Fuel 47

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General Information

The fuel system delivers fuel from the fuel tanks to the engine. It consists of the engine fuel system components, the fuel tank(s) and tank mounting components, the fuel lines, and (if so equipped) the shutoff valve. See **Fig. 1** for a schematic of the fuel system.

The engine fuel system components include fuel filters, injectors, fuel transfer pumps, and a fuel governor. For service and maintenance procedures, refer to the applicable engine manufacturer's service and maintenance manuals.

The fuel tanks are held in place by metal bands and brackets that transfer the load to the vehicle frame. On some installations, cab-access and chassis-access step assemblies attach to the fuel tank mountings.

To ensure sufficient clearance between the fuel tanks and moving parts of the front suspension, fuel tank spacers are sometimes required on vehicles with flat leaf front suspensions or greaseable spring pins. On standard installations with frame outserts, spacers are not required.

Fuel suction and return lines made of nylon, or reinforced braided fabric, bring fuel from the tank to the engine, and return surplus fuel from the engine to the tank. A single right-side rectangular tank holding 30 gallons is standard. Tanks holding 40, 50, 60, 80 and 100 gallons are also available in both single- and dual-tank systems.

An EquiFlo® dual suction/dual return fuel system is standard on all vehicles with dual-tank systems. This system provides equal fuel levels in both fuel tanks without the need of a low crossover line.

Standard equipment also includes a fuel level sensor (in the primary tank in a dual-tank system), and an electronic fuel level gauge in the cab instrument cluster.

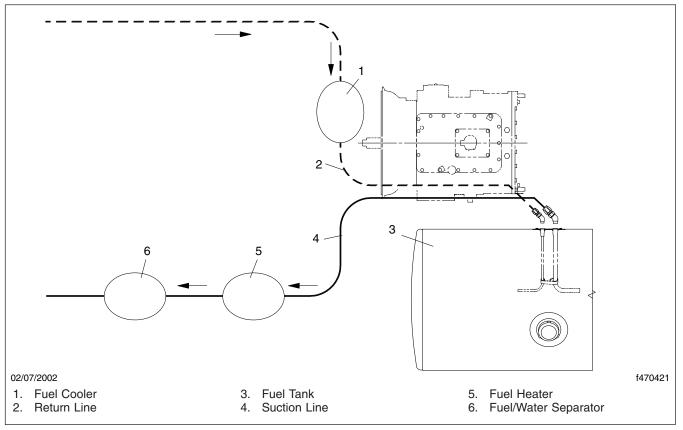


Fig. 1, Fuel System Schematic

Tank-Mounted Step Assembly Removal and Installation

Removal

NOTE: The procedure below describes a twostep installation. To remove a single step, follow the procedure for the bottom step of the twostep installation.

1. Remove the torx-head screws and washers that attach the top step to the braces welded to the fuel tank bands. See Fig. 1.

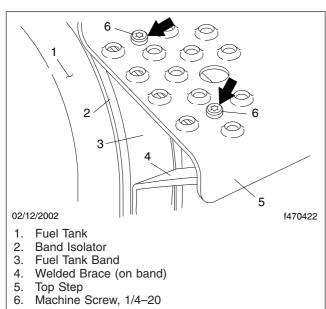


Fig. 1, Top Step Removal and Installation

IMPORTANT: Removing the bottom step from the riser is necessary only when the step itself needs replacement. If replacing the fuel tank, remove the step and risers as an assembly.

- 2. Remove the torx-head machine screws, locknuts and washers that attach the bottom step to the risers. See Fig. 2.
- 3. Remove the 3/8–16 mounting bolts, locknuts and washers that attach a step riser to each tank bracket. See Fig. 3.
- 4. Remove the step from the vehicle.

Installation

NOTE: The procedure below describes a twostep installation. To install a single step, follow

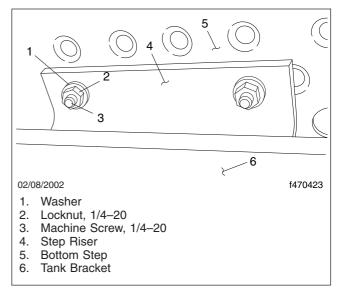


Fig. 2, Bottom Step Removal and Installation

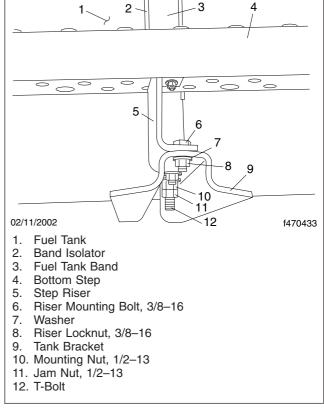


Fig. 3, Step Riser Removal and Installation

Tank-Mounted Step Assembly Removal and Installation

the procedure for the bottom step of the twostep installation.

- 1. Install a step riser on each tank bracket.
 - 1.1 Position a riser on each bracket, as shown in Fig. 3.
 - 1.2 Install the 3/8–16 mounting bolts, locknuts, and washers, as removed. Leave the fasteners finger-tight.
 - 1.3 When all the risers have been installed, tighten the locknuts 28 lbf·ft (38 N·m).
- 2. Install the bottom step on the risers, if removed.
 - 2.1 Position the bottom step on the risers, as shown in **Fig. 2**.
 - 2.2 Install the 1/4–20 machine screws, locknuts, and washers on the step, as removed. Leave the fasteners loose.
- 3. Install the top step on the fuel tank.
 - 3.1 Position the top step on the braces welded to the fuel tank bands, as shown in **Fig. 1**.
 - 3.2 Install the 1/4–20 machine screws, locknuts, and washers on the step, as removed. Leave the fasteners loose.
- 4. Tighten the step locknuts 72 lbf-in (800 N-cm).

Fuel Tank Removal and Installation

Removal

A WARNING

Damaged fuel tanks must be replaced. A repaired fuel tank may not meet U.S. Federal strength, leakage, and venting standards required for all fuel tanks. A repaired fuel tank may be more likely to spill fuel or be ruptured in a vehicle accident, which could lead to personal injury or property damage.

If a damaged tank is found, use the following procedure:

- 1. Park the vehicle on level ground. Apply the parking brakes and chock all the tires.
- 2. Remove the cab-access step(s). For instructions, see **Subject 100**.



Do not drain fuel near, or allow fuel vapor near, open flame or intense heat. Doing so is a dangerous practice, and creates a severe fire hazard. This could lead to personal injury, or property damage.

3. Remove the fuel from the tank. See Fig. 1 for location of the fuel drain plug.

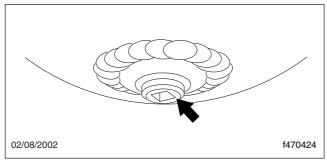


Fig. 1, Fuel Drain Plug

- 3.1 Place a suitable container under the fuel tank.
- 3.2 On a dual-tank installation, close the fuel shutoff valve (if equipped) located on the primary fuel tank.
- 3.3 Remove the drain plug.
- 3.4 Protect the fuel from contaminants. Store it in a clean container for later re-use.

 Disconnect the fuel return and suction lines from the tank. Cap the lines to prevent fuel spillage. See Fig. 2.

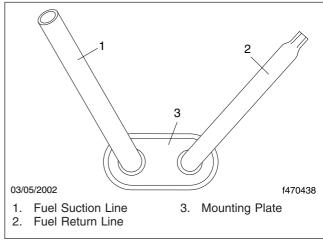


Fig. 2, Fuel Lines

- Disconnect the electrical connector from the fuel level sensor harness and remove the cushioned clamp from the flange of the fuel level sensor. See Fig. 3.
- Remove the fuel tank bands and isolators. See Fig. 4. For detailed procedures, see Subject 120.
 - 6.1 Remove the nuts and washers from the T-bolt at the lower (outboard) end of each tank bracket.
 - 6.2 Remove the cotter pins and clevis pin from the upper (inboard) end of each tank bracket.
 - 6.3 Remove the band and isolators from each tank bracket.
- Using a fork lift, remove the fuel tank. Remove the tank bracket isolator from the fuel tank, if it adheres to the tank.
- 8. Inspect the bands, isolators, and brackets for wear and damage. Replace worn or damaged parts with new parts.

Fuel Tank Removal and Installation

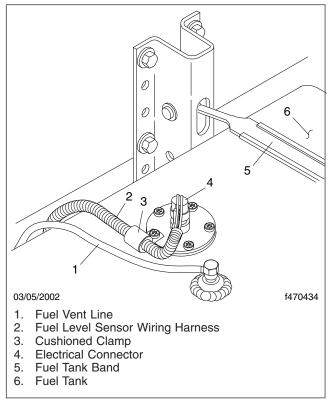


Fig. 3, Electrical Connector, Fuel Level Sensor

WARNING

Failure to replace worn or damaged parts could result in loss of a fuel tank and spilling of fuel, which could cause property damage or personal injury.

- When replacing a fuel tank, remove all parts necessary to install the new fuel tank. Inspect the parts, and replace them as needed.
 - 9.1 Remove and clean the pipe plugs and fittings for the fuel return and suction lines. Transfer them to the new fuel tank.
 - 9.2 Remove and clean the fuel vent line, pipe plug, and fitting. Transfer it as a unit to the new fuel tank.
 - 9.3 If a single or primary fuel tank is being replaced, transfer the fuel level sensor and gasket to the new fuel tank.

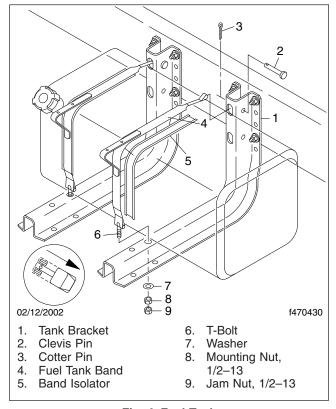
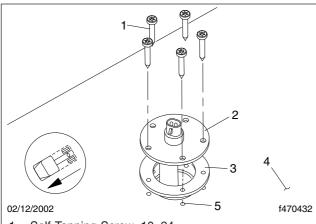


Fig. 4, Fuel Tank

Installation

- Install all necessary components on the new fuel tank before installation of the tank on the vehicle. See Fig. 5 for fuel level sensor installation.
 - 1.1 If removed, install the fuel level sensor and gasket in the fuel tank. Install the selftapping screws until contact is made with the sensor unit. Do not tighten the screws yet.
 - 1.2 Install all removed pipe plugs and fittings. Coat all tapered pipe plug and fitting threads with Loctite® 592, or an equivalent sealer. Install the vent line as a unit along with its pipe plug and fitting.
- 2. Make sure the tank bracket isolator is correctly positioned on the tank bracket.
- Using a fork lift, or other approved lifting device, and place the fuel tank in its approximate installed position. Make sure the fuel filler neck is outboard.

Fuel Tank Removal and Installation



- 1. Self-Tapping Screw, 10-24
- 2. Fuel Level Sensor
- 3. Gasket
- 4. Fuel Tank
- 5. Mounting Hole in Tank

Fig. 5, Fuel Level Sensor

On 106-inch cabs only, move the tank fore or aft until the distance from the front of the tank to the centerline of the forward tank bracket is $9.84 \pm .20$ inches (250 ± 5 mm).

- 4. Install the fuel tank bands and isolators.
 - 4.1 Position the closed (non-slotted) loop of a fuel tank band through the slot in the upper (inboard) end of each tank bracket.
 - 4.2 Install the clevis pin through the upper (inboard) end of each tank bracket and the loop of the fuel tank band. Install new cotter pins and bend back the ends to lock in the clevis pins.

A CAUTION

Do not overtighten the fuel tank bands. To do so could damage the fuel tanks.

- 4.3 Insert the T-bolt at the lower (slotted) end of each band into the tank bracket.
- 4.4 Install a washer and two nuts on each T-bolt. Tighten the mounting nuts 15 lbf·ft (20 N·m).
- 4.5 While holding the first nut stationary with a wrench, tighten each jam nut an additional 15 lbf·ft (20 N·m).

- 5. Attach the electrical connector to the fuel level sensor wiring harness. Attach the cushioned clamp to the flange of the sensor unit. Using a star pattern to distribute the torque evenly around the sensor unit, tighten the screws 15 to 30 lbf-in (160 to 340 N·cm).
- Make certain the fuel lines are clean and install them on their fittings on the fuel tank. See Subject 150 for general guidelines.

IMPORTANT: Install pipe plugs in any remaining open threaded holes. Coat all remaining tapered pipe plug and fitting threads with Loctite 592, or an equivalent sealer.

- Install the cab-access step(s). For instructions, see Subject 100.
- 8. Add clean fuel to the fuel tank.
- Prime the engine fuel system. For instructions, see Subject 140.
- 10. Remove the chocks from the tires.

Fuel Tank Band Replacement

Replacement

- 1. Apply the parking brakes and chock all the tires.
- 2. Remove the cab-access step(s). For instructions, see **Subject 100**.
- 3. Remove the fuel tank band and isolator. See Fig. 1.

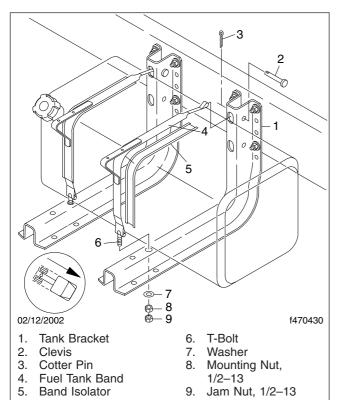


Fig. 1, Fuel Tank Band Removal

- 3.1 Remove the two nuts and one washer from the T-bolt at the lower (outboard) end of the tank bracket.
- 3.2 Remove the cotter pin and clevis pin from the eye at the upper (inboard) end of the tank bracket.
- 4. Inspect the isolator and clevis pin for wear or damage; replace if needed.

WARNING

Failure to replace worn or damaged parts could result in loss of a fuel tank and spilling of fuel, which could cause personal injury or property damage.

5. Install the isolator and the new tank band on the tank. See Fig. 2.

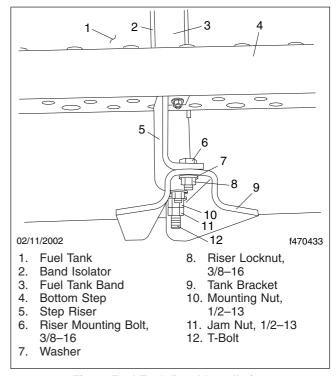


Fig. 2, Fuel Tank Band Installation

5.1 Install the clevis pin through the inboard end of the tank bracket and tank strap. Install and lock a new cotter pin in the clevis pin.

IMPORTANT: Fuel tanks can be damaged by overtightening the fuel tank straps.

- 5.2 Install a washer and two nuts on the tank strap T-bolt. Tighten the mounting nut 15 lbf-ft (20 N·m).
- 5.3 While holding the mounting nut stationary with a wrench, tighten the jam nut an additional 15 lbf·ft (20 N·m).

Fuel Tank Band Replacement

- Install the cab-access step(s). For instructions, see Subject 100.
- 7. Remove the chocks from the tires.

Fuel Tank Bracket Replacement

Replacement

- Remove the fuel tank. For instructions, see Subject 110.
- Remove the locknut, washers, spacer (if installed), and capscrew that attach each bracket to the frame rail. See Fig. 1 for bracket installation on different size fuel tanks and Fig. 2 for fasteners.
- onto the outboard ends of the capscrews. Position the new tank bracket on the capscrews, then install the two upper hardened washers and locknuts, finger-tight.
- 5. Install the two lower sets of fasteners. Tighten all of the 5/8–11 locknuts 136 lbf·ft (184 N·m).
- 6. Install the fuel tank. For instructions, see **Subject 110**.

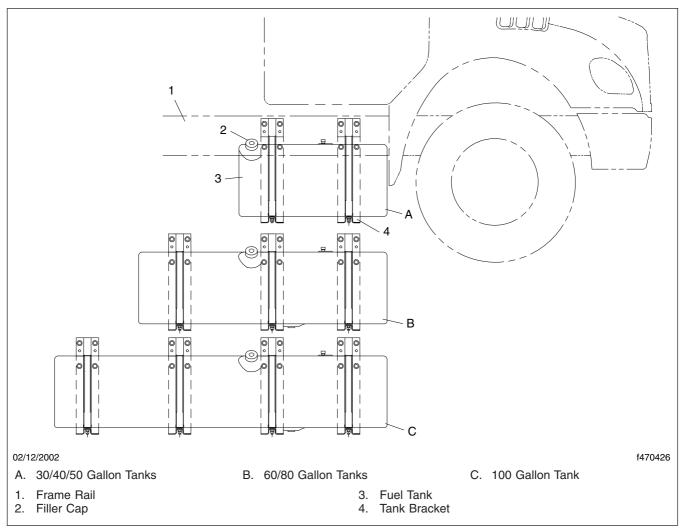


Fig. 1, Fuel Tank Sizes

- 3. Remove the tank bracket from the vehicle.
- 4. From outside the frame rail, install the two upper capscrews and hardened washers. If so equipped, install the fuel tank bracket spacers

Fuel Tank Bracket Replacement

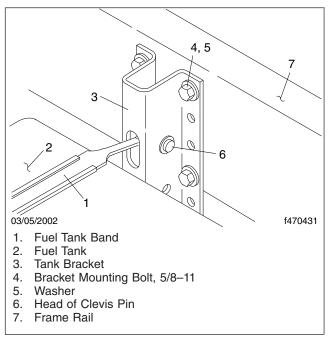


Fig. 2, Fuel Tank Bracket

Fuel System Priming

Priming

Before priming the system, make sure there is enough fuel in the tank(s). Don't fill them to more than 95 percent of capacity.

A WARNING

Federal regulations prohibit filling a fuel tank to more than 95 percent of its capacity. A tank with air space is much less likely to rupture in an accident than one that has little or no air space. Fuel tank rupture could result in fuel spillage and a hazardous condition.

Don't crank the starter more than 30 seconds at a time during any of the following procedures; wait 2 minutes after each try to allow the starter to cool, or starter damage may occur.

- On MBE900 engines, use the following procedure:
 - 1.1 Make sure that all high-pressure lines have been tightened to 18 lbf·ft (25 N·m) and all banjo bolts to 37 lbf·ft (50 N·m).

A CAUTION -

Correct torque on the high-pressure lines is critical. Incorrect torques could result in leaks or lack of power due to restricted fuel flow.

1.2 If equipped with a hand pump on the fuel/ water separator, work the hand pump 50 times.

NOTE: There should be a strong resistance in the hand pump, caused by the pressure build-up within the fuel system.

- 1.3 Crank the engine for 30 seconds at a time, but *no longer*. Before cranking the engine again, wait at least two minutes. The engine should start within four 30-second attempts.
- 1.4 If the engine still does not start, open the high-pressure lines and bleed the air from the fuel system while cranking. Tighten the high-pressure lines and repeat the priming procedure.

- 2. On Caterpillar engines, if the engine is equipped with a priming pump, use it to prime the fuel transfer pump.
 - 2.1 Operate the priming pump plunger until there is resistance.
 - 2.2 Start the engine; if it doesn't start, more priming is needed. Once the engine has started, it may run rough; if so, run the engine at low idle until it runs smoothly.
- 3. On Caterpillar engines, if the engine isn't equipped with a priming pump, use the same procedure as for Mercedes-Benz engines.

Fuel Line Routing

Diesel Fuel Lines

If diesel fuel lines are worn, damaged, or deteriorated, replace them. Use the following guidelines for installing and routing them.

- Fuel lines must be free of droops, sharp bends, and kinks in the lines.
- Fuel lines must not extend below the fuel tank unless they are completely enclosed in a protective housing.
- Fuel lines must be routed in a continuous upward slope from the fuel tank to prevent high and low spots in the hoses.
- Fuel lines must be routed at least six inches (15 cm) from unshielded exhaust pipes and at least three inches (7.5 cm) from shielded exhaust pipes.
- Heat shields and/or hose insulation must be used to protect any section of fuel line that is less than six inches (15 cm) from a heat source.
- Fuel lines must be routed to allow routinely serviceable components such as dipsticks, filters, and water separators to be readily accessed without the need to disconnect the fuel lines.
- Fuel lines must be secured to prevent chafing, kinking, or other damage.
- Fuel lines must be long enough to allow movement of the parts to which they are attached.
- Coat all pipe threads (tapered threads) with Loctite® 592, or an equivalent.
- Finger-tighten pipe fittings; then tighten one and one half turns. Tighten more if necessary to seal.
- Fuel lines and fittings must be free of leaks, to prevent fuel loss or entry of air into the line, which may result in a loss of prime by the engine fuel system.
- Drains or other bottom fittings must not extend more than 3/4 inch (19 mm) below the lowest part of the fuel tank or sump.

Fuel Shutoff Valve Replacement, EPA10 Engines

Replacement

NOTE: Fuel shutoff valves are only installed on vehicles with dual tanks.

- Park the vehicle on a level surface, shut down the engine, and set the parking brake. Put the transmission into high gear, chock the tires and open the hood.
- 2. Disconnect the fuel control rod(s) from the fuel shutoff valve lever(s). Swing the control rod(s) out of the way without removing them from the control rod mounting bracket. See **Fig. 1**.

WARNING

Aftertreatment device (ATD) internal temperatures can remain hot enough to cause personal injury or ignite combustible materials for hours after the engine is shut down, causing potentially serious burns or material damage. Wear appropriate protective gear when working around the ATD. Do not to let diesel from the fuel lines come into contact with the ATD.

- Disconnect the driveline from the transmission output yoke. For instructions, see Section 41.00, Subject 100 for uncoupling from a half-round end-yoke, or Section 41.00, Subject 110 for uncoupling from a full-round endyoke.
- Disconnect the driveline midship bearing from the midship bearing bracket, and set the driveline out of the way.
- Disconnect the aftertreatment device (ATD) wiring harnesses located on the EquiFlo bracket.
- 6. Disconnect the diesel exhaust fluid (DEF) coolant lines located on the EquiFlo bracket.
- 7. Disconnect the fuel lines from the tee fittings, then cap the lines.
- 8. In order to gain access to the fuel shutoff valves, it may be necessary to remove the standoff brackets that secure the DEF lines to the EquiFlo bracket, then move the lines aside. See Fig. 1.
- 9. Remove any remaining cables and brackets as needed to access the fuel shutoff valves.
- Loosen the two jam nuts that secure the fuel shutoff valves and tee fittings to the EquiFlo

- bracket. Remove the tee fittings and valves as an assembly.
- 11. Remove the shutoff valves from the tee fittings, then install new shutoff valves.
- 12. Using two jam nuts, install the tee fitting and shutoff valve assembly on the EquiFlo bracket.
- 13. Install the fuel lines on the tee fittings and tighten the fittings.
- 14. If any ATD wiring harness standoff brackets were previously removed, install them on the EquiFlo bracket, then connect the wiring harnesses.
- 15. If any DEF line standoff brackets were previously removed, install them on the EquiFlo bracket.
- 16. Connect the DEF coolant lines.
- 17. Connect the ATD wiring harnesses.
- 18. Install any remaining cables and brackets that were previously removed.
- Connect the driveline to the transmission output yoke. For instructions, see Section 41.00, Subject 100 for coupling to a half-round end-yoke, or Section 41.00, Subject 110 for coupling to a full-round end-yoke.
- 20. Connect the midship bearing to the midship bearing bracket.
- Connect the control rod(s) to the fuel shutoff valve lever(s). Tighten the nuts 16 lbf-ft (22 N.m).
- 22. Start the engine and check for leaks.

Fuel Shutoff Valve Replacement, EPA10 Engines

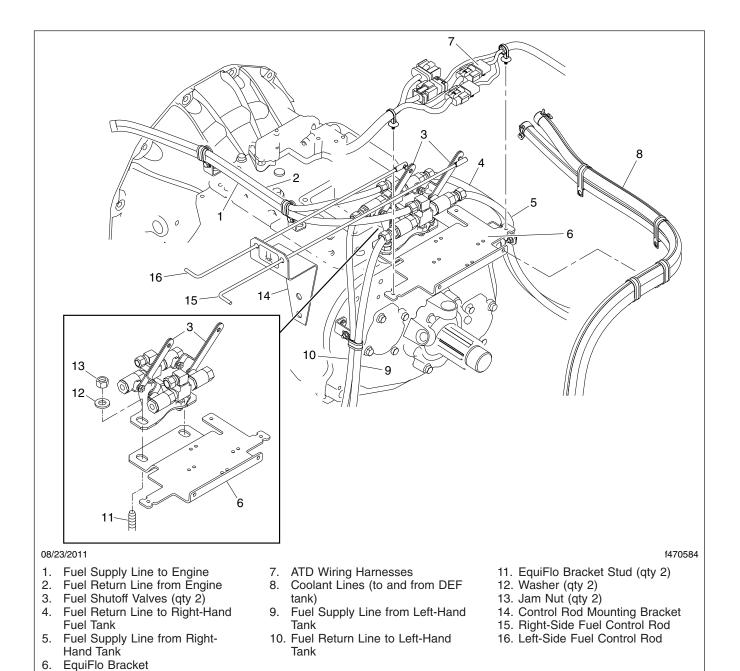


Fig. 1, Fuel Shutoff Valve Assembly, Dual-Tank Vehicle

Fuel Tank Flushing

Flushing

In the event of a catastrophic failure of the highpressure fuel pump, it is necessary to clean the fuel tank(s) and all other system components between the tank(s) and the engine. The preferred method for cleaning the chassis fuel system is to replace the fuel tank(s) if fuel tanks are available in a time frame that is acceptable for the customer. If the customer can not wait, cleaning and reusing the fuel tank(s) is acceptable. For information about cleaning the engine components after a failure, refer to the engine manufacturer's service literature.

IMPORTANT: Always follow Environmental Protection Agency (EPA) and local regulations when disposing of contaminated fuel.

Replacing Tanks and Flushing the Fuel System, Vehicles With a DAVCO Fuel/Water Separator

- Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
- 2. Disconnect the batteries.
- 3. Remove the fuel/water separator(s) from the system. For instructions, refer to **Group 47**.
- 4. Remove and discard the filter element. Then thoroughly clean the unit.
- 5. Install a new filter element.
- 6. Disconnect the fuel supply line from the engine fuel filter module, and clean the line.
- Install the fuel/water separator back on the chassis. Refer to Group 47.
- Connect the chassis supply line (running between the chassis fuel filter module and the engine fuel filter module) to the chassis fuel filter module. Do not connect it to the engine fuel filter module at this time.
- 9. Disconnect the chassis return line from the engine fuel filter module.
- Connect the DAVCO ShopProFXP, or an equivalent tool, to the chassis supply and return lines and back flush the chassis fuel lines.
- 11. Drain all of the fuel from the tank(s) into a suitable container. Use a DAVCO ShopProFXP or

- equivalent to remove and filter/separate the water and debris from the fuel so it can be reused.
- 12. Replace the fuel tank(s). For instructions, refer to **Subject 110**.
- 13. Install magnetic drain plug(s) (Grainger part number 5044121) in the new tank(s).
- 14. Using the DAVCO ShopProFXP or an equivalent tool to filter and separate the fuel again, fill the fuel tanks from the storage tank.
- 15. Connect the batteries.

Replacing Tanks and Flushing the Fuel System, Vehicles Without a DAVCO Fuel/Water Separator

- Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
- 2. Disconnect the batteries.
- 3. Disconnect the chassis fuel supply and return lines from the engine fuel filter module.
- 4. Connect the DAVCO ShopProFXP, or an equivalent tool, to the chassis supply and return lines and back flush the chassis fuel lines.
- Drain all of the fuel from the tank(s) into a suitable container. Use a DAVCO ShopProFXP or equivalent to remove and filter/separate the water and debris from the fuel so it can be reused
- 6. Replace the fuel tank(s). For instructions, refer to **Subject 110**.
- 7. Install magnetic drain plug(s) (Grainger part number 5044121) in the new tank(s).
- 8. Using the DAVCO ShopProFXP or an equivalent tool to filter and separate the fuel again, fill the fuel tanks from the storage tank.
- 9. Connect the batteries.

Fuel Tank Flushing

Cleaning Tanks and Flushing the Fuel System, Vehicles With DAVCO Fuel/Water Separators

- Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
- 2. Disconnect the batteries.
- Remove the fuel/water separator(s) from the system. For instructions, refer to Group 47.
- Remove and discard the filter element. Then thoroughly clean the unit.
- 5. Install a new filter element.
- 6. Disconnect the fuel supply line from the engine fuel filter module, and clean the line.
- 7. Install the fuel/water separator on the chassis.
- Connect the chassis supply line (running between the chassis fuel filter module and the engine fuel filter module) to the chassis fuel filter module. Do not connect it to the engine fuel filter module at this time.
- 9. Disconnect the chassis return line from the engine fuel filter module.
- Connect the DAVCO ShopProFXP or an equivalent tool, to the chassis supply and return lines and back flush the chassis fuel lines.
- Drain all of the fuel from the tank(s) into a suitable container. Use a DAVCO ShopProFXP or equivalent to remove and filter/separate the water and debris from the fuel so it can be reused.
- Remove the tank(s) from the vehicle. For instructions, refer to Subject 110.
- 13. Thoroughly steam clean the inside of the tank until all water leaving the drain hole looks clean.
- 14. Install a magnetic drain plug (Grainger part number 5044121) and cap any other open outlets.
- 15. Put two gallons of diesel fuel in the tank, and install the cap. Slosh the diesel around in the tank making sure it reaches all interior surfaces. This should collect most of any remaining contaminants in the tank.

- Drain this fuel from the tank into a suitable container. Dispose of the contaminated fuel in an appropriate manner.
- 17. Remove, clean, and install the magnetic drain plug in the fuel tank.
- 18. Install the fuel tank(s) on the vehicle. For instructions, refer to **Subject 110**.
- 19. Using the DAVCO ShopProFXP or an equivalent tool to filter and separate the fuel again, fill the fuel tanks from the storage tank.
- 20. Connect the batteries.

Cleaning Tanks and Flushing the Fuel System, Vehicles Without DAVCO Fuel/Water Separators

- Park the vehicle on a level surface, shut down the engine, and set the parking brake. Chock the tires.
- Disconnect the batteries.
- 3. Disconnect the chassis fuel supply and return lines from the engine fuel filter module.
- 4. Connect the DAVCO ShopProFXP, or an equivalent tool, to the chassis supply and return lines and back flush the chassis fuel lines.
- Drain all of the fuel from the tank(s) into a suitable container. Use a DAVCO ShopProFXP or equivalent to remove and filter/separate the water and debris from the fuel so it can be reused.
- Remove the tank(s) from the vehicle. For instructions, refer to Subject 110.
- 7. Thoroughly steam clean the inside of the tank until all water leaving the drain hole looks clean.
- 8. Install a magnetic drain plug (Grainger part number 5044121) and cap any other open outlets.
- Put two gallons of diesel fuel in the tank, and install the cap. Slosh the diesel around in the tank making sure it reaches all interior surfaces. This should collect most of any remaining contaminants in the tank.
- Drain this fuel from the tank into a suitable container. Dispose of the contaminated fuel in an appropriate manner.

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Fuel Tank Flushing

- 11. Remove, clean, and install the magnetic drain plug in the fuel tank.
- 12. Install the fuel tank(s) on the vehicle. For instructions, refer to **Subject 110**.
- 13. Using the DAVCO ShopProFXP or an equivalent tool to filter and separate the fuel again, fill the fuel tanks from the storage tank.
- 14. Connect the batteries.

Fuel-Level Sending Unit Replacement

Replacement

- Park the vehicle on a level surface, shut down the engine, and set the parking brakes. Chock the tires.
- 2. Disconnect the batteries.
- 3. If needed, remove the side fairing.
- Disconnect the fuel-level sending unit harness connector.
- 5. Remove the five fasteners from the top plate of the fuel-level sending unit and discard them.
- Lift the fuel-level sending unit out of the hole in the tank.

NOTICE —

There is only one correct way to install the fuellevel sending unit. See Fig. 1 for the correct orientation. Incorrect installation will damage the unit, and possibly the fuel tank, leading to inaccurate fuel-level readings and fuel leaks.

7. Install the gasket on the fuel-level sending unit, making sure that the holes align properly and the convex side of the gasket is facing the tank. Then insert new screws in the holes. This will assist in properly aligning the sensor in the tank.

IMPORTANT: When properly installed, the float on the fuel-level sending unit will point toward the outboard side of the tank, and all five screw holes in the fuel-level sending unit top plate will align with the screw holes in the tank.

8. Position the fuel-level sending unit and gasket in the hole in the tank, making sure that the screw holes align properly. See Fig. 2.

— NOTICE —

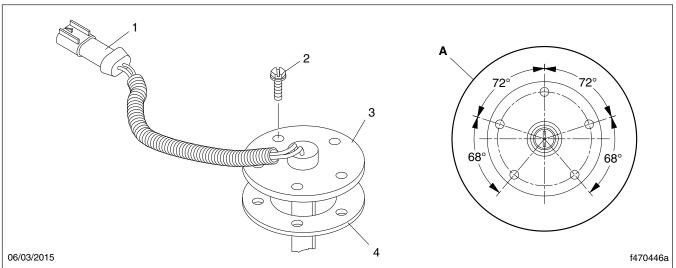
Tapping the screw holes in a new tank requires more torque than the recommended final tightening torque. The self-tapping fasteners will completely tap the tank wall before they are seated. Failure to follow the proper procedure will damage the tank and cause leaks.

Position the cushioned clamp for the wiring harness on the flange of the fuel-level sending unit, then start the five fasteners. If installing the fuel-level sending unit in a new tank, start all five of the self tapping fasteners through the tank wall before applying the final tightening torque.

If installing the fuel-level sending unit in a used tank, start all five self tapping screws until contact is made with top plate of the fuel-level sending unit. Do not tighten the screws at this time.

- Using the tightening sequence shown in Fig. 3, and even progression to distribute the torque evenly around the fuel-level sending unit, sequentially tighten the screws 15 to 25 lbf·in (160 to 212 N·cm).
- Connect the fuel-level sending unit harness connector.
- 12. Connect the batteries.

Fuel-Level Sending Unit Replacement



NOTE: The screw holes are unevenly spaced. Make sure the holes in the fuel-level sending unit and gasket match the holes in the tank.

- A. Screw Hole Spacing
- 1. Connector to Chassis Harness
- 2. Self Tapping Screw

- 3. Fuel-Level Sending Unit
- 4. Gasket

Fig. 1, Fuel-Level Sending Unit

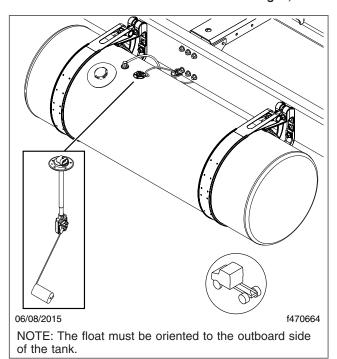


Fig. 2, Fuel-Level Sending Unit Orientation

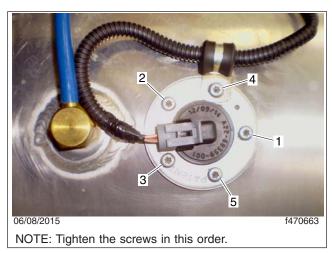


Fig. 3, Tightening Sequence

Specifications

See Fig. 1 for a schematic of the fuel system.

Fastener Torques						
Description Size Grade Torque						
Fuel Tank Band Mounting Nut and Jam Nut	1/2–13	В	15 lbf·ft (20 N·m)			
Riser-to-Tank Bracket Locknut	3/8–16	С	28 lbf·ft (38 N·m)			
Step-to-Riser Locknut	1/4–20	В	72 lbf·in (800 N·cm)			
Tank Bracket Mounting Locknut	5/8–11	С	136 lbf·ft (184 N·m)			

Table 1, Fastener Torques

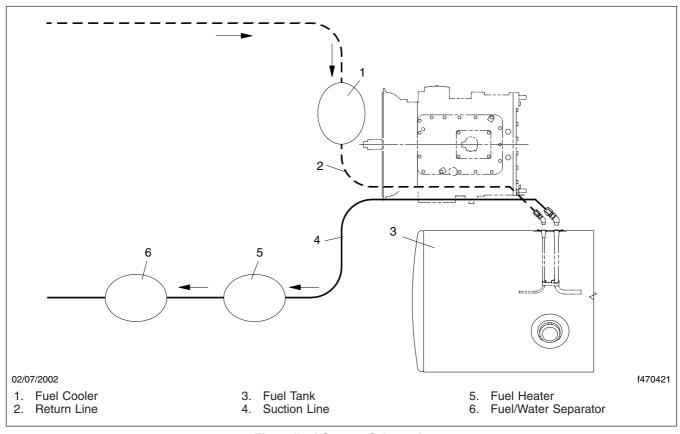


Fig. 1, Fuel System Schematic

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General Description

Fuel/water separators are mounted between the fuel tank and the fuel pump. Fuel drawn to the engine travels through the fuel/water separator, which removes water and impurities. See Fig. 1, Fig. 2, or Fig. 3 for DAVCO fuel/water separator configurations.

Heavier contaminants and water separate from the fuel in the lower housing of the fuel/water separator, and collect in the bottom to be drained out when the drain valve is opened. From the lower housing, the fuel level rises into the clear cover, which contains the replaceable filter element. The fuel passes through the filter element into the center of the filter, and on to the outlet port.

When the filter is new, the fuel is able to pass through the lower part of the filter element. As the element's lower portion clogs, the fuel level rises in order to pass through the filter. This process continues until the filter element is clogged all the way to the top.

For efficiency, the filter should be changed only when the fuel level has reached the top of the filter element. There is no significant restriction to fuel flow until the element is completely clogged.

DAVCO fuel/water separators come in a number of different configurations. There may be an electric heating element installed in the lower housing (Fig. 1, items 11 and 12) or there may be a fluid heat exchanger in the lower housing (Fig. 2, item 3). If there is fluid heat, the warming fluid may be fuel returning from the engine or engine coolant. Fig. 4 shows the patterns that fuel and heating fluids follow in fluid-heated units.

NOTE: The Daimler Trucks North America Learning Center (accessible through www.AccessFreightliner.com) and DAVCO (www.DavcoTec.com) offer excellent online resources for understanding, testing, and diagnosing fuel/ water separator problems.

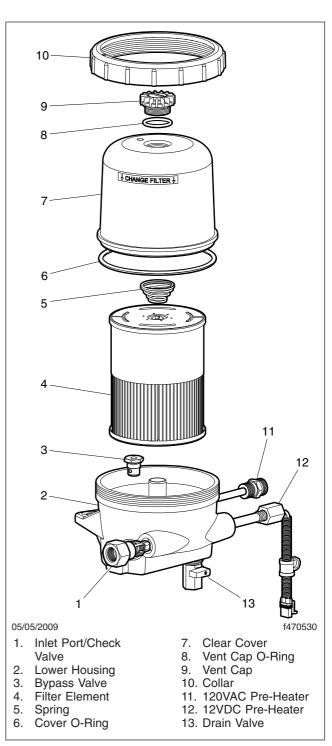
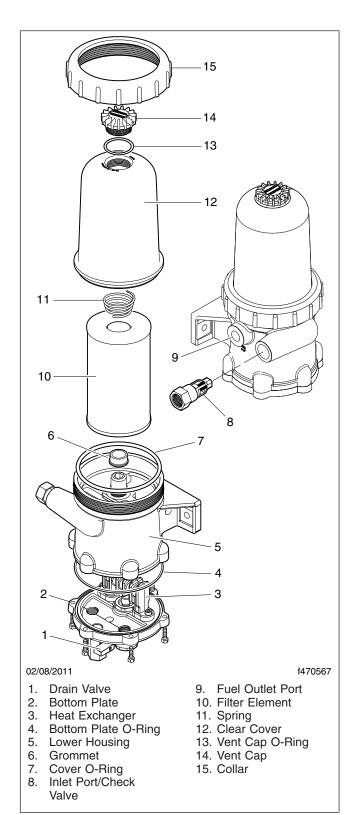


Fig. 1, DAVCO Fuel Pro 482



10 13 02/09/2011 f470568 1. Drain Valve 9. Filter Element Lower Housing
 Cover O-Ring
 Vent Cap O-Ring
 Vent Cap 10. Check Valve Assembly 11. Fuel Inlet Port 12. Pre-Heater Collar 13. Fuel Outlet Port 7. Clear Cover 14. Water-In-Fuel 8. Spring Sensor

Fig. 3, DAVCO Diesel Pro 243

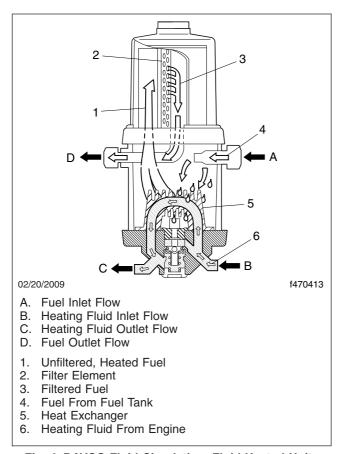


Fig. 4, DAVCO Fluid Circulation, Fluid-Heated Units

Removal and Installation

Removal

A WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

Most service procedures are done with the fuel/water separator in place, but some procedures, such as pressure testing, require that the fuel/water separator be removed from the vehicle.

 Shut down the engine, apply the parking brake, and chock the tires.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- Remove the vent cap (Fig. 1, Item 14) and open the drain valve (Fig. 1, Item 1) to drain the fuel to just below the collar level, then close the drain valve.
- 4. Unplug the electric heating element, if equipped, or disconnect the heating fluid lines.
- 5. Disconnect the fuel outlet line.
- Disconnect the fuel inlet line. If the inlet line is difficult to reach, loosen the connection, then fully disconnect it after the fuel/water separator is removed from the frame rail.
- 7. Remove the fuel/water separator mounting fasteners and remove the fuel/water separator from

the frame rail. If the fuel inlet line was not completely disconnected in the previous step, disconnect it.

Installation

IMPORTANT: All fittings, including the locking collars, must be very clean as they are installed. A piece of grit or a damaged surface on a sealing face or in threads can cause air leaks.

Use paste sealer to ensure that the tapered thread fuel line fittings will not leak. Do not use sealer on compression fittings and do not seal the fittings with tape, which will eventually leak.

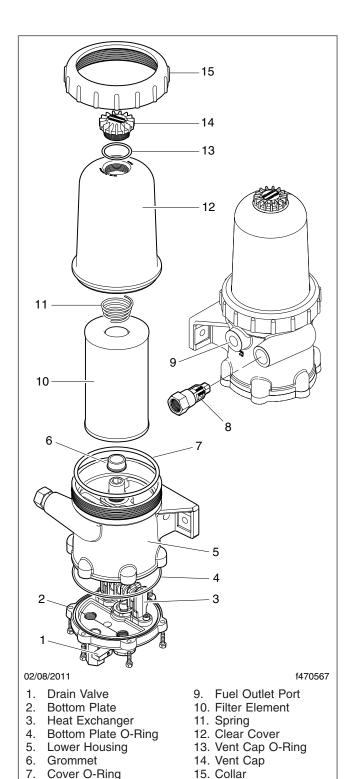
- If the inlet fuel line is inaccessible when the fuel/ water separator is mounted on the vehicle, loosely connect the inlet fuel line before mounting the fuel/water separator on the frame rail.
 - To minimize restrictions, keep fuel line routing as smooth as possible, with no low-hanging loops that could trap water. If the fuel line is being made to length on the job, be sure that the inner liner of the hose is not cut by the fitting. Be certain the interior of all fuel lines is clean and free of debris before connecting them, and confirm that all fittings are clean.
- 2. Mount the fuel/water separator on the frame rail and install the mounting fasteners.

NOTICE -

The lower housings on DAVCO fuel/water separators are made of aluminum. To avoid damaging threads, be careful not to overtighten fasteners or fittings on the fuel/water separator.

- 3. If the fuel inlet line was loosely connected previously, tighten it. If it was not connected, connect and tighten it.
- 4. Connect the fuel outlet line. Tighten the fitting 25 to 40 lbf·ft (34 to 54 N·m).
- Install the electric heating element, if equipped, and connect the wiring harness, or connect the fluid heater lines. It does not matter which direction the heating fluid flows through the housing; the lines can be reversed.
- 6. Prime the system
 - 6.1 Ensure that the drain valve is closed.

Removal and Installation



- 6.2 Remove the vent cap from the cover, and fill the housing to the top with clean diesel fuel.
- 6.3 Install and hand-tighten the vent cap.
- 6.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
- 6.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
- 6.6 Check for leaks and shut down the engine.

Fig. 1, Fuel/Water Separator (Fuel Pro 382 shown)

Inlet Port/Check

Valve

Filter Element Replacement

A WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

 Shut down the engine, apply the parking brake, and chock the tires.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap (Fig. 1, Item 14) and open the drain valve (Fig. 1, Item 1) to drain the fuel to just below the collar level, then close the drain valve.
- 4. Using a DAVCO Collar Wrench (Fig. 2), remove the clear cover and collar.

NOTE: Broken vent cap and collar warranty claims will not be accepted if any tool other than a DAVCO Collar Wrench, p/n 380134 or 382002, is used for removal. During installation, the vent cap and collar are to be **hand-tightened only**, not tightened with a wrench.

- Remove the filter, cover O-ring, and vent cap O-ring. Dispose of them in an environmentally acceptable manner.
- Clean all threads and sealing surfaces very thoroughly. Even a small amount of dirt will prevent

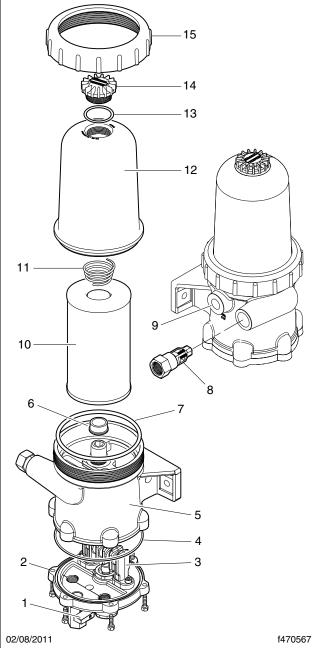
- the fuel/water separator from sealing, and an air leak will result.
- Install the grommet on the bottom of the new filter.
- 8. Install the new filter and grommet assembly and cover O-ring on the housing.
- 9. Install the clear cover and the collar. Hand-tighten the collar.
- 10. Prime the system
 - 10.1 Ensure that the drain valve is closed.
 - 10.2 Fill the housing to the top with clean diesel fuel.
 - 10.3 Install and hand-tighten the vent cap O-ring and vent cap.
 - 10.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system
 - 10.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
 - 10.6 Check for leaks and shut down the engine.

Emergency Temporary Filter Replacement

A WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.



- 1. Drain Valve
- 2. Bottom Plate
- 3. Heat Exchanger
- 5. Heat Exchanger
- 4. Bottom Plate O-Ring
- 5. Lower Housing
- 6. Grommet
- 7. Cover O-Ring
- Inlet Port/Check Valve
- 9. Fuel Outlet Port
- 10. Filter Element
- 11. Spring
- 12. Clear Cover
- 13. Vent Cap O-Ring
- 14. Vent Cap
- 15. Collar

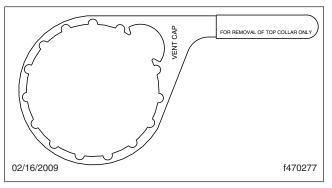


Fig. 2, DAVCO Collar Wrench

 Shut down the engine, apply the parking brake, and chock the tires.

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.

Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap (Fig. 1, Item 14) and open the drain valve (Fig. 1, Item 1) to drain the fuel to just below the collar level, then close the drain valve.
- 4. Using a DAVCO Collar Wrench (Fig. 2), remove the clear cover and collar.

NOTE: Broken vent cap and collar warranty claims will not be accepted if any tool other than a DAVCO Collar Wrench, p/n 380134 or 382002, is used for removal. During installation, the vent cap and collar are to be **hand-tightened only**, not tightened with a wrench.

- 5. Remove the filter and dispose of it in an environmentally acceptable manner.
- Clean all threads and sealing surfaces very thoroughly. Even a small amount of dirt will prevent the fuel/water separator from sealing, and an air leak will result.
- 7. Ensure that the drain valve is closed.

- 8. Remove the filter grommet from the filter stud, if equipped.
- 9. Fill the housing to the top with clean diesel fuel.
- 10. Install a standard engine spin-on filter (part number FF105 or equivalent) on the filter stud.
- 11. Install the cover O-ring, clear cover, and the collar. Hand-tighten the collar.
- 12. Install and hand-tighten the vent cap O-ring and vent cap.
- 13. Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
- 14. Check for leaks and shut down the engine.

Check Valve Replacement, Fuel Pro 382/482 and Diesel Pro 233 Configurations

A WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

 Shut down the engine, apply the parking brake, and chock the tires.

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.

Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle. NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap (Fig. 1, Item 14) and open the drain valve (Fig. 1, Item 1) to drain the fuel to just below the collar level, then close the drain valve.
- 4. Place a shop towel under the fuel inlet fitting. Hold the check valve body in place with an openend wrench and, using a flare-nut wrench, carefully remove the fuel inlet fitting. Drain any residual fuel into the container.
- Remove the check valve assembly from the fuel/ water separator housing.
- 6. Remove and discard the check ball, spring, and plastic retainer. See **Fig. 3**.

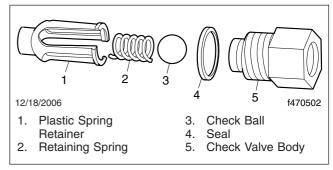


Fig. 3, Check Valve Assembly

- 7. Carefully clean the threads on the check valve body. Install the new check ball, spring, and plastic retainer on the check valve body.
- Clean the threads on the fuel inlet fitting and fuel/water separator housing. Apply a soft-set pipe thread sealant to the check valve body threads.
- Install the check valve body in the fuel/water separator housing and tighten per the specifications in **Table 1**. Do not use tape to seal the fuel fittings; it will eventually leak.

Check Valve Assembly Torque Values				
Fuel/Water Separator Torque Value: lbf·ft (N·m)				
Fuel Pro 382	44-60 (60-81)			
Fuel Pro 482 45 (61)				

Check Valve Assembly Torque Values				
Fuel/Water Separator Torque Value: Ibf-ft (N·m)				
Diesel Pro 233 25–40 (34–54)				

Table 1, Check Valve Assembly Torque Values

- 10. Prime the system
 - 10.1 Ensure that the drain valve is closed.
 - 10.2 Remove the vent cap from the clear cover, and fill the housing to the top with clean diesel fuel.
 - 10.3 Install and hand-tighten the vent cap.
 - 10.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
 - 10.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
 - 10.6 Check for leaks and shut down the engine.

Check Valve Replacement, Diesel Pro 243

WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

1. Shut down the engine, apply the parking brake, and chock the tires.

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.

- 2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.
- 3. Remove the vent cap (Fig. 4, Item 5) and open the drain valve (Fig. 4, Item 1) to drain the fuel to just below the collar level, then close the drain valve.
- Using a DAVCO collar wrench (Fig. 2), remove the clear cover and collar.

NOTE: Broken vent cap and collar warranty claims will not be accepted if any tool other than a DAVCO collar wrench, p/n 380134 or 382002, is used for removal. During installation, the vent cap and collar are to be **hand-tightened only**, not tightened with a wrench.

- 5. Remove the filter and O-rings. Dispose of the filter and O-rings in an environmentally acceptable manner.
- 6. Remove the check valve from the lower housing.
- Clean all threads and sealing surfaces very thoroughly. Even a small amount of dirt will prevent the fuel/water separator from sealing, and an air leak will result.
- Install the new check valve body in the lower housing. Tighten the check valve 12 to 14 lbf-ft (16 to 19N·m).
- Install the new filter and cover O-ring on the housing.
- 10. Install the clear cover and the collar. Hand-tighten the collar.
- 11. Prime the system
 - 11.1 Ensure that the drain valve is closed.
 - 11.2 Fill the housing to the top with clean diesel fuel.
 - 11.3 Install and hand-tighten the vent cap O-ring and vent cap.
 - 11.4 Start the engine. When the lubricating oil reaches its normal operating pressure,

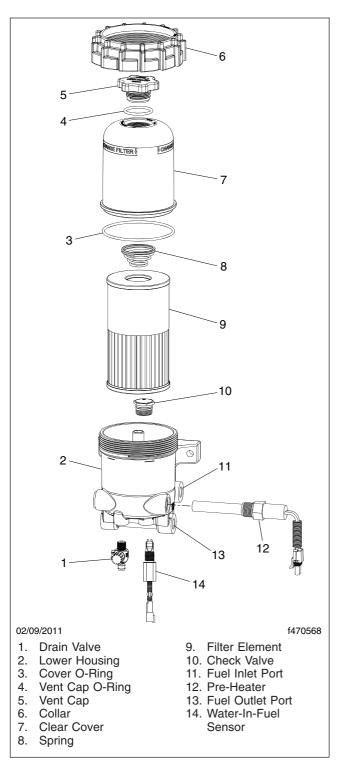


Fig. 4, DAVCO Diesel Pro 243

- increase engine speed to high idle for one to two minutes to purge air from the system
- 11.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
- 11.6 Check for leaks and shut down the engine.

The Daimler Trucks North America Learning Center (accessible through www.AccessFreightliner.com) and DAVCO (www.DavcoTec.com) offer excellent online resources for understanding, testing, and diagnosing fuel/water separator problems.

Identifying Bubble Types

Vapor Bubbles

Vapor bubbles are harmless and are present in all diesel fuel systems. Vapor bubbles are often mistaken for air bubbles, but *do not affect engine performance.*

Vapor bubbles (see **Fig. 1**) may be visible in a diagnostic sight tube installed between the fuel/water separator and the fuel pump. They consist of harmless fuel vapor and trapped air, may vary from champagne-size to 1/4-inch (6-mm) diameter, and may increase in volume or size as the engine rpm increases. The lower pressure inside a fuel/water separator filter, caused by the suction of the fuel pump pulling fuel through the fuel/water separator, creates vapor bubbles. These vapor bubbles are normal and harmless to engine operation. In the fuel pump, the fuel is pressurized and the vapor bubbles dissolve. Vapor bubbles do not appear on the fuel return side of the system.

There is no troubleshooting or repair procedure required for vapor bubbles. Vapor bubbles do not cause performance issues and will not be present downstream of the fuel pump.

Air and Gas Bubbles

Air or gas bubbles indicate harmful leaks, and can cause hard starting and impaired engine performance. All diesel fuel holds some trapped air, caused by the natural splashing that occurs in the fuel tank. But excessive air bubbles, severe enough to degrade engine performance, indicate an air leak on the suction side of the fuel system, from the fuel tank into the fuel pump.

Air bubbles visible in the clear cover of a DAVCO fuel/water separator may indicate an air leak in the fuel system upstream of the bubbles, or in the fuel/water separator; see Fig. 2. If there are no bubbles visible in the clear cover but the engine runs rough, there may be an air leak at or between the fuel/water separator outlet port and the fuel pump inlet. These

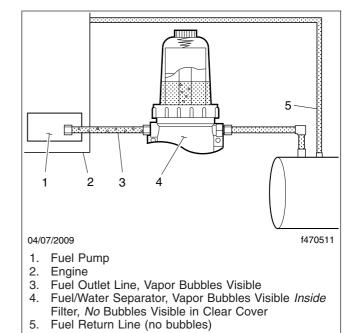


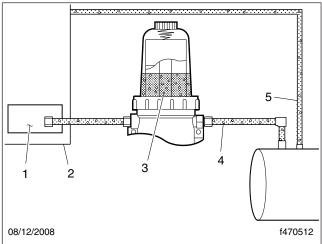
Fig. 1, Harmless Vapor Bubbles

bubbles will be visible in a diagnostic sight tube installed between the fuel pump and the fuel/water separator, and in a diagnostic sight tube installed in the fuel return hose.

Exhaust gas bubbles may also be visible in the clear filter cover. They are the result of leaking fuel injector seals, which can allow combustion gases to enter the fuel system, pass through the fuel return line into the fuel tank, and be drawn into the fuel/water separator. They may be visible in a diagnostic sight tube installed in the fuel return line. To test for combustion gas in the fuel, disconnect the return line at the tank, submerge the end in a bucket of fuel, run the engine, and watch for bubbles. As they pop, these bubbles may smell like exhaust fumes.

In extreme cases, these combustion gas bubbles cause enough aeration in the fuel tank to create visible bubbles in the clear cover of the fuel/water separator and impair engine performance. See the engine manufacturer's documentation for diagnosis and repair of injector seal leakage.

Use the following procedures to determine which bubbles are present in the fuel system, and whether repair is necessary.



- 1. Fuel Pump
- 2. Engine
- Fuel/Water Separator, Bubbles Visible in Clear Cover
- 4. Fuel Inlet Line. Bubbles Visible
- 5. Fuel Return Line, Bubbles Visible

Fig. 2, Air Bubbles Indicating a Leak

Initial Diagnostic Procedure

- Apply the parking brake, chock the tires, and turn on the engine.
- Check for air bubbles in the fuel/water separator clear cover.
- If no bubbles are visible in the clear cover, but the engine continues to run rough, lopes, or has loss of power, there may be an air leak between the fuel/water separator outlet and the fuel pump inlet.

If so, bubbles should be visible in a diagnostic sight tube installed at the fuel pump inlet. Air bubbles may also be visible in a diagnostic sight tube installed in the fuel return line to the fuel tank.

Replace fuel lines and tighten fittings as needed.

Testing Procedures

Air Leak in the Fuel System

Air leaks are sometimes caused by:

loose fittings;

- · a faulty inlet check valve;
- faulty O-rings;
- leakage elsewhere in the fuel system;
- or dirt on threads and sealing surfaces.

Air leaks originating between the fuel tank and the fuel/water separator cause air bubbles visible in the clear cover, as shown in **Fig. 2**.

If there are symptoms of sucking air and there are no bubbles in the clear cover, look for the air leak at:

- · the outlet fitting;
- the fuel pump inlet connection;
- the fuel hose connections;
- or at the vent cap O-ring.
- Shut down the engine, apply the parking brake, and chock the tires.



Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

- Remove the fuel hose from the fuel pump inlet port.
- Install a jumper hose from the inlet port into the fuel tank through the fill cap, or into a container of fuel.
- 4. Start the engine and look for bubbles in the clear filter cover. If the air bubbles are eliminated, the air source (and the leak) is at either the fuel tank fittings, or the hose connections.

If air bubbles persist after the tank fittings and hose connections are secured, the leak may be in the fuel/water separator.

If the leak is suspected to be in the fuel/water separator, disconnect all fuel connections, coat

the threads with liquid or paste sealer, and reconnect the fuel connections and tighten them securely.

Air Pressure Testing

1. Shut down the engine, apply the parking brake, and chock the tires.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- Remove the vent cap and open the drain valve to drain the fuel to just below the collar level, then close the drain valve.
- Remove the fuel/water separator from the chassis. For instructions, see Subject 100.

A WARNING

Wear goggles and skin protection when pressure-testing a fuel/water separator, and be careful not to perform this test near a source of possible ignition, such as an open flame. Never exceed the maximum pressure stipulated for the test, and do not perform this test if the clear cover appears to be damaged.

- Plug the fuel outlet port. Do not remove the filter, filter cover, collar, vent cap, drain valve, or check valve. Do not remove the electric heating element (if equipped), and do not plug the fluid heat ports (if equipped).
- 6. Apply 15 psi (207 kPa) air pressure at the fuel inlet. Immerse the unit in a tank of water and look for air bubbles.
- 7. If no bubbles appear, the air leak is not in the fuel/water separator.
- Install the fuel/water separator onto the chassis frame rail. For instructions, see Subject 100.
- 9. Prime the system
 - 9.1 Ensure that the drain valve is closed.

- 9.2 Remove the vent cap from the cover, and fill the housing to the top with clean diesel fuel.
- 9.3 Install and hand-tighten the vent cap.
- 9.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
- 9.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.

Filter Element Restriction Check

A properly assembled DAVCO fuel/water separator does not restrict fuel flow until the fuel level has risen to the top of the filter. If the fuel level has risen to the top of the filter, replace the filter.

Check Valve Operation Test, Fuel Pro Configurations

When air is introduced into the fuel system, (e.g. when draining fluid or when replacing the fuel filter), the check valve (**Fig. 3**) works to keep the fuel system primed from the fuel tