (MRKR INT) paddle switch temporarily deactivates the marker lamps and taillights. See Fig. 4.4.

With the vehicle lights on, raise and hold the paddle switch to briefly turn off the marker lamps and taillights. When the paddle switch is released the marker lamps and taillights return to normal operation. With the vehicle lights off, raise the paddle switch to momentarily turn the marker lamps and taillights on.

**Multifunction Turn Signal Lever**

The multifunction turn signal lever has the following functions:

- turn signals
- windshield wipers and washers

- high-beam headlights
- hazard warning lights

See Fig. 4.5 for the multifunction switch and its component parts.

**Turn Signal Lever**

Moving the multifunction turn signal lever down activates the left turn signal lights; moving it up activates the right turn signal lights. See Fig. 4.6 for an example of the multifunction turn signal lever.

- Press down on the upper part of the rocker switch to activate the hazard warning lights.
- 1. Washer Button
- 2. Wiper Control Dial
- 3. Turn Signal Lever
- 4. Hazard Warning Light Rocker Switch (red)
- 5. Multifunction Switch Module

Move the lever down to activate the left turn signals.
Move the lever up to activate the right turn signals.
When a turn signal is activated, a green indicator arrow flashes at the far left or far right of the instrument panel.

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

**Windshield Wiper/Washer Controls**

---

**NOTICE**

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

The wipers are operated by a rotary switch in the wiper control dial, located on the end of the turn signal lever. See Fig. 4.7. There are five delay settings, marked on the dial by lines of increasing length, and two steady speed settings, LO and HI.

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

Rotating the control dial in the opposite direction (clockwise) reduces the speed of the wipers. Rotating the control dial clockwise as far as it will go (to the OFF setting) turns the wipers off.

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

**High-Beam Headlights**

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

To activate the high-beam headlights, push the turn signal lever forward, towards the windshield. Pull the lever back to its original position to turn the high-beam headlights off. See Fig. 4.8. The low beams remain on during high beam operation.

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

To flash the high beams momentarily, pull the lever backward, towards the steering wheel.

---

**Hazard Warning Lights**

To activate the hazard warning lights, press down on the upper part of the rocker switch located on the top of the multifunction switch module (towards the
When the rocker switch is pushed down, all of the turn control lights will flash. To cancel the hazard warning lights, press down on the lower part of the rocker switch (towards the steering wheel).

**Aftertreatment System (ATS) Regen Switch**

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

A regen switch, located on the dash, allows the driver to control three states. See **Fig. 4.9**. These include:

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

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

**Horn Controls**

NOTE: It is possible to have both the electric and the air horn installed on one vehicle.

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

**Electric Horn**

The button for the horn is located in the center of the steering wheel. To sound the horn, press the center of the steering wheel pad. See **Fig. 4.10**.

**Air Horn**

Single and dual air horns are available as options.

---

**Cruise Control**

**Cruise Control Switch**

**WARNING**

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

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

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

---

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

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

---

**Fast Idle System**

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

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

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

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

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

Any of the following actions will turn off the fast idle system:
- Applying the brake.
- Moving the transmission shifter out of Park (P) or Neutral (N); this will engage the transmission.
- Pressing and releasing the cruise control On/Off rocker switch when it is on.

Powertrain Controls
For complete transmission operating instructions see Chapter 10.

Automatic Transmissions
Vehicles equipped with a standard Allison On-Highway series automatic transmission, have a T-handle shift selector. See Fig. 4.13.

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

On vehicles with an Allison MD Series automatic transmission or an Eaton Autoshift automated transmission, a push-button shift selector, shown in Fig. 4.14, provides four, five, or six forward ranges and one reverse range. See Chapter 10 for more information about the push-button shift selector.

Transmission Mode Switch
Some vehicles are equipped with a transmission mode switch, shown in Fig. 4.15. The transmission mode switch is a fuel conservation option that allows the driver to choose either performance or economy shifting. When the switch is in the on position (the top of the rocker switch is pushed down), the transmission shift pattern changes from primary (performance) shift mode to secondary (economy) shift mode. When the transmission mode switch is in the off position (the bottom of the rocker switch is pushed down), the transmission reverts back to the primary shift mode.

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

All axle switches contain a red LED that illuminates the switch when it is turned on (the upper part of the rocker is pressed). The legend under the LED, if any, is not visible until the switch is turned on. For more information on axle switch function, see Chapter 11.

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

Differential Lock Switch

NOTICE

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

The optional differential lock switch is a two-position guarded rocker switch. It causes the wheels on each axle governed by the switch to rotate together. It is also known as side-to-side wheel lock. See Fig. 4.16.

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

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

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

Manual Dump Valve

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

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

Parking Brake Control Knob

All pneumatic-braked vehicles are equipped with a diamond-shaped parking brake control knob. See Fig. 4.17. 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).

Meritor™ WABCO® Antilock Braking System (ABS)

The Meritor WABCO ABS has an indicator lamp (ABS legend) and, if equipped with automatic traction control (ATC), a wheel spin indicator lamp (WHEEL SPIN legend). See Fig. 4.18.

See the brake system operating instructions in Chapter 13 for more information about ABS.

Exhaust Brake Switch

An exhaust brake is an optional auxiliary braking system that assists, but does not replace the service brake system. The exhaust brake is controlled by a dash-mounted rocker switch to help slow the vehicle when the accelerator is released.

To turn the exhaust brake on, press the upper part of the rocker switch. The exhaust brake turns off automatically. See Fig. 4.19.
Cab Features

Windows ................................................................. 5.1
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Windows

Standard windows operate mechanically using a hand crank.

Power windows are optional, and can be installed on one side or both sides. One power window switch (window icon) will be installed on the dash for each window. See Fig. 5.1. If your vehicle is equipped with power windows, press up to raise the window; press down to lower the window. Releasing the switch causes the window to stop.

![Fig. 5.1, Power Window Switch](Image)

10/09/2001
Press up to raise the window; press down to lower the window. Releasing the switch causes the window to stop.

Standard vent (wing) windows do not open. Operating vent windows are optional. To open the operating vent window, turn the latch on the window and push the window open. See Fig. 5.2.

![Fig. 5.2, Operating Vent Window (optional)](Image)

10/05/2001
1. Latch 2. Vent Window

Mirrors

The standard outside mirrors are mounted on the door frame. There is a primary rear view mirror and a convex mirror.

Mirror Heat Switch, Optional

One or both outside door mirrors can be heated to keep them clear of fog, frost, and ice.

To heat the mirrors, press the upper part of the mirror heat switch (MIRR HEAT) on the dash. See Fig. 5.3. When the mirror heat switch is on, an amber indicator light illuminates inside the switch.

![Fig. 5.3, Mirror Heat Switch](Image)

10/09/2001
To heat the mirrors, press up; press down to turn off the heat.

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

Power Mirrors, Optional

The main outside mirrors, if heated, can be equipped with an electrical remote control located on the driver’s door. See Fig. 5.4.

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

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

Down View Mirror, Optional

A down view mirror can be installed on the top of the passenger door frame to allow the driver a view of the area adjacent to the right side of the cab. See Fig. 5.5.
Cab Features

Seats

General Information

⚠️ WARNING ⚠️

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

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

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

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

1. Seat Slide (fore-and-aft): When this adjustment is made, the entire seat moves forward or backward on its track. See Fig. 5.6.

2. Isolator: This feature (also referred to as back-slap isolator or Chugger-Snubber®) reduces the amount of road shock by isolating the occupant from the motion of the vehicle, and allowing the upper seat to move in a simple pendulum motion. Whenever the isolator is not desired, it can be locked out. See Fig. 5.6.

3. Lumbar Support: Lumbar support changes the shape of the seat back to give more or less support to the occupant’s lumbar (lower back) area. This adjustment is either mechanical or air controlled, depending on the make and model of the seat. See Fig. 5.7.

4. Headrest: When this adjustment is made, the upper part of the backrest (back cushion) changes angle to provide head and upper back support as shown in Fig. 5.7.

5. Backrest Tilt: This adjustment pivots the backrest forward or backward as shown in Fig. 5.8.

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

1. Mirror Select Switch  2. Keypad

Fig. 5.4, Power Mirror Switch Pad

10/05/2001 f720396

1. Mirror

Fig. 5.5, Down View Mirror (optional)

10/05/2001 f910482

A. Seat Slide (fore-and-aft) Adjustment
B. Isolator Feature

Fig. 5.6, Seat Slide Adjustment and Isolator Feature

1. Mirror

Fig. 5.5, Down View Mirror (optional)
6. Seat Cushion Tilt: This adjustment raises or lowers the front and/or back of the seat (bottom) cushion. This adjustment is easier to perform when all weight is removed from the seat. See Fig. 5.8.

7. Seat Tilt: When this adjustment is made, the seat assembly, both backrest and seat cushion, tilts forward or backward as shown in Fig. 5.8.

8. Ride Height Adjustment: The entire seat moves up or down when adjusting the ride height. The adjustment is either manual or air controlled, depending on the make and model of the seat. See Fig. 5.9.

9. Damper: When you sit on the seat, a leveling valve places you in the center of the ride zone. When the damper is adjusted properly under normal driving conditions, the seat should not top or bottom against the limits of the vertical travel.

10. Ride Firmness: A firmer ride gives a better feel for the road but less protection against unevenness in the road surface. A softer ride smooths out the bumps.

**Bostrom Seat**

**Seat Slide Adjustment**

Move the seat slide and isolator lever, shown in Fig. 5.10, to the left and hold it there to slide the seat forward or backward to the desired position.

**Isolator**

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

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

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

Seat Cushion Tilt

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

Backrest Tilt

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

Ride Height and Damper Adjustment

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

Press the damper adjustment switch to adjust the damper.

National 2000 Series Seat

Seat Slide Adjustment

Move the seat slide lever, shown in Fig. 5.11, to the left and hold it there to slide the seat forward or backward to the desired position. Move the lever back to its original position to lock the seat in place.

Isolator

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

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

**Backrest Tilt**

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

**Seat Cushion Adjustment**

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

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

**Ride Height Adjustment**

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

**Sears Seat**

**Seat Slide Adjustment**

Push the seat slide (fore-and-aft adjustment) lever, shown in Fig. 5.12, all the way to the left and slide the seat forward or backward, as desired. Release the lever to lock the seat in the desired position.

**Isolator**

To engage the isolator (if installed), move the seat slide and isolator lever shown in Fig. 5.13 all the way to the right. To lock out the isolator, move the isolator lever to the center position.

**Lumbar Support**

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

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

For seats with air support, use the aft rocker switch on the control panel on the left-hand side of the seat. See Fig. 5.14. Press up to make the seat firmer; press down to make the seat less firm.
Seat Cushion Tilt
To raise the seat cushion, lift upward on the front of the seat cushion, and then push it rearwards. To lower the seat cushion, pull forward on the front of the seat cushion, and then push downwards.

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

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

For seats with air support, use the forward rocker switch on the control panel on the left-hand side of the seat. See Fig. 5.14. Press up to raise the seat; press down to lower the seat.

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

Seat Belts and Tether Belts
General Information
Seat belt assemblies are designed to secure persons in the vehicle to help reduce the chance of injury or the amount of injury resulting from accidents or sudden stops. For this reason, Freightliner Custom Chassis Corporation (FCCC) urges that the driver and all passengers, regardless of age or physical condition, use seat belts when riding in the vehicle.

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

Seat belt assemblies in FCCC vehicles meet Federal Motor Vehicle Safety Standard 209, “Type 1” and “Type 2” requirements.

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

In addition to seat belt assemblies, tether belts are installed on suspension-type seats. Tether belts help secure the seat to the floor and are intended to restrain the seat and seat belt in case of an accident or sudden stop.

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

Seat Belt Inspection

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

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

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

Seat Belt Operation
Three-Point Seat Belt With Komfort Latch or Sliding Komfort Latch

WARNING

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

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

When engaged and used properly, the Komfort Latch and the Sliding Komfort Latch, shown in Fig. 5.15 and Fig. 5.16 respectively, introduce a small amount of slack into the seat belt, resulting in a more comfortable ride.

1. Slowly pull the latch end of the three-point seat belt out of the retractor and pull it across your lap (from outboard to inboard) far enough to engage the buckle. If the retractor locks too soon,
3. Tug on the seat belt to make sure it is securely fastened. If the buckle unlatches, repeat this step. If the problem continues, replace the three-point seat belt.

4. Snug the seat belt to your waist.

5. Position the shoulder strap diagonally across your chest with the adjustable D-loop bracket, if so equipped. If desired, engage the Komfort Latch or Sliding Komfort Latch as follows.

   If equipped with a Sliding Komfort Latch, make sure that the shoulder strap is snug against your chest. Without loosening the shoulder strap, push the Sliding Komfort Latch switch to the ON position. See Fig. 5.16. To activate the latch, lean forward until you hear a click. This will allow for approximately 1 inch (2.5 cm) of slack between your chest and the shoulder harness. Once engaged, the latch will allow you to lean forward about 5 inches (13 cm) without having to reset the latch. Leaning forward more than 5 inches (13 cm) will disengage the Sliding Komfort Latch, requiring it to be reset.

   If equipped with a Komfort Latch, pull on the shoulder strap to lessen the pressure of the strap on your shoulder and chest. Allow no more than 1 inch (2.5 cm) of slack between your chest and the shoulder harness. More slack can significantly reduce the seat belt effectiveness in an accident or a sudden stop. While holding the belt slack, press the Komfort Latch lever up, clamping the seat belt webbing. See Fig. 5.18 and Fig. 5.19.

6. Unbuckle the three-point seat belt and release the Komfort Latch or the Sliding Komfort Latch as follows.

   If equipped with a Sliding Komfort Latch, unbuckle the seat belt, then tug on the shoulder belt to release the Sliding Komfort Latch, or press the Sliding Komfort latch to the OFF position, then unbuckle the seat belt.

   If equipped with a Komfort Latch, unbuckle the seat belt, then release the Komfort Latch by giving the shoulder belt a quick tug. If you lean forward against the shoulder belt, the Komfort Latch will automatically release, and will need to be reset.
NOTE: Neither the Komfort Latch nor the Sliding Komfort Latch need to be manually released in an emergency situation. Each will release by itself under rough road or other abnormal conditions. Make sure the three-point seat belt is completely retracted when it is not in use.

Cab Amenities

Cup Holders
There are two cup holders molded into the lower part of the auxiliary dash panel, one on either side of the HVAC control head.

Cab Storage
There is a dash storage bin located under the cup holders on the center panel. The bin has a hinged cover and can be used to store sunglasses. There is also a small storage pocket above the radio.

Overhead Storage
Vehicles without an overhead console have two storage bins located above the windshield.

On vehicles equipped with an overhead console, most vehicles have a storage bin located in the overhead console. See Fig. 5.20. The overhead storage bin is often removed and replaced with a CB radio.

Two map holders with netted openings are located overhead, one on either side of the overhead console.
Electrical System General Information ................................................ 6.1
Power Distribution Modules .............................................................. 6.1
Electrical System General Information

The S2 Chassis uses an electrical system where multiple electrical signals are carried along a simplified set of wires, reducing the size of wiring bundles. There are significantly fewer wires overall, meaning less chance of damage, shorts, and other problems. The information in this chapter is to help familiarize the driver with the basic electrical system. Servicing the electrical system requires special skills and equipment and should be performed only by a qualified technician. Take the vehicle to an authorized Freightliner service facility for repairs.

WARNING

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

Power Distribution Modules

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

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

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

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

<table>
<thead>
<tr>
<th>Main PDM Fuse Identification</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CAV</td>
<td>Description</td>
</tr>
<tr>
<td>F1</td>
<td>Engine VCU (spare)</td>
</tr>
<tr>
<td>F2</td>
<td>Blower Motor</td>
</tr>
<tr>
<td>F3</td>
<td>Engine ECU</td>
</tr>
<tr>
<td>F4</td>
<td>Spare</td>
</tr>
<tr>
<td>F5</td>
<td>Ignition Switch</td>
</tr>
<tr>
<td>F6</td>
<td>HydroMax RLY (if equipped with hydraulic brakes)</td>
</tr>
<tr>
<td>F7</td>
<td>Bulkhead Module</td>
</tr>
<tr>
<td>F8</td>
<td>ICU3</td>
</tr>
<tr>
<td>F9</td>
<td>Transmission ECU</td>
</tr>
<tr>
<td>F10</td>
<td>Spare</td>
</tr>
<tr>
<td>F11</td>
<td>Spare</td>
</tr>
<tr>
<td>F12</td>
<td>Radio/Diagnostic</td>
</tr>
<tr>
<td>F13</td>
<td>Chassis Module</td>
</tr>
<tr>
<td>F14</td>
<td>Spare</td>
</tr>
<tr>
<td>F15</td>
<td>Bulkhead Module</td>
</tr>
<tr>
<td>F16</td>
<td>ABS ECU</td>
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<tr>
<td>F17</td>
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<td>F18</td>
<td>Bulkhead Module</td>
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<tr>
<td>F19</td>
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### Main PDM Fuse Identification

<table>
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<tr>
<th>CAV</th>
<th>Description</th>
<th>Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>F24</td>
<td>Hydraulic Pump and RLY (if equipped with hydraulic brakes)</td>
<td>25A</td>
</tr>
<tr>
<td>F25</td>
<td>Spare</td>
<td>—</td>
</tr>
<tr>
<td>F26</td>
<td>Spare</td>
<td>—</td>
</tr>
</tbody>
</table>

**Table 6.1, Main PDM Fuse Identification**

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**Fig. 6.2, Main PDM (top view)**

1. Battery Power Mega Fuse 1
2. Battery Power Mega Fuse 2
3. Engine Harness (green)
4. Forward Chassis Harness (blue)
5. Forward Chassis Harness (gray)
6. Frontwall Harness (black)
Heater, Ventilating, and Air Conditioner (HVAC)

Climate Control Panel

7.1
Climate Control Panel

The climate control panel controls the HVAC for the driver. The climate control panel without air conditioning is shown in Fig. 7.1. The climate control panel with air conditioning is shown in Fig. 7.2.

Standard controls consist of an eight-speed fan switch, an air selection switch, and a temperature control switch. See Fig. 7.1. On vehicles with air conditioning, the panel also contains a telltale light emitting diode (LED) and an air recirculation button.

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

Air Selection Switch Without Air Conditioning

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

**Fig. 7.1, Climate Control Panel Without Air Conditioning**

| 1. Fan Switch | 2. Air Selection Switch | 3. Temperature Control Switch |

**Fan Switch**

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

To increase airflow, turn the fan switch clockwise to a higher number. To decrease the airflow, turn the switch counterclockwise to a lower number.

**Air Selection Switch**

The air selection switch allows the driver to control the flow of air through the face outlets, the floor outlets, the defrost (windshield) outlets, or a combination of these outlets. Nine air selection modes are available on a system without air conditioning. See Fig. 7.3. A system with air conditioning has 11 air selection modes, four of which are air conditioning modes. See Fig. 7.4.
9. **Defrost Mode**: Directs all airflow through the defrost outlets.

Fig. 7.2, Climate Control Panel With Air Conditioning

Fig. 7.3, Air Selection Switch Without Air Conditioning

through the defrost outlets and 25 percent through the floor outlets.

Fig. 7.4, Air Selection Switch With Air Conditioning

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

1. **Air Conditioning Face Mode**: Directs all airflow through the face or instrument panel outlets.

2. **Selection between the Air Conditioning Face Mode and the Air Conditioning Bi-Level Mode**: Directs 75 percent of the airflow to the face outlets and 25 percent to the floor outlets.

3. **Air Conditioning Bi-Level Mode**: Directs the airflow equally to the face outlets and the floor outlets.

4. **Selection between the Air Conditioning Bi-Level Mode and the Face Mode**: Directs 25 percent of the airflow to the face outlets and 75 percent to the floor outlets.

5. **Face Mode**: Directs all airflow through the face outlets.

6. **Selection between Face Mode and Floor Mode**: Directs the airflow equally through the face outlets and the floor outlets.

7. **Floor Mode**: Directs all airflow through the floor outlets.

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

9. **Floor/Defrost Mode**: Directs the airflow equally to the floor outlets and the defrost outlets. The recirculation button will not work in this mode.

10. **Selection between Floor/Defrost Mode and Defrost Mode**: Directs 75 percent of the airflow through the defrost outlets and 25 percent through the floor outlets. The recirculation button will not work in this mode.

11. **Defrost Mode**: Directs all airflow through the defrost outlets. The recirculation button will not work in this mode.

Temperature Control Switch

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

Fresh Air Mode

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

Recirculation Mode

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

The recirculation mode limits the amount of outside air entering the cab. Press the recirculation button to prevent dusty or smoky air from entering the cab. The recirculation mode can also be used to decrease the time required to cool or heat the cab interior during extreme outside temperature conditions. When the recirculation mode is on, the recirculation indicator will illuminate. See Fig. 7.2.

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

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

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

**IMPORTANT**: The HVAC system enters a partial recirculation mode for five minutes after being in full recirculation mode for 20 minutes. This cycle repeats every 20 minutes.

Defrosting

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

Air Conditioning

There are four air conditioning modes on the air selection switch. The air conditioning settings on the air selection switch are blue, in addition to the selection between the air conditioning bi-level mode and the face mode.

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

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

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

Engine Starting ............................................................... 8.1
Engine Operation .............................................................. 8.2
Engine Shutdown .............................................................. 8.4
Engine Starting

For cold-weather starting, refer to the Cummins or Mercedes-Benz engine manufacturer’s operator’s manual, as applicable, for detailed instructions.

General Information

NOTE: Before starting the engine, read Chapter 3 and Chapter 4 in this manual for detailed information on how to read the instruments and operate the controls.

Before operating the vehicle, perform the engine pre-trip inspection and daily maintenance checks in Chapter 14 and Chapter 15 of this manual.

NOTICE

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

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

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

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

3. For manual transmissions, place the transmission in neutral and depress the clutch pedal.
   For automatic transmissions, make sure that the transmission shift control is in Neutral (N), or if so equipped, the Park (P) or Park Brake (PB) position.

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

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

NOTICE

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

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

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

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

Starting After Extended Shutdown or Oil Change

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

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

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

**Engine Operation**

**IMPORTANT:** For cold-weather starting, engine break-in, and cold-weather operation, refer to the Cummins or Mercedes-Benz engine manufacturer’s operator’s manual, as applicable, for detailed instructions.

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

---

**DANGER**

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

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

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

The driver should be familiar with the vehicle warning system in order to bring the vehicle to a safe stop if the engine malfunctions. If the driver doesn’t understand how the warning system works, an engine shutdown could occur, causing a safety hazard. See Chapter 3 for information on the control panel for these engines.

Follow the directions in the Cummins or Mercedes-Benz engine manufacturer’s operator’s manual and this manual for trouble-free, economical vehicle engine operation.

---

**NOTICE**

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

1. Cummins and Mercedes-Benz diesel engines are designed to operate successfully at full throttle under transient conditions down to rated rpm. This is consistent with recommended operating practices.
2. Depending on the vehicle gearing, the posted speed limit can sometimes allow operation in either of the top two gears; however, for improved operating efficiency (fuel economy and engine life), operate in the top gear at reduced rpm.
rather than in the next lower gear at the maximum rpm.

3. Cruise at partial throttle whenever road conditions and speed requirements permit. This driving technique permits operating within the most economical power range of the engine.

4. When approaching a hill, open the throttle smoothly to start the upgrade at full power, then shift down as desired to maintain the optimum vehicle speed. The high torque of the engine may permit topping some grades without shifting.

5. Engines are designed to operate over a wide speed range. More frequent shifting than necessary does not allow proper utilization of this flexibility. The driver who stays in top gear and uses the wider speed range will achieve the best fuel economy.

6. The Cummins and Mercedes-Benz engines are effective as a brake on downhill grades, but take care not to overspeed the engine going downhill. The governor has no control over engine speed when the engine is being pushed by the loaded vehicle.

---

**NOTICE**

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

7. Never turn the ignition switch to the OFF position while going downhill. With the engine still in gear, fuel pressure will build up against the shutdown valve and can prevent it from opening when the ignition switch is turned to the ON/RUN position.

8. Use a combination of brakes and gears to keep the vehicle under control at all times, and to keep the engine speed below the rated governed rpm.

9. Check the coolant temperature and oil pressure gauges frequently.

---

**NOTICE**

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

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

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

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

---

**High Idle Options**

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

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

**High Idle with Cruise Control**

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

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

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

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

**Voltage-Based Auto High Idle**

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

2. The idle rpm will automatically increase when the voltage drops below 12.2 volts. The rpm will incrementally increase every five seconds until 13.4 volts is achieved and maintained.

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

Engine Shutdown

Shut down the engine immediately if:

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

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

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

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

---

**NOTICE**

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

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

Aftertreatment System, EPA10 and Newer Engines ........................................... 9.1
Diesel Exhaust Fluid and Tank, EPA10 and Newer Engines ................................. 9.5
EPA07 Aftertreatment System (ATS) ................................................................. 9.7
Aftertreatment System, EPA10 and Newer Engines

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

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

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

Principles of Operation

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

- Nitrogen Oxides (NOx) – 0.2 g/bhp-hr
- Particulate Matter (PM) – 0.01 g/bhp-hr

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

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

- Use ultralow-sulfur diesel with 15 ppm sulfur content or less.
- Do not use fuel blended with used engine lube oil or kerosene.

- Engine lube oil must have a sulfated ash level less than 1.0 wt %; currently referred to as CK-4 oil.
- Use only certified diesel exhaust fluid (DEF) in the DEF tank.

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

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

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

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

WARNING

Active regeneration can occur automatically anytime the vehicle is moving. The exhaust gas temperature could reach 1500°F (816°C), which is hot enough to cause a fire, heat damage to objects or materials, or personal injury to persons near the exhaust outlet. See Regen-Inhibit Switch later in this chapter for instructions on preventing automatic regen if necessary.
The exhaust temperature can remain high even after the vehicle has stopped. When stopping the vehicle shortly after an automatic regen, ensure the exhaust outlets are directed away from structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by exposure to high heat.

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

NOTE: Beginning September 2, 2014 some chassis are equipped with an option that allows a regen to occur at 0 or 1 mph (0 or 2 km/h), instead of the standard 5 mph (8 km/h) threshold. Based on the engine programming parameter, if a regen occurs and vehicle speed is reduced to either 0 or 1 mph (0 or 2 km/h), the regen process will not be cancelled.

If the vehicle is programmed for the 0 mph (0 km/h) parameter, vehicle speed can be reduced to 0 mph (0 km/h) and the regen will continue. Vehicles with this option are equipped with a regen inhibit switch to cancel the regen if needed.

If the vehicle is programmed for the 1 mph (2 km/h) parameter, vehicle speed can be reduced to 1 mph (2 km/h) and the regen will continue. If vehicle speed is less than 1 mph (2 km/h), the regen will be cancelled.

After the exhaust stream passes through the ATD, it flows through another canister housing the SCR device. A controlled quantity of DEF is injected into the exhaust stream, where heat converts it to ammonia (NH₃) gas. This mixture flows through the SCR device, where the ammonia gas reacts with the NOx in the exhaust, to produce harmless nitrogen (N₂) and water vapor (H₂O), which then exits out of the tailpipe.

ATS Warning Lamps

Warning lamps in the driver’s message center alert the driver of situations with the ATS.

- An illuminated DPF lamp indicates a regen is needed. See Fig. 9.1.

![Fig. 9.1, Diesel Particulate Filter (DPF) Status Lamp](image1)

- A slow, 10-second flashing of the HEST lamp alerts the driver that a parked regen is in progress, but the exhaust temperatures are still relatively cool. See Fig. 9.2. It also indicates that the high-idle speed is being controlled by the engine software, not the driver.

![Fig. 9.2, High Exhaust System Temperature (HEST) Lamp](image2)

- A steadily illuminated HEST lamp alerts the operator of high exhaust temperatures when vehicle speed is below 5 mph (8 km/h) while it is performing an automatic regen, and during a parked regen. See Fig. 9.2.

Parked Regen

**DANGER**

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

Before initiating a parked regeneration, make certain the exhaust outlets are directed away from...
structures, trees, vegetation, flammable materials, and anything else that may be damaged or injured by prolonged exposure to high heat. A reference label is included with the driver’s documentation package initially in the glove box, that explains the ATS warnings, and actions required to avoid further engine protection sequences. See Fig. 9.3.

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

The regen-inhibit switch (optional when available) provides additional control over the aftertreatment regeneration process. Depressing the regen-inhibit switch will prevent a regen from occurring during a drive cycle. After the vehicle has been shut down and restarted, regens will occur normally unless the inhibit switch is pressed again. See Fig. 9.5.

### EXHAUST AFTERTREATMENT SYSTEM INFORMATION

<table>
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<tr>
<th>INDICATOR LAMP(S)</th>
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<th>Level 2</th>
<th>Level 3</th>
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<td>Indicator Lamp Message(s)</td>
<td>Filter Regeneration Recommended</td>
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<td>Parked Regeneration Required – Engine Derate</td>
<td>Parked Regeneration Required – Engine Shut Down</td>
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<tr>
<td>Diesel Particulate Filter Condition</td>
<td>Filter is reaching maximum capacity.</td>
<td>Filter is now reaching maximum capacity.</td>
<td>Filter has reached maximum capacity.</td>
<td>Filter has exceeded maximum capacity.</td>
</tr>
<tr>
<td>Required Action</td>
<td>Bring vehicle to highway speeds to allow for an Automatic Regeneration or perform a Parked Regeneration.</td>
<td>To avoid engine derate bring vehicle to highway speeds to allow for an Automatic Regeneration or perform a Parked Regeneration as soon as possible.</td>
<td>Vehicle must be parked and a Parked Regeneration must be performed – engine will begin derate.</td>
<td>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.</td>
</tr>
</tbody>
</table>

For a driver performed Parked Regeneration, vehicle must be equipped with a dash mounted Regeneration Switch.

See Engine Operator’s Manual for complete Regeneration Instructions.

---

**Fig. 9.3, Exhaust-Aftertreatment Warnings Reference Label**

The regen switch, located on the dash, is used to initiate a parked regen of the aftertreatment device. See Fig. 9.4.

**Fig. 9.4, Regen Switch**

**Fig. 9.5, Regen Inhibit Switch (optional when available)**
To initiate a parked regeneration, perform the following steps.

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

2. Set the parking brake. If the parking brake was already set, you must release it, then set it again.
   - For manual transmissions, fully depress the clutch pedal, put the transmission in neutral, then release the pedal.
   - If the vehicle has a two-pedal automated transmission, shift it into gear, then back to neutral.

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

3. Press and hold the regen switch for 4 seconds. The engine will increase rpm and initiate the regen process.

4. After the parked regen has run for 20 to 40 minutes, the regen cycle is completed. The engine idle speed will drop to normal, and the vehicle may be driven normally. The HEST lamp may be illuminated, but will go out when the vehicle speed exceeds 5 mph (8 km/h), or the system has cooled to normal operating temperature.

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

Shorting Plug

NOTE: The DPF lamp must be illuminated before the shorting plug will initiate a parked regen. See Fig. 9.1.

The shorting plug is used to initiate a parked regen of the ATD. The shorting plug is located under the dash, next to the steering column. Mounting locations vary. See Fig. 9.6.

To initiate a parked regeneration, perform the following steps.

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

2. Set the parking brake. If the parking brake was already set, it must be released, then set again.
8. To stop a parked regen at any time during the process, engage the clutch, service brake, or accelerator pedal, or turn off the engine.

DPF Maintenance
Eventually ash will accumulate in the DPF and the filter will require servicing. DPF servicing must be performed by an authorized technician, following the engine manufacturer's instructions. A record must be maintained for warranty purposes, that includes:
- date of cleaning or replacement;
- vehicle mileage;
- particulate filter part number and serial number.

Diesel Exhaust Fluid and Tank, EPA10 and Newer Engines

Diesel Exhaust Fluid
Diesel exhaust fluid (DEF) is used in the ATS to lower NOx in the exhaust stream. DEF is colorless and close to odorless (it may have a slightly pungent odor similar to ammonia). It is nontoxic, nonflammable, and biodegradable. It is mildly corrosive to aluminum, but does not affect the strength or structure of the aluminum.

