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.

   NOTE: If the vehicle is moving when shifting, press the clutch pedal just far enough to disengage the clutch. Pressing it to the floor will engage the clutch brake, if so equipped, causing premature clutch brake wear.

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

   On unsynchronized models, disengage the clutch and move the shift lever to neutral. Engage the clutch again. With the shift lever in neutral, disengage the clutch and move the shift lever to second gear.

   3.3 Engage the clutch 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, disengage the clutch and move the shift lever to the next lower gear.

   On unsynchronized models, disengage the clutch and move the shift lever to neutral. Engage the clutch again. With the shift lever in neutral, disengage the clutch and move the shift lever to the next lowest gear.

   4.3 Engage the clutch smoothly.

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

Eaton Fuller Range-Shift Transmissions


General Information, Range-Shift

Eaton Fuller 9-Speed Models

Eaton Fuller 9-speed range-shift models are not synchronized. They have nine forward speeds and two reverse speeds. The shift lever controls five forward gears and one reverse gear in the transmission front section, and the range lever controls a LO and HI range in the two-speed auxiliary section. The first position in the front section is used only as a starting gear. The other four ratios are used once in LO range and once again in HI range. See Fig. 8.6 for the shift patterns.

After shifting out of the first gear position, use the Roadranger® "repeat H" shift pattern. Select both LO range and HI range with the range lever (range knob). It is used once during the upshift sequence and once during the downshift sequence.

Always preselect the range shift. After preselection, the transmission will automatically make the synchronizer range shift as the shift lever passes through neutral.

Eaton Fuller 10-Speed Models

Eaton Fuller 10-speed range-shift models are not synchronized. They have ten forward speeds and
two reverse speeds. The shift lever controls five forward gears and one reverse gear in the transmission front section, and the range lever controls a LO and HI range in the two-speed auxiliary section. The five forward gears selected in LO range are used again in HI range to provide the 10 progressive forward gears. See Fig. 8.7 for the shift patterns. See Table 8.1 for the shift progressions.

Once the highest shift lever position (fifth gear) is reached in LO range, the driver preselects the range shift lever for HI range. The range shift occurs automatically as the shift lever is moved from fifth gear position to the sixth gear position.

When downshifting, the driver preselects the range lever for LO range and the range shift occurs automatically during the shift lever movement to the next gear position.

**Eaton Fuller Deep-Reduction Models**

Eaton Fuller deep-reduction models are not synchronized. They have a five-speed front section and a two-speed auxiliary section which has an extra deep reduction gear. The LO gear in the front section is used only as a starting gear. The other four ratios are used once in LOW RANGE and once in HIGH RANGE giving eight highway ratios. LO-LO is selected by the DEEP REDUCTION lever on the dashboard. See Fig. 8.8 for the shift pattern.

**Operation, Range-Shift**

1. When operating off-highway or under adverse conditions, always use low gear when starting to move the vehicle.
When operating on-highway, with no load or under ideal conditions, use first gear when starting to move the vehicle.

For all conditions, use the highest gear that is still low enough to start the vehicle moving with the engine idling and without excessively slipping the clutch.

2. Use the clutch brake to stop gear rotation when shifting into low (or first) or reverse when the vehicle is stationary. The clutch brake is applied by pressing the clutch pedal all the way to the floor.

For normal upshifts and downshifts, only a partial disengagement of the clutch is necessary to break engine torque.

3. Do not make range shifts with the vehicle moving in reverse gear.

4. Never attempt to move the range preselection lever with the gear shift lever in neutral while the vehicle is moving. Preselection with the range preselection lever must be made prior to moving the shift lever out of gear into neutral.

5. Do not shift from high range to low range at high vehicle speeds.

6. Use double-clutching between all upshifts and downshifts.

7. After your shifting ability improves, you may want to skip some of the ratios. This may be done only when operating conditions such as load, grade, and road speed permit.

**Upshifting**

1. Position the gear shift lever in neutral. Start the engine and bring the air system pressure up to 100 to 120 psi (689 to 827 kPa).

2. Position the range preselection lever down into low range.

3. Press the clutch pedal to the floor. Shift into low or first gear, then engage the clutch with the engine at or near idle speed to start the vehicle moving. Accelerate to 80 percent of engine governed speed.

4. Shift progressively up from low or 1st gear to the top gear in low range, double-clutching between shifts and accelerating to 80 percent of engine governed speed.

5. While in the top gear of the low-range shift pattern and ready for the next upshift, flip the range preselection lever up into high range. Double-clutch through neutral and shift into the bottom gear in high range. As the shift lever passes through neutral, the transmission will automatically shift from low range to high range.

6. With the transmission in high range, shift progressively up through each of the high range gears, double-clutching between shifts.

**Downshifting**

1. With the transmission in high range, shift progressively down to the bottom gear in high range, double-clutching between shifts.

2. When in the bottom gear of the high-range shift pattern and ready for the next downshift, push the range preselection lever down into low range. Double-clutch through neutral and shift into the top gear of the low-range shift pattern. As the shift lever passes through neutral, the transmission will automatically shift from high range to low range.

3. With the transmission in low range, downshift through the low range gears as conditions require.

Never use the clutch brake when downshifting or as a brake to slow the vehicle.

**Operation, Deep-Reduction Models**

**Upshifting**

1. Position the gear shift lever in neutral. See Fig. 8.8 for the shift pattern. Start the engine, and bring the air system pressure up to 95 to 125 psi (655 to 862 kPa).

2. Position the range preselection lever down into low range.

3. Press the clutch pedal to the floor. Shift into low or first gear, then engage the clutch with the engine at or near idle speed to start the vehicle moving. Accelerate to 80 percent of engine governed speed.

4. Shift progressively up from low or 1st gear to the top gear in low range, double-clutching between shifts and accelerating to 80 percent of engine governed speed.

5. While in the top gear of the low-range shift pattern and ready for the next upshift, flip the range preselection lever up into high range. Double-clutch through neutral and shift into the bottom gear in high range. As the shift lever passes through neutral, the transmission will automatically shift from low range to high range.

6. With the transmission in high range, shift progressively up through each of the high range gears, double-clutching between shifts.

**Downshifting**

1. With the transmission in high range, shift progressively down to the bottom gear in high range, double-clutching between shifts.

2. When in the bottom gear of the high-range shift pattern and ready for the next downshift, push the range preselection lever down into low range. Double-clutch through neutral and shift into the top gear of the low-range shift pattern. As the shift lever passes through neutral, the transmission will automatically shift from high range to low range.

3. With the transmission in low range, downshift through the low range gears as conditions require.

Never use the clutch brake when downshifting or as a brake to slow the vehicle.

**Operation, Deep-Reduction Models**

**Upshifting**

1. Position the gear shift lever in neutral. See Fig. 8.8 for the shift pattern. Start the engine, and bring the air system pressure up to 95 to 125 psi (655 to 862 kPa).

2. Position the range preselection lever down into low range.

NOTE: If conditions are difficult, start out in LO-LO. Move the DEEP REDUCTION lever on the dashboard to the IN position. Otherwise start out in LO with the DEEP REDUCTION lever in the OUT position.
3. Depress the clutch pedal to the floor. Shift into LO gear; then, engage the clutch, with the engine at or near idle rpm to start the vehicle moving. The vehicle will start in LO or LO-LO depending on the DEEP REDUCTION lever position.

4. To upshift if in LO-LO, move the DEEP REDUCTION lever to the OUT position and immediately release the accelerator, depress the clutch pedal once to break torque, and reengage the clutch. The auxiliary section will shift from LO-LO to LO when the gears reach the same speed.

5. Shift progressively upward from LO through 1st, 2nd, 3rd, and 4th gears while the range preselection lever is in LO. Always double-clutch between gears.

6. When in 4th gear and ready for the next upshift, pull up the range preselection lever and move the shift lever, double-clutching, to the 5th gear position. As the shift lever passes through neutral, the auxiliary section will automatically shift from low to high range.

CAUTION

Never move the shift lever into the LO gear position after high range preselection or anytime the auxiliary section is in high range. Transmission damage could result.

7. Continue upshifting from 5th gear through 8th gear, always double-clutching between gears.

Downshifting

1. While in high range, move the gear shift lever from 8th gear through 5th gear as conditions require, always double-clutching between gears.

2. When in 5th gear and ready for the next downshift, push down the range preselection lever and move the shift lever to the 4th gear position, being sure to double-clutch. As the shift lever passes through neutral, the auxiliary section will automatically shift from high to low range.

3. While in the low range, continue downshifting from 4th through LO as conditions require, always double-clutching between gears.

4. Do not downshift into LO-LO from LO unless operating conditions make it necessary. If it is necessary, make sure that the shift lever is in the LO gear position and the auxiliary section is in the low range. Then, move the DEEP REDUCTION lever on the dashboard to the IN position. Immediately release the accelerator, depress the clutch pedal once to break torque, engage the clutch, and accelerate. The auxiliary section will automatically shift from LO to LO-LO when the gears reach the same speed.

CAUTION

Never use the clutch brake when downshifting, or as a brake to slow the vehicle. This will cause premature clutch brake wear.

Eaton Fuller AutoShift™


IMPORTANT: Before starting the vehicle, always do the following:

- Be seated in the driver’s seat.
- Place the transmission in neutral.
- Set the parking brakes.
- Press the clutch pedal (if equipped) down to the floor.

The AutoShift ASW is an automated 6-speed Eaton Fuller transmission. No clutch is necessary to operate the vehicle.

The AutoShift AS2 is a partially automated 10-speed Eaton Fuller transmission. The driver must use the clutch and put the transmission in neutral to start and stop the vehicle. A push-button shift selector (Fig. 8.9) is used with AutoShift AS2 and ASW transmissions.

IMPORTANT: If you have to leave the cab with the engine running:

- Place the transmission in neutral.
- Set the parking brakes.
- Chock the tires.

Push-Button Shift Selector

Gear information is presented to the driver on the push-button shift selector, usually mounted on the...
right-hand control panel. On this display, the information is presented as follows:

- To select neutral, press the N button. When neutral is engaged, the telltale LED will light up next to the N button.
- To select reverse, press the R button. When reverse is engaged, the telltale LED will light up next to the R button.
- To select drive, press the D button. When drive is engaged, the telltale LED will light up next to the D button.
- To select low gear, press the LOW button. When low is engaged, the telltale LED will light up next to the LOW button.
- To change gears manually, press the MANUAL button. When the manual mode is engaged, the telltale LED will light up next to the MANUAL button.
- Use the shift buttons (upshift/downshift) to change the current starting gear selection in R, D, and LOW. In MANUAL, the shift buttons can be used to select gears.
- In automatic mode, the number of the forward gear currently engaged appears continually on the mode indicator when in drive. In MANUAL, the last gear selected appears on the mode indicator.
- If the SERVICE indicator illuminates, take the vehicle as soon as possible to an authorized Freightliner service facility.
- The mode button is reserved for future use.

IMPORTANT: To prevent engine overspeed, the transmission software will override both MANUAL and LOW if necessary. The system will not respond to gear selection requests that will either overspeed or excessively lug the engine.

Automatic Mode

The AutoShift AS2 transmission is normally operated in an automatic mode. To select MANUAL mode, press the MANUAL button on the push-button shift selector.

When the transmission is in automatic mode, the transmission automatically selects and engages the gears, although the transmission will respond to upshift and downshift requests as though in manual mode. See the instructions for shifting under heading "Manual Mode" below.

Manual Mode

When the transmission is in manual mode, the driver must select the appropriate gear, using the shift buttons on the push-button shift selector.
To upshift in MANUAL, press the upshift button (up arrow), and release. The number of the gear will appear on the mode indicator. If the requested gear is available, the transmission will shift up.

--- CAUTION ---

Do not attempt to upshift until the vehicle has reached a sufficient speed. The clutch absorbs the speed difference by generating heat, which causes the clutch to wear out too soon.

Many drivers upshift into the next gear or even skip-shift into a higher gear before the vehicle has reached the correct speed. This type of shifting is almost as bad as starting off in a gear that is too high. When the engine speed (rpm) and the vehicle speed (mph or km/h) are too far apart, the clutch must absorb the difference in speed by generating heat.

To downshift in MANUAL, press the downshift button (down arrow), and release. The number of the gear will appear on the mode indicator. If the requested gear is available, the transmission will shift down.

If any requested gear is not available, an audible warning will sound and the digital display will indicate that the gear is not available.

Selecting Gears

**R (Reverse)**

Reverse (R) is used to back the vehicle. Make sure the vehicle comes to a full stop and the clutch pedal has been pressed before shifting into reverse.

To select reverse, press the clutch pedal to the floor. Then press the R button.

**N (Neutral)**

Neutral (N) is used for starting, parking, or any stationary operation. No gear is selected. The transmission must be in neutral to start the engine.

IMPORTANT: If the vehicle starts up in any gear but neutral, bring the vehicle to an authorized Freightliner service facility as soon as possible.

To select neutral, press the clutch pedal to the floor. Then press the N button. Set the parking brakes and slowly release the clutch pedal.

**D (Drive)**

Drive (D) is used for normal highway driving. In drive, the transmission shifts into the proper gear for starting, and then automatically selects additional gears as needed, in a range between the starting gear and the highest gear.

To select drive, press the clutch pedal to the floor. Then press the D button. Slowly release the clutch pedal and drive the vehicle.

To start up in a gear other than the normal starting gear, push the upshift arrow with D selected, and while the vehicle is stopped.

IMPORTANT: AutoShift will not start up in any gear higher than third gear.

The number of the gear selected will flash on the auxiliary display until the driver presses the clutch pedal. This gear will be stored in memory as the default starting gear until a different starting gear is selected by the driver, or until the engine is shut down.

NOTE: The transmission may be programmed so that it is not possible to select a starting gear other than the preprogrammed starting gear.

**L (Low)**

LOW is used to hold the transmission in low gear when descending steep hills. If LOW is selected when the vehicle is stopped, the transmission remains in low gear until drive is selected. If LOW is selected while the vehicle is moving, the transmission downshifts at a higher engine speed than normal, in order to maximize the engine braking effect.

To select LOW, press the clutch pedal to the floor. Then press the LOW button. Slowly release the clutch pedal and drive the vehicle.

IMPORTANT: Before parking the vehicle, always do the following:

- Place the transmission in neutral.
- Set the parking brakes.
- Chock the tires, if parking on an incline.
Freightliner SmartShift Shift Control

General Information, SmartShift

The SmartShift transmission control is an electronic transmission control device. It is installed with the following transmissions:

- Eaton Fuller UltraShift™
- Mercedes-Benz Automated Gear Shift (AGS)

It replaces the typical floor-mounted shift lever or dash-mounted push button control.

SmartShift accepts driver requests for transmission functions and transmits them through hard wiring to the transmission control unit (TCU). SmartShift is a true shift-by-wire system.

SmartShift offers two main advantages over conventional transmission control devices. Without a floor-mounted shift control, usable cab space is increased. The SmartShift control mounts to the right-hand side of the steering column and is operated by the fingers of the driver’s right hand, allowing both hands to remain on the steering wheel.

A two-position slide switch (Fig. 8.10) is mounted on the body of the control lever just before the paddle widens out. The slide switch allows the driver to choose automatic (AUTO) or manual (MAN) mode.

In AUTO mode, gears shift automatically, without driver interaction. Manual gearshifts are accomplished by a momentary pull or push on the control in the plane perpendicular to the steering wheel. Pull upward (toward you) on the control to upshift and push downward (away from you) to downshift. The control is spring-loaded and returns to mid-position when released after an upshift or downshift.

For Eaton Fuller UltraShift (Fig. 8.10), a four-position (R, N, D, L) selector switch is located at the end of the lever. For the Mercedes-Benz AGS (Fig. 8.11), a three-position (R, N, D) selector switch is located at the end of the lever.

Embedded in the selector switch is a small neutral lock button to prevent accidental shifts into gear from neutral. Any time you shift through N, press down on the neutral lock button to move the switch from neutral (N) to another gear, such as drive (D), low (L), or reverse (R). When shifting to N, it is not necessary to press the neutral lock button.

Eaton Fuller UltraShift

The Eaton® Fuller® UltraShift™ transmission uses the four-position SmartShift control lever on the steering column to change gears, combined with a gear indicator on the right-hand control panel as shown in Fig. 8.12. All forward shifts can be made either manually or automatically, at the driver’s choice. No clutch pedal is required to operate the vehicle.

General Information, UltraShift ASW

UltraShift ASW is a six-speed medium-duty fully automated transmission used on the M106 only. Six-speed UltraShift ASW uses a “wet” clutch system in which the drive and driven discs rotate in a bath of transmission fluid (Dexron III).

General Information, UltraShift DM

UltraShift DM is a ten-speed heavy-duty fully-automated transmission used on the M112 only. Ten-speed UltraShift DM uses a dry clutch system which
Operation, UltraShift

Power Up

NOTE: These operating instructions apply equally to six-speed UltraShift ASW and ten-speed UltraShift DM, with the exceptions explained below.

1. With the parking brake set, select neutral (N) by moving the selector switch to the N position.

2. With the transmission in neutral, turn on the ignition switch. The "CHECK TRANS" and "TRANS TEMP" telltale lights come on and go out again (bulb check). See Fig. 8.13.

3. After the ignition is turned on, the current gear indicator shows the dot display, arranged in a square pattern. All dots in the pattern should light up, without gaps or spaces. See Fig. 8.14.

4. Wait for the current gear indicator to show a solid "N." When the "N" is solid, rather than flashing, the UltraShift transmission control unit (TCU) is powered up. Apply the service brake and start the engine.

5. Select drive (D) by pressing in the neutral lock button and moving the selector switch downward to the position below neutral. Release the parking brake. The gear is displayed on the current gear indicator.
NOTE: When D is selected, the transmission controller starts up in second gear. On both six-speed Ultrashift ASW and ten-speed Ultrashift DM, the driver can select to start up in first. No other start gear is available.

6. On a level grade, release the service brake and press down on the throttle pedal to allow the vehicle to move forward.

**WARNING**

When starting or stopping on hills and grades, use extra care to prevent the vehicle from rolling back. A rollback accident could cause death, serious personal injury, or property damage.

7. Prevent the vehicle from rolling backward when stopped on a hill or grade, or when the vehicle is starting from a stop on a hill or grade.

7.1 To start from a full stop on a hill or grade, quickly move your foot from the brake pedal and press firmly on the throttle pedal.

On steep hills, set the parking brake and release it only when there is enough engine power to prevent rollback.

7.2 To stop on a hill or grade, press and hold the brake pedal to keep the vehicle from moving.

On steep hills, set the parking brake. When parking, chock the tires, front and/or rear. Never hold a hill with the throttle pedal. This will cause the clutch to overheat.

**Power Down**

1. Apply the service brake.

2. Select neutral (N) by moving the selector switch to the N position. When the "N" on the gear indicator is solid, rather than flashing, the UltraShift TCU is ready to power down. See Fig. 8.13.

3. With the transmission in neutral, set the parking brake.

4. Turn off the ignition key and shut down the engine.

**Automatic and Manual Modes**

The SmartShift control has a slide switch located on the body of the control lever just before the paddle widens out. See Fig. 8.15. The slide switch controls the forward driving mode, automatic or manual.
To change mode at any time, move the slide switch in the desired direction. This allows the driver to respond to a wide range of driving conditions, such as blind corners, tight curves, and steep hills.

IMPORTANT: Whatever the mode, it is always possible to shift manually by moving the lever up or down as needed. When the engine speed is within 75 revolutions per minute (rpm) of the load-based shift point for an automatic shift, the UltraShift TCU will advance the shift.

In either mode, the gear indicator displays the current gear. See Fig. 8.16.

At the start of a shift, the current gear continues to display until the transmission has been pulled into neutral. At this point, as the transmission is synchronizing for the new (target) gear, the gear indicator flashes the number of the new gear.

When the shift is complete, the new gear displays solid, without flashing.

Automatic Mode (AUTO)

In automatic drive mode (AUTO), upshifts and downshifts are made by the transmission without driver intervention. Press in the neutral lock button, move the selector switch to drive (D), and press down on the throttle pedal. The transmission will shift automatically.

If driving conditions require, it is still possible to request a manual shift. The transmission will make the shift if the engine speed is within 75 rpm of the load-based shift point for that gear.

If the driver presses down on the throttle pedal after a manual downshift in automatic mode, the transmission will upshift again if the UltraShift TCU requires it.

Manual Mode (MAN)

In manual drive mode (MAN), upshifts and downshifts are made by the driver:

- To shift up, pull the lever up (towards you).
- To shift down, push the lever down (away from you).

The system will hold the current gear until the driver requests a shift. In downhill situations in particular, the driver must be alert to vehicle speed by downshifting and/or using the service brake.

A shift request will still be refused if the selected gear would cause engine overspeed or excessive lugging.

Selecting Gears

Reverse

Reverse (R) is at the upper end of the four-position selector switch located at the end of the SmartShift control lever. To select R, press in the neutral lock button and move the selector switch upward to the position above neutral.

Six-speed UltraShift ASW has one reverse gear. When reverse is selected, the letter "R" displays on the gear indicator. See Fig. 8.17.
Ten-speed UltraShift DM has two reverse gears, reverse low and reverse high. To shift manually between them, use the shift lever as described for MAN mode. There is no AUTO mode for reverse.

When reverse low is selected, the letter "R" displays on the current gear indicator. When reverse high is selected, the letter "H" displays on the current gear indicator.

IMPORTANT: Under normal conditions, do not select reverse with the vehicle moving forward. The vehicle must be moving at less than two miles per hour (3 km/h) before selecting reverse. If reverse is selected when the vehicle is moving faster, an audible alert will sound and continue sounding at three-second intervals until the control lever is returned to the D position. When the vehicle is moving at the proper speed, reverse can be engaged.

On ten-speed UltraShift DM only, if necessary to rock the vehicle, use the selector switch to shift back and forth at low speed between reverse and drive.

Neutral

IMPORTANT: Always start the engine with the transmission in neutral, the parking brake set, and the service brakes applied.

Neutral (N) is directly below R on the four-position selector switch located at the end of the SmartShift control lever. To select N, move the selector switch to the position below R. When neutral is selected, the letter "N" displays on the gear indicator. See Fig. 8.18.

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

Neutral is always available during operation, whatever the vehicle speed. When in neutral, requests to upshift or downshift are ignored. If the selector switch is moved from neutral to drive while the vehicle is moving, the transmission will shift into a gear within the engine’s operating speed range.

When shifting from neutral, always press on the brake pedal. If the brake pedal is not pressed, the transmission will not shift, the current gear display will flash "N," and an audible alert will sound.

NOTE: To reset the transmission, return the selector switch on the SmartShift lever to N and attempt the shift again, this time with the brake pedal pressed.

Before shutting down the engine, return the selector switch to "N." When the ignition is turned off, the transmission will reset to neutral in a few minutes regardless of the position of the shift lever.

Drive

Drive (D) is directly below N on the four-position selector switch located at the end of the SmartShift control lever. To select D, press in the neutral lock button and move the selector switch to the position below N. When drive is selected, the number of the currently selected forward gear (1 through 6 on six-speed UltraShift ASW; 1 through 10 on ten-speed UltraShift DM) displays on the gear indicator. See Fig. 8.16.

When in drive, requests to upshift or downshift are enabled. Either manual or automatic mode can be selected on the slide switch.

Two starting gears are available, first and second. The default starting gear is second, but first can be selected by the driver, if desired. To change the starting gear, press the brake pedal and select D with the vehicle stopped. The current gear indicator will display the starting gear. Move the shift lever up or down until the desired starting gear is displayed.

The UltraShift TCU adapts to the working conditions of each vehicle and its driver. After power-up or a load change, it needs to learn the new conditions.
While learning, it may hold a gear too long before upshifting. Start the upshift manually. It may take three or four shifts before UltraShift succeeds in learning the new load-based shift points, but after that it will handle the shifting automatically.

Low

Low (L) is located at the lower end of the four-position selector switch located at the end of the SmartShift control lever. To select L, press in the neutral lock button and move the selector switch to the position below D. When in low, the current gear is maintained. Requests to upshift are not enabled.

IMPORTANT: If the engine is approaching overspeed, the UltraShift TCU will override the current gear setting and upshift to prevent engine damage.

To enhance engine braking, downshifts are performed at higher rpm than normal.

If L is selected from neutral while stopped, the vehicle starts up in first gear and stays there until the engine approaches overspeed.

Upshifting

To request an upshift with the transmission in drive, pull the control lever up (towards you). If the gear is available, the transmission upshifts and the new gear displays on the gear indicator. No skip shifts are available while upshifting.

No upshifts are available in low, except to prevent engine overspeed.

If the transmission does not upshift quickly enough after power-up or a load change, begin the shift manually. The UltraShift TCU will learn the new load-based shift conditions after three or four shifts.

If the gear requested is unavailable, a tone will sound. An unavailable request to upshift is not stored in memory. The upshift must be requested again.

Downshifting

NOTE: The driver can manually downshift at any time, even when the slide switch is set to AUTO mode.

To request a downshift with the transmission in drive or low, push the control lever down (away from you).

If the gear is available, the transmission downshifts and the new gear displays on the gear indicator. Skip shifts are available while downshifting.

For best engine braking, select low while moving. In low, downshifts are performed at higher rpm than in drive.

IMPORTANT: If the engine is approaching overspeed, the UltraShift TCU will override the current gear setting and upshift to prevent engine damage.

If the gear requested is unavailable, a tone will sound. An unavailable request to downshift is not stored in memory. The downshift must be requested again.

When coasting to a stop, the UltraShift TCU may not finish the downshift until the driver presses down on the throttle pedal again.

IMPORTANT: A downshift request can never result in a shift into neutral, even if the vehicle is in the drive position in the lowest possible gear.

Before starting down a hill, slow down. Downshift to a speed that you can control without hard pressure on the service brakes.

Before entering a curve, slow down to a safe speed. Downshift if necessary. This lets you use some power through the curve to help the vehicle be more stable on the turn. It also allows you to regain speed faster as you come out of the curve.

UltraShift Diagnostics

Clutch Calibration

NOTE: Clutch calibration only occurs on six-speed UltraShift ASW.

The UltraShift TCU automatically adjusts for clutch wear. The calibration takes place whenever the following conditions are met:

- The engine is at normal operating temperature
- The vehicle is stopped
- The engine is at idle speed
- The selector switch on the control lever is in neutral
Calibration may take up to two minutes to complete. The engine may slow and return to normal idle several times during calibration.

To stop calibration at any time, select one of the drive positions on the selector switch (R, D, or L).

**Clutch Protection Fault**

Excessive clutch slippage creates heat and reduces the life of the clutch. These are some conditions which lead to clutch abuse:

- Using the throttle to hold the vehicle on a grade
- Starting the vehicle in too high a gear
- Overloading the vehicle
- Using high idle with the vehicle in gear

The UltraShift TCU is programmed to prevent clutch abuse. When the clutch overheats, the following alerts take place:

- The “TRANS TEMP” light comes on
- The gear indicator displays “CA"
- A warning tone sounds at one second intervals

The alerts continue until the clutch cools, the throttle is released, or the clutch is fully engaged.

**System Problem**

In the event of a problem, do the following steps:

1. Note the driving conditions at the time the problem occurred.
2. Record the status of the transmission at the time of the problem (AUTO or MAN mode, gear setting R, N, D, or L, current gear, engine speed, etc.)
3. Reset the system, using the procedure below.

**Reset Procedure**

Transmission operation can sometimes be restored by doing the following reset procedure:

1. Stop the vehicle when it is safe to do so.
2. Place the selector switch in neutral and turn off the ignition.
3. Check all harness connectors as described in Chapter 11.

4. Wait at least two minutes with the engine shut down.
5. Restart the engine.

If the problem continues, contact an authorized Freightliner or Eaton service facility.

**Locked In Gear**

If the transmission becomes locked in gear, a dash (–) will appear on the gear indicator when the vehicle is restarted during the reset procedure.

NOTE: If the transmission becomes locked in gear while the vehicle is moving, increased braking effort may be required to stop the vehicle.

If the current gear indicator displays a dash during power-up with the selector switch in neutral, do the following steps:

1. Make sure the parking brake is set.
2. Turn off the ignition and wait at least two minutes.
3. Apply the service brakes.
4. With the service brakes applied, release the parking brake.
5. Make sure the selector switch is in neutral and turn on the ignition key. Do not attempt to start the engine at this time.
6. If necessary to get the transmission to shift into neutral, release the pressure on the brake pedal slightly.
7. Once the UltraShift TCU reaches neutral, a solid “N” will appear on the current gear indicator and the vehicle will start. Make sure the service brakes are applied and the parking brake is set.

If the gear indicator continues to display a dash, contact an authorized Freightliner or Eaton service facility.
Mercedes-Benz Manual Transmissions

⚠️ CAUTION ⚠️

Operating a manual transmission with the fluid level higher or lower than recommended can result in transmission damage.

Mercedes-Benz transmissions use a simple 6-speed gear pattern as shown in Fig. 8.19.

![Fig. 8.19, Shift Pattern, M-B Transmissions](image)

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

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

While traveling, check the tachometer regularly to be sure the engine speed is within the most economical range (1400 to 2000 rpm).

On level roads, drive in the highest usable gear, keeping engine speed down.

⚠️ CAUTION ⚠️

Do not rest your hand on the gear shift lever while driving. This can cause synchronizer damage.

When approaching an uphill grade, shift down ahead of time to prevent loss of engine rpm. When approaching a downhill grade, shift down ahead of time to prevent runaway speed. For information about shift points and "progressive shifting," see Chapter 7.

Change gears only when absolutely necessary. Skip gears if needed.

When shifting, always press the clutch pedal all the way down. Do not force the gear lever.

Before shifting into reverse, be sure the engine is idling and the vehicle is not moving.

⚠️ CAUTION ⚠️

If the transmission locks up while driving, making further shifting impossible, continue driving in the gear already selected to reach service assistance, as circumstances allow. Or, safely park the vehicle off the roadway and contact your nearest Freightliner dealer or other qualified service provider for roadside assistance. To prevent further transmission damage, do not move the vehicle from a standing start unless this can be accomplished safely, taking into account the gear that is engaged and the load on the vehicle.

Mercedes-Benz Automated Transmissions

General Information, AGS

The AGS Automated Gear Shift is a fully automated 6-speed medium-duty transmission. The clutch is activated by a hydraulic system that is integral to the transmission. No clutch pedal is needed to operate the vehicle.

AGS transmissions use the SmartShift control lever on the steering column to select gears. A manual shift is possible at any time by moving the SmartShift lever up or down as needed.

The transmission control unit (TCU) can direct all forward shifts in response to driving conditions and the driver's pressure on the brake and throttle pedals. To know which gear the transmission is in, look at the round current gear indicator on the right-hand control panel as shown in Fig. 8.12.

The TCU always selects first gear to start the vehicle in motion. It is possible, in manual mode, to start an unloaded or lightly loaded vehicle in second gear. In most cases, second gear is acceptable for downhill starts. In other situations, for best results always start moving in first gear. Loaded vehicles, or vehicles on substantial grades, must start moving only in first gear.
CAUTION

At the first sign of a transmission malfunction, take the vehicle out of service immediately. Depending on the type of problem, further shifting may not be possible, and driveline torque may be interrupted.

Operation, AGS

Power Up

1. With the parking brake set and/or the brake pedal pressed down, select neutral (N) by moving the selector switch to the center position.

2. With the transmission in neutral, turn on the ignition switch. The "CHECK TRANS" and "TRANS TEMP" telltale lights come on and go out again (bulb check). See Fig. 8.13.

3. On power up, the current gear indicator shows the dot display, arranged in a square pattern. All dots in the pattern should light up, without gaps or spaces. See Fig. 8.14.

4. When the current gear indicator shows "N," start the engine.

NOTE: No matter what the circumstances, do not start the engine unless the current gear indicator shows "N." See Chapter 13 for jump starting information.

5. Select drive (D) by pressing in the neutral lock button and moving the selector switch downward to the position below neutral. Release the parking brake and/or service brake pedal. The gear is displayed on the current gear indicator.

NOTE: When D is selected, the transmission starts up in first gear. To start up in second gear (downhill start, vehicle unloaded or lightly loaded), pull up on the SmartShift lever when the current gear indicator displays "1."

6. On a level grade, press down on the throttle pedal to allow the vehicle to move forward. The vehicle will not move until the pedal is depressed.

WARNING

When starting or stopping on hills and grades, use extra care to prevent the vehicle from rolling back. A rollback accident could cause death, serious personal injury, or property damage.

7. Prevent the vehicle from rolling backwards when stopped on a hill or grade, or when the vehicle is starting from a stop on a hill or grade.

7.1 To start from a full stop on a hill or grade, quickly move your foot from the brake pedal and press firmly on the throttle pedal.

On steep hills, set the parking brake and release it only when there is enough engine power to prevent rollback.

7.2 To stop on a hill or grade, press and hold the brake pedal to keep the vehicle from moving.

On steep hills, set the parking brake. Never hold a hill with the throttle pedal. This will cause the clutch to overheat.

Power Down

1. Bring the vehicle to a complete stop.

2. Set the parking brake.

3. Move the selector switch to N. Wait until "N" appears on the current gear indicator.

WARNING

Always apply the parking brake before shutting down the engine. AGS will shift into neutral after shutdown, regardless of the position of the shift lever. If you do not set the parking brake, the vehicle could roll and cause an accident resulting in death, serious personal injury, or property damage.

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

5. If the current gear indicator flashes "PB" when the engine is shut down, set the parking brake and move the selector switch to "N."
Automatic and Manual Modes

The SmartShift control has a slide switch located on the body of the lever just before the paddle widens out. See Fig. 8.20. The slide switch controls the forward driving mode, automatic or manual.

If driving conditions require, it is still possible to request a manual shift. The transmission will make the shift unless the selected gear would cause engine overspeed.

If the driver presses down on the throttle pedal after a manual downshift in automatic mode, the transmission will upshift again if the TCU requires it.

On downgrades, the transmission holds the current gear until the driver requests a shift, or presses the throttle pedal.

**WARNING**

While driving off-road or with locked differential in AUTO mode, use extra caution. Shifts of the AGS could interrupt power to the drive wheels, causing a rollback accident while climbing steep grades at low speeds. A rollback accident could cause death, serious personal injury, or property damage.

Manual Mode (MAN)

Manual mode may be required under certain conditions, such as:

- In difficult or slippery conditions
- On hills, steep grades, or other situations where driveline torque interruption is not desirable
- During off-road driving or driving with a locked differential
- In downhill driving where control of engine braking is needed
- If necessary to hold a specific gear on a downgrade

In manual drive mode (MAN), upshifts and downshifts are made by the driver:

- To shift up, pull the lever up (towards you).
- To shift down, push the lever down (away from you).

The system will hold the current gear until the driver requests a shift. In downhill situations in particular, the driver must be alert to vehicle speed and maintain vehicle control by downshifting and/or using the service brakes as needed.
When braking or slowing in MAN, downshift as necessary to prevent lugging the engine when speed is resumed. If the vehicle comes to a complete stop, the TCU resets the transmission to neutral.

NOTE: A downshift request will be refused if the selected gear would cause engine overspeed.

**Cruise Control**

Cruise control is fully functional with AGS transmission in either AUTO or MAN mode.

In AUTO, the TCU will adjust the gear selections to maintain the speed settings as desired. No driver action is necessary.

In MAN, the vehicle speed settings must be within the engine speed range for the gear selected. If the engine cannot maintain set speed due to changes in road grade, the driver must downshift or upshift as necessary.

For vehicles equipped with a power take-off (PTO) unit, two modes of operation are possible, stationary and mobile. For PTO operation, see Chapter 7.

**Selecting Gears**

**Reverse**

Reverse (R) is at the upper end of the three-position selector switch located at the end of the SmartShift control lever. To select reverse (R), press in the neutral lock button and move the selector switch upward to the position above neutral. When reverse is selected, the letter "R" displays on the gear indicator. See Fig. 8.17.

IMPORTANT: The vehicle must come to a complete stop before selecting reverse. If reverse is selected with the vehicle moving forward, an audible alert will sound and continue sounding at three-second intervals until the selector switch is returned to N or D.

Once the vehicle has come to a complete stop, reverse can be engaged.

**Neutral**

Neutral (N) is in the center of the three-position selector switch located at the end of the SmartShift control lever. Always start the engine in neutral. To select neutral, move the selector switch to the center position. When neutral is selected, the letter "N" displays on the gear indicator. See Fig. 8.18.

**Drive**

IMPORTANT: The vehicle must come to a complete stop before selecting drive. If drive is selected with the vehicle moving in reverse, an audible alert will sound and continue sounding at three-second intervals until the selector switch is returned to N or R.

Drive (D) is at the lower end of the three-position selector switch located at the end of the SmartShift control lever. To select drive, press in the neutral lock button and move the selector switch to the position below neutral. When drive is selected, the number of the currently selected forward gear (1, 2, 3, 4, 5, or 6) displays on the gear indicator.

**Upshifting**

NOTE: The driver can manually upshift at any time, even when the slide switch is set to AUTO mode.

To request an upshift with the transmission in drive, pull the control lever up (towards you). If the gear is

**WARNING**

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

Neutral is always available during operation, whatever the vehicle speed. When in neutral, requests to upshift or downshift are ignored. If the selector switch is moved from neutral to drive while the vehicle is moving, the transmission will shift into a gear within the operating torque range of the engine.

**WARNING**

Always apply the parking brake before shutting down the engine. AGS will shift into neutral after shutdown, regardless of the position of the shift lever. If you do not set the parking brake, the vehicle could roll and cause an accident resulting in death, serious personal injury, or property damage.

Before shutting down the engine, return the selector switch to "N." When the ignition is turned off, the transmission will reset to neutral during power down.
available, the transmission upshifts and the new gear displays on the gear indicator.

As in a manual transmission, upshifting too early causes engine lugging and uneven operation.

To achieve smooth operation in MAN mode, upshift when the engine speed reaches approximately 2000 revolutions per minute (rpm). Heavy loads or steep grades require higher rpm; lighter loads require lower rpm.

An unavailable request to upshift is not stored in memory. The upshift must be requested again.

Downshifting

NOTE: The driver can manually downshift at any time, even when the slide switch is set to AUTO mode.

To request a downshift with the transmission in drive, push the control lever down (away from you). If the gear is available, the transmission downshifts and the new gear displays on the gear indicator.

Downshifts are not available if the engine speed after the shift would exceed 2700 rpm. If the gear requested is unavailable, an audible alert will sound. An unavailable request to downshift is not stored in memory. The downshift must be requested again.

To achieve smooth operation in MAN mode, downshift when the engine speed reaches approximately 1200 rpm.

Before starting down a hill, slow down. Downshift to a speed that you can control without hard pressure on the service brakes.

Before entering a curve, slow down to a safe speed. Downshift if necessary. This lets you use some power through the curve to help the vehicle be more stable when turning. It also allows you to regain speed faster as you come out of the curve.

AGS Diagnostics

——— CAUTION ———

At the first sign of a transmission malfunction, take the vehicle out of service immediately. Depending on the type of problem, further shifting may not be possible, and driveline torque may be interrupted.

System Malfunction

If the "CHECK TRANS" telltale light comes on while driving, the audible alert sounds, and the current gear indicator begins to flash between the current gear and "SM" (system malfunction), there is a problem which may or may not be apparent to the driver. Bring the vehicle at once to a safe stopping place and call an authorized Freightliner service facility for assistance.

Clutch Overload

If the "TRANS TEMP" telltale light comes on while driving and the current gear indicator begins to flash between the current gear and "CO" (clutch overload), the clutch has begun to overheat.

The clutch overload may have been caused by improper driving practices such as frequent and rapid start/stop driving, or hillholding with the throttle pedal. In this case, allow the clutch to cool, and continue on, but cease the improper driving practices.

If the clutch overload message returns or continues, the clutch is worn or damaged. Bring the vehicle at once to a safe stopping place and call an authorized Freightliner service facility for assistance.

Low Hydraulic Fluid Level

IMPORTANT: The only hydraulic fluid permitted in this system is Pentosin CHF 11S. No other fluid can be substituted.

If the "CHECK TRANS" telltale light comes on while driving and the current gear indicator begins to flash between the current gear and "FL" (fluid level), there has been an unusual loss of hydraulic fluid. Bring the vehicle at once to a safe stopping place and call an authorized Freightliner service facility for assistance. The hydraulic reservoir holds about 1.05 quarts (one liter) of Pentosin CHF 11S.

NOTE: After hydraulic fluid loss, a special procedure is required to fill the hydraulic reservoir. This procedure must be carried out by an authorized Freightliner service facility.

Meritor™ Drive Axles

Refer to the Meritor website for additional information, www.arvinmeritor.com.
Drive Axles With Differential Lock

The Meritor driver-controlled differential lock feature (side-to-side wheel lock, traction control, or traction equalizer) is available on single-drive or dual-drive rear axles. It is available on both axles of a dual-drive vehicle, or on one only. It is only available on drive axles. Differential lock must only be used under adverse road conditions where greater traction is needed. With differential lock on, the turning radius is increased and vehicle handling is affected. The differential lock switch (Fig. 8.21) allows the driver to lock the wheels on the same axle together. The red differential lock warning light illuminates on the dash message center when differential lock is engaged.

**Differential Lock Switch**

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.

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

**Differential Lock Switch**

![Differential Lock Switch](image)

**CAUTION**

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

Normally, when differential lock is available on dual-drive vehicles, one switch activates the lock on both rear drive axles. As an option, it possible to have two differential lock switches, one for the forward rear and one for the rearmost drive axle. It is also possible for some vehicles to have differential lock on only one of the drive axles.

A two-position guarded rocker switch (Fig. 8.21) controls differential lock, causing the wheels on each axle governed by the switch to rotate together. To lock the wheels together, press the upper half of the rocker momentarily (at the red LED). To unlock the wheels, press the upper half of the rocker again.

**IMPORTANT:** The differential lock rocker 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. 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 comes on steady and stays illuminated. 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 comes on steady and stays illuminated once the wheels have locked.

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

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

**WARNING**

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

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. 8.22. Drive cautiously and do not exceed 25 mph (40 km/h).

To disengage differential lock after leaving poor road conditions, operate the differential lock switch as discussed above 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.

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**CAUTION**

The interaxle lock should not be engaged on a vehicle with obviously spinning wheels. Engagement at high speed or power can damage the axle(s).

Meritor has an interaxle lock (axle lock, interaxle differential lockout) feature that is standard on all dual-drive (tandem-drive) vehicles. Interaxle lock is recommended for use under adverse road conditions where greater traction is needed. See the axle manufacturer’s manual provided with the vehicle for more information.

The interaxle lock switch (Fig. 8.23) allows the driver to lock both rear axles together. The red interaxle warning light illuminates on the dash message center when interaxle lock is engaged.

When the interaxle lock is not engaged, there is differential action between the two axles. The differential compensates for different wheel speeds and variations in tire size. Keep the interaxle lock disengaged when driving on roads where traction is good.

When the interaxle lock is engaged, the differential action between the two axles is locked. Both drive axles now share the power. Both axles, and both
sets of wheels, turn together at the same speed. The interaxle lock should be used when the vehicle encounters poor traction conditions; however, it also increases drivetrain and tire wear and should be used only when improved traction is required.

Interaxle Lock Switch

A two-position guarded rocker switch (Fig. 8.23) controls interaxle lock, causing both axle shafts to rotate together. To lock the axles together, press the upper half of the rocker momentarily (at the red LED). To turn off interaxle lock, press the lower half of the rocker (at the double-axle icon).

IMPORTANT: The interaxle lock rocker switch is guarded to prevent unintentional switch activation. This switch does not have a diagnostic blink function when inactive.

When the interaxle 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 interaxle lock is engaged. At this point, the LED comes on steady and stays illuminated. In normal operation, the interaxle 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 too fast, etc.), the LED will stop blinking and turn off.

Slow Response: If operation of the switch is slowed for any reason (by cold weather, low air pressure, etc.), the switch will continue to blink until the axles lock together, or for a maximum of 10 seconds. As in the normal response, the LED comes on steady and stays illuminated.

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.

Interaxle Lock Operation

To engage interaxle lock and achieve maximum pulling power in slippery or hazardous road conditions, operate the interaxle lock switch as discussed above, while maintaining vehicle speed. Let up momentarily on the accelerator until the axle lock engages. Proceed over poor road conditions with caution. Do not wait until traction is lost and the tires are spinning before engaging the interaxle lock.

CAUTION

Do not turn on the interaxle lock switch when the tires are slipping. Do not continuously operate the vehicle with the interaxle lock engaged during good road conditions. To do so could result in damage to the axle gearing and excessive tire wear.

To disengage the interaxle lock after leaving poor road conditions, operate the interaxle lock switch as discussed above while maintaining vehicle speed. Let up momentarily on the accelerator to allow the axles to fully unlock, then resume driving at normal speed.

Axle Shift

CAUTION

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

Axle shift is a function installed on vehicles with two-speed axles to allow the use of the low speed range when greater traction and maximum pulling power is needed at low engine speed (rpm).

Under normal operating conditions, the vehicle is operated using the high-speed gear ratios of the axle. Under extreme weather or off-road conditions, at low speed and rpm and/or to pull heavy loads, the vehicle must be operated using the low-speed, or reduction, gear ratios of the axle.
Axle Shift Switch

The axle shift switch is a two-position guarded rocker switch (Fig. 8.24) installed on vehicles with two-speed axles.

To shift the axle from low speed to high speed, press the upper half of the rocker momentarily (at the LED). To turn the axle shift off (switch from high speed back to low speed), press the upper half of the rocker again. When the axle has shifted speed, the LED turns off.

When the panel lights are on, the AXLE SHIFT legend is backlit in green.

IMPORTANT: The axle shift rocker 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. Bring the vehicle to an authorized Freightliner service facility as soon as possible.

When the axle shift 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 shifts speed. At this point, the LED comes on steady and stays illuminated. In normal operation, the axle may shift so quickly that the blinking of the switch is barely noticeable.

If operation of the switch is not possible for any reason (interaxle lock is on, ignition is turned off, etc.), the LED will stop blinking and turn off.

Slow Response: If operation of the switch is slowed for any reason (by cold weather, low air pressure, etc.), the switch will continue to blink until the axle shifts. As in the normal response, the LED comes on steady and stays illuminated.

Abnormal Response: If the LED blinks for more than 30 seconds, the axle shift function/mechanism may not be operating correctly. Bring the vehicle to an authorized Freightliner service facility for testing.

Axle Switch Interlock

NOTE: On vehicles with tandem drive axles, there is an interlock that prevents an axle from shifting speed whenever the interaxle lock is on.

If the axle shift switch is pressed when the interaxle lock is on, the axle shift will not be completed. The LED does the following:

- If the LED is off, the LED comes on briefly and turns off again.
- If the LED is on, it stays on.

To complete the axle shift, turn off the interaxle lock and press the axle shift switch again. If still needed, the interaxle lock can then be reactivated.
9

Steering and Brake Systems

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Steering System

Steering Wheel Adjustment

Two steering wheels are available: a standard 18-inch (450-mm) steering wheel and an optional 20-inch (500-mm) steering wheel.

When there is no load on the vehicle and the front tires are pointed straight ahead, the standard steering wheel spokes should be at the 3 o’clock and 9 o’clock positions or within 10 degrees of these positions. See Fig. 9.1.

On the optional 20-inch (500-mm) wheel, the steering wheel spokes should be at the 4 o’clock and 8 o’clock positions or within 10 degrees of these positions. For steering wheel adjustment procedures, see Group 46 of the Business Class® M2 Workshop Manual.

Power Steering System

The power steering system consists of a steering gear (which includes a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder), hydraulic hoses, power steering pump, power steering reservoir, and other components. Some models are also equipped with a separate hydraulic power cylinder on the right side of the front axle.

The power steering pump, driven by the engine, provides the power assist for the steering system. If the engine is not running, there is no power assist.

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

WARNING

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

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

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. Service brake signals from both systems are sent to the trailer.

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. In addition, the trailer brakes (if equipped) will 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. In addition, the trailer brakes (if equipped) will be operated by the primary air system.
Emergency Braking System

When air pressure is lost in either the primary or secondary air system, the air compressor will operate, but the air supply in the other system, the one that is not leaking, will not be replenished. There will be enough air in the other 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, Tractor and Trailer

The yellow diamond-shaped knob (parking brake control valve) on the auxiliary dash panel applies the parking brakes (spring brakes). Pulling out the knob applies both the tractor and the trailer parking brakes and automatically causes the red octagonal knob (trailer air supply valve) to pop out. See Fig. 9.2.

The red octagonal-shaped knob on the auxiliary dash panel operates the trailer air supply valve. After the vehicle and its air hoses are connected to a trailer, and the pressure in the air system is at least 65 psi (448 kPa), the red knob must be pushed in (and should stay in) to charge the trailer air supply system and release the trailer parking brakes. Before disconnecting a trailer or when operating a vehicle without a trailer, the red knob must be pulled out.

If pressure in both air systems drops to 35 to 45 psi (241 to 310 kPa), the red knob automatically pops out, exhausting the trailer air supply and applying the trailer parking brakes.

If the trailer is not equipped with parking brakes, pulling out the yellow knob applies both the tractor parking brakes and the trailer service brakes. When the tractor and trailer parking brakes (or trailer service brakes) are both applied, the trailer brakes can be released by pushing in the red knob, leaving the tractor parking brakes applied.

The trailer brake lever (hand control valve) is used for applying the trailer brakes without applying the truck or tractor service brakes. It is usually mounted on the right-hand control panel. See Fig. 9.3.

On Tractor-Trailers

If both the primary and secondary air systems become inoperative on tractor-trailers, the trailer service brakes or parking brakes will automatically apply when the air pressure drops below 35 to 45 psi (241 to 310 kPa).

The tractor parking brakes will automatically apply when the air pressure drops below 20 to 30 psi (138 to 207 kPa).

On Trucks

Trucks are equipped with spring brake modulation. If an air pressure loss occurs in the primary air system, the rear parking brakes will be modulated (applied and released) in proportion to the service brake application. There will only be enough air in the secondary system for two to four brake applications, at
which time the parking brake control valve will pop out and fully apply the brakes.

On trucks, the parking brakes will apply when the air pressure drops below 20 to 30 psi (138 to 207 kPa). Do not wait for the brakes to apply automatically. Before continuing to operate the vehicle, correct the cause of the air loss.

**Automatic Slack Adjusters**

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

When the brake pushrod stroke exceeds the legal brake adjustment limit on a vehicle, there likely is 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.

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**WARNING**

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

**Air Brake Operation**

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**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 cab so that they will not fly forward during a full brake application. Make sure all occupants are wearing seat belts.

**Parking Brake Interlock**

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**CAUTION**

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. If the yellow knob is pressed in, it will pop back out unless the service brake pedal is being pressed down.

A decal on the dash alerts you to press down on the service brake pedal before releasing the parking brake. If you do not, the yellow knob will not allow itself to be pressed in, but will return to its old position.

**Operating the Brakes**

To ensure safe operation and minimum brake wear, do the following steps when operating the brakes.

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.

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

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

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 (yellow knob) 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.

6. If the brakes are wet, drive the vehicle in low gear and lightly apply the brakes to heat and dry them.

--- CAUTION ---

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

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

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

Parking the Vehicle

--- WARNING ---

Do not use the trailer service brakes for parking; they are not designed for this purpose. If air bleeds out of the trailer air tank during parking, the vehicle could roll, causing serious personal injury or property damage.

IMPORTANT: Air pressure in the primary or secondary reservoir must be at least 65 psi (448 kPa) before the tractor parking brakes and the trailer service brakes (or parking brakes) can be released.

On trailers without parking brakes, do the following to park safely:
- To park just the trailer, chock the trailer tires before disconnecting the tractor.
- To park a tractor with a trailer, apply the tractor parking brakes.

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.

Meritor™ WABCO® Antilock Braking System (ABS) for Air Brakes

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.

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 wheel.

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 close on slippery road surfaces.

The main circuit of the control unit interprets the speed sensor signals and calculates wheel speed, wheel retardation, and a vehicle reference speed. If the calculations indicate wheel lockup, the main circuit signals the appropriate solenoid control valve to reduce braking pressure.

The electronic control unit also has a safety circuit that constantly monitors the wheel sensors, solenoid control valves, and the electrical circuitry. During emergency braking, the solenoid control valve alternately reduces, increases, or maintains the supply of air pressure in the brake chamber, thereby preventing front and/or rear wheel lockup.

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.

ABS Indicator Lights

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

Tractor ABS Light

If equipped only with the tractor ABS system, the amber TRACTOR ABS indicator light (see Fig. 9.4) comes on after the ignition switch is turning on. The indicator light goes out only if all of the tractor ABS components are working.

Fig. 9.4, ABS Indicator Lights

An accumulation of road salt, dirt, or debris on the ABS tone wheels and sensors can cause the ABS warning light to come on. If the ABS light does come on, the tone rings and sensors should be inspected for corrosion and serviced if necessary. The service should include cleaning.
of the tone rings and sensors. If any tone ring on a vehicle shows severe corrosion, all tone rings on that vehicle should be replaced.

During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle, including the tone rings and sensors, to ensure proper ABS function and to protect the components from corrosion. Clean more frequently when unusually corrosive chemicals are being used.

During vehicle operation, if the safety circuit senses a failure in any part of the ABS system (a sensor, solenoid control valve, wiring connection, short circuit, etc.), the TRACTOR ABS indicator light comes on and the control circuit where the failure occurred is switched to normal braking action. The remaining control circuit will retain the ABS effect.

Trailer ABS Light
The amber TRAILER ABS indicator light operates as follows when a compatible trailer is properly connected to the tractor:

• When the ignition switch is turned to the on position, the trailer ABS light will illuminate momentarily, then turn off.

• If the light comes on momentarily during vehicle operation, then shuts off, a fault was detected and cleared.

• If the light flickers, or comes on and goes off repeatedly, it could indicate an intermittent wiring problem. Bring the vehicle to an authorized Freightliner service facility for testing and repairs.

• If the light comes on and stays on during vehicle operation, there is a fault with the trailer ABS. Repair the trailer ABS system immediately to ensure full antilock braking capability.

The Trailer ABS light will not illuminate unless a compatible trailer is connected to the tractor.

IMPORTANT: If a compatible trailer is connected, and the light is not illuminating for three seconds when the ignition switch is turned to the ON position, it is possible that the light is burnt out.

Wheel Spin Light
If equipped with Automatic Traction Control (ATC), the amber WHEEL SPIN indicator light illuminates if one of the drive wheels spins during acceleration. When the light illuminates, partially release the throttle pedal until the light goes out. The light goes out when the wheel stops spinning.

If slippery road conditions continue, turn on the differential lock switch (on dual-drive vehicles, turn on the interaxle lock switch). See Chapter 8 for axle switch instructions.

CAUTION
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 Traction Control, Optional
Automatic Traction Control is an option available on ABS-equipped vehicles with air brake systems. It improves traction when vehicles are on slippery surfaces by reducing drive wheel overspin. ATC works automatically in two ways.

• If a drive wheel starts to spin, ATC applies air pressure to brake the wheel. This transfers engine torque to the wheels with better traction.

• If all drive wheels spin, ATC reduces engine torque to provide improved traction.

ATC turns itself on and off. Drivers do not have to select this feature. If drive wheels spin during acceleration, the WHEEL SPIN indicator comes on, indicating ATC is active. It goes out when the drive wheels stop spinning.

Hydraulic Brake System
General Information
The hydraulic brake system includes a power booster, master cylinder, reservoir, hydraulic lines, a brake rotor on each wheel hub, and a brake caliper and pad assembly at each rotor.

IMPORTANT: Make sure that the fluid level in the master cylinder reservoir is up to the ridge that surrounds the reservoir. See Fig. 9.5. Use only heavy-duty brake fluid, DOT 3, in the hydraulic brake system.
The master cylinder controls braking power to the front and rear brakes. The Bendix Hydro-Max® power booster is attached to the rear of the master cylinder and is connected to the power steering system (which provides pressurized power steering fluid). An electrically powered backup pump operates if there is inadequate fluid flow from the power steering pump to the power booster. The brake system warning light comes on if there is a problem within the system. Bring the vehicle to a safe stop and correct the problem before continuing operation of the vehicle. See Group 42 of the Business Class® M2 Workshop Manual for hydraulic brake system troubleshooting and adjustment procedures.

**Operation**

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

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

**Meritor™ WABCO® Antilock Braking System (ABS) for Hydraulic Brakes**

The Meritor WABCO Antilock Braking System (ABS) is an electronic wheel-speed monitoring and control system that works with the hydraulic brake system. ABS passively monitors vehicle wheel speed at all times, but controls wheel speed during an emergency or reduced-traction stop. In normal braking applications, the standard hydraulic brake system is in effect.

**IMPORTANT:** For proper hydraulic ABS operation, Meritor WABCO recommends that front and rear tire sizes be within 16% of each other. Contact the Meritor WABCO Customer Support Center at 800-535-5560 if you plan a tire size difference greater than ±8%. Installing different sized tires could result in inaccurate wheel speed signals to the ECU resulting in a reduced braking force, which could lead to longer stopping distances.

ABS includes signal-generating tone rings and sensors located in the wheel hubs of each sensed axle. The sensors transmit vehicle wheel speed information to the ECU which interprets these signals to calculate wheel speed and a vehicle reference speed. If the calculations indicate wheel lockup, the appropriate control circuit signals the brake pressure modulator to increase or decrease braking pressure.

**CAUTION**

An accumulation of road salt, dirt, or debris on the ABS tone wheels and sensors can cause the ABS warning light to come on. If the ABS light does come on, the tone rings and sensors should be inspected for corrosion and serviced if necessary. The service should include cleaning of the tone rings and sensors. If any tone ring on a vehicle shows severe corrosion, all tone rings on that vehicle should be replaced.

During winter months in areas where corrosive materials are used on the highways, periodically clean the underside of the vehicle, including the tone rings and sensors, to ensure proper ABS.
function and to protect the components from corrosion. Clean more frequently when unusually corrosive chemicals are being used.

The ECU also has a safety circuit that constantly monitors the wheel sensors, brake pressure modulator, and the electrical circuitry. The ABS indicator lamp comes on after the ignition is switched on and will go out within three seconds if the system is functioning correctly. If the ABS indicator lamp does not come on, or does not go out after three seconds, have the vehicle serviced before operation.

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

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

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

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

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Fifth Wheels, General Information

**WARNING**

Do not use any fifth wheel that fails to operate properly. Doing so may cause loss of vehicle control, possibly resulting in severe personal injury or death.

Air-Suspension Dump Valve

The air-suspension dump valve may be used to adjust the tractor height to aid with coupling to or uncoupling from a trailer. See Fig. 10.1. When the switch is set to LOWER, the air-suspension dump valve deflates the air springs to lower the rear of the vehicle. In the AUTO position, the automatic ride-control valves operate for normal driving.

**WARNING**

Never exhaust air from the suspension while driving. The suspension will not absorb road shocks, possibly damaging components, and vehicle handling may be compromised. This could result in loss of vehicle control, possibly resulting in severe personal injury or death.

**NOTICE**

Do not operate the vehicle over uneven ground such as ramps, speed bumps, curbs, etc. with the air springs deflated. Doing this may lead to air bag separation from the piston, preventing the suspension air springs from inflating.

Fifth Wheel Lubrication

**WARNING**

Keep the fifth wheel plate lubricated to prevent binding between the tractor and trailer. A binding fifth wheel could cause erratic steering and loss of vehicle control, possibly resulting in personal injury or death.

The standard fifth wheel plate must be kept well lubricated with chassis grease to prevent friction and binding between the tractor fifth wheel plate and the trailer.

For a low-lube fifth wheel plate, inspect the condition of the low-lube pads. There should be no damaged or missing pieces. Slight puckering at the outside edges is normal.

For lubrication instructions, see Group 31 of the Business Class M2 Maintenance Manual.

Fifth Wheel Coupling

Fifth wheel coupling is activated with the lock control handle located on either the right side or left side of the fifth wheel. Coupling has successfully occurred when the kingpin has been forced into the jaws and the lock control handle has moved to the locked position.

**NOTICE**

Some fifth wheels may be mounted on sliding rails. Before attempting to couple a trailer to a sliding fifth wheel, the slide feature must be locked to prevent the top plate from sliding rapidly forward or rearward, causing damage to the fifth wheel or kingpin.

Fontaine and Holland Fifth Wheels Coupling

1. Chock the front and rear of the trailer tires to prevent the trailer from moving.
2. Ensure the fifth wheel jaw is fully open and the operating rod is in the unlocked position. See Fig. 10.2 or Fig. 10.3.
3. Make sure the fifth wheel top plate is tilted so the ramps are as low as possible.
Position the tractor so that the center of the fifth wheel is in line with the trailer kingpin. The kingpin should be in a position to enter the throat of the locking mechanism.

**NOTICE**

Attempting to couple at the wrong height may cause improper coupling, which could result in damage to the fifth wheel or kingpin.

5. Adjust the trailer height if required.

   **For a standard fifth wheel plate,** the trailer should contact the fifth wheel approximately 4 to 8 inches (10 to 20 cm) behind the fifth wheel pivot. See Fig. 10.4.

   **For a low-lube fifth wheel plate,** the fifth wheel must slide freely under the trailer, and the trailer should contact the fifth wheel at the pivot. See Fig. 10.5.

6. With the fifth wheel lock opening aligned with the trailer kingpin, back the tractor slowly toward the trailer. After sliding under the trailer, STOP to prevent from hitting the kingpin too hard, then resume backing slowly until the fifth wheel locks.

On a standard fifth wheel, the fifth wheel must lift the trailer.

On a low-lube fifth wheel, do not lift the trailer as this may damage the fifth wheel plate.
Fifth Wheels and Trailer Couplings

7. Apply the tractor parking brakes.

**WARNING**

A visual inspection is required by law. Some improper couplings can pass a pull test. Sound is not reliable. Get out of the cab and look. Incorrect coupling could cause the trailer to disconnect, possibly resulting in serious personal injury or death.

8. Perform a coupling inspection, checking that there is no gap between the bottom of the trailer and the fifth wheel, and that the kingpin is securely locked. See Fig. 10.6

When lockup has occurred, the fifth wheel control handle moves to the locked position. Make sure that the safety latch is down over the lock control handle to hold the control handle in the locked position. (The safety latch will only rotate down if the operating rod is fully retracted in the locked position.) See Fig. 10.6 for Fontaine fifth wheels. See Fig. 10.3 for Holland fifth wheels.

9. Release the tractor parking brakes. Test for kingpin lockup slowly inching the tractor forward, pulling on the trailer against the chocks.

10. After lockup is completed, connect the tractor-to-trailer air system lines and the electrical cable to the trailer. Take care to prevent dirt or foreign material from entering the air system lines.

11. Charge the air brake system with air, checking that the air connections do not leak.

**WARNING**

Incorrect fifth wheel lock adjustment could cause the trailer to disconnect, possibly resulting in serious personal injury or death.

12. With the trailer wheels chocked and the brakes set, check for clearance between the kingpin and the fifth wheel jaws by moving the tractor forward and backward against the locked kingpin. If slack is present, uncouple the trailer and have the fifth wheel inspected and adjusted by a certified technician.

Jost Fifth Wheel Coupling

1. Tilt the ramp down.
2. Open the kingpin locks. See Fig. 10.7.
3. Back the vehicle close to the trailer, centering the kingpin on the fifth wheel.
4. Chock the trailer wheels.
5. Connect the air lines and electrical cable.
6. Ensure that the red trailer air supply valve (trailer brake) is pulled out, and that the trailer parking...
brakes are set. See Chapter 5 in this manual for operation of the dash-mounted brake controls.

**NOTICE**

Attempting to couple at the wrong height may cause improper coupling, which could result in damage to the fifth wheel or kingpin.

7. Adjust the trailer height (if required).

   For a standard fifth wheel plate, the trailer should contact the fifth wheel approximately 4 to 8 inches (10 to 20 cm) behind the pivot. See Fig. 10.4.

   For a low-lube fifth wheel plate, the fifth wheel must slide freely under the trailer, and the trailer should contact the fifth wheel at the pivot. See Fig. 10.5.

8. Back the tractor under the trailer.

   On a standard fifth wheel, the fifth wheel must lift the trailer.

   On a low-lube fifth wheel, do not lift the trailer as this may damage the fifth wheel plate.

9. After sliding under the trailer, STOP to prevent from hitting the kingpin too hard, then resume backing slowly until the fifth wheel locks.

**WARNING**

A visual inspection is required by law. Some improper couplings can pass a pull test. Sound is not reliable. Get out of the cab and look. Incorrect coupling could cause the trailer to disconnect, possibly resulting in serious personal injury or death.

10. Apply the tractor parking brake, then perform a physical check for positive kingpin lockup, and that there is no gap between the trailer and the fifth wheel. See Fig. 10.6.

11. Ensure that the release handle is in the locked position adjacent to the casting. See Fig. 10.8.

12. Release the tractor parking brakes and test for kingpin lockup by slowly moving the tractor forward, pulling on the trailer against the chocks.

**Fifth Wheel Uncoupling**

**Manual Uncoupling**

1. Apply the tractor and trailer parking brakes.

2. Chock the trailer rear wheels.

3. Lower the trailer landing gear until the weight is removed from the fifth wheel.

4. Disconnect the tractor-to-trailer air system lines and electrical cable. Plug the air lines to prevent dirt or foreign material from entering the lines.

5. Verify that both the yellow parking-brake and red trailer-air-supply knobs are out, the tractor and trailer parking brakes are set, and that the trailer is prepared for uncoupling.

6. Release the kingpin locking mechanism following the instructions for each manufacturer below.

   6.1 **Fontaine**: Lift the safety latch and pull the lock control handle to the unlocked position.

   6.2 **Holland**: In the locked position the safety indicator swings freely over the operating rod. See Fig. 10.9, View A.

      To unlock the mechanism, manually rotate the safety indicator toward the rear of the fifth wheel. See Fig. 10.9, View B.

      Pull the operating rod out. When the upper operating rod shoulder is outside the slot, raise the handle and place the shoulder of the upper rod against the plate casting, above the slot. See Fig. 10.9, View C.
The fifth wheel is now in the lockset position and is ready for uncoupling. As the tractor pulls away from the trailer the kingpin forces the jaw to rotate, contacting the lock. Continued rotation of the jaw forces the lock to move outward, and drops the upper rod back into the slot. See Fig. 10.9 View D. The wheel is now ready for coupling.

6.3 Jost: Pull the retractable handle out, then secure it in the open position with the catch.

7. Release the tractor parking brake then drive out slowly, allowing the trailer to slide down the fifth wheel and pick-up ramps.

Air-Actuated Uncoupling

An air-actuated kingpin release valve is optional with all fifth wheels. See Fig. 10.10.

NOTE: In the event of an air system failure, air-actuated kingpins can be manually released following the instructions for manual unlocking.

Once the kingpin release valve has been pulled the kingpin lock is released. The vehicle MUST NOT be driven with the trailer until the trailer has been uncoupled and coupled again. Failure to do so may result in separation of the trailer from the tractor, possibly causing serious personal injury or death.

Preparing the Trailer for Uncoupling

Before using the air valve to unlock a fifth wheel kingpin, prepare the trailer as follows.

1. Apply the tractor and trailer parking brakes.
2. Chock the trailer rear wheels.
3. Lower the trailer landing gear until the weight is removed from the fifth wheel.
4. Disconnect the tractor-to-trailer air lines and electrical cable. Plug the air lines to prevent dirt or foreign material from entering the lines.

Fontaine and Holland Fifth Wheels Air-Activated Kingpin Unlock

1. Verify that both the yellow parking-brake and red trailer-air supply knobs are out, the tractor and trailer parking brakes are set, and that the trailer is prepared for uncoupling.

NOTE: On Fontaine and Holland fifth wheels, if the tractor parking brake is not set, the air-actuated kingpin-release valve will not activate.
2. Pull and hold the kingpin release valve until the kingpin lock mechanism opens and locks in place. See Fig. 10.10.

3. Release the pull valve.

4. Release the tractor parking brake.

5. Drive out from under the trailer.

**Jost Fifth Wheels Air-Activated Kingpin Unlock**

1. Verify that both the yellow parking-brake and red trailer-air-supply knobs are out, the tractor and trailer parking brakes are set, and that the trailer is prepared for uncoupling.
NOTE: With Jost fifth wheels, if the trailer parking brake is not set the air-actuated valve will not activate.

2. Release the tractor parking brake.
3. Pull and hold the kingpin release valve, then drive forward slowly.
4. After the trailer has slid down the fifth wheel and pick-up ramps, release the pull valve.

**Fifth Wheel Slide**

**WARNING**

Adjust the fifth wheel slide correctly, and do not overload any tractor axle by incorrectly loading the trailer. Incorrect slide adjustment or improper axle loading could cause erratic steering and loss of vehicle control, possibly resulting in serious personal injury or death.

On sliding fifth wheel assemblies, the fifth-wheel plate is attached to rails that allow forward and rearward movement of the fifth wheel to optimally distribute the load across the axles. Slots are evenly spaced along the slide rails, and retractable wedges are positioned through the slots to hold the fifth wheel in the desired position.

The amount of load distribution on the front steering axle and rear drive axle(s) will have a direct effect on the steering control of the vehicle. Determine the front and rear axle weights by weighing the vehicle on scales designed for this purpose.

The maximum axle weight ratings are shown on the Federal Motor Vehicle Safety Standard (FMVSS) label or Canadian Motor Vehicle Safety Standard (CMVSS) label attached to the left rear door post of the tractor. The desired load on the axle is no less than 80 percent of the maximum axle weight rating, but in no instances should the axle load exceed the maximum axle weight rating given on the FMVSS or CMVSS label.

**Manual Slide Operation**

The manual slide feature is operated from the fifth wheel plate with a manual release handle using the following procedure. See Fig. 10.11.

1. Stop the tractor and trailer in a straight line on level ground. Pull the red trailer air supply knob to apply the trailer parking brakes.
2. Apply the tractor parking brake, then release the sliding mechanism using the appropriate method for the fifth wheel manufacturer.
   2.1 **Fontaine**: Lift the slide release pull handle to disengage it from the guide plate. Then, pull out the handle until it is in the unlocked position and can be positioned against the guide plate to hold it out. The
handle will stay in the unlocked position until it is manually disengaged from the guide plate. See Fig. 10.12.

2.2 Holland: Pull the operating rod out. Make sure both side plungers have released. See Fig. 10.13.

3. Lower the trailer landing gear just enough to remove the weight from the tractor.

4. Chock the front and rear of the trailer tires to prevent the trailer from moving.

5. Release the tractor parking brakes, then slowly move the tractor forward or backward until the fifth wheel is in the desired location.

**NOTICE**

When moving the fifth wheel to the desired position, be sure the trailer landing gear will not at any time come in contact with the tractor frame or other components. Make sure that the front of the trailer will not come in contact with the rear of the cab or with other components if they extend beyond the rear of the cab.

**WARNING**

Check that the locking wedges have seated in the slots. Failure to achieve complete lockup may allow disengagement of the tractor from the trailer, possibly resulting in serious personal injury or death.

6. Apply the tractor parking brakes, then lock the sliding member in position using one of the following methods:

6.1 Fontaine: Disengage the slide release pull handle from the guide plate. The slide release pull handle is spring-loaded in the locked position and will seek the locked position when disengaged from the guide plate. After the slide release pull handle returns to the fully locked position, visually and physically check the locking wedges to make sure they are fully inserted into the slots in the slide rails. Make sure the handle is locked in position against the guide plate.

6.2 Holland: Raise the operating rod so that it is free to move inward. Make sure that the lock pins have seated in the base plate rail holes and the operating rod moves into the locked position.

NOTE: The fifth wheel may need to be moved slightly to enable the locking wedges to enter the fully locked position.
Air Slide Operation

The slide feature may be operated with an air switch mounted in the dash, that operates an air cylinder that locks and unlocks the slide. See Fig. 10.14.

1. Set the air-slide switch to UNLOCK. See Fig. 10.14
   Ensure the locking plungers have released. See Fig. 10.15.
   For Jost fifth wheels, the mechanism activates as shown in Fig. 10.16.
2. Lower the trailer landing gear just enough to remove the weight from the tractor.

3. Pull the red trailer-air-supply knob to set the trailer-parking brakes.
4. Slowly move the tractor forward or backward until the fifth wheel is in the desired location.

**NOTICE**

Ensure the trailer landing gear does not come in contact with the tractor frame or other components, and that the front of the trailer will not come in contact with the rear of the cab or other components if they extend beyond the rear of the cab.

5. Apply the tractor parking brakes.

**WARNING**

Check that the locking wedges have seated in the slots. Failure to achieve complete lockup may allow disengagement of the tractor from the
trailer, possibly resulting in serious personal injury or death.

6. Set the air-slide switch to LOCK. Visually inspect the locking wedges or plungers to make sure that they are fully inserted in the slide rail slots. Verify that the plungers have engaged by tugging the tractor forward while the trailer brakes are locked and the wheels are chocked.

NOTE: The fifth wheel may need to be moved slightly to enable the locking wedges to fully lock.
11

Pretrip and Post-Trip Inspections and Maintenance

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Pretrip and Post-Trip Maintenance Procedures ........................................... 11.3
Pretrip and Post-Trip Inspections and Maintenance

Pretrip and Post-Trip Inspection Checklists

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

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

Use the inspection checklists to ensure that vehicle components are in good working condition before each 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.

NOTE: Procedure reference numbers in the checklists reference the corresponding detailed instructions found under the pretrip and post-trip maintenance procedures.

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

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 Business Class® M2 Workshop Manual for procedures and specifications, and see the Business Class® M2 Maintenance Manual for lubricant recommendations, specifications, and maintenance intervals.

See Table 11.1 for a list of procedures that should be performed daily, before the first trip.

See Table 11.2 for a list of procedures that should be performed weekly, post-trip.

See Table 11.3 for a list of procedures that should be performed monthly, post-trip.

IMPORTANT: Before performing any checks, apply the parking brake and chock the tires.
<table>
<thead>
<tr>
<th>Procedure Performed (check off)</th>
<th>Daily Pretrip Inspections/Checks</th>
<th>Procedure Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>Drain manually drained air reservoirs (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>Check</td>
<td>surge tank coolant; and, if equipped, coolant for hybrid cooling system</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, connections, and fuel level</td>
<td>D8</td>
</tr>
<tr>
<td>Check</td>
<td>fuel/water separator</td>
<td>D9</td>
</tr>
<tr>
<td>Inspect</td>
<td>natural gas fuel system, if equipped</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>__________</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>Inspect</td>
<td>hub oil seals and lubrication levels</td>
<td>D22</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>D23</td>
</tr>
<tr>
<td>Inspect</td>
<td>air brake lines</td>
<td>D24</td>
</tr>
<tr>
<td>Inspect</td>
<td>slack adjusters</td>
<td>D25</td>
</tr>
<tr>
<td>Check</td>
<td>air brake system operation</td>
<td>D26</td>
</tr>
<tr>
<td>Check</td>
<td>Bendix Hydro-Max® Power Booster, if equipped</td>
<td>D27</td>
</tr>
<tr>
<td>Inspect</td>
<td>frame rails (missing bolts) and 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>Inspect</td>
<td>seat belts and tether belts</td>
<td>D28</td>
</tr>
<tr>
<td>____</td>
<td>Remove chocks and test service brakes</td>
<td>D29</td>
</tr>
</tbody>
</table>

Inspector________________________ Date_____________________

Table 11.1, Daily Pretrip Inspection and Maintenance Checklist
Procedure Performed
(check off) Weekly Post-Trip Inspections/Checks Procedure Reference

Inspect _______ manually drain air reservoirs that are equipped with automatic drain valves —
Inspect _______ batteries and battery cables W1
Check _______ wheel bearing lubricant level W2
Inspect _______ steering components W3
Check _______ serpentine drive belt condition W4
Check _______ V-belt tension W5
Inspect _______ seat belts and tether belts W6
Inspector___________________________________________________ Date ________________

Table 11.2, Weekly Post-Trip Inspection and Maintenance Checklist

Procedure Performed
(check off) Monthly Post-Trip Inspections/Checks Procedure Reference

Inspect _______ clean the battery terminals M1
Inspect _______ radiator hoses and heater hoses M2
Check _______ fluid level in the hydraulic clutch reservoir (if applicable, and if necessary, fill with DOT 4 brake fluid) —
Check _______ steering wheel play M3
Check _______ outer surfaces of the hood and body (for visible surface breaks and damage) —
Check _______ hood tilt damper (attached at both ends) —
Inspect _______ brake lining wear M4
Inspect _______ driveshaft —
Inspect _______ natural gas fuel system leak test, if equipped M5
Inspect _______ drain the CNG high-pressure fuel filter housing, if equipped M6
Inspector___________________________________________________ Date ________________

Table 11.3, Monthly Post-Trip Inspection and Maintenance Checklist

Pretrip and Post-Trip Maintenance Procedures

Daily Pretrip Inspection and Maintenance

Whenever equipment requires adjustment, replacement, and/or repair, see the Business Class® M2 Workshop Manual for procedures and specifications. Specific references to the manual will be found where appropriate.

1. Drain manually drained air reservoirs.

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

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

WARNING

When draining the air reservoir, do not look into the air jets or direct them 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 engine coolant levels in the radiator surge tank, and, if equipped, the reservoir for the hybrid cooling system.

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

For natural gas vehicles, use only Fleetguard ES Compleat™ EG Premix 50/50 engine coolant.
For vehicles equipped with a hybrid cooling system, the coolant should be approximately 1.5 inches (4 cm) below the top of the reservoir for this system. If the coolant is low, add a 50/50 mixture of water and the type of antifreeze specified for your vehicle.

**CAUTION**

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

4. Inspect the radiator and charge air cooler.

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

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

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 On vehicles equipped with air conditioning, 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 Business Class® M2 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.
Pretrip and Post-Trip Inspections and Maintenance

**CAUTION**

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

6.1 Check the intake-air restriction indicator (if mounted in the air intake system).

6.2 Replace the primary filter element in the air cleaner (see Fig. 11.2) if the yellow signal stays locked at 25 inH₂O for Caterpillar engines or 20 inH₂O for Mercedes-Benz engines. See Group 09 of the Business Class® M2 Workshop Manual for filter element replacement instructions.

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

6.3 Inspect the secondary or safety filter element in the air cleaner when replacing the primary element, and replace it when clogged or dirty. This element should be replaced with every third primary element replacement.

6.4 Check the engine air intake piping from the air cleaner to the engine intake. Inspect the piping for loose connections, cracks, torn or collapsed hoses, punctures, and other damage. Tighten loose connections, and have damaged components replaced. Make sure the piping system is airtight so that all of the intake air passes through the air cleaner.

7. **Check the engine oil level.**

If the oil level is at or below the minimum fill (or "add") mark on the dipstick, add enough oil to maintain the level between the minimum fill (or "add") and the maximum fill (or "full") marks on the dipstick. See Fig. 11.3. Engine lube oil must have a sulfated ash level less than 1.0 wt %; currently referred to as CJ-4 oil. Use the proper SAE viscosity rating for the temperature and time of year.

For natural gas vehicles, use only Exxon Bus- gard® Geo 15W-40 natural gas engine oil. Bus- gard Geo engine oil with an SAE grade of 15W-40 has multiple benefits in natural gas vehicles, including improved cold-weather starting and pumping, and reduced oil consumption.

CAUTION

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.

8. Inspect the fuel tanks, fuel lines, and connections for leaks, and check the fuel level in the fuel tank(s).
Pretrip and Post-Trip Inspections and Maintenance

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 Business Class® M2 Workshop Manual, or take the vehicle in 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 loss of engine power and reduced vehicle control.

8.5 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.

**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) 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.

8.6 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.

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

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

9. If equipped with a fuel/water separator, check for water. Drain any water found. Check the fuel/water separator for leaks and contaminants.

9.1 Place a suitable container under the fuel/water separator.

9.2 Check the water level in the sight bowl, if equipped, and loosen the filter vent at the top of the separator.

9.3 Drain the water by loosening the valve at the bottom and allowing the water to run out. Close and tighten the valve finger-tight.

9.4 Close and tighten the filter vent at the top of the separator.

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.

10. Inspect all natural gas fuel system components, if equipped, for damage or leaks. Replace components as necessary.

10.1 Inspect fuel tanks for dents, scratches, gouges, or other signs of damage. Inspect the fuel lines and connections for leaks.

10.2 Check that the fuel tanks are securely mounted. Look for signs of abrasion between components.

CNG Fuel System: Ensure that the CNG fuel cylinder storage box is secured to the frame. Inspect for any signs of looseness.

LNG Fuel System: Ensure that the LNG fuel tank is secured to the mounting brackets and that the mounting brackets are secured to the frame. Inspect for any
signs of looseness. Ensure all rubber isolator straps are secure around the LNG fuel tank.

10.3 Check for the presence of all required decals. Natural gas decals should be present in the following locations:
- Left front bumper
- End-of-frame crossmember
- LNG fuel tank fill port (maximum psi), if equipped

10.4 Check for the presence of all necessary vent caps on pressure relief valves and devices.

CNG Fuel System: Check for the presence of blue caps on all pressure relief devices. Each fuel cylinder is equipped with two caps (one on each end), which are visible on the back of the CNG fuel cylinder storage box. One cap is located on the pressure relief valve on the inboard side of the CNG fuel box, next to the fuel outlet line. If any blue caps are missing, remove the vehicle from service and have the fuel system inspected by a qualified technician.

LNG Fuel System: Check for the presence of a red cap on the secondary relief valve. If the red vinyl cap is missing from the secondary relief valve (Fig. 11.4, Item 4), remove the vehicle from service and have the fuel system inspected by a qualified technician.

10.5 Inspect all plumbing components, including the fuel shutoff valve(s), primary and secondary relief valves, and the LNG vapor shutoff and excess flow valves, if equipped, for signs of damage or leaks. See Fig. 11.4 or Fig. 11.5.

Inspect the fuel fill fitting for signs of damage or leaks.
Inspect all lines for signs of leaks or damage, and check all threaded connections.

10.6 Inspect all fuel gauge components for signs of leaks or damage. Inspect the LNG fuel level sender cable and wiring, if equipped.

10.7 Inspect all coolant hoses for signs of chafing, kinks, or leaks. The LNG fuel system utilizes coolant hoses between the engine and the vaporizer, while the CNG fuel system utilizes coolant hoses between the engine and the pressure regulator inside the fuel panel.

10.8 If equipped with an LNG fuel system, check the LNG fuel tank pressure gauge to ensure that pressure is within the normal range of 120 to 150 psi (827 to 1034 kPa). In the unlikely event that tank pressure exceeds 230 psi (1586 kPa) and the pressure relief valve does not open automatically, vent the tank immediately.

10.9 Inspect the LNG vaporizer, if equipped, for signs of damage or leaks. See Fig. 11.6. Inspect the vaporizer mounting brackets for signs of looseness.
Inspect the LNG vaporizer overpressure regulator, if equipped, for signs of damage or leaks.

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

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

Inspect the shock absorbers for loose fasteners and leaks.

Tighten all loose fasteners and have any component(s) replaced that are worn, cracked, or otherwise damaged.

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

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

Check the condition of the windshield wiper arms and blades.

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

Inspect the wiper blades for damage and deteriorated rubber.

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

Replace damaged or deteriorated wiper blades.

**WARNING**

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

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.

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

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).

**NOTE:** 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.

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 ECU, 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 2 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.

18. Make sure all the exterior lights are working properly.

Check that all the lights and reflectors are clean. See Fig. 11.7.

18.1 Check that the brake lights, taillights, headlights, parking lights, turn signals, marker lights, identification lights, road lights (if so equipped), and front clearance lights are working properly and are clean.
Pretrip and Post-Trip Inspections and Maintenance

**WARNING**

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

**IMPORTANT:** The load and cold inflation pressure must not exceed the rim or wheel manufacturer's recommendations, even though the tire may be approved for a higher load inflation. Some rims and wheels are stamped with a maximum load and maximum cold inflation rating. If they are not stamped, consult the rim or wheel manufacturer for the correct tire inflation pressure for the vehicle load. If the load exceeds the maximum rim or wheel capacity, the load must be adjusted or reduced.

**CAUTION**

A weekly pressure loss of 4 psi (28 kPa) or more in a tire may indicate damage. The tire should be inspected and, if necessary, repaired or replaced.

18.2 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.**

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 the wheel for proper lockring and side-ring seating, and possible wheel, rim, 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.

![Fig. 11.7, Exterior Lights](image)

**NOTE:** The parking lights, front clearance lights, and taillights all function as turn signals.

1. Utility Light  
2. Identification Light  
3. Marker Lights  
4. Front Clearance Light  
5. Headlight Low Beam  
6. Headlight High Beam  
7. Parking Light  
8. Road Light

**WARNING**

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

**IMPORTANT:** The load and cold inflation pressure must not exceed the rim or wheel manufacturer's recommendations, even though the tire may be approved for a higher load inflation. Some rims and wheels are stamped with a maximum load and maximum cold inflation rating. If they are not stamped, consult the rim or wheel manufacturer for the correct tire inflation pressure for the vehicle load. If the load exceeds the maximum rim or wheel capacity, the load must be adjusted or reduced.

**CAUTION**

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. **Inspect each tire for wear, bulges, cracks, cuts, penetrations, and oil contamination.**

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 or rim nuts for indications of looseness. Examine each rim and 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. 11.8 and Fig. 11.9.

21.2 Examine the rim and wheel assembly components (including rims, rings, flanges, studs, and nuts) for cracks, or other damage.

See Group 33 or Group 35 of the Business Class<sup>®</sup> M2 Workshop Manual for service procedures on the studs and hubs, and see Group 40 in the same manual for wheel and tire servicing, or take the vehicle to an authorized Freightliner dealer.

**WARNING**

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

21.3 Have broken, cracked, badly worn, bent, rusty, or sprung rings and rims replaced. Be sure that the rim base, locking, and side ring are matched according to size and type.

21.4 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. 11.10 for 10-hole wheels and the tightening pattern in Fig. 11.11 for 8-hole wheels. See Group 40 of the Business Class<sup>®</sup> M2 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. Use the recommended torque values and follow the proper tightening sequence.

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

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

If needed, fill the hubs to the level indicated on the hub cap. See Group 35 of the Business Class<sup>®</sup> M2 Maintenance Manual for recommended lubricants.

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

23. Inspect the air brake chamber and the air brake chamber pushrods.

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**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.

23.1 Check that the air brake chamber is mounted securely on its mounting bracket, and that there are no loose or missing bolts.

23.2 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.

23.3 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 Business Class® M2 Workshop Manual.

CAUTION

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.

23.4 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 Business Class® M2 Workshop Manual to replace any damaged parts.
Pretrip and Post-Trip Inspections and Maintenance

**DANGER**

Do not loosen or remove the parking brake clamp ring for any purpose. 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 Business Class® M2 Workshop Manual.

23.5 On all parking brake installations, make sure the end cover cap or dust plug is securely snapped into place. See Fig. 11.12.

23.6 Check for rusted connections, missing snap rings, and damaged camshaft grease seals. Have damaged or missing parts repaired or replaced.

24. Inspect the air brake lines.

24.1 Check the clearance between the hoses and the exhaust manifold or other hot spots. Excessive heat will cause material in 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.

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

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

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

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

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

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

24.7 Check for kinked or twisted hoses. A seven-percent twist in the hose can reduce its life by up to 90 percent. A twisted hose under pressure tends to untwist, which may loosen the fitting. Reconnect hoses that are twisted.

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

24.8 Check for rusted connections, missing snap rings, and damaged camshaft grease seals. Have damaged or missing parts repaired or replaced.

NOTE: The front brake lines flex continuously in vehicle operation, so they require special examination. Give particular attention to the areas near where they connect to the front air brake chambers. This inspection requires two people, one in the driver seat.
and another to inspect the brake line connections at the wheels.

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

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

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

25. Inspect the slack adjusters.

25.1 Meritor Slack Adjusters: Check the boot for cuts, tears, or other damage. Have it replaced if necessary.

25.2 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. 11.13.

25.3 Haldex Slack Adjusters: Inspect each slack adjuster and anchor strap for damage. See Fig. 11.14. Have any damaged components replaced.

26. Check the air brake system for proper operation.

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

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

26.2 Check the air pressure buildup time as follows.

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

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

Check the air leakage in the system as follows.

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

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

If leakage exceeds the limits shown in Table 11.4, repair all areas of leakage before driving the vehicle.

<table>
<thead>
<tr>
<th>Description</th>
<th>Air Leakage in psi (kPa) Per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Released</td>
</tr>
<tr>
<td>Truck or Tractor Only</td>
<td>2 (14)</td>
</tr>
<tr>
<td>Truck or Tractor w/Single Trailer</td>
<td>3 (21)</td>
</tr>
<tr>
<td>Truck or Tractor w/Two Trailers</td>
<td>5 (35)</td>
</tr>
</tbody>
</table>

Table 11.4, Maximum Allowable Service Brake Air Leakage

27. Check the operation of the Bendix Hydro-Max® brake booster, if equipped, as follows.

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

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

28. Inspect the seat belts and tether belts.

**WARNING**

Inspect and maintain seat belts. When any part of a seat belt system needs replacement, the entire seat belt must be replaced, both retractor and buckle side. Any time a vehicle is involved in an accident, and the seat belt system was in use, the entire vehicle seat belt system must be replaced before operating the vehicle. Do not attempt to modify the seat belt system; doing so could change the effectiveness of the system. Failure to replace worn or damaged seat belts, or making any modifications to the system, may result in personal injury or death.
28.1 Check the web for fraying, cuts, extreme dirt and dust, or for severe fading from exposure to sunlight, especially near the buckle latch plate and in the D-loop guide area.

28.2 Check operation of the buckle, latch, Komfort Latch or Sliding Komfort Latch (if equipped), web retractor, and upper seat belt mount on the door pillar. Check all visible components for wear or damage.

28.3 Check the seat belt and tether belt connection points and tighten any that are loose.

29. 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

**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. Inspect the batteries and battery cables.
   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 Group 35 of the Business Class® M2 Maintenance Manual, for recommended lubricants.

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

3. Examine the steering components.
   See Fig. 11.15. If repairs are needed, see Group 46 of the Business Class® M2 Workshop Manual for instructions, or take the vehicle to an authorized Freightliner dealer.

---

1. Steering Gear Mounting Bolt
2. Pitman Arm Pinch Bolt Nut
3. Drag Link Nut

**Fig. 11.15, Steering Gear Fasteners**

3.1 Check the mounting bolts and pitman arm nut for tightness.
3.2 Check the drag link nuts for missing cotter pins.
3.3 Inspect the steering drive shaft and steering linkage for excessive looseness, or other damage.
3.4 Tighten loose nuts and have damaged parts replaced as needed.
4. **Check the condition of the 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 *Business Class® M2 Workshop Manual.*

   **NOTICE**
   Do not drive with a serpentine belt that is visibly worn or damaged. If it fails, the lack of coolant flow could rapidly cause damage to engine components.

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. 11.16.** 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 *Business Class® M2 Workshop Manual* for instructions, or take the vehicle to an authorized Freightliner dealer.

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**Monthly Post-Trip Inspection and Maintenance**

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**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.

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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 steering wheel for excessive play.**
3.1 Start the engine. With the front tires straight ahead, turn the steering wheel until motion is observed at the front wheels.

3.2 Align a reference mark on a ruler, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels.

3.3 Check the lash (free play) at the rim of the steering wheel. See local/federal regulations for acceptable ranges of lash.

If there is excessive lash, check the steering system for wear or incorrect adjustment of the linkage and steering gear before operating the vehicle.

4. Check the brake lining wear on all vehicles, including those with automatic slack adjusters. Proper brake operation is dependent on periodic maintenance and inspection of the brake linings.

4.1 Check that brake linings are free of oil and grease.

4.2 Inspect the thickness of the brake linings. If the axle assembly is equipped with a dust shield or backing plate, remove the inspection plugs. If any brake linings are worn to less than approximately 1/4 inch (6.4 mm) at the thinnest point, have the linings replaced on all brake assemblies on that axle. See Group 42 of the Business Class® M2 Workshop Manual for lining replacement instructions and camshaft end-play inspection.

4.3 Check the brake drums for wear and cracks.

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

5. Leak test the natural gas fuel system, if equipped.

Use a methane detector to test all fuel system components, joints, and fittings for leaks. A bubble solution can be used to pinpoint the exact location of leaks.

Replace any leaking or damaged fuel tanks and fuel lines; repair or replace leaking or damaged fittings.

6. Drain the CNG high-pressure fuel filter housing, if equipped.

6.1 Purge the CNG fuel lines by closing the CNG fuel cylinder shutoff valves. Start the engine and let it idle until the fuel lines are empty and the engine stops.

Gauges on the fuel panel should now read at or near 0 psi (0 kPa).

6.2 Close the manual fuel shutoff valve on the fuel panel.

6.3 Remove the two capscrews that secure the access cover to the fuel panel, then remove the access cover. See Fig. 11.17. Save the capscrews for installation.

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Fig. 11.17, CNG Fuel Panel Assembly
6.4 Slowly open the bleed valve on the manifold to relieve remaining fuel pressure within the system. See Fig. 11.18.

6.5 Put a clean receptacle under the filter assembly.

6.6 Using an 11/16-inch wrench, remove the drain plug from the filter bowl.
When all liquid has drained, install and tighten the drain plug on the filter bowl.

6.7 Close the bleed valve on the manifold and open the manual fuel shutoff valve on the fuel panel.
Open the fuel cylinder shutoff valves.

6.8 Use a methane detector to leak test all fuel system components between the fuel cylinders and the solenoid valve. A bubble solution can be used to pinpoint the exact location of leaks.
Repair or replace any leaking components.

6.9 Using the two capscrews removed in sub-step 6.3, install the access cover on the fuel panel.

**Fig. 11.18, CNG Fuel Panel Components**

**IMPORTANT:** Some pressure may remain in the fuel system between the solenoid valve and the engine. Use caution when loosening fittings, as a small amount of gas may leak out.
Cab Appearance

Cab Washing and Polishing ................................................................. 12.1
Care of Fiberglass Parts ................................................................. 12.1
Care of Chrome Parts ................................................................. 12.1
Care of Exterior Lights ................................................................. 12.1
Dashboard Care ........................................................................ 12.1
Vinyl Upholstery Cleaning .......................................................... 12.2
Velour Upholstery Cleaning ......................................................... 12.2
Cab Washing and Polishing

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 finish of your new vehicle, follow these guidelines carefully:

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

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

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

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.

**CAUTION**

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 Care

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

**CAUTION**

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

**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, 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 damp cloth, using 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.
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</table>
Hazard Warning Lights

The hazard warning light flasher (Fig. 13.1) is part of the multifunction turn signal switch. It is a red rocker switch located on the top of the multifunction switch module.

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

Fire Extinguisher

A fire extinguisher is located in the cab by the driver’s door.

Emergency Kit, Optional

An optional emergency kit is located in the cab. The kit includes one or more of the following: a first aid kit, a reflective vest, a triangular reflector, a flare kit, and (on vehicles with a Davco fuel/water separator) a spin-on fuel filter element.

If there is an emergency while driving, cautiously pull off the road. Turn on the hazard warning lights. Place the flares and reflector along the side of the road to alert other drivers that an emergency situation exists.

WARNING

Use extreme care when placing flares in emergency situations that involve exposure to flammable substances such as fuel. An explosion or fire could occur causing serious personal injury.

Emergency Filter Replacement, Davco

If the filter cover on the Davco fuel/water separator is broken, it will not be possible to operate the vehicle. A standard spin-on filter will correct this problem.


To replace the filter on all Davco fuel/water separators, follow these procedures:

1. Drain the fuel until it is below the level of the filter collar. See Fig. 13.2 for the model 232/233 fuel/water separator and Fig. 13.3 for the model 382 fuel/water separator.

2. Remove the filter vent and vent seal.

NOTE: The filter vent and vent seal are not needed in the emergency replacement. They should be retained for later installation at the time when the filter cover is replaced.

3. Remove the filter collar using channel-lock pliers.

4. Remove the filter cover, filter cover seal and spring. Retain them for later assembly.

5. Remove the filter element and dispose of it properly.

6. Install the standard engine spin-on filter (included in the emergency kit) on the threaded stud.

NOTE: Remove the rubber grommet from the stud.

7. Install the filter cover, filter cover seal, and spring, as removed.

8. Install the filter collar over the filter cover. Tighten the filter collar finger-tight.

9. Start the engine and run it at increased rpm for one minute to purge air from the fuel lines.
Emergency Starting With Jumper Cables

When using jumper cables, follow the instructions below.

**WARNING**

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

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

NOTE: On vehicles equipped with an optional jump-start post, attach the positive cable clamp to that post instead of to the battery.

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

2. To gain access to the batteries, open the battery compartment. See Fig. 13.4. For detailed instructions, see Chapter 2.

Always connect the battery, jumper cables, and charger correctly (positive-to-positive and negative-to-negative). Connecting a charging device backwards (positive-to-negative) will blow fuses that power the bulkhead module (BHM) and...
chassis module (CHM), and the devices they control will not work.

3. Connect an end of one jumper cable to the positive terminal of the booster battery (or jump-start post if equipped), and connect the other end of the cable to the positive terminal of the discharged battery (or jump-start post if equipped). See Fig. 13.5.

4. Connect one end of the second jumper cable to the negative terminal of the booster battery, and connect the other end of the cable to a ground at least 12 inches (300 mm) away from the batteries of the vehicle needing the start. The vehicle frame is usually a good ground. Do not connect the cable to or near the discharged batteries.

5. Start the engine of the vehicle with the booster batteries, and let the engine run a few minutes to charge the batteries of the other vehicle.

6. Attempt to start the engine of the vehicle with the batteries receiving the charge. Do not operate the starter longer than 30 seconds, and wait at least two minutes between starting attempts to allow the starter to cool.

7. When the engine starts, let it idle a few minutes.

8. Disconnect the grounded cable from the frame or other non-battery location, then disconnect the other end of the cable.

9. Disconnect the remaining cable from the newly charged battery (or jump-start post if equipped) first, then disconnect the other end.

In an Emergency

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

On vehicles with Mercedes-Benz AGS transmissions, make sure the current gear indicator displays "N" before starting the vehicle. If the transmission starts in gear, it could cause an accident resulting in death, serious personal injury, or property damage.

5. Start the engine of the vehicle with the booster batteries, and let the engine run a few minutes to charge the batteries of the other vehicle.

6. Attempt to start the engine of the vehicle with the batteries receiving the charge. Do not operate the starter longer than 30 seconds, and wait at least two minutes between starting attempts to allow the starter to cool.

7. When the engine starts, let it idle a few minutes.

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

8. Disconnect the grounded cable from the frame or other non-battery location, then disconnect the other end of the cable.

9. Disconnect the remaining cable from the newly charged battery (or jump-start post if equipped) first, then disconnect the other end.
10. Close the battery compartment. For detailed instructions, see Chapter 2.

Towing

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

**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.

Front Towing Hookup

1. Disconnect the battery ground cables.

**CAUTION**

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 both drive axle shafts. On dual drive axles, if the vehicle is to be lifted and towed, remove only the rearmost drive axle shafts.

   On vehicles equipped with an air fairing, remove both the forward and rearmost drive axle shafts if there is insufficient towing clearance.

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

**CAUTION**

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

4. On dual drive axles, if the vehicle is to be lifted and towed, chain the forward rear-axle assembly to the vehicle frame. Use protection to keep the chains from damaging the frame.

5. Remove the bumper end caps and chrome bumper (if equipped).

**CAUTION**

Do not pass a sling (for example, a rope or chain) from one tow hook to another to fasten for towing (see Fig. 13.6). Known as reeving, this practice is not permissible in most industrial applications of towing and hoisting. Reeving can overload the hooks and result in damage to the vehicle.

6. 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.

7. Lift the vehicle and secure the safety chains. If extra towing clearance is needed, remove the front wheels.

8. 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.

9. 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 brakes and remove the chocks.

Rear Towing Hookup

**CAUTION**

Using a rear towing hookup on a vehicle equipped with a roof fairing could cause damage to the cab structure.

1. Place the front tires straight forward and secure the steering wheel in this position.

2. Disconnect the battery ground cables.
Failure to protect the frame rails from the chains could cause damage, leading to eventual frame failure.

3. On dual drive axles, using protection to keep the chains from damaging the vehicle frame, chain the forward-rear drive axle to the frame.

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 clearance is needed, remove the bumper extension if equipped.

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

Fire in the Cab

The incidence of fire in medium-duty trucks is rare, according to data from the National Highway Traffic Safety Administration. Federal Motor Vehicle Safety Standard #302 limits the flammability of specified materials used inside the cab, but despite this, most materials will burn. The cab of this vehicle contains urethane foam, which is of concern in this respect.

Urethane foam is flammable! Do not allow any flames, sparks, or other heat sources such as cigarettes or light bulbs to contact urethane foam. Urethane foam in contact with such heat sources could cause a serious, rapid fire, which could result in death, severe burns, or gas poisoning, as well as damage to the vehicle.

In Case of a Cab Fire

As quickly as possible, bring the vehicle to a safe stop, apply the parking brake, turn off the ignition, and get out of the vehicle.
Headlight Aiming

Preliminary Checks ................................................. 14.1
Checking Headlight Aim ........................................... 14.1
Adjusting Headlight Aim ......................................... 14.2
Preliminary Checks

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

- Remove large amounts of mud or ice from the underside of the fenders.
- Check the springs for sagging or broken leaves.
- Check the suspension for proper functioning of the leveling mechanism. On cabs with air suspensions, make sure that the height is properly adjusted.
- Check for damage to the hood and hinge assembly. Repair as necessary.
- With the vehicle unloaded, check that the tires are inflated to the recommended air pressure.
- Clean the headlight lenses. Clean by hand only, using a flannel cloth with mild, non-caustic soap or detergent, and water.

CAUTION

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.

Checking Headlight Aim

1. Park the vehicle on a level surface 25 ft (7.6 m) from a screen or wall that can be used for aiming the headlights. Shut down the engine, apply the parking brake, and chock the front tires. See Fig. 14.1.

NOTE: The low-beam headlight is the top bulb in the dual-beam assembly.

2. On each headlight, find the bulb center. See Fig. 14.2.

3. Measure the distance from the ground to the center of each low-beam bulb. Note those distances.

---

**Fig. 14.1, Headlight Aiming Screen or Wall**
4. On the screen or wall 25 ft (7.6 m) away, make the appropriate markings directly across from each headlight and at the same height as measured for the headlight.

5. Turn on the headlights to the low-beam setting. See Fig. 14.3 for the ideal and acceptable patterns for both headlights.

- If either or both headlights do not aim into the inner edges of the centerline, follow the adjusting procedure below.
- If both headlights come close to the inside of each headlight centerline (as shown), no further work is needed. Turn off the headlights and remove the chocks from the front tires.

## Adjusting Headlight Aim

1. Lift the flap over the rear end of the headlight bucket to expose the two plastic adjusting knobs on each headlight. See Fig. 14.4.

2. With the vehicle parked 25 ft (7.6 m) from the screen or wall, put the headlights on low beams, and turn both adjusting knobs the same amount, as needed to adjust the lights until the beam pattern meets the acceptable standard. Turn the knobs clockwise to raise the beam and counterclockwise to lower it.

NOTE: Blocking off each light is not necessary, but it can help to present a clearer beam pattern.

3. Remove the chocks from the front tires.
Hybrid Electric Vehicle (HEV) Overview

A hybrid electric vehicle (HEV) has both a diesel engine and an electric motor. Engine torque is augmented with electrical torque. The electric motor is powered by batteries, which are charged by regenerative braking and, on vehicles equipped with the ePTO option, the diesel engine.

The batteries cannot move the vehicle for long distances at highway speeds. In the event of a diesel engine failure, drive the vehicle to a safe location as quickly as possible.

Eaton Corporation developed and supplies the hybrid electric system for Freightliner Trucks. The primary system components are the hybrid drive unit (or "HDU", which includes the electric generator/motor and automated transmission), power electronics carrier (PEC), and the motor inverter/controller. Electric power take-off (ePTO) and auxiliary power generator (APG) components are optional on the HEV system.

Freightliner Trucks designed the stand-alone liquid cooling system required to support the operation of Eaton’s HEV system. Its primary system components are the electric water pump, reservoir/expansion tank, radiator, electric radiator fan, and coolant plumbing.

Body builders will develop the components for the PTO, the PTO plumbing, and a safety switch to prevent the diesel engine from starting when the hood is open.

Regenerative Braking

Regenerative braking reduces vehicle speed by converting some of the vehicle’s kinetic energy into electric energy to charge the hybrid system’s batteries. When the accelerator pedal is at idle while coasting, or the service brake is depressed to slow the vehicle, the hybrid system charges the batteries.

The regeneration will feel as if the brake is being lightly applied when you remove your foot from the accelerator pedal. The full power of the service brake is always available to the driver, and regenerative braking is automatically shut off during an ABS (anti-lock brake) event.

The Eaton Hybrid Control Unit will automatically shut off regenerative braking when the batteries are fully charged.

High-Voltage Safety Features

The HEV has high-voltage cables and a service switch on the PEC.

High-voltage cables are covered in orange insulation and conduit. Each high-voltage component is tagged with a warning or danger label.

IMPORTANT: The service switch on the PEC should only be used for an emergency shutdown, or when the service manual or troubleshooting guide calls for work on the high-voltage system. The service manual and troubleshooting guide for the hybrid electric system are available from www.roadranger.com.

The red service switch is located next to the high-voltage cable connections at one end of the PEC. Pushing in the red service switch will shut down the engine. The hybrid system will be disabled, and the high-voltage batteries in the PEC, though still live, are isolated in the PEC.

NOTE: The PEC may be mounted in an area with limited access.

For information on emergency shutdowns, see "Emergencies" in this chapter.

Cooling System

The HEV requires a liquid cooling system for the HDU, inverter, DC/DC Converter (if ePTO equipped), and APG (if equipped). The HEV’s cooling system is separate from the engine cooling system.

For coolant, use a mixture of 50 percent ethylene glycol and 50 percent water.

Electric Power Take-Off (ePTO)

The Electric Power Take-Off (ePTO) option provides standard hydraulic functions without continuous diesel engine operation. The PTO drive power is provided by the hybrid motor and hybrid batteries. When the hybrid batteries deplete, the diesel engine automatically starts to recharge them and provide PTO drive power. Once the batteries are fully charged, the engine shuts down automatically. Vehicles with the ePTO option are designed with a safety switch to ensure the diesel engine does not start when the hood is open.

A DC/DC converter is required for ePTO applications to convert high-voltage DC to 12-volt DC.
NOTE: To maintain a power supply from the vehicle’s low-voltage batteries, the alternator charges them when the vehicle is being driven.

Safety Precautions (HEV)

The HEV has high-voltage components, including 340-volt DC batteries and a 500-volt AC motor. Never cut high-voltage cables or connectors. Do not paint high-voltage cables.

Avoid direct pressure wash on high-voltage connections (PEC, DC/DC Converter) and the air intake and exhaust on the PEC.

Starting, and Engine Shutdown (HEV)

The Cranking System

The primary engine starter is the electric motor in the HDU, which cranks the engine very quickly. The back-up cranking system is the standard 12-volt starter on the engine. If the hybrid system is offline or the hybrid batteries are insufficiently charged, the vehicle will automatically use the 12-volt cranking system to start the engine.

Starting

1. Set the parking brake.
2. Place the key in the ignition, and turn it clockwise to the ON position to initiate power to the hybrid system.
   Wait for the gauges on the instrument panel to complete two sweeps (one from left to right, and one from right to left) and return to their normal ranges.
3. Ensure the transmission is in neutral. The gear display should display a solid "N".

   WARNING

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

4. Turn the key clockwise to the START position. The engine will crank after a brief delay. As soon as the engine starts, release the key, allowing it to return to the ON position. The engine will continue to run with the key in the ON position.
5. Apply the service brake, then release the parking brake.
6. With the service brake applied, press the desired mode on the shift control to put the vehicle into gear.
7. Slowly release the service brake.

NOTE: The vehicle may be powered by the electric motor or the diesel engine, depending on battery charge and the demand for driveline torque. If the electric motor alone is powering the driveline, the diesel engine will stay at idle.

Engine Shutdown

1. Place the transmission in neutral by selecting N on the shift control.

   IMPORTANT: The transmission must be in neutral for proper shutdown.
2. Set the parking brake.
3. Turn the key counterclockwise to the OFF position.

   NOTE: Intermittent noises such as clicking and transmission shifting may be audible from the transmission while it completes a self-test and shutdown.

Hybrid System Fault Lamps (HEV)

There are two lamps on the dashboard that indicate a hybrid system fault is active — the red STOP HYBRID lamp and the amber CHECK HYBRID lamp. See Fig. 15.1. When the red STOP HYBRID lamp is illuminated, do not drive the vehicle; have it towed to a Freightliner dealer or an authorized service center for repairs. When the amber CHECK HYBRID lamp is illuminated, the vehicle can still be driven, though it may operate without the assistance of the hybrid electrical system.
WARNING

After disabling the vehicle, power is maintained in the high-voltage electrical system for up to five minutes. Unprotected contact with any "live" high voltage components can cause serious injury or even death.

There are two options for performing an emergency shutdown. The preferred method is to turn off the ignition key. The other option is to disconnect the low-voltage (12-volt) vehicle batteries. In either case, the engine will shut down, dash lights will shut down, the hybrid electrical system will shut down, and the high-voltage batteries in the Power Electronics Carrier (PEC) will remain "live" but isolated in the PEC.

NOTE: If the service switch on the PEC is accessible, it may be pushed in to shut down the hybrid electrical system and isolate the "live" HEV batteries in the PEC.

In Case of an Accident or Fire

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

- Do not cut into or open the DC/DC converter.
- Do not cut into or open the inverter.

If it is necessary to remove occupants using cutting equipment, avoid high-voltage cables and the PEC.

Jumpstarting (HEV)

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

Towing (HEV)

When towing the vehicle, the output shaft of the transmission must not be allowed to spin or turn. If the vehicle is towed with the drive wheels still in contact with the road surface, the vehicle axle shafts or driveline must be removed or disconnected. See "Towing" in Chapter 13.
Natural Gas Vehicle

General Information .......................................................... 16.1
Safety Precautions .............................................................. 16.1
Fuel Tank Filling Procedures .................................................. 16.2
Gas Detection System .......................................................... 16.5
Engine Starting ................................................................. 16.9
Major Repair and Replacement of Parts ................................. 16.10
General Information

The Business Class® M2 can be equipped with a compressed natural gas (CNG) fuel system, or a liquefied natural gas (LNG) fuel system. CNG is made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure. LNG is created by condensing natural gas into a liquid by cooling it to approximately -259°F (-162°C).

When vaporized at ambient temperatures, natural gas is less dense than air, and it rises and disperses. However, LNG is initially heavier than air due to its cryogenic temperature. When released in large amounts, it may drop or pool on the ground before it’s temperature rises and the LNG vaporizes. Cold atmospheric conditions may prevent natural gas from dispersing quickly when released in large amounts.

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

CNG often contains an odor-producing chemical, while LNG does not have any odor. Users of natural-gas-fueled vehicles should never expect to detect natural gas leaks by scent.

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

A typical natural gas fuel system consists of:

- Fuel supply cylinders that store compressed gas at high pressure (CNG), or a tank that stores liquefied gas at an extremely low temperature (LNG).
- A vaporizer or heat exchanging device that changes LNG to gaseous form (LNG fuel systems only).
- Pressure relief and manual fuel shutoff valves.
- A filling connection with a check valve that prevents the gas from flowing back out of the fuel filling line.
- High-pressure and low-pressure fuel filters.
- A pressure control regulator that reduces the high fuel tank or cylinder pressure to the lower pressure needed for the engine.
- A fuel contents gauge that indicates the fuel supply in the tank or cylinders.

Safety Precautions

DANGER

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

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

- Do not start the engine if a natural gas leak is detected.
- Do not transfer CNG from one vehicle to another, as a buildup of static electricity could cause a spark and ignite the fuel.
- Avoid open flames or sparks near a natural gas vehicle.
- Cover eyes and exposed skin when working on a natural gas fuel system or fueling a natural gas vehicle.
- Permit no smoking or other ignition sources within thirty feet of a natural gas vehicle.
- Have CO₂ fire extinguishers (ABC minimum) located in a highly visible and easily accessible location.
- Always purge the fuel lines before performing maintenance or repairs on a natural gas fuel system. To purge the lines, close the manual fuel shutoff valve, and start the engine. Let the vehicle idle until the fuel lines are empty and the engine stops.
- Always use a natural gas detector to test the system for leaks, whether an odor is present or not. Routinely inspect the fuel filtering and regulating mechanisms, and the fuel lines. A bubble solution can be used to pinpoint the exact location of leaks.
- Always tighten fasteners and fuel connections to the required torque specification. Overtightening or undertightening could cause leaks.
- Close the fuel shutoff valve(s) before performing maintenance and repairs.
- Do not store a natural gas vehicle indoors for any extended period of time. Do not bring a natural gas vehicle inside indoors unless the
workshop is equipped with a methane detection and ventilation system.

**Fuel Tank Filling Procedures**

**CNG Vehicle Fueling**

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

CNG fuel cylinders cannot be filled to their full capacity of 3600 psi (24 800 kPa) in cooler weather. Since temperature change causes gas to expand and contract, less pressure in the cylinders on a cold day is equal to the same amount of gas at a higher pressure on a warm day. The fuel station dispenser has a temperature-pressure compensating device, which accounts for ambient temperature during fueling. See Table 16.1 for approximate full cylinder pressures at various temperatures.

<table>
<thead>
<tr>
<th>Temperature: °F (°C)</th>
<th>3000 psi (20 684 kPa) Set Point</th>
<th>3600 psi (24 821 kPa) Set Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 (37.8)</td>
<td>3415 (23 546)</td>
<td>4086 (28 172)</td>
</tr>
<tr>
<td>90 (32.2)</td>
<td>3276 (22 587)</td>
<td>3909 (26 952)</td>
</tr>
<tr>
<td>80 (26.7)</td>
<td>3138 (21 636)</td>
<td>3754 (25 883)</td>
</tr>
<tr>
<td>70 (21.1)</td>
<td>3000 (20 840)</td>
<td>3600 (24 813)</td>
</tr>
<tr>
<td>60 (15.6)</td>
<td>2861 (19 726)</td>
<td>3445 (23 752)</td>
</tr>
<tr>
<td>50 (10)</td>
<td>2723 (18 774)</td>
<td>3288 (22 670)</td>
</tr>
<tr>
<td>40 (4.4)</td>
<td>2584 (17 816)</td>
<td>3131 (21 587)</td>
</tr>
<tr>
<td>30 (-1.1)</td>
<td>2446 (16 865)</td>
<td>2973 (20 498)</td>
</tr>
<tr>
<td>20 (-6.7)</td>
<td>2307 (15 906)</td>
<td>2814 (19 402)</td>
</tr>
<tr>
<td>10 (-12.2)</td>
<td>2169 (14 955)</td>
<td>2655 (18 306)</td>
</tr>
<tr>
<td>0 (-17.8)</td>
<td>2031 (14 003)</td>
<td>2495 (17 202)</td>
</tr>
<tr>
<td>-10 (-23.3)</td>
<td>1893 (13 052)</td>
<td>2336 (16 106)</td>
</tr>
<tr>
<td>-20 (-28.9)</td>
<td>1755 (12 100)</td>
<td>2180 (15 031)</td>
</tr>
<tr>
<td>-30 (34.4)</td>
<td>1616 (11 142)</td>
<td>2024 (13 955)</td>
</tr>
<tr>
<td>-40 (-40)</td>
<td>1477 (10 184)</td>
<td>1868 (12 879)</td>
</tr>
</tbody>
</table>

Table 16.1, CNG Temperature/Pressure Compensation Values

Use the following steps to fuel a CNG vehicle.

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

**WARNING**

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

2. Ensure all fuel cylinder shutoff valves are open. See Fig. 16.1.

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**Table 16.1, CNG Temperature/Pressure Compensation Values**

**Fig. 16.1, CNG Fuel Cylinder Storage Box (5-cylinder system shown)**
3. Ensure the vehicle fuel system main shutoff valve is open.
4. Open the CNG fuel panel access door and remove the dust cap from the vehicle fuel fill port.
5. Ensure the O-ring is present inside the fuel fill port. If the O-ring has been dislodged or is missing, the station dispensing nozzle will not connect securely to the fill port.
6. Turn the selector knob on the service pump to the VENT position, if equipped.
7. Connect the quick coupling on the dispensing nozzle securely to the vehicle fuel fill port.
8. Turn the selector knob on the service pump to the FILL position, if equipped.

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

9. Switch on the service pump. A slight hissing noise may be heard as the fuel cylinders fill.
10. Watch the pressure gauge on the service pump. When the gauge reads approximately 3600 psi (24 800 kPa), or when the fill pressure stops climbing, the CNG cylinders are full. The service pump will shut itself down automatically. See Table 16.1 for pressure compensation values based on ambient temperatures.
11. Move the selector knob on the service pump to the VENT position, if equipped. A short hiss will be heard as a small amount of natural gas is vented into the hose.

**WARNING**

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

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

**LNG Vehicle Fueling**

The LNG fuel tank is designed to be filled from any LNG fuel source that has a 100 micron or finer fuel filter and a fuel delivery pressure between 120 and 225 psi (827 and 1551 kPa).

The LNG fuel tank is designed to be top-filled through a single hose with no vent return. As cold LNG is sprayed into the vapor space of the tank, the cold liquid condenses the vapor and creates space for itself inside the tank, eliminating any need to vent during the filling process.

The LNG tank is equipped with a small internal ullage tank for vapor space, which allows for fuel expansion and increases vehicle standby time. When an LNG tank is full, fuel can continue to flow into the ullage tank. However, if the ullage tank is completely filled during fueling, standby time will be reduced to zero and the primary relief valve will open almost immediately after fueling, allowing excess LNG vapor to escape. If fueling is stopped when the ullage tank is empty (i.e., the fuel tank has sufficient LNG vapor space to accommodate fuel expansion due to temperature increase), the vehicle will have approximately one week of standby time before venting will occur.

Use the following steps to fuel an LNG vehicle.

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

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

**WARNING**

Liquefied natural gas is a cryogenic liquid stored at approximately -259°F (-162°C). Cryogenic burns can be caused by coming into contact with the pressurized liquid stream, or by coming into contact with fuel system components that have been cooled to cryogenic temperatures. Always wear gloves and a face shield, and cover exposed skin when fueling.

2. Remove the fuel fill fitting dust cap. See Fig. 16.2.
3. Using compressed air, remove any dirt, debris, or water that may have collected in the fuel fill fitting and the station dispensing nozzle. Contaminants in the fuel system can cause drivability problems.

**WARNING**

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

4. Connect the station fueling nozzle to the tank fuel fill fitting.

5. Connect an electrical ground clamp and cable to the fuel tank.

**IMPORTANT:** An LNG tank which is first installed, or is on a vehicle that has not been operated in approximately ten days, is considered to be a hot tank. When fueling a hot tank, LNG entering the tank will immediately vaporize, causing tank pressure to spike above 250 psi (1724 kPa) and automatically shutting down the station fuel pump. To prevent the pump from shutting down, connect a vent line to the fill vent fitting on the LNG tank to capture escaping vapor, then open the shroud cover and open the vapor shutoff valve (Fig. 16.3, Item 2).

6. Open the station’s fill valve, if equipped, and start fueling. Monitor the flow or line pressure as filling progresses. When filling begins, line pressure will spike quickly until the vehicle tank cools down. The flow and pressure will then remain stable during the remainder of the filling procedure.

**IMPORTANT:** When fueling a hot tank, initially put 5 to 10 gallons (19 to 37 liters) of LNG in the tank and manually stop the fueling process. Drive the vehicle for 15 to 20 minutes to cool.
the tank and reduce tank pressure, then con-
tinue fueling the tank to full.

7. When the tank is full, the line pressure will rap-
idly spike and the flow rate will fall. When a pres-
sure rise or flow rate drop is observed, close the
station’s fill valve, if equipped.

NOTE: Do not over-fill an LNG tank. If the ul-
lage tank is completely filled during fueling, tank
standby time will be reduced to zero and the
primary relief valve will open almost immediately
after fueling.

8. Disconnect the station hose from the tank fuel fill
fitting.

9. Disconnect the electrical ground clamp and cable
from the fuel tank.

10. Install the dust cap on the tank fuel fill fitting.

Gas Detection System

A gas detection system is used in all Daimler Trucks
natural-gas-fueled vehicles. This system has a sen-
sor in the engine compartment and one in the cab,
both situated in high areas to detect natural gas
buildup as a result of leaks.

The AMGaDS III Plus is a natural gas detection sys-
tem. This device is meant to serve as a supplemen-
tal warning only. It is not intended to replace stan-
dard safety practices that should be conducted
around flammable gases.

IMPORTANT: To function properly, the gas de-
tection system must be powered at all times.
The gas detection system is directly powered by
the batteries, and can only be powered off by
disconnecting the batteries. When servicing a
natural-gas-fueled vehicle, disconnect the bat-
terries only when necessary, and do not leave
the batteries disconnected for extended periods
of time.

The lower flammability limit (LFL) is the smallest
amount of the gas that supports a flame when mixed
with oxygen and ignited. Zero percent (0%) LFL indi-
cates a gas-free atmosphere. One hundred percent
(100%) LFL indicates that gas concentration has
reached its lower flammability limit (5% gas in air by
volume). The red warning light and audible alarm
located in the overhead console activate when a sen-
sor detects gas fumes in concentrations above 50%
LFL, and should allow ample time to utilize safety
procedures. However, individuals with special needs
should review the system with a professional safety
engineer.

Alarm Procedure

Before operating the vehicle, the driver must be fa-
miliar with the procedures as shown on the interior
sticker on the overhead panel (Fig. 16.4) and the
exterior sticker on the door (Fig. 16.5).

![Image](Fig. 16.4, Interior Warning Sticker)

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IMPORTANT: If an audible alarm activates, do
not operate any electrical switch, including
lights. Avoid causing sparks and stay away from
arching switches and equipment. Do not use a
telephone, including cellular phones or any
types of portable communication or electronic
devices that have a battery.

If the vehicle is in motion when the audible alarm
activates, bring it to a safe stop, shut down the en-
gine, and exit the vehicle. *Do not open the hood.*

If outside the vehicle when the audible alarm acti-
vates, *do not open the cab door or hood.*

In the event of an audible alarm, immediately follow
these procedures, as allowed by conditions:

1. Immediately shut off all engines. Extinguish any
cigarettes, pilot lights, flames, or other sources of
ignition in the area and adjacent areas.
2. Manually close all fuel shutoff valves, including those on the LNG tank or CNG cylinders.

3. If the vehicle is indoors (as in a service shop), immediately open windows and doors to provide extra ventilation to the area. Do not start the engine or any other type of equipment until the gas leak is corrected and the area cleared of natural gas.

4. Evacuate the area.

5. Check the fuel lines, LNG tank/CNG cylinders, and fittings to locate the leak. After the area is cleared of natural gas and the alarm is no longer active, have the vehicle inspected by a qualified technician.

IMPORTANT: Do not consider the area clear until all alarm indicators are off, and the alarm panel light returns to green.

Sensors

Gas detection sensors are located on the cab overhead console and in the engine compartment on the frontwall. The sensors are located in high areas, where rising gas vapors will pass by or accumulate.

If the system detects that one of the sensors has been disconnected or has malfunctioned, the sensor fault light for that zone will illuminate. A failed sensor may trigger and lock on an alarm. If a fault condition or locked alarm continues after the sensor’s connection and wiring integrity has been verified, replace the sensor.

The sensors are sensitive to all hydrocarbon vapors. An alarm may be triggered by the use of chemicals such as cleaners, paint, polish, lacquer, gasoline, silicone, silicone spray, or other harsh chemicals. The sensors will also detect hydrogen fumes from an overcharged battery. If a sensor sends an alarm, but no gas fumes are present, check for recent use of chemicals or a battery charger.

NOTICE

Silicone-based chemicals and cleaners will permanently disable the sensors. When cleaning the vehicle, cover the sensors with a plastic covering. Keep the sensors covered until the area has been cleared of any cleaning fumes.

Harsh chemicals and extremely high temperatures may damage the sensor.

Puncture of or damage to the seal located inside the sensor housing will significantly shorten the sensor life.

Frequent exposure to high concentrations of gas will accelerate sensor deterioration.

Overhead Console

The overhead console consists of an alarm panel on the right side and the control module on the left side.

The alarm panel has a green light, a red light, a buzzer, and a sensor. See Fig. 16.6. It is located within view from outside of the vehicle. The large green light is continuously illuminated during normal operating conditions.

Before entering the vehicle, always verify that the green light is illuminated. If the green light is not illuminated, do not enter the vehicle. Complete the alarm procedure previously outlined.

The alarm panel meets the California Highway Patrol Title 13-2008 and NFPA 52 2010 requirements. All
drivers and technicians using it should be trained re-

garding the red and green lights, and the audible

warning.

The control module, located on the left side of the

overhead console, contains the status lights and con-

trol buttons for the system. The areas that the sen-

sors monitor are defined as Zone 1 (cab) and Zone 2

(engine compartment). The control module has lights

assigned to each zone that will illuminate if a sensor

detects a trace level leak (between 20% and 30%

LFL), a significant level leak (above 50% LFL), or if a

sensor is disconnected or malfunctioning.

• Trace Level: If either sensor detects gas fumes at a concentration greater than 20% to 30%

LFL (1% gas in air by volume), the amber light

destined for that zone will flash. There is no buzzer alarm for a trace level detection, and the large green light on the alarm panel will remain illuminated.

• Significant Level: If either sensor detects gas fumes at a concentration greater than 50% to

60% LFL (2.5% gas in air by volume), the small red light next to the SIGNIFICANT indi-
cator for that zone will flash. After approximately 15 seconds, the large green light on the alarm panel will switch off, the red light will illu-
minate, and the buzzer will sound. All alarm indicators will remain on as long as fumes are detected.

• Sensor Fault: If the system detects that either of the sensors has been disconnected or has malfunctioned, an amber light next to the Sensor Fault indicator for that zone will illuminate.

The control module also has buttons used to test or reset the control module after an alarm. Red lights next to each button indicate when they are en-
gaged.
• Shutdown Reset: If an alarm has been activated and the Relay Engaged light is illuminated, the Shutdown Reset button will reset the internal relay. Press the Shutdown Reset button only after the gas has cleared, the buzzer has turned off, and the alarm panel light has returned to green.

• Push To Silence: If an alarm has been activated, the Push To Silence button will silence the buzzer.

See Table 16.2 for the functions of all lights and buttons on the overhead console.

Testing
Daimler Trucks North America strongly recommends that all operators follow California Code of Regulations (CCR) inspection requirements, regardless of where the vehicle is operated. Per Title 13 CCR § 935 (2), gas detection systems should be tested three times per calendar year at equal intervals. The testing procedure should simulate the same operating environment in which the vehicle is used, with the same gaseous fuel.

Test results validating the performance of the gas detection system within the parameters established by the component manufacturer and NFPA 52 2010 should be maintained as a permanent part of the vehicle service records. Use of alcohol, propane, and other harsh liquids or gases are not acceptable methods for testing.

Always test the system and sensors after any component has been replaced, or if the vehicle has been involved in an accident or fire. Ensure that the gas detection system is wired directly to the battery.

It is recommended that the highest level of safety validation be utilized if there are multiple validation requirements in the state or locality where the vehicle is operated or domiciled.

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<th>Display</th>
<th>Function</th>
<th>Action Required</th>
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<td>Green Power Light</td>
<td>Illuminated</td>
<td>System is on.</td>
<td>None required.</td>
<td></td>
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<tr>
<td>Unlit</td>
<td>Detection system is not functioning.</td>
<td>Ensure the batteries are connected and replace any blown fuses. If the gas detection system is still not functioning, replace the system immediately.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGNIFICANT Gas Concentration Lights</td>
<td>Red (illuminated)</td>
<td>Dangerous gas concentration detected.</td>
<td>Suspend vehicle operation immediately and follow alarm procedures.</td>
<td></td>
</tr>
<tr>
<td>Trace Gas Concentration Lights</td>
<td>Amber (flashing)</td>
<td>Minor gas concentration detected.</td>
<td>Use caution and monitor the system.</td>
<td></td>
</tr>
<tr>
<td>Sensor Fault Lights</td>
<td>Off</td>
<td>Sensor is functioning properly.</td>
<td>None required.</td>
<td></td>
</tr>
<tr>
<td>On</td>
<td>Sensor has malfunctioned.</td>
<td>Replace the sensor immediately.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shutdown Reset Button</td>
<td>—</td>
<td>Resets the system after an alarm activation.</td>
<td>Press to reset the system only after the gas has cleared, the buzzer has turned off, and the alarm panel light has returned to green.</td>
<td></td>
</tr>
<tr>
<td>Relay Engaged Light</td>
<td>On</td>
<td>Relay is engaged and test or alarm is being cleared.</td>
<td>Press the Shutdown Reset button.</td>
<td></td>
</tr>
<tr>
<td>Off</td>
<td>Normal condition.</td>
<td>None required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Button</td>
<td>—</td>
<td>Tests the overhead console operation and circuitry.</td>
<td>Press and hold for one minute to activate a test of all overhead console components.</td>
<td></td>
</tr>
<tr>
<td>Silence Button</td>
<td>—</td>
<td>Silences the alarm buzzer.</td>
<td>Press to silence the alarm buzzer.</td>
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Control Module Functions

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<tr>
<td>Silence Engaged Light</td>
<td>On</td>
<td>Indicates the buzzer is active but silenced.</td>
<td>Suspend vehicle operation immediately and follow alarm procedures.</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>Normal condition.</td>
<td>None required.</td>
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Table 16.2, Control Module Functions

**Overhead Console Test**

Press and hold the *Push To Test* button for one minute. The system will proceed with a self-diagnostic test that will include illumination of the *Trace* and *SIGNIFICANT* gas concentration lights, and the sensor fault lights. Verify the large red light and buzzer activate, and that all lights illuminate or flash to ensure that all bulbs are operational.

**Sensor Test**

The gas detection system sensors must be tested using certified test gas, which can be purchased as part of a test kit. Testing with alcohol or heavy gases such as butane or propane does not satisfy CCR § 935 (2) or NFPA 52 regulations.

Expose each sensor to certified test gas for at least thirty seconds. The system will proceed through the alarm procedure consistent with a significant leak and the buzzer will sound after approximately fifteen seconds. If a sensor fails to respond after exposure to the test gas, replace the sensor.

**Engine Starting**

**NOTE:** Before starting the engine, read Chapter 3 for detailed information on how to read the instruments and Chapter 4 for detailed information on how to operate the controls. Read the operating instructions in the engine manufacturer’s operation manual before starting the engine.

1. Before engine start-up, complete the engine pre-trip and post-trip inspections and maintenance procedures in Chapter 11.
2. Ensure the fuel shutoff valve is open.
3. Set the parking brake.
4. Ensure that the transmission shift control is in Neutral (N), Park (P), or the Park Brake (PB) position.
5. Without starting the engine, turn the ignition switch to the ON position (Fig. 16.7). The electronic gauges on the instrumentation control unit (ICU) will complete a full sweep of their dials, the warning and indicator lights will illuminate, and the buzzer will sound for three seconds.

![Fig. 16.7, Ignition Switch Positions](image_url)

6. Turn the ignition switch to the START position.
   Press down on the clutch pedal, if equipped, but do not press down on the accelerator pedal.
   Release the key the moment the engine starts.

7. Bring the engine up to operating speed gradually as it warms up and develops stable oil pressure. If the vehicle has not been operated previously in a 24-hour period, allow the vehicle to idle for five minutes.

**NOTICE**

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

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

**Major Repair and Replacement of Parts**

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