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

DEF consumption varies depending on ambient conditions and vehicle application.

Freezing Conditions
DEF freezes to slush at around 12°F (-11°C). It is not damaged or destroyed if frozen, and is fully usable when thawed. The DEF in the tank is allowed to freeze while a vehicle is non-operational. At start-up, normal operation of the vehicle is not inhibited if the DEF is frozen; an immersion heater with engine coolant flowing through it warms the DEF once the engine is running, allowing the SCR system to operate.

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

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

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

The DEF tank will require filling a minimum of approximately every second diesel refuel depending on the DEF tank capacity. The S2 Chassis has an 11.5-gallon tank capacity. DEF consumption is approximately 2% of fuel consumption, dependent on vehicle operation. For every 50 gallons of diesel fuel consumed, approximately 1 gallon of DEF will be consumed.

Fuel/DEF Gauge
The fuel and DEF levels are measured in a dual purpose fuel/DEF gauge. See Fig. 9.7.

Fuel level is indicated at the top of the gauge. Below the fuel level, a low fuel warning lamp illuminates amber when the fuel level drops below 1/8th of the capacity.

The lower portion of the gauge has a DEF warning lamp that illuminates when the DEF tank is near empty, and a DEF lightbar that indicates the level in the DEF tank as follows.
- Four bars illuminated green—Between 75% and 100% full
- Three bars illuminated green—Between 50% and 75% full
- Two bars illuminated green—Between 25% and 50% full
- One bar illuminated green—Between approximately 10% and 25% full
- One bar illuminated amber—DEF low, refill DEF
- One bar flashing red—DEF empty, refill DEF

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

When the DEF level reads low the following warnings strongly encourage the driver to refill the DEF tank. See Fig. 9.8.

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

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

DEF Level Low—Critical Warning

When the DEF level reads low, the following warnings are activated. See Fig. 9.9.

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

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

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

When the DEF level reads empty, the following warnings are activated. See Fig. 9.10.

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

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

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

DEF Level Empty and Ignored

If the empty warning is ignored and the DEF is not refilled, the DEF warning lamp flashes, one bar of the DEF-level lightbar flashes red, and the red STOP engine lamp illuminates in addition to the CHECK engine warning lamp. See Fig. 9.11.

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

DEF Quality or SCR Tampering

--- NOTICE ---

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

If contaminated DEF or tampering is detected, the DEF warning lamp flashes, and engine power is limited with progressively harsher limits applied. If the fault is not corrected, the STOP engine lamp illuminates and a 5 mph (8 km/h) speed limit is applied after the next engine shutdown, or while parked and idling. See Fig. 9.11.

EPA07 Aftertreatment System (ATS)

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

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

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

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

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

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

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

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

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

DANGER

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

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

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

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

A steadily illuminated HEST lamp alerts the operator of high exhaust temperature during the regeneration process, if vehicle speed is below 5 mph (8 km/h). See Fig. 9.2. The HEST lamp does not indicate the need for any kind of vehicle or engine service; it only alerts the vehicle operator of high exhaust temperatures. Make sure the engine exhaust pipe outlet is not directed at any person, or at any surface or material that will melt, burn, or combust.

WARNING

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

WARNING

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

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

IMPORTANT: Due to the high exhaust temperature during the regen process, a diffuser is used to reduce the temperature at the exhaust pipe outlet. See Fig. 9.12. If the diffuser is damaged,
it must be replaced to ensure proper operation of the vehicle and to reduce the possibility of damage or injury.

A steadily illuminated yellow DPF lamp indicates a regen is required soon. Bring the vehicle to highway speeds to allow for an active regen, or a parked regen should be scheduled for the earliest convenient time. See Fig. 9.1.

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

A DPF lamp blinking at the same time as a steadily illuminated yellow Check Engine lamp indicates that a parked regen must be performed immediately, or an engine derate will occur. If the red Stop Engine lamp illuminates with the blinking DPF lamp and the yellow Check Engine lamp, a parked regen must occur or an engine shutdown will occur. Park the vehicle and perform a parked regen. See Fig. 9.13 and Fig. 9.4.

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

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

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

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

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

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

A steadily illuminated Malfunction Indicator Lamp (MIL) indicates an engine fault that affects the emissions. The MIL lamp applies to the Mercedes-Benz engine only. See Fig. 9.14.

High-Soot-Load Idle Shutdown

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

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

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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 13 for information on brake operation.

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

NOTICE

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

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

WARNING

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

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

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

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

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

Allison On-Highway Transmissions

The Allison on-highway transmissions are fully automatic and include the 2100 Series, B210 Series, 2200 Series, B220 Series, 2500 Series, 3000 Series, and B300 Series. Refer to www.allisontransmissions.com for additional information.

Safety Precautions

2000 and B200 Series

WARNING

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

On vehicles with Allison 2000 or B200 series transmissions, do the following steps if you have to leave the vehicle with the engine running (for example, when checking the transmission fluid).

Without Auto-Apply Parking Brake

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

With Auto-Apply Parking Brake

1. Bring the vehicle to a complete stop using the service brake.
2. Ensure that the engine is at low idle rpm.
3. Put the transmission in PB (auto-apply parking brake).
4. Apply the parking brake (if so equipped), and make sure it is properly engaged.
5. Chock the rear tires and take any other steps necessary to keep the vehicle from moving.
Range Inhibit Indicator, 2000 and B200 Series

A RANGE INHIBIT indicator is a standard feature of the 2000 and B200 series transmissions. The RANGE INHIBIT indicator comes on to alert the driver that transmission operation is being inhibited and that the range shifts being requested by the driver may not occur. When certain operating conditions are detected by the transmission control module (TCM), the controls will lock the transmission in the current operating range.

Shift inhibits occur under the following conditions:

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

Operating Instructions, 2000 and B200 Series Transmissions

2000 and B200 series transmissions are electronically controlled. The shift selector provides four forward ranges and one reverse range. A T-handle shift control is used by the driver to select the ranges. See Fig. 10.1.

P (Park)

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

NOTE: This does not apply the parking brake.

Fig. 10.1, T-Handle Shifter (standard)

The park pawl is standard on the 2200 series transmission. The park pawl effectively grounds the transmission output shaft, thereby preventing rotation of the driveline. Provided the vehicle is stationary, selecting P (park) on the shift selector, if so equipped, places the transmission in neutral and engages the park pawl.

PB (Auto-Apply Parking Brake, optional on 2000 and B200 Series)

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

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

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

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

**N (Neutral)**
The neutral position places the transmission in neutral. When neutral is selected, the vehicle service brakes, parking brake, or emergency brake must be applied. Selecting neutral does not apply vehicle brakes unless an auxiliary system to apply the parking brake is installed.

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

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

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

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

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

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

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

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

**Operating Instructions, 3000 and B300 Series**
The Allison 3000 and B300 series transmissions are electronically controlled and have a push-button shift control that provides five or six forward ranges and one reverse range. The push-button shift selector has R (reverse), N (neutral), and D (drive) ranges, up and down arrows, a mode button, and a digital display. See Fig. 10.2.

![Fig. 10.2, Push-Button Shift Selector](image)

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

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

**NOTICE**

Extended idling in reverse may cause transmission overheating and damage.

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

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

**N (Neutral)**

**WARNING**

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

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

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

**WARNING**

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

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

Always select neutral before turning off the engine.

**D (Drive)**

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

**NOTICE**

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

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

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

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

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

**WARNING**

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

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

**1 (First Range)**

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

**Up and Down Arrows**

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

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

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

**Mode Button**

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

**Mode Indicator LED**

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

**Digital Display**

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

**Oil Level Sensor**

Allison 3000 and B300 Series transmissions have an electronic oil level sensor to read fluid level information. The fluid level diagnostic will display whether the oil level is OK, too low, or too high. It will also display a default code and indicate if the preconditions (of receiving the fluid level information) are not met.

**Diagnostic Codes**

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

**Eaton® Fuller® Straight-Shift Transmissions**


**General Information, Straight-Shift**

Eaton Fuller 5-speed FS models are fully synchronized. They have five forward speeds and one reverse. See Fig. 10.3 for the shift pattern.
Eaton Fuller 6-speed FS and FSO models are fully synchronized. They have six forward speeds and one reverse. See Fig. 10.4 for the shift pattern.

These transmissions are designed for use with on-highway, fuel economy engines where a minimum of shifting is desired and less gear reduction is acceptable.

**Operation, Straight-Shift**

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

**NOTICE**

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

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

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

3. To upshift, do the following steps:
   3.1 Accelerate to engine governed speed.
   3.2 On synchronized models, depress the clutch pedal and move the shift lever to second gear.

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

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

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

4. To downshift, do the following steps:
   4.1 Wait until the engine speed drops to the rpm noted immediately after the upshift.

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

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

   4.3 Release the clutch pedal smoothly.

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

**Clutches**

**Clutch Operation**

**Applying the Clutch Brake**

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

--- NOTICE ---

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

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

Vehicle Overload, or Overloading the Clutch

--- NOTICE ---

Overloading will not only result in damage to the clutch, but also to the entire powertrain.

Clutches are designed for specific vehicle applications and loads. These limitations should not be exceeded.

Riding the Clutch Pedal

Riding the clutch pedal is destructive to the clutch. Partial clutch engagement permits slippage, and generates excessive heat. Riding the clutch pedal will also put a constant thrust load on the release bearing, which can thin out the lubricant. Release bearing failures can be attributed to this type of misuse.

Holding the Vehicle on an Incline With a Slipping Clutch

A slipping clutch accumulates heat faster than it can be dissipated, resulting in early clutch failures. Never use the clutch to hold a vehicle on a hill.

Coasting With the Clutch Released (pedal down) and the Transmission in Gear

--- WARNING ---

Do not allow the vehicle to coast with the clutch released (pedal down) and the transmission in gear. If the clutch facing is thrown off the disc, flying debris could cause injury to persons in the vehicle.

If the transmission remains in a low gear and the vehicle gains speed, as may occur on a downgrade, the input shaft and clutch driven disc will turn at speeds that are higher than normal. This occurs because the rear wheels and the driveline become the input for the transmission, and a higher-than-normal speed for a given transmission gear translates to a higher rpm value for the clutch driven disc.

Clutch driven discs are designed to allow for some amount of excess rotational speed, but the facing has a limited burst strength. If the clutch driven disc rpm increases too much, the clutch facing can be thrown off the disc(s).

Engaging the Clutch While Coasting

Engaging the clutch while coasting can result in tremendous shock loads and possible damage to the clutch as well as to the entire drivetrain.

Report Erratic Clutch Operation Promptly

Reporting erratic clutch operation as soon as possible will give maintenance personnel a chance to inspect the clutch components.

--- CAUTION ---

Operating the vehicle with incorrect clutch pedal free-travel could result in clutch damage. See Group 25 of the S2 Chassis Workshop Manual for free-pedal adjustment procedures and specifications.

On mechanical clutch linkages, free-pedal travel should be included and commented on daily in the driver’s report, since clutch free-pedal travel is the best guide to the condition of the clutch and the release mechanism.
Clutch Wear

The major reason clutches wear out too soon is excessive heat. Clutches are designed to absorb and dissipate more heat than encountered in typical operation. The temperatures developed in typical operation will not break down the clutch friction surfaces. However, if a clutch is slipped excessively or required to do the job of a fluid coupling, high temperatures develop quickly and destroy the clutch. Temperatures generated between the flywheel, driven discs, and pressure plates can be high enough to cause the metal to flow and the friction facing material to char and burn.

---

**NOTICE**

Do not allow sustained slippage of the clutch; this could severely damage the clutch disc, pressure plate, or flywheel. Damage caused by clutch slippage due to improper break-in is not warrantable.

Slipping and excessive heat are practically nonexistent when a clutch is fully engaged. But during the moment of engagement, when the clutch is picking up the load, it generates considerable heat. An incorrectly adjusted or slipping clutch will rapidly generate sufficient heat to destroy itself.

The most important items that a driver should be aware of to ensure long service life of the clutch include: starting in the right gear, recognizing clutch malfunctions, and knowing when to adjust a clutch.

Clutch Adjustments

Some clutches have an internal adjustment. See the applicable section in Group 25 of the S2 Chassis Workshop Manual for clutch adjustment procedures and specifications.

---

**NOTICE**

Operating the vehicle with the clutch incorrectly adjusted could result in clutch or clutch brake failure.

Clutch Lubrication

The release bearing should be lubricated at frequent intervals. See Group 25 of the S2 Chassis Maintenance Manual for intervals and procedures.
Drive Axles, Detroit™ and Meritor™

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

Drive Axles With Differential Lock

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

A differential lock provides maximum traction under slippery conditions. When the differential lock is engaged, the clutch collar completely locks the differential case, gearing, and axle shafts together, maximizing the traction of both wheels and protecting against spinout. Do not exceed 25 mph (40 km/h) when the differential lock is engaged.

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

Differential Lock Switch

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

A two-position guarded rocker switch controls the differential lock. See Fig. 11.1. To lock the wheels together, momentarily press the upper half of the switch. To unlock the wheels, press the upper half of the switch again.

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

When the differential lock switch is pressed, three responses are possible: a normal response, a slow response, and an abnormal response.

Normal Response: The LED in the switch blinks until the axle has responded to the request to lock the wheels. At this point, the LED remains illuminated constantly. In normal operation, the wheels may lock so quickly that the blinking of the switch is barely noticeable.

If operation of the switch is not possible for any reason (ignition is turned off, vehicle is moving faster than 25 mph, etc.), the LED will stop blinking and turn off.

Slow Response: If operation of the switch is slowed for any reason (vehicle moving too fast, low air pressure, etc.), the switch will continue to blink until the wheels are able to lock. As in the normal response, the LED remains illuminated when the differential lock is engaged.

NOTE: If the vehicle is moving too fast, let up slightly on the accelerator. As the vehicle slows, the wheels will lock.

Abnormal Response: If the LED blinks for more than 30 seconds, the lock mechanism may not be fully engaged/disengaged. Bring the vehicle to an authorized Freightliner service facility for testing.

Differential Lock Operation

Locking the wheels when the vehicle is traveling down steep grades or when the wheels are slipping could damage the differential and/or lead to loss of vehicle control, causing personal injury and property damage.

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

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

Lock the wheels only when the vehicle is standing still or moving at very low speed, less than 5 mph (8 km/h). Never lock the wheels when the vehicle is traveling down steep grades or when the wheels are slipping.

NOTE: On some vehicles, the differential lock system is connected through the low speed range of the transmission. If this system is used, the transmission must be in the low speed range for the wheels to fully lock.

**WARNING**

A vehicle with locked wheels can still slip sideways, causing possible loss of vehicle control, personal injury, and property damage.

Be especially careful when driving under slippery conditions with the wheels locked. Though forward traction is improved, the vehicle can still slip sideways.

If the vehicle is moving, maintain a constant vehicle speed when the differential lock is turned on. Briefly let up on the accelerator to relieve torque on the gearing, allowing the wheels to lock completely. When the wheels are fully locked, the turning radius will increase because the vehicle understeers. See Fig. 11.2. Drive cautiously and do not exceed 25 mph (40 km/h).

To disengage the differential lock after leaving poor road conditions, press the upper half of the switch, while maintaining vehicle speed. Let up momentarily on the accelerator to allow the wheels to fully unlock, then resume driving at normal speed.

NOTE: If the differential lock system is connected with the transmission in its low speed range, shifting out of the low speed range will also disengage the differential lock function. The switch will blink until the wheels unlock, and then go out.
Steering System

Steering Controls ................................................................. 12.1
Steering Controls

WARNING

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

When there is no load on the vehicle and the front tires are pointed straight ahead, the steering wheel spokes should be at the 9 o’clock and 3 o’clock positions, or within 10 degrees to either side as shown in Fig. 12.1. See Group 46 of the S2 Chassis Workshop Manual for steering adjustment procedures.

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

To tilt the steering column, press down on the foot pedal located below the steering wheel to release the steering column lock. Adjust the column to the desired position. Release the foot pedal to lock the steering column in place. See Fig. 12.2.

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

NOTE: For safety, the steering column is locked at all times unless the foot pedal is pressed down.
Hydraulic and Air Brake Systems

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Dual Air Brake System

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

Primary Air Brake System

Loss of air pressure in the primary air system causes the rear service brakes to become inoperative. The front brakes will continue to be operated by the secondary air system.

Secondary Air Brake System

Loss of air pressure in the secondary air system causes the front axle brakes to become inoperative. The rear service brakes will continue to be operated by the primary air system.

Emergency Braking System

When air pressure is lost in one air system, the air compressor will operate, but the air supply in the leaking system will not be replenished. There will be enough air in the working system to stop the vehicle safely. The dual air brake system thus provides emergency braking capability. When the low air pressure warning light and emergency buzzer first come on, stop the vehicle immediately. Do not drive the vehicle until the cause of the problem is corrected.

Parking Brakes

Pulling out the yellow diamond-shaped knob (parking brake control valve) on the auxiliary dash panel applies the parking brakes (spring brakes). See Fig. 13.1.

Air Brake Operation

WARNING

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

Before driving the vehicle, secure all loose items in the vehicle so that they will not fly forward during a full brake application.

Parking Brake Interlock, Optional

NOTICE

Do not continually press down on the parking brake control valve (yellow knob) without pressing down on the service brake pedal. This will damage the safety interlock.

The service brakes and parking brakes have a safety interlock that prevents the unintentional release of the parking brake. These instructions need to be followed for the appropriately equipped vehicle to release the parking brake interlock.

Parking Brake Interlock Release

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

Parking Brake and Ignition Key Release

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

Parking Brake, Ignition Key, Wheel Chair Lift Interlock Release

1. Turn the ignition key to the ON position.
2. Check to see that the wheel chair lift is in the stowed position.
3. Confirm that the wheel chair lift switch is in the OFF position.
4. Depress the brake pedal.
5. Push the parking brake control valve in.
Transmission Shifter Interlock Release

1. If the vehicle is equipped with a wheel chair lift, make sure the lift is in the stowed position, and that the wheel chair lift switch is in the OFF position.

2. Depress the service brake pedal to move the vehicle shifter out of the park position.

Operating the Brakes

To ensure safe operation and minimum brake wear, follow the steps below when operating the brakes.

1. When the ignition switch is turned on, the low air pressure warning light (pressure circle icon) illuminates and the emergency buzzer sounds.

   1.1 Monitor the air pressure system by observing the low air pressure warning light, the emergency buzzer, and both the primary and secondary air pressure gauges.

   1.2 The warning light and buzzer shut off when air pressure in both systems reaches 65 to 75 psi (448 to 517 kPa).

2. Before driving the vehicle, continue to monitor the air pressure system until the air compressor has built up a minimum pressure of 95 psi (655 kPa) in both the primary and secondary air systems.

3. While driving, the low air pressure warning light and buzzer come on if air pressure drops below 65 to 75 psi (448 to 517 kPa) in either system.

   3.1 If this happens, check the air system pressure gauges to determine which system has low air pressure.

   3.2 Although vehicle speed can be reduced using the service brake, either the front or rear service brakes will not be operating, causing a longer stopping distance.

   3.3 Bring the vehicle to a safe stop and have the air system repaired before continuing.

4. During normal brake stops, depress the service brake until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop.

   IMPORTANT: In the event of a total loss of service brakes, use the parking brake control valve to bring the vehicle to a complete stop in the safest location possible.

5. When the forward speed of the vehicle has decreased almost to the idling speed of the engine, press in the clutch pedal (on manual transmissions) and shift the transmission to neutral. Apply the parking brakes, if the vehicle is to be parked.

---

NOTICE

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

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

Caging the Parking Brakes

---

WARNING

Do not drive the vehicle with the parking brakes caged. If the vehicle is driven with the parking brakes caged, there would be no means of stopping the vehicle if a complete loss of air pressure occurred. This could result in serious personal injury or vehicle damage.

To move a vehicle with insufficient system air pressure, it is necessary to release the parking brake springs.

There are two ways to do this:

- Apply an external air source at the gladhands;
- Cage (manually release) the parking brakes.

IMPORTANT: Before caging the parking brakes, make the connection to a towing vehicle or chock the tires.

After correcting the brake system problem, uncage the parking brakes before resuming normal vehicle operation.
Bosch Hydraulic Pin Slide Brakes

General Information

The Bosch hydraulic pin slide disc brake is a two-piston sliding caliper brake and is used at both the front and rear wheel locations. Each pin slide caliper disc brake wheel installation is made up of a caliper assembly, anchor plate assembly, and disc brake pads.

Caliper Assembly

The caliper assembly has two hydraulic piston bores. The piston bores contain pistons, piston seals, and piston boots. The caliper assembly attaches and slides on sealed pins located in the anchor plate. The caliper housing is the main component of the caliper assembly. The material of the caliper housing is ductile iron and has a protective coating to provide additional environmental protection. The disc brake caliper housing straddles the rotor, the inner pad, and the outer pad.

Anchor Plate Assembly

The anchor plate assembly includes lubricated floating guide pins sealed by rubber boots. The anchor plate abutments are protected by stainless steel slippers.

Disc Brake Pads

There are two pads per caliper assembly, and they are the inner and outer pads. The inner pad is located between the caliper piston and rotor. The outer pad is located between the rotor and caliper housing legs. The pads are made of friction material and a stamped steel backing plate. The pads are referred to as the shoe and lining assembly. These brake pads can be removed without removing the caliper.

Operation

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

During normal braking stops, depress the foot brake control pedal until braking action slows down the vehicle. Increase or decrease the pressure on the pedal so that the vehicle comes to a smooth, safe stop. Apply the hand parking brake if the vehicle is to be parked.

IMPORTANT: Make sure that the fluid level in the master cylinder reservoirs is at the bottom of the fill-neck. See Fig. 13.2. Use only DOT 3 brake fluid in the Bosch hydraulic pin slide brake system.

Meritor Cam-Master® Q Plus Brakes

Cam-Master brakes are air-actuated, cam-operated, foundation brakes. The Q Plus increases service life and mileage between relines by providing more lining thickness. A specially designed S-cam and heavy-duty shoe return spring allow additional shoe travel required to fully wear the thicker lining blocks. An improved camshaft bushing contributes to longer service life.

Cam-Master Q Plus Operation

When the brake pedal is depressed, compressed air enters the brake chamber, causing the diaphragm to move a pushrod assembly.
The pushrod turns the slack adjuster and brake camshaft. As the camshaft turns, the S-type cam head forces the brake shoes against the brake drum and braking occurs.

When the brakes are released and air is exhausted from the brake chamber, the actuator return spring (within the brake chamber) and the brake shoe return spring return the camshaft, brake shoes, slack adjuster, and pushrod to their released positions.

Meritor WABCO Pneumatic Antilock Braking System (ABS)

Pneumatic ABS is an electronic wheel speed monitoring and control system that works with the air brake system. It passively monitors vehicle wheel speed at all times, but controls wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard air brake system is in effect.

Pneumatic ABS Operation

The Meritor WABCO ABS is a four-sensor system. It combines one front-axle control channel with one rear-axle control channel to form one control circuit.

Example: The sensor and solenoid control valve at the left front wheel form a control circuit with the sensor and solenoid valve at the right rear axle.

ABS includes signal-generating tone wheels and sensors located in the wheel hubs of each sensed axle. The sensors transmit vehicle wheel speed information to an electronic control unit.

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

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

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

Even if the ABS system is partially or completely inoperative, normal braking ability is usually maintained.

IMPORTANT: If a solenoid control valve (or combination solenoid control valve) is damaged and inoperative, normal braking may be impaired.

Automatic Traction Control

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

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

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

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

NOTICE

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

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

During vehicle operation, solid illumination of the ABS light indicates a problem with the vehicle ABS.
Hydraulic and Air Brake Systems

Repair the ABS immediately to ensure full braking capability.

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

If slippery road conditions continue, turn on the differential lock switch. See Chapter 11 for axle switch instructions.

--- NOTICE ---

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

Automatic Slack Adjusters

--- NOTICE ---

Manually adjusting an automatic slack adjuster to bring the pushrod stroke within legal limits is likely masking a mechanical problem. Adjustment is not repairing. In fact, continual adjustment of automatic slack adjusters may result in premature wear of the adjuster itself. Further, the improper adjustment of some automatic slack adjusters may cause internal damage to the adjuster, thereby preventing it from properly functioning.

Automatic slack adjusters should never be manually adjusted except during routine maintenance of the foundation brakes (e.g., replacing shoes), during slack adjuster installation, or in an emergency situation.

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

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

Exhaust Brake

General Information

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

The exhaust brake is controlled by a dash-mounted rocker switch, shown in Fig. 13.3, to help slow the vehicle when the accelerator is released.

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

--- Fig. 13.3, Exhaust Brake Switch ---

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

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

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

Starting the Engine

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

**WARNING**

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

When you remove your feet from both the accelerator and clutch pedal (if so equipped), and the upper half of the exhaust brake switch is pressed in with the amber LED illuminated, the exhaust brake is applied. The following conditions should exist if the brake is operating properly:

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

**Driving Downhill**

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

**NOTICE**

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

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

**Shutting Down the Engine**

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

**Engine Brake**

**Engine Brake Switch**

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

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

To turn the two-position Hi-Lo Switch on high, raise the paddle. To turn the two-position Hi-Lo Switch on low, lower the paddle. See Fig. 13.4.

**A three-position switch is used on MBE900 engines equipped with both the regular engine brake and the constant-throttle (decompression) brake. It works the same as the two-position Hi-Lo switch, except that there is a third (off) position when the switch is left at its normal position.**
When the panel lights are on, the Hi-Lo icon is backlit in amber on the three-position switch. On both the three-position switch and the two-position switch, the ENG BRK legend is backlit in green when the panel lights are on.

Constant-Throttle Valves

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

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

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

Brake Burnishing (new vehicle)

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

1. In a safe area, make 10 sharp brake applications or “snubs,” slowing the vehicle from 40 to 20 mph (64 to 32 km/h) using light (approximately 10 to 20 psi [69 to 138 kPa]) brake pressure.

2. Make 10 stops from 20 mph (32 km/h) using moderate (20 to 30 psi [138 to 207 kPa]) brake pressure.

3. Make 2 stops from 20 mph (32 km/h) using hard (full application of air pressure) brake applications.

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

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

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

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

Pretrip and Post-Trip General Information ................................................................. 14.1
Daily Pretrip Inspection and Maintenance Checklist ................................................... 14.1
Weekly Post-Trip Inspection and Maintenance Checklist ........................................... 14.3
Monthly Post-Trip Inspection and Maintenance Checklist ........................................ 14.3
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 roadworthiness of a vehicle before placing it into service for the day. Commercial vehicles may be subject to inspection by authorized inspectors, and an unsafe vehicle can be put "out of service" until the driver or owner repairs it.

IMPORTANT: The pre- and post-trip checklists, 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 15.

If any system or component does not pass this inspection, it must be corrected before operating the vehicle. Whenever equipment requires adjustment, replacement, repair, addition of lubricants, or a change of lubricants, see the S2 Chassis Workshop Manual for procedures and specifications, or take the vehicle to an authorized Freightliner dealer.

Daily Pretrip Inspection and Maintenance Checklist

IMPORTANT: Before performing any of these checks, apply the parking brake and chock the tires.
### Table 14.1, Daily Pretrip Inspection and Maintenance Checklist

<table>
<thead>
<tr>
<th>Procedure Performed (check off)</th>
<th>Daily Pretrip Inspections/Checks</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______</td>
<td>Drain manually drained air reservoirs (that are not equipped with automatic drain valves)</td>
<td>D1</td>
</tr>
<tr>
<td>Check</td>
<td>windshield washer reservoir fluid</td>
<td>D2</td>
</tr>
<tr>
<td>Inspect</td>
<td>wheel seal and hub cap (for leakage)</td>
<td>D2</td>
</tr>
<tr>
<td>Check</td>
<td>surge tank coolant level</td>
<td>D3</td>
</tr>
<tr>
<td>Inspect</td>
<td>radiator and charge air cooler</td>
<td>D4</td>
</tr>
<tr>
<td>Check</td>
<td>engine for fuel, oil, or coolant leaks</td>
<td>—</td>
</tr>
<tr>
<td>Inspect</td>
<td>engine and chassis wiring</td>
<td>D5</td>
</tr>
<tr>
<td>Inspect</td>
<td>air intake system</td>
<td>D6</td>
</tr>
<tr>
<td>Check</td>
<td>intake-air restriction indicator mounted on air intake</td>
<td>D6</td>
</tr>
<tr>
<td>Check</td>
<td>engine oil level</td>
<td>D7</td>
</tr>
<tr>
<td>Check</td>
<td>power steering fluid level</td>
<td>—</td>
</tr>
<tr>
<td>Inspect</td>
<td>fuel tank(s), fuel lines, and connections</td>
<td>D8</td>
</tr>
<tr>
<td>Check</td>
<td>fuel level</td>
<td>D9</td>
</tr>
<tr>
<td>Check</td>
<td>fuel/water separator</td>
<td>D10</td>
</tr>
<tr>
<td>Inspect</td>
<td>front and rear suspension components</td>
<td>D11</td>
</tr>
<tr>
<td>Inspect</td>
<td>headlights, mirrors, and window glass, and windshield wipers</td>
<td>D12</td>
</tr>
<tr>
<td>Check</td>
<td>doors (open without difficulty and close securely)</td>
<td>—</td>
</tr>
<tr>
<td>Check</td>
<td>Adjust driver’s seat, then align rearview and downview mirrors</td>
<td>—</td>
</tr>
<tr>
<td>Check</td>
<td>dash-mounted intake-air restriction indicator</td>
<td>D6</td>
</tr>
<tr>
<td>Check</td>
<td>oil- and air-pressure warning systems</td>
<td>D13</td>
</tr>
<tr>
<td>Check</td>
<td>ICU fault codes</td>
<td>D14</td>
</tr>
<tr>
<td>Check</td>
<td>horn, windshield wipers, and windshield washer</td>
<td>D15</td>
</tr>
<tr>
<td>Check</td>
<td>heater, defroster, and optional mirror heat controls</td>
<td>D16</td>
</tr>
<tr>
<td>Check</td>
<td>backup alarm</td>
<td>—</td>
</tr>
<tr>
<td>Check</td>
<td>panel lights and interior lights</td>
<td>D17</td>
</tr>
<tr>
<td>Check</td>
<td>exterior lights and reflectors</td>
<td>D18</td>
</tr>
<tr>
<td>Check</td>
<td>tire pressure</td>
<td>D19</td>
</tr>
<tr>
<td>Inspect</td>
<td>tire condition</td>
<td>D20</td>
</tr>
<tr>
<td>Inspect</td>
<td>rims and wheels</td>
<td>D21</td>
</tr>
<tr>
<td>Check</td>
<td>automatic transmission fluid level</td>
<td>—</td>
</tr>
<tr>
<td>Inspect</td>
<td>air brake chambers and pushrods</td>
<td>D22</td>
</tr>
<tr>
<td>Inspect</td>
<td>air brake lines</td>
<td>D23</td>
</tr>
<tr>
<td>Inspect</td>
<td>slack adjusters</td>
<td>D24</td>
</tr>
<tr>
<td>Check</td>
<td>air brake system operation</td>
<td>D25</td>
</tr>
<tr>
<td>Check</td>
<td>Bendix® Hydro-Max Power Booster</td>
<td>D26</td>
</tr>
<tr>
<td>Inspect</td>
<td>frame rails (missing bolts), crossmembers (bent or loose)</td>
<td>—</td>
</tr>
<tr>
<td>Check</td>
<td>mud flaps (aren’t damaged, at least 10 inches above the ground, and brackets are secure)</td>
<td>—</td>
</tr>
<tr>
<td>Check</td>
<td>exhaust system (mounted securely, connected tightly, no signs of leaks such as soot trails)</td>
<td>—</td>
</tr>
<tr>
<td>_______</td>
<td>Remove chocks and test service brakes</td>
<td>D27</td>
</tr>
</tbody>
</table>

Inspector ___________________________________________________________ Date ________________
Weekly Post-Trip Inspection and Maintenance Checklist

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

For the weekly post-trip inspection and maintenance checklist see Table 14.2.

<table>
<thead>
<tr>
<th>Procedure Performed (check off)</th>
<th>Weekly Post-Trip Inspections/Checks</th>
<th>Procedure Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>_________</td>
<td>Manually drain air reservoirs that are equipped with automatic drain valves</td>
<td>—</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>batteries and battery cables</td>
<td>W1</td>
</tr>
<tr>
<td>Check ________</td>
<td>wheel bearing lubricant level</td>
<td>W2</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>steering components</td>
<td>W3</td>
</tr>
<tr>
<td>Check ________</td>
<td>serpentine drive belt condition</td>
<td>W4</td>
</tr>
<tr>
<td>Check ________</td>
<td>drive belt tension</td>
<td>W5</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>seat belts and tether belts</td>
<td>W6</td>
</tr>
</tbody>
</table>

Inspector___________________________________________________ Date ________________

Table 14.2, Weekly Post-Trip Inspection and Maintenance Checklist

Monthly Post-Trip Inspection and Maintenance Checklist

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

For the monthly post-trip inspection and maintenance checklist see Table 14.3.

<table>
<thead>
<tr>
<th>Procedure Performed (check off)</th>
<th>Monthly Post-Trip Inspections/Checks</th>
<th>Procedure Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>________</td>
<td>Clean the battery terminals</td>
<td>M1</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>radiator hoses and heater hoses</td>
<td>M2</td>
</tr>
<tr>
<td>Check ________</td>
<td>fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 4 brake fluid)</td>
<td>—</td>
</tr>
<tr>
<td>Check ________</td>
<td>fluid level in the hydraulic brake reservoir (if applicable, and if necessary, fill with DOT 3 brake fluid)</td>
<td>M3</td>
</tr>
<tr>
<td>Check ________</td>
<td>steering wheel play</td>
<td>M4</td>
</tr>
<tr>
<td>Check ________</td>
<td>outer surfaces of the hood and body (for visible surface breaks and damage)</td>
<td>—</td>
</tr>
<tr>
<td>Check ________</td>
<td>hood till damper (attached at both ends)</td>
<td>—</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>brake lining wear</td>
<td>M5</td>
</tr>
<tr>
<td>Inspect ________</td>
<td>driveshaft</td>
<td>—</td>
</tr>
</tbody>
</table>

Inspector___________________________________________________ Date ________________

Table 14.3, Monthly Post-Trip Inspection and Maintenance Checklist
Pre- and Post-Trip Inspections and Maintenance

Safety Precautions ............................................................... 15.1
Daily Pretrip Inspection and Maintenance Procedures ........................................ 15.1
Weekly Post-Trip Inspection and Maintenance Procedures ................................. 15.11
Monthly Post-Trip Inspection and Maintenance Procedures ............................ 15.12
Safety Precautions

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

Daily Pretrip Inspection and Maintenance Procedures

Whenever equipment requires adjustment, replacement, and/or repair, see the S2 Chassis Workshop Manual for procedures and specifications. Specific references to the manual will be found where appropriate.

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

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

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

   **WARNING**

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

   1.2 Exhaust the remaining air and moisture from the system by opening the drain cocks on the 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. Unscrew the cap to add fluid.

   **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. 15.1. If the coolant is low, add a 50/50 mixture of water and antifreeze. Refer to the engine manufacturer’s service literature for approved coolants. Fill the surge tank with coolant to the FULL line when the tank is cool. If the surge tank was empty, start the engine after re-filling and check the level again when the engine is at operating temperature.

   **NOTICE**

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

4. Inspect the radiator and charge air cooler.
4.1 Inspect the radiator and charge air cooler for clogged fins. Use compressed air or water directed from the fan side of the core to backflush any material restricting airflow.

4.2 Inspect the radiator and charge air cooler for damage and accumulated debris. Straighten bent or damaged fins to permit airflow across all areas of the cores.

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

4.3 Also inspect and clean the condenser. If clogged, the condenser can restrict airflow through the radiator.

4.4 Check the radiator for leaks. If leaks are found, have the radiator repaired or replaced. See Group 20 of the S2 Chassis Workshop Manual for instructions, or take the vehicle to an authorized Freightliner dealer.

5. *Inspect the engine and chassis wiring.*

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

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

---

**NOTICE**

Failure to maintain a sealed air intake system could allow 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.

6.2 Replace the primary filter element in the air cleaner if the yellow signal stays locked at 20 inH₂O for Mercedes-Benz engines and 25 inH₂O for Cummins ISB engines. See Group 09 of the S2 Chassis Workshop Manual for filter element replacement instructions, or take the vehicle to an authorized Freightliner dealer. See Fig. 15.2.

---

**NOTICE**

Operating the engine with the oil level below the minimum fill (or “add”) mark or above the maximum fill (or “full”) mark could result in engine damage.
Pre- and Post-Trip Inspections and Maintenance

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

7. Check the engine oil level.

---

**NOTICE**

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

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

NOTE: For diesel engines, follow the engine manufacturer’s guidelines for engine shutdown time requirements prior to checking the oil level.

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

7.3 If the oil is below the cross-hatched area, or the add mark, at the tip of the dipstick, add at least one quart (liter) of the recommended oil. See Fig. 15.3 and Fig. 15.4 for diesel engines, and Fig. 15.5 for propane engines.

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

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

---

**NOTICE**

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

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

8.1 Check that the fuel tanks are secured to their mounting brackets and that the mounting brackets are secured to the frame.

8.2 Replace leaking fuel tanks.

8.3 If lines or connections are leaking, have them repaired or replaced.

For repair and/or replacement procedures, see Group 47 of the S2 Chassis Workshop Manual, or take the vehicle to an authorized Freightliner dealer.

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

---

**WARNING**

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

9. 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**

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.

9.1 Fuel should always be strained or filtered before being put into the tanks. This will lengthen the life of the engine fuel filter and reduce the chances of dirt getting into the engine.

9.2 Before installing the fuel cap, clean the area with a rag, or if necessary, clean the cap with solvent.

9.3 If needed, prime the fuel system. For priming procedures, see the applicable engine manufacturer’s manual.

10. *If equipped with a fuel/water separator, check for water.*

Drain any water found. Check the fuel/water separator for leaks and contaminants.

For an Alliance Model, see Fig. 15.6. Place a suitable container under the fuel/water separator. Check the water level in the sight bowl, if so equipped. To drain the water, loosen the valve at the bottom and allow the water to run out. Close and tighten the valve finger-tight.

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

11. *Inspect the front and rear suspension components, including springs, spring hangers, shocks, and suspension brackets.*

11.1 Check for broken spring leaves, loose U-bolts, cracks in the suspension brackets, and loose fasteners in the spring hangers and shackles.

11.2 Inspect the shock absorbers for loose fasteners and leaks.

11.3 Tighten all loose fasteners and have any components replaced that are worn, cracked, or otherwise damaged.

11.4 On vehicles with air suspensions, check for leaks. Check air suspension components for cuts and bulges.

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

Check the condition of the windshield wiper arms and blades.

Be sure the windshield wiper blades are tensioned against the windshield.
Inspect the wiper blades for damage and deteriorated rubber.

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

Replace damaged or deteriorated wiper blades.

**WARNING**

When cleaning windshields and windows, always stand on the ground or on a secure ladder or platform. Use a long-handed 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.

13. **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.

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

13.2 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. For vehicles with an optional Bendix dryer reservoir module (DRM), the cut-out pressure is 130 psi (896 kPa).

14. **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 3** for detailed operating instructions for the ICU.

15. **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.**

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

15.2 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.

16. **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.**

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

Turn on the headlights, dash lights, and four-way flashers and leave them on. If any of the gauge bulbs, the dome light bulbs, or the right- and left-turn indicator bulbs are not working, replace them. See **Chapter 19** of this manual for replacement bulb identification.

18. **Make sure all the exterior lights are working properly.**

Check that all the lights and reflectors are clean. See **Fig. 15.7**.

18.1 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.

18.2 Test the high and low beams of the headlights.

18.3 Replace light bulbs or sealed beam units that are not working.

18.4 Be sure all reflectors and lenses are in good condition and are clean. Replace any broken reflectors or lenses.

19. **Check tire inflation pressures using an accurate tire pressure gauge.**
Pre- and Post-Trip Inspections and Maintenance

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

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

19.2 Inflate the tires to the applicable pressures if needed.

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

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

**WARNING**

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

**IMPORTANT:** The load and cold inflation pressure must not exceed the wheel manufacturer's recommendations, even though the tire may be approved for a higher load inflation. Some wheels are stamped with a maximum load and maximum cold inflation rating. If they are not stamped, consult the wheel manufacturer for the correct tire inflation pressure for the vehicle load. If the load exceeds the maximum wheel capacity, the load must be adjusted or reduced.

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

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

20. **Inspect each tire for wear, bulges, cracks, cuts, penetrations, and oil contamination.** A weekly pressure loss of 4 psi (28 kPa) or more in a tire may indicate damage. The tire should be inspected and if necessary, repaired or replaced.

20.1 Check the tire tread depth. If tread is less than 4/32 inch (3 mm) on any front tire, or less than 2/32 inch (1.5 mm) on any rear tire, replace the tire.

20.2 Inspect each tire for bulges, cracks, cuts, and penetrations.

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

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

21.1 Remove all dirt and foreign material from the assembly. Dirt or rust streaks from the stud holes, metal buildup around stud holes, or out-of-round or worn stud holes may be caused by loose wheel nuts. See [Fig. 15.8](#) and [Fig. 15.9](#).

21.2 Examine the wheel components (including studs, and nuts) for cracks, or other damage.
21.3 Make sure all wheel nuts are tightened 450 to 500 lbf-ft (610 to 678 N·m) for Accuride wheels with unlubricated threads. Use the tightening pattern in Fig. 15.10 for 10-hole wheels and the tightening pattern in Fig. 15.11 for 8-hole wheels. See Group 40 of the S2 Chassis Workshop Manual for more information.

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**NOTICE**

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

---

**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.

---

**NOTICE**

Use the recommended torque values and follow the proper tightening sequence.
NOTE: Vehicles operating under severe or adverse conditions should be checked more frequently.

22. Inspect the air brake chamber and the air brake chamber pushrods. See Fig. 15.12.

**DANGER**

Do not loosen or remove the parking brake clamp ring for any purpose. See Fig. 15.11. The parking/emergency brake section of the brake chamber is not intended to be serviced. Serious injury or death may result from sudden release of the power spring.

Before doing any repairs or adjustments on a service/parking brake chamber, read the applicable warnings and instructions in Group 42 of the S2 Chassis Workshop Manual.

---

**NOTICE**

If the external breather tube or breather cap is missing or incorrectly installed, road dirt and debris can adversely affect the operation of the brake chamber. Once inside of the chamber, dirt and debris can cause the internal parts of the chamber to deteriorate faster.

22.1 Check that the air brake chamber is mounted securely on its mounting bracket, and that there are no loose or missing bolts.

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

22.3 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. See Group 42 of the S2 Chassis Workshop Manual.

22.4 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. See Group 42 of the S2 Chassis Workshop Manual to replace any damaged parts.

22.5 On all parking brake installations, make sure the end cover cap or dust plug is securely snapped into place.

**NOTE:** On most MGM parking brake chambers equipped with an integral release bolt, an end cover cap is installed over the release bolt.

22.6 Check for rusted connections, missing snap rings, and damaged camshaft grease seals. Have damaged or missing parts repaired or replaced.

23. Inspect the air brake lines.
23.1 Check the clearance between the hoses and the exhaust manifold or other hot spots. Excessive heat will cause 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 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.

23.3 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.

23.4 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.

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

23.6 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.

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.

23.7 This inspection requires two people, one in the driver 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.

23.8 Turn the wheels to full lock in the other direction and inspect both lines. If a hose is leaking, have it replaced.

24. Inspect the slack adjusters.

24.1 Meritor Slack Adjusters: Check the boot for cuts, tears, or other damage. Have it replaced if necessary.

24.2 Gunite 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. See Fig. 15.13.

24.3 Haldex Slack Adjusters: Inspect each slack adjuster and anchor strap for damage. Have any damaged components replaced.

25. Check the air brake system for proper operation.

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

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

25.2 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.

If leakage exceeds the limits shown in Table 15.1, repair all areas of leakage before driving the vehicle.

### Table 15.1, Maximum Allowable Service Brake Leakage

<table>
<thead>
<tr>
<th>Maximum Air Leakage Per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brakes Released</td>
</tr>
<tr>
<td>2 psi (14 kPa)</td>
</tr>
</tbody>
</table>

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

#### 26.1
With the ignition off, depress the brake pedal and listen for the back-up motor to engage. The operator should also feel the pedal force relieve and the pedal should depress easily.

#### 26.2
With the engine running, and the parking brake released, ensure that the BRAKE warning indicator light is **not** on. This is a dual indicator, and indicates that the parking brake is set, and warns if there is a Hydro-Max failure condition other than loss of back-up motor power.

### 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.

   **WARNING**

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

   1.1 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.
   1.2 If the battery is equipped with a built-in hydrometer, examine the hydrometer. If a green dot shows in the sight glass, the battery is sufficiently charged. If the sight glass is dark, the charge is low and the battery must be recharged. If the sight glass is clear, the battery has a low level of electrolyte and must be replaced.

2. Check the level of the wheel bearing lubricant in the hub cap at each end of the front axle.
   If needed, fill the hubs to the level indicated on the hub cap. See Chapter 19, for recommended lubricants.

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

3. Examine the steering components.

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

4. Check the condition of the serpentine drive belt.

   Look for signs of glazing, wear (frayed edges), damage (breaks or cracks), or oil contamination. If a belt is glazed, worn, damaged, or oil soaked, have the belt replaced, following the instructions in Group 01 of the S2 Chassis Workshop Manual.

5. Check the drive belt for proper tension.

   Use your index finger to apply force at the center of the belt free-span. See Fig. 15.15. There is no
adjustment for belt tension on engines with automatic belt tensioners. If there is not proper tension, have the belt tensioner replaced. See Group 01 of the S2 Chassis Workshop Manual for instructions, or take the vehicle to an authorized Freightliner dealer.

6. Inspect the seat belts and tether belts.

**WARNING**

Inspect and maintain seat belts as instructed below. Worn or damaged seat belts could fail during a sudden stop or crash, possibly resulting in serious injury or death.

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

**NOTE:** When any part of a seat belt needs replacement, the entire seat belt must be replaced, both retractor and buckle side.

6.1 Check the web for fraying, cuts, or extreme wear, especially near the buckle latch plate and in the D-loop guide area.

6.2 Check the web for extreme dirt or dust and for severe fading from exposure to sunlight.

6.3 Check the buckle and latch for operation and for wear or damage.

6.4 Check the Komfort Latch for function and cracks or other damage.

6.5 Check the web retractor for function and damage.

6.6 Check the mounting bolts for tightness and tighten any that are loose.

### Monthly Post-Trip Inspection and Maintenance Procedures

**WARNING**

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

1. *Clean the batteries.*

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

**NOTICE**

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

1.2 Use a soda solution to neutralize the acid present, then rinse off the soda solution with clean water.

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

2. *Inspect the radiator and heater hoses, including the clamps and support brackets.*

   2.1 Make sure the radiator inlet and outlet hoses are pliable and are not cracking 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 hose clamps as necessary, but do not overtighten, as hose life can be adversely affected.

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

**IMPORTANT:** Replace all hoses, including heater hoses, at the same time. Service-type knitted or braided yarn-reinforced neoprene hose is acceptable. Silicone hoses having an extended service life can be substituted for the reinforced neoprene type. See the Freightliner Service Parts Catalog or contact your Freightliner dealer.
3. Check the fluid level in the hydraulic brake fluid reservoir, if so equipped. If needed, fill the reservoir to the bottom of the fill-neck with DOT 3 heavy-duty brake fluid. See Fig. 15.16.

4. Check the steering wheel for excessive play. See Fig. 15.17.

   4.1 With the front tires straight ahead, turn the steering wheel until motion is observed at the front wheels.

   4.2 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.

   4.3 Measure 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.

5. 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.

   5.1 Check that brake linings are free of oil and grease.

   5.2 Inspect the thickness of the brake linings. If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs. If any brake linings are worn to less than approximately 1/4 inch (6.4 mm) at the thinnest point, have the linings replaced on all brake assemblies on that axle. See Group 42 of the S2 Chassis Workshop Manual for lining replacement instructions and camshaft end-play inspection.

   5.3 Check the brake drums for wear and cracks.

   5.4 Check that the inspection plugs in the dust shields or backing plates, if so equipped, are installed.
Cleaning and Care

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Care of Fiberglass Parts .......................................................... 16.1
Care of Chrome Parts .......................................................... 16.1
Care of Exterior Lights .......................................................... 16.1
Dashboard and Instrument Panel Care ..................................... 16.1
Vinyl Upholstery Cleaning ...................................................... 16.2
Velour Upholstery Cleaning .................................................... 16.3
Cleaning and Care

Washing and Polishing

NOTICE

When pressure washing the vehicle or leaving the hood open when parked outdoors and subject to rain, cover the air cleaner inlet with a plastic bag to prevent water from entering the air intake system and possibly damaging the engine.

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

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

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

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

Care of Fiberglass Parts

Wash unpainted fiberglass air fairings and shields monthly with a mild detergent, such as dishwashing liquid. Avoid strong alkaline cleansers.

Apply a wax specifically designed for fiberglass.

Care of Chrome Parts

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

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

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

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

Care of Exterior Lights

Clean the headlight lenses by hand only, using a flannel cloth with mild, non-caustic soap or detergent, and water.

NOTICE

Do not use a power buffer, paper towels, chemical solvents, or abrasive cleaners on the headlight lens, all of which can remove the UV coating from the surface, and result in yellowing of the lens.

Dashboard and Instrument Panel Care

NOTICE

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

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

**Vinyl Upholstery Cleaning**

To prevent soiling, frequent vacuuming or light brushing to remove dust and dirt is recommended. Harsh cleaning agents can cause permanent damage to vinyl upholstery. To preserve the upholstery and prevent damage, carefully review the following sections for recommended cleaning procedures. Waxing or refinishing improves soil resistance and cleanability for all vinyls. Any hard wax, such as that used on automobiles, may be used.

**Ordinary Dirt**

Wash the upholstery with warm water and mild soap, such as saddle or oil soap. Apply soapy water to a large area and allow to soak for a few minutes, then rub briskly with a cloth to remove the dirt. This can be repeated several times as necessary.

If dirt is deeply imbedded, use a soft bristle brush after applying the soap.

If dirt is extremely difficult to remove, wall-washing preparations normally found around the home can be used. Powdered cleaners, such as those used for sinks and tiles, are abrasive and must be used with caution as they can scratch the vinyl or give it a permanent dull appearance.

**Chewing Gum**

Harden the gum with an ice cube wrapped in a plastic bag, then scrape it off with a dull knife. Any remaining traces of gum can be removed with an all-purpose light oil (peanut butter will also work) and wiped off.

**Tars, Asphalts, and Creosote**

Tars, asphalts, and creosote stain vinyl after prolonged contact. They should be wiped off immediately and the area carefully cleaned, using a cloth dampened with naphtha.

**Paint and Shoe Heel Marks**

Paint should be removed immediately. Do not use paint remover or liquid-type brush cleaner on vinyl. An unprinted cloth, dampened with naphtha or turpentine may be used. Use care to prevent contact with parts of the upholstery that are not vinyl.

**Sulfide Stains**

Sulfide compounds, such as those found in eggs and some canned goods, can stain after prolonged contact with vinyl. These stains can be removed by placing a clean, unprinted piece of cloth over the spotted area and pouring a liberal amount of 6 percent hydrogen peroxide onto the cloth. Allow the saturated cloth to remain on the spot for 30 to 60 minutes. For stubborn spots, allow the hydrogen-peroxide saturated cloth to remain on the area overnight. Use caution to prevent the solution from seeping into the seams or it will weaken the cotton thread.

**Nail Polish and Nail Polish Remover**

Prolonged contact with these substances causes permanent damage to vinyl. Careful blotting immediately after contact minimizes damage. Do not spread the liquid during removal.

**Shoe Polish**

Most shoe polishes contain dyes which penetrate vinyl and stain it permanently. Shoe polish should be wiped off as quickly as possible using naphtha or lighter fluid. If staining occurs, try the procedure used for sulfide stains.

**Ball Point Ink**

Ball point ink can sometimes be removed if rubbed immediately with a cloth damp with water or rubbing alcohol. If this does not work, try the procedure used for sulfide stains.

**Miscellaneous**

If stains do not respond to any of the treatments described above, it is sometimes helpful to expose the vinyl to direct sunlight for up to 30 hours. Mustard, ball point ink, certain shoe polishes, and dyes often bleach out in direct sunlight, leaving the vinyl undamaged.
Velour Upholstery Cleaning

To prevent soiling, frequent vacuuming or light brushing to remove dust and dirt is recommended. Spot clean with a mild solvent or an upholstery shampoo, or the foam from a mild detergent. When using a solvent or a dry-cleaning product, follow the instructions carefully and clean only in a well-ventilated area. Avoid any product that contains carbon tetrachloride or other toxic materials. With either method, pretest a small area before proceeding. Use a professional upholstery cleaning service when extensive cleaning is needed.

Grease and Oil-Based Stains

Dampen a small absorbent cloth with dry-cleaning solvent or spot remover. Apply the cloth carefully to the spot from the outer edge to the center. Pat and blot the spot with a clean, dry cloth. Repeat several times, as necessary, turning the cloths so that the stain does not redeposit on the fabric.

Sugar and Water-Based Stains

Apply water-based detergent or cleaner, working in circular motions. Pat and blot as dry as possible. Repeat if necessary before drying thoroughly.

Chewing Gum or Wax

Harden the gum or wax with an ice cube wrapped in a plastic bag, then scrape it off with a dull knife. Excess wax can be absorbed by placing a thick white blotter over the wax and heating with a warm (not hot) iron. Remove the remainder by using the procedure for grease and oil-based stains.

Mildew

Brush the dry fabric with a soft brush. Sponge with detergent, and blot. If the fabric is colorfast, dilute a teaspoon of bleach in one quart (one liter) of cool water. Apply with a swab, directly on the mildew stain. Dab repeatedly with clear, cool water, and blot dry.
In an Emergency

Hazard Warning Lights ............................................................ 17.1
Emergency Starting With Jumper Cables ............................................ 17.1
Towing ........................................................................ 17.3
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Fire Extinguisher ..................................................................... 17.5
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Hazard Warning Lights

The hazard warning light switch is part of the multifunction turn signal switch. It is a red rocker switch located on the top of the multifunction switch module. See Fig. 17.1.

Press down on the upper part of the rocker to activate the hazard warning lights.
1. Washer Button
2. Wiper Control Dial
3. Turn Signal Lever
4. Hazard Warning Light Switch (red)
5. Multifunction Switch Module

Fig. 17.1, Multifunction Turn Signal Switch

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

Emergency Starting With Jumper Cables

When using jumper cables, follow the instructions below.

WARNING

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

NOTICE

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

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

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

2. Open the battery door to access the batteries. Pull both pull-pin spring latches and slide the battery tray out. See Fig. 17.2.

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

Fig. 17.2, Battery Access

NOTICE

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

3. Connect the positive (+) jumper cable to the positive terminal on the discharged battery. See Fig. 17.3.

4. Connect the other end of the positive jumper cable to the positive terminal on the booster battery providing the charge.
WARNING

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

5. Connect the negative (-) jumper cable to the negative terminal on the booster battery.

6. Connect the other end of the negative jumper cable to the negative ground stud on the vehicle requiring the jump start.

7. Start the engine of the vehicle providing the jump start and let the engine run for a few minutes to charge the batteries of the other vehicle.

01/07/2011

Disconnect jumper cables in the REVERSE order that they were connected.

A. Discharged Battery
B. Negative Ground Stud
C. Positive Jumper Cable
D. Negative Jumper Cable
E. Booster Battery

1. 1st Connection: Positive Jumper Cable to Discharged Battery
2. 2nd Connection: Positive Jumper Cable to Booster Battery
3. 3rd Connection: Negative Jumper Cable to Booster Battery
4. 4th Connection: Negative Jumper Cable to Negative Ground Stud (discharged battery)

Fig. 17.3, Jumper Connections (three battery system shown for clarity)
**NOTICE**

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

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

**WARNING**

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

10. Disconnect the negative jumper cable from the negative cable stud on the jump started vehicle.
11. Disconnect the negative jumper cable from the booster battery.
12. Disconnect the positive cable from the booster battery.
13. Disconnect the other end of the positive jumper cable from the jump started vehicle.
14. Pull both pull-pin spring latches and slide the battery tray back into position. Release the pull-pin spring latches to lock the battery tray, then close the battery door.

**Towing**

**WARNING**

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

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

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

**Front Towing Hookup**

**NOTICE**

The vehicle should never be towed from the rear. The gross axle weight rating (GAWR) of the front axle may not be sufficient to support the increased load when towing from the rear. This could damage the front axle.

1. Disconnect the battery ground cables.

**WARNING**

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

2. Remove the drive axle shaft.

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

**NOTICE**

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

3. Remove the bumper.

4. Attach the towing device. Due to the many variables that exist in towing, positioning the lifting and towing device is the sole responsibility of the towing-vehicle operator.

5. Lift the vehicle and secure the safety chains. If extra towing clearance is needed, remove the front wheels.

6. Connect the clearance lights, taillights, and signal lights. Connect any special towing lights required by local regulations.
WARNING

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

NOTICE

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

7. Chock the tires on the disabled vehicle and connect the towing vehicle’s air brake system to the vehicle being towed. Then, release the spring parking brake and remove the chocks.

8. On vehicles equipped with hydraulic disc brakes be sure the parking brake is released before starting the towing process.

Running Out of Fuel

WARNING

Do not mix gasoline or alcohol with diesel fuel. This mixture could cause an explosion. When filling fuel tanks, do not smoke or use an open flame near the fuel tanks. Combustion of diesel fuel oil or fuel vapors could result, possibly causing personal injury or property damage.

1. If possible, stop the vehicle on a level surface, away from traffic.

2. Apply the parking brake.

IMPORTANT: Any time the vehicle runs out of fuel, the fuel system should be primed. This will purge any trapped air in the system and allows fuel to fill the fuel filter.

3. See the engine manufacturer’s manual for instructions to prime the fuel system.

4. If further assistance is needed, call the Freightliner Customer Assistance Center at 1-800-385-4357 or 1-800-FTL-HELP.

NOTICE

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

5. Add fuel to the fuel tank.

6. After adding fuel to the fuel tank, start the engine. Once the vehicle is running, let the engine idle until it operates smoothly before driving the vehicle.

Changing a Flat Tire

DANGER

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

WARNING

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

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

1. Stop the vehicle on a level surface, away from traffic.

2. Apply the parking brake, place the transmission in neutral (N), and shut down the engine.

3. Turn on the hazard warning lights.

4. Block the wheel diagonally opposite the wheel being changed.

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

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

IMPORTANT: The jacking point for the front wheels is on the front axle beam and other locations shown in Fig. 17.4. The jacking point for rear wheels is on the rear axle and at the locations on the rear suspension H-frame, shown in Fig. 17.4.

Only use the front bumper locations if the vehicle is equipped with a jackable bumper. When jacking the front bumper, the jacking point(s) must be centered and within the bottom surface of the bumper support as shown in Fig. 17.4. Do not position the jack under the dropped frame rails in the center section of the vehicle.

6. Place the jack on a solid surface. Insert the jack handle and pump the handle slightly. Do not raise the wheel off of the ground yet. Loosen the wheel lug nuts, but do not remove them.

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

8. Install the spare wheel and lug nuts. Make sure that the beveled sides of the nuts face inward, or, on hub-piloted wheels, make sure that the hub-pilot pad is centered at the top.

IMPORTANT: When a tire is changed, the vehicle should be taken to a mechanic as soon as possible, to have the lug nuts tightened properly with an impact air gun.

9. In a star pattern, tighten the nuts evenly until snug. See Group 40 of the S2 Workshop Manual for wheel tightening patterns and torque specifications. Lower the vehicle until the wheel touches the ground. Tighten the nuts.

10. Finish lowering the vehicle to the ground, then remove the jack.

11. Remove the block, then stow the jack, jack handle, and lug wrench.

12. After operating the vehicle for 50 to 100 miles (80 to 161 km), retighten the wheel nuts to the specified torque values.

**Fire Extinguisher**

An optional fire extinguisher is located in the front of the cab, between the driver and passenger seats.
First Aid Kit
An optional first aid kit is mounted to the back of the cab, between the driver and passenger seats.

Flare Kit
An optional flare kit is located in the center of the cab, between the driver and passenger seats.
Headlight Aiming

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Checking Headlight Aim ........................................................ 18.1
Adjusting Headlight Aim ...................................................... 18.1
Preliminary Checks

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

- Check that the hood is closed and latched.
- Check the suspension for proper functioning of the leveling mechanism. On vehicles with air suspensions, make sure that the height is properly adjusted.
- Remove any large amounts of mud or ice from the underside of the fenders.
- Check the springs for sagging or broken leaves.
- Check for damage to the hood and hinge assembly. Repair as necessary.
- Clean the headlight lenses. Use a soft cloth with mild, non-caustic soap or detergent, and water.
- With the vehicle unloaded, check that the tires are inflated to the recommended air pressure.

Checking Headlight Aim

1. Park the vehicle on a level surface, 25 ft (7.6 m) away from, and perpendicular to, a vertical screen or wall. Shut down the engine and set the parking brake. Chock the tires.

2. Each headlight has a height adjusting dot. See Fig. 18.1. Measure the distance from the ground to the height adjusting dot on each headlight. Note those distances. See Fig. 18.2, Ref. A.

3. Mark the vertical distances found in step 2 on the screen or wall, directly in front of the headlights. These marks represent the desired locations of each headlight bulb center in the following steps. See Fig. 18.2, Items 2 and 3.

4. Turn on the low-beam headlights.

5. Identify the center of each beam projection by marking the area of brightest intensity on the wall. The area of brightest intensity should fall on or very near the marks made during step 3. See Fig. 18.3.

6. Use Table 18.1 to determine the maximum vertical distance allowable between the marks made in step 3 and the marks made in step 5. If the vertical distance between the marks made in steps 3 and 5 is greater than the maximum distance given in Table 18.1, adjust the vertical positioning of that headlight.

Adjusting Headlight Aim

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

1. Lift the flap over the rear end of the headlight bucket to expose the two plastic adjusting knobs on each headlight. See Fig. 18.4.

2. If necessary, adjust the horizontal positioning of the headlights so that each projection points directly forward.

3. Turn the vertical adjustment knob to adjust the headlight beam to meet the desired height. See Table 18.1. Turn the knob clockwise to raise the beam; turn the knob counterclockwise to lower it.

4. Adjust the other headlight.
A. Measure the distance from the ground to the center of each headlight bulb.
B. Mark where the center of each headlight projection should appear.

1. Screen or Wall
2. Center of Right-Hand Headlight Projection
3. Center of Left-Hand Headlight Projection

**Fig. 18.2, Headlight Aiming Screen/Wall**

---

1. Low-Beam Angle Upper Limit
2. Ideal Low-Beam Projection
3. Low-Beam Angle Lower Limit

**Fig. 18.3, Vertical Low-Beam Headlight Variation Limits**
NOTE: The right-hand side headlight bucket is shown. The left-hand side is opposite.

1. Horizontal (inboard) Adjusting Knob
2. Vertical (outboard) Adjusting Knob

**Fig. 18.4, Headlight Adjusting Knobs**

**Vertical Low-Beam Headlight Variation Limits**

<table>
<thead>
<tr>
<th>Distance Between Ground and Headlight: in (mm)</th>
<th>Desired Variation (Fig. 18.3, Item 2): in (mm)</th>
<th>Upper Limit (Fig. 18.3, Item 1): in (mm) up</th>
<th>Lower Limit (Fig. 18.3, Item 3): in (mm) down</th>
</tr>
</thead>
<tbody>
<tr>
<td>22–36 (560–900)</td>
<td>0</td>
<td>3.9 (100)</td>
<td>3.9 (100)</td>
</tr>
<tr>
<td>36–48 (900–1200)</td>
<td>2 (50) down</td>
<td>2 (50)</td>
<td>6 (150)</td>
</tr>
<tr>
<td>48–54 (1200–1400)</td>
<td>2.5 (64) down</td>
<td>1.6 (40)</td>
<td>6.5 (165)</td>
</tr>
</tbody>
</table>

**Table 18.1, Vertical Low-Beam Headlight Variation Limits**
Propane Fuel System

General Information .............................................................. 19.1
Ignition Switch and Key ........................................................... 19.1
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General Information

**CAUTION**

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

**DANGER**

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

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

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

**IMPORTANT:** For assistance with propane engine related questions, contact Freightliner Custom Chassis Corporation at 1-800-385-4357, option 1.

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

**NOTICE**

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

HD5 grade propane is recommended for propane engines. HD5 is a heavy duty engine grade propane with a minimum of 90% propane and a maximum of 5% propylene. This grade of propane is 100 plus octane and provides proper performance and emissions control, which the fuel system is designed to deliver.

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

**NOTICE**

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

**WARNING**

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

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

**Ignition Switch and Key**

The ignition switch can be turned to four positions: ACCESSORY, OFF, RUN, and START. See Fig. 19.1.

**NOTE**

The key can be inserted and removed only in the OFF position. The headlights (low beams), taillights, brake lights, road lights, clearance lights, turn signals, hazard warning lights, horn, CB radio, clock,
and electric oil pan heater operate with the ignition in the OFF position, regardless of whether the key is inserted.

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

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

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

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

Engine Operation
General Information
NOTE: Before starting the engine, read the "Ametek Panel" information in this chapter and Chapter 4 for detailed information on how to read the instruments and operate the controls.

Before operating the vehicle, perform the pretrip inspection and daily maintenance checks in Chapter 14 and Chapter 15 of this manual.

--- NOTICE ---

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

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

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

--- WARNING ---

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

IMPORTANT: Do not depress the throttle pedal while starting the engine.
4. Turn the ignition switch to the START position. After the engine starts, release the key.

--- NOTICE ---

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

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

IMPORTANT: When the engine is started, it takes a short time to build up a lubricating oil film between the shafts and bearings, and between the pistons and cylinder walls. The oil pressure gauge indicates any drop in lubricating oil pressure within 15 seconds of engine startup.

Engine Shutdown
Shut down the engine immediately if:
- the oil pressure gauge needle swings back and forth or falls sharply;
- engine power and rpm fall, even though the accelerator pedal remains steady;
the exhaust pipe gives off heavy smoke;
• the coolant and/or oil temperature climb abnor-
mally;
• abnormal sounds suddenly occur in the engine.

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

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

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

Transmission

T-Handle Shift Selector

The S2 propane chassis is equipped with an Allison 2300 or 2350 Series transmission. A T-handle shift selector is used by the driver to select the transmission ranges. See Fig. 19.2. Refer to www.allison-transmission.com for additional information.

P (Park)

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

NOTE: This does not apply the parking brake.

The park pawl is standard on the 2350 series transmission. The park pawl effectively grounds the transmission output shaft, thereby preventing rotation of the driveline. Provided the vehicle is stationary, selecting P (park) on the shift selector, if so equipped, places the transmission in neutral and engages the park pawl.

PB (Auto-Apply Parking Brake, optional on 2300 Series)

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

R (Reverse)

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

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

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

N (Neutral)

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

This position is used when starting the engine and for stationary operation. It is also used to shut down the vehicle when P (park) or PB (auto-apply parking brake) are not available on the shifter. In this case, the parking brake must be applied.
Do not let the vehicle coast in neutral. If the vehicle is allowed to coast in neutral, the engine brake will not work and the driver could lose control of the vehicle.

**D (Drive)**

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

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

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

**4 and 3 (Fourth and Third Ranges)**

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

**L (Low Range)**

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

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

**Transmission Mode Switch**

Some vehicles are equipped with a transmission mode switch, shown in Fig. 19.3. The transmission mode switch is a fuel conservation option that allows the driver to choose either performance or economy shifting. When the switch is in the on position (the top of the rocker switch is pushed down), the transmission reverts back to the primary shift mode.

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

**Propane Refueling**

Agility Fuel Systems recommends that the Liquid Propane Injection® (LPI) vehicle be refilled with fuel at stations that are specifically designed for vehicle refueling. For assistance locating LPG fuel stations, contact Agility Fuel Systems at www.agilityfuelsystems.com or at 1-949-267-7745.

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

LPI fuel tanks are equipped with both an 80% fixed liquid level gauge, and an automatic overfill protection device (OPD). The LPI system is designed to be
Propane is a liquid under pressure and is stored in a pressure vessel unlike a gasoline or diesel tank. A propane tank must never be filled to more than 80% of its actual capacity, to allow room for expansion. 80% is considered "full" for all propane tanks. When the tank is filled to the correct 80% level, the fuel gauge should read full.

The following steps describe a typical refueling procedure. See Fig. 19.4 for an example of the dual propane tank system.

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

**CAUTION**

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

6. Connect the propane fill nozzle to the tank fill valve.
7. Rotate the propane fill valve nozzle clockwise until it is firmly attached to the tank fill valve.
8. Close the fill nozzle vent valve if so equipped.
9. Open the 80% bleeder valve only if required. Agility Fuel Systems does not recommend using the bleeder valve. Use of the valve in a low emission fuel station is prohibited.
10. Open the valve on the refueling nozzle.
11. Turn the propane dispenser on to begin refueling.

12. When the OPD stops the flow of fuel into the tank, close the filling valve.
   If use of the 80% bleeder valve is required, stop filling when liquid from the bleeder appears in the form of a white cloudy vapor.

13. Turn the propane dispenser off.

--- CAUTION ---

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

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

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

15. Install the fuel cap.

16. Check for leaks on the fill valve and connecting piping, and around the 80% bleeder valve.

17. Ensure that all of the fuel tank valves are in the fully-closed position.

Warning and Indicator Lamps

There are 19 warning and indicator lamps (telltales) installed in the dash message center. See Fig. 19.5.

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

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

Maintenance Warning Lamp

When amber maintenance warning lamp illuminates, the message display center alerts the driver as follows:

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

Left-Turn Indicator

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

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

Check Engine Warning

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

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

Stop Engine Warning

--- WARNING ---

When the red STOP engine lamp illuminates, the driver must immediately move the vehicle to a safe location at the side of the road to prevent causing a hazardous situation that could cause bodily injury, property damage, or severe damage to the engine.

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

--- NOTICE ---

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

If the engine is shut down while the vehicle is in service, a single restart attempt may be performed. Depending on the nature of the fault condition, a cool-down period may be required before restarting. If, upon restarting, the fault condition still exists the indicator will come on and the engine should be shut down. At this point, the vehicle is unsafe to drive and should be transported to an authorized Freightliner service facility.

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

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

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

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

Wait to Start Indicator
The wait-to-start indicator illuminates when the intake heater is active. Wait until the indicator goes off to start the engine.

Hydraulic Brake System Warning
The brake system warning lamp illuminates if there is a hydraulic brake system failure, or if the vehicle is powered and the engine is not running.
ABS Warning
The ABS indicator illuminates when there is a malfunction in the vehicle antilock brake system (ABS).

NOTE: For more information about this indicator and the ABS system, see Chapter 13.

Traction Control Indicator
The traction control indicator illuminates when the wheels lose traction.

Shift Inhibit Indicator
The shift inhibit indicator illuminates when the transmission ECU prohibits shifting.

Check Transmission Indicator
The LPG check transmission indicator has a different icon (exclamation point), and illuminates when the transmission fluid temperature goes above a preset level set by the transmission manufacturer.

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

Stop Transmission Indicator
The stop transmission indicator illuminates when the transmission control unit senses a malfunction.

Right-Turn Indicator
The right-turn indicator flashes on and off when the right-turn signal lights are flashing.
Both turn signal indicators flash when the hazard warning flasher is turned on.

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

When the engine is operating, if the driver’s seat belt is unfastened and the park brake is not set, the seat belt warning indicator illuminates and a warning chime activates. The warning chime will remain active for 15 seconds. The warning indicator remains illuminated until the driver’s seat belt is fastened.

Parking Brake On Warning
The parking brake on indicator activates when the parking brake is engaged.

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

Cruise Control Indicator
The cruise control indicator illuminates when the cruise control is activated.

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

- The engine oil pressure falls below the preset level which is 6 psi (41 kPa) at 700 rpm, or 18 psi (124 kPa) at 4400 rpm.
- The air pressure falls below the preset level, which is 65 psi (448 kPa).
- The parking brake is set with the vehicle moving at a speed greater than 2 mph (3 km/h).
- The coolant temperature rises above 253°F (123°C) and the check engine and stop engine lamps illuminate. When the coolant temperature falls below 244°F (118°C) the emergency buzzer and stop engine lamp turn off.

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

Speedometer and Tachometer

Speedometer
Three kinds of speedometer faces are available. The U.S. version of the speedometer registers speed in both miles per hour (mph) and kilometers per hour (km/h), with mph in larger numbers. See Fig. 19.6.

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

Tachometer
The tachometer indicates engine speed in revolutions per minute (rpm) and serves as a guide for shifting the transmission and keeping the engine in the appropriate rpm range. See Fig. 19.6.
Standard Instruments
Fuel Level Gauge
The fuel level gauge indicates the level of fuel in the fuel tank. See Fig. 19.7. A low-level warning lamp illuminates when the diesel fuel level registers 1/8th of capacity.

WARNING
If air pressure falls below minimum pressure, the braking ability of the vehicle will be limited. Slow the vehicle down and bring it to a gradual stop. Do not attempt to move the vehicle until air pressure has risen above the minimum level. Moving a vehicle without adequate braking power could cause an accident resulting in property damage, personal injury, or death.

Primary and Secondary Air Pressure Gauges
Air pressure gauges register the pressure in the primary and secondary air systems. Normal pressure with the engine running is 100 to 120 psi (690 to 827 kPa) in both systems. See Fig. 19.8.

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

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

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

During normal engine operation, the coolant temperature gauge should read 200 to 205°F (93 to 96°C). See Fig. 19.9. If the temperature remains below 160°F (71°C) or exceeds 235°F (113°C), inspect the cooling system to determine the cause. See the vehicle workshop manual for troubleshooting and repair procedures.

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

**Grade Brake**

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

Chassis equipped with a propane engine may have an optional grade brake. The grade brake is designed to downshift the transmission—when going downhill for example—without overspeeding the engine. Refer to the *Allison Operator’s Manual* for proper operation of the grade brake. See Fig. 19.10 for an example of the grade brake switch. An amber light activates at the top of the switch when the grade brake is activated.

**Ametek Instrument Panel**

The following information describes the Ametek instrument panel, used with liquid propane gas (LPG) engines. The instrument panel is shown in Fig. 19.11.

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

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

- Odometer
- Trip Odometer 1/Trip Odometer 2
- Chassis Battery Voltage
- Instantaneous Fuel Rate
- Average Fuel Rate
- Gear Attained Status
- Transmission Temperature
- Hour Meter
- Boost Pressure
- Engine Oil Pressure
- Coolant Temperature
- Fuel Level
- Percent Engine Load
- Engine RPM

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

Priority Messages

Priority messages (including warning messages) are displayed in the LCD due to various inputs or data messages. Unless noted otherwise, the priority message will take over the whole screen, allowing multiple messages to be displayed in five second intervals.

Self-Test

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

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

Menu System

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

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

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

Setup Menu

Select Display Units

The set units screen allows the driver to choose between English or metric units of measurement for the displayed values. To navigate to the set units screen, see Fig. 19.12, screens H, I, and J.

Startup Screen

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

LCD Contrast

Select contrast from the menu to set the LCD contrast. Use the down toggle button to set the contrast to the desired level. To navigate to the contrast screen, see Fig. 19.12, screen M.
Reset Parameters
The reset parameters screen is included with vehicles that have the Allison transmission prognostics feature.

Maintenance Menu
The maintenance menu has the following three sub menus:

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

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

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

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

Diagnostic Menu
The diagnostic menu contains the following items:

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

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

Engine Faults
This screen displays engine fault codes that are received from the engine electronic control unit (ECU). To navigate to the engine fault screen, see Fig. 19.13, screen AA.

Transmission Faults
This screen displays transmission fault codes that are received from the transmission ECU. To navigate to the transmission fault screen, see Fig. 19.13, screen AB.

ABS Diagnostics
This screen displays Antilock Brake System (ABS) fault codes that are received from the ABS ECU. To navigate to the ABS diagnostic screen, see Fig. 19.13, screen AC.

Check Gauges
The check gauges screen allows the driver to set each gauge as a percentage of scale (either 0, 50, or 100%), as shown in the LCD. To navigate to the check gauges screen, see Fig. 19.14, AG screens.

Warning Lamp
The warning lamp screen allows the driver to test each warning lamp (not the vehicle load) on and then off, displaying the lamp name and status in the LCD. To navigate to the warning lamp screen, see Fig. 19.14, screen AH.

Check LCD
Selecting the check LCD screen displays the Freightliner Custom Chassis Corporation (FCCC) logo in normal and reverse video three times and then returns to the menu. To navigate to the check LCD screen, see Fig. 19.14, screen AI.

Check Binary Inputs
The check binary inputs screen displays the pin number and status of each binary input. The toggle buttons allow the driver to select each binary input. This information is continuously updated to assist in troubleshooting. To navigate to the check binary inputs screen, see Fig. 19.14, screen AJ.
Check Analog Inputs
The check analog inputs screen displays the pin number and actual value of each analog input defined in the system. The toggle buttons allow the driver to select each analog input. This information is continuously updated to assist in troubleshooting. To navigate to the check analog input screen, see Fig. 19.15, screen AK.

Check Datalink
The check datalink screen allows the driver to view all devices that communicate on the J1939, J1587, and GMLAN datalinks. To navigate to the check datalink screen, see Fig. 19.15, screen AL.

Menu Navigation
The menu navigation screens are provided to illustrate the menu system. The paths to specific screens are shown, along with instructions for using the toggle buttons to move from one screen to another. See Fig. 19.12, Fig. 19.13, Fig. 19.14, Fig. 19.15, Fig. 19.16, Fig. 19.17, Fig. 19.18, Fig. 19.19, Fig. 19.20, Fig. 19.21, Fig. 19.22, Fig. 19.23, and Fig. 19.24.

IMPORTANT: Follow the steps below to change the three items (also known as favorites) shown in the message display center. The message display center is referred to as screen C in Fig. 19.18.

NOTE: The driver can check the pressure of the propane in the fuel rail (pressure of the fuel in both the tank and pump booster), and make this one of the three items shown in the message display center. Select the item with the fuel pump and psi reading, then follow the directions below to make it one of the favorites.

1. With the vehicle in park, turn the ignition to RUN, and allow the self test to complete.
2. Press the down toggle button to select an item to change. The selected item will now be highlighted.
3. Press the right toggle button once to enter the favorites display menu, shown in Fig. 19.18, as screen D.
4. Use the down toggle button to scroll through the available items.
5. Highlight the new item, then press the right toggle button. The selected item will now appear
1. Tachometer
2. Dash Message Center
3. Speedometer
4. Fuel Level Gauge
5. Primary Air Pressure Gauge
6. Secondary Air Pressure Gauge
7. Coolant Temperature Gauge
8. Dash Driver Display Screen
9. Toggle Button, Down
10. Toggle Button, Right

Fig. 19.11, Gauge Layout (typical, U.S.), LPG Engines
Fig. 19.12, Setup Menu Screens
Screen Z scrolls to display the following items:

- ENGINE FAULTS
- TRANSMISSION FAULTS
- ABS FAULTS
- CHECK OUTPUTS
- CHECK DATA INPUTS
- ODOMETER DIAGNOSTICS
- CHECK GAUGES
- CHECK WARNING LAMPS
- CHECK LCD
- CHECK BINARY INPUTS
- CHECK ANALOG INPUTS
- CHECK DATA LINK
- VERSION INFORMATION
- EXIT

The last DIAGNOSTIC MENU remains fixed on the first line.

Fig. 19.13, Diagnostic Menu Screens, Screen 1
Fig. 19.15, Diagnostic Menu Screens, Screen 3
Propane Fuel System

Fig. 19.16, Ignition On, Normal Mode
The Self Test screens display the FCCC logo in normal video (Screen A) and in reverse video (Screen B).

Fig. 19.17, Self Test
Fig. 19.18, Display Messages
Fig. 19.19, Auxiliary Screens
Fig. 19.20, Maintenance Menu Screens, Screen 1
Fig. 19.21, Maintenance Menu Screens, Screen 2
Note 6:
Screen AO scrolls to display the following items:
- Trip Time
- Idle Time
- Max RPM
- Avg RPM
- Max Speed
- Avg Speed
- Avg Fuel Economy
- Reset All
- Exit
WARNING MESSAGES

Fig. 19.23, Warning Messages
Fig. 19.24, Ignition Off (shown when ignition is keyed OFF)
## Specifications

<table>
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<th>Section</th>
<th>Page</th>
</tr>
</thead>
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<td>Fluids and Lubricants</td>
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<tr>
<td>Fuse Information</td>
<td>20.5</td>
</tr>
<tr>
<td>Bulb Replacement</td>
<td>20.5</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Regular Hex</strong></td>
<td>7 (9)</td>
</tr>
<tr>
<td><strong>Flanged</strong></td>
<td>8 (11)</td>
</tr>
<tr>
<td><strong>Torque: lbf·ft (N·m)</strong></td>
<td>6 (8)</td>
</tr>
</tbody>
</table>

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

Table 20.1, Torque Values for U.S. Customary Thread Fasteners With Lubricated or Plated Threads
<table>
<thead>
<tr>
<th>Thread Diameter—Pitch</th>
<th>Regular Hex</th>
<th>Flanged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade 5 Bolt</td>
<td>Grade 5 or B Nut</td>
</tr>
<tr>
<td>Torque: lbf·ft (N·m)</td>
<td>Torque: lbf·ft (N·m)</td>
<td>Torque: lbf·ft (N·m)</td>
</tr>
<tr>
<td>1/4–20</td>
<td>8 (11)</td>
<td>10 (14)</td>
</tr>
<tr>
<td>1/4–28</td>
<td>9 (12)</td>
<td>12 (16)</td>
</tr>
<tr>
<td>5/16–18</td>
<td>15 (20)</td>
<td>22 (30)</td>
</tr>
<tr>
<td>5/16–24</td>
<td>17 (23)</td>
<td>25 (34)</td>
</tr>
<tr>
<td>3/8–16</td>
<td>28 (38)</td>
<td>40 (54)</td>
</tr>
<tr>
<td>3/8–24</td>
<td>31 (42)</td>
<td>45 (61)</td>
</tr>
<tr>
<td>7/16–14</td>
<td>45 (61)</td>
<td>65 (88)</td>
</tr>
<tr>
<td>7/16–20</td>
<td>50 (68)</td>
<td>70 (95)</td>
</tr>
<tr>
<td>1/2–13</td>
<td>70 (95)</td>
<td>95 (129)</td>
</tr>
<tr>
<td>1/2–20</td>
<td>75 (102)</td>
<td>110 (149)</td>
</tr>
<tr>
<td>9/16–12</td>
<td>100 (136)</td>
<td>140 (190)</td>
</tr>
<tr>
<td>9/16–18</td>
<td>110 (149)</td>
<td>155 (210)</td>
</tr>
<tr>
<td>5/8–11</td>
<td>135 (183)</td>
<td>190 (258)</td>
</tr>
<tr>
<td>5/8–18</td>
<td>155 (210)</td>
<td>215 (292)</td>
</tr>
<tr>
<td>3/4–10</td>
<td>240 (325)</td>
<td>340 (461)</td>
</tr>
<tr>
<td>3/4–16</td>
<td>270 (366)</td>
<td>380 (515)</td>
</tr>
<tr>
<td>7/8–9</td>
<td>385 (522)</td>
<td>540 (732)</td>
</tr>
<tr>
<td>7/8–14</td>
<td>425 (576)</td>
<td>600 (813)</td>
</tr>
<tr>
<td>1–8</td>
<td>580 (786)</td>
<td>820 (1112)</td>
</tr>
<tr>
<td>1–12</td>
<td>635 (861)</td>
<td>900 (1220)</td>
</tr>
<tr>
<td>1–14</td>
<td>650 (881)</td>
<td>915 (1241)</td>
</tr>
</tbody>
</table>

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

Table 20.2, Torque Values for U.S. Customary Thread Fasteners With Dry (Unlubricated) Plain (Unplated) Threads
### Specifications

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

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

† Use these torque values if either the bolt or nut is lubricated or plated (zinc-phosphate conversion-coated, cadmium-plated, or waxed, Geomet 321XL coated, or waxed).

**Table 20.3, Torque Values for Metric Thread Fasteners With Lubricated or Plated Threads**
## Conversion Charts

<table>
<thead>
<tr>
<th>Length</th>
<th>U.S. Customary</th>
<th>Multiply By</th>
<th>To Get Metric</th>
<th>Metric</th>
<th>Multiply By</th>
<th>To Get U.S. Customary</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches (in)</td>
<td>25.4</td>
<td>millimeters (mm)</td>
<td>0.03937</td>
<td>inches (in)</td>
<td>25.4</td>
<td>millimeters (mm)</td>
</tr>
<tr>
<td>inches (in)</td>
<td>2.54</td>
<td>centimeters (cm)</td>
<td>0.3937</td>
<td>inches (in)</td>
<td>2.54</td>
<td>centimeters (cm)</td>
</tr>
<tr>
<td>feet (ft)</td>
<td>0.3048</td>
<td>meters (m)</td>
<td>3.281</td>
<td>feet (ft)</td>
<td>0.3048</td>
<td>meters (m)</td>
</tr>
<tr>
<td>yards (yd)</td>
<td>0.9144</td>
<td>meters (m)</td>
<td>1.094</td>
<td>yards (yd)</td>
<td>0.9144</td>
<td>meters (m)</td>
</tr>
<tr>
<td>miles (mi)</td>
<td>1.609</td>
<td>kilometers (km)</td>
<td>0.6215</td>
<td>miles (mi)</td>
<td>1.609</td>
<td>kilometers (km)</td>
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</table>

<table>
<thead>
<tr>
<th>Area</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>square inches (in²)</td>
<td>645.16</td>
<td>square millimeters (mm²)</td>
<td>0.00155</td>
<td>square inches (in²)</td>
<td>645.16</td>
<td>square millimeters (mm²)</td>
</tr>
<tr>
<td>square inches (in²)</td>
<td>6.452</td>
<td>square centimeters (cm²)</td>
<td>0.155</td>
<td>square inches (in²)</td>
<td>6.452</td>
<td>square centimeters (cm²)</td>
</tr>
<tr>
<td>square feet (ft²)</td>
<td>0.0929</td>
<td>square meters (m²)</td>
<td>10.764</td>
<td>square feet (ft²)</td>
<td>0.0929</td>
<td>square meters (m²)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume</th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>cubic inches (in³)</td>
<td>16387.0</td>
<td>cubic millimeter (mm³)</td>
<td>0.000061</td>
<td>cubic inches (in³)</td>
<td>16387.0</td>
<td>cubic millimeter (mm³)</td>
</tr>
<tr>
<td>cubic inches (in³)</td>
<td>16.387</td>
<td>cubic centimeters (cm³)</td>
<td>0.06102</td>
<td>cubic inches (in³)</td>
<td>16.387</td>
<td>cubic centimeters (cm³)</td>
</tr>
<tr>
<td>cubic inches (in³)</td>
<td>0.01639</td>
<td>liters (L)</td>
<td>61.024</td>
<td>cubic inches (in³)</td>
<td>0.01639</td>
<td>liters (L)</td>
</tr>
<tr>
<td>fluid ounces (fl oz)</td>
<td>29.54</td>
<td>milliliters (mL)</td>
<td>0.03381</td>
<td>fluid ounces (fl oz)</td>
<td>29.54</td>
<td>milliliters (mL)</td>
</tr>
<tr>
<td>pints (pt)</td>
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<td>liters (L)</td>
<td>2.1134</td>
<td>pints (pt)</td>
<td>0.47318</td>
<td>liters (L)</td>
</tr>
<tr>
<td>quarts (qt)</td>
<td>0.94635</td>
<td>liters (L)</td>
<td>1.0567</td>
<td>quarts (qt)</td>
<td>0.94635</td>
<td>liters (L)</td>
</tr>
<tr>
<td>gallons (gal)</td>
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<td>liters (L)</td>
<td>0.2642</td>
<td>gallons (gal)</td>
<td>3.7854</td>
<td>liters (L)</td>
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<td>cubic feet (ft³)</td>
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<td>liters (L)</td>
<td>0.03531</td>
<td>cubic feet (ft³)</td>
<td>28.317</td>
<td>liters (L)</td>
</tr>
<tr>
<td>cubic feet (ft³)</td>
<td>0.02832</td>
<td>cubic meters (m³)</td>
<td>35.315</td>
<td>cubic feet (ft³)</td>
<td>0.02832</td>
<td>cubic meters (m³)</td>
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<table>
<thead>
<tr>
<th>Weight/Force</th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ounces (av) (oz)</td>
<td>28.35</td>
<td>grams (g)</td>
<td>0.03527</td>
<td>ounces (av) (oz)</td>
<td>28.35</td>
<td>grams (g)</td>
</tr>
<tr>
<td>pounds (av) (lb)</td>
<td>0.454</td>
<td>kilograms (kg)</td>
<td>2.205</td>
<td>pounds (av) (lb)</td>
<td>0.454</td>
<td>kilograms (kg)</td>
</tr>
<tr>
<td>U.S. tons (t)</td>
<td>907.18</td>
<td>kilograms (kg)</td>
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<td>kilograms (kg)</td>
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<td>metric tons (t)</td>
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<td>U.S. tons (t)</td>
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<td>metric tons (t)</td>
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<th>Torque/Work Force</th>
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<td>inch–pounds (lbf-in)</td>
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<td>Newton–centimeters (N-cm)</td>
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<td>Newton–centimeters (N-cm)</td>
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<td>foot–pounds (lbf-ft)</td>
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<td>Newton–meters (N-m)</td>
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<td>Newton–meters (N-m)</td>
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<td>3.37685</td>
<td>kilo Pascals (kPa)</td>
<td>0.29613</td>
<td>inches of mercury (inHg)</td>
<td>3.37685</td>
<td>kilo Pascals (kPa)</td>
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<td>pounds per square inch (psi)</td>
<td>6.895</td>
<td>kilo Pascals (kPa)</td>
<td>0.14503</td>
<td>pounds per square inch (psi)</td>
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<td>kilo Pascals (kPa)</td>
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Table 20.4, Metric/U.S. Customary Conversion

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<th></th>
<th></th>
<th></th>
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</thead>
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<tr>
<td>degrees Fahrenheit (°F)</td>
<td>Subtract 32</td>
<td>Then Divide By 1.8</td>
<td>To Get degrees Celsius (°C)</td>
<td>Multiply By 1.8</td>
<td>Then Add 32</td>
<td>To Get degrees Fahrenheit (°F)</td>
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</table>

Table 20.5, Temperature Conversion
### Fluids and Lubricants

See Table 20.6 for fluid and lubricant specifications.

<table>
<thead>
<tr>
<th>Component</th>
<th>Recommended Fluid or Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Axle Spindle Pins, Tie Rods, Drag Link, Intermediate Steering Shaft, Front Brake and Pedal Shafts, Slip Spline and Universal Joints</td>
<td>Multipurpose Grease Lithium 12- Hydroxy Stearate NLGI No. 2; for temperatures below 0°F (−18°C), use MIL-G-10924B</td>
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<tr>
<td>Hydraulic Brake Master Cylinder</td>
<td>Heavy-Duty DOT 3 Brake Fluid</td>
</tr>
<tr>
<td>Brake and Pedal Pivots</td>
<td>Starplex 2 (lithium soap-based grease)</td>
</tr>
<tr>
<td>Engine</td>
<td>See Manufacturer's Recommendations</td>
</tr>
<tr>
<td>Transmission</td>
<td>Mobil Delvac Synthetic ATF</td>
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<tr>
<td>Fuel</td>
<td>Ultralow-Sulfur Diesel Fuel</td>
</tr>
<tr>
<td>Disc Brake Caliper Rails</td>
<td>FCCC No. 4JD623 Brake Caliper Slide Grease</td>
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<tr>
<td>Rear Axle Differential</td>
<td>See Manufacturer's Recommendations</td>
</tr>
<tr>
<td>Hydraulic System Reservoir</td>
<td>ATF must meet Dexron® III or TES-389 specifications</td>
</tr>
<tr>
<td>Engine Coolant</td>
<td>Refer to the engine manufacturer's service literature for approved coolant.</td>
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**Table 20.6, Fluid and Lubricant Specifications**

### Fuse Information

See Table 20.7 for descriptions of a typical set of fuses. Fuse identification varies with options.

<table>
<thead>
<tr>
<th>Main PDM Fuse Identification</th>
<th>CAV</th>
<th>Description</th>
<th>Fuse</th>
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<tbody>
<tr>
<td>F1</td>
<td>Engine VCU (spare)</td>
<td>10A</td>
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<tr>
<td>F2</td>
<td>Blower Motor</td>
<td>30A</td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>Engine ECU</td>
<td>20A</td>
<td></td>
</tr>
<tr>
<td>F4</td>
<td>Spare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F5</td>
<td>Ignition Switch</td>
<td>5A</td>
<td></td>
</tr>
<tr>
<td>F6</td>
<td>Hydro-Max RLY (if equipped with hydraulic brakes)</td>
<td>30A</td>
<td></td>
</tr>
<tr>
<td>F7</td>
<td>Bulkhead Module</td>
<td>30A</td>
<td></td>
</tr>
<tr>
<td>F8</td>
<td>ICU3</td>
<td>10A</td>
<td></td>
</tr>
<tr>
<td>F9</td>
<td>Transmission ECU</td>
<td>10A</td>
<td></td>
</tr>
<tr>
<td>F10</td>
<td>Spare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F11</td>
<td>Spare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F12</td>
<td>Radio/Diagnostic</td>
<td>20A</td>
<td></td>
</tr>
<tr>
<td>F13</td>
<td>Chassis Module</td>
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</tr>
<tr>
<td>F14</td>
<td>Spare</td>
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<td>F15</td>
<td>Bulkhead Module</td>
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<td>F16</td>
<td>ABS ECU</td>
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<td>F17</td>
<td>Chassis Module</td>
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<tr>
<td>F18</td>
<td>Bulkhead Module</td>
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<td>F19</td>
<td>Chassis Module</td>
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**Table 20.7, Main PDM Fuse Identification**

### Bulb Replacement

See Table 20.8 for bulb replacement information.

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<th>Replacement Bulb Part Numbers</th>
<th>Description</th>
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<td>Headlight, Low Beam</td>
<td>WEE 9006</td>
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<td>Headlight, High Beam</td>
<td>WEE 9005</td>
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<tr>
<td>Front Turn Signal Light</td>
<td>WEE 3157</td>
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<tr>
<td>Front Fender Marker Light</td>
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**Table 20.8, Replacement Bulb Part Numbers**
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<th>Page</th>
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<tbody>
<tr>
<td>Adjusting Headlight Aim</td>
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<tr>
<td>Aftertreatment System (ATS)</td>
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<td>Regen Switch</td>
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<td>Aftertreatment System, EPA10 and Newer Engines</td>
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<tr>
<td>ATS Warning Lamps</td>
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<td>Shorting Plug</td>
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<td>Operating Instructions, 2000 and B200 Series</td>
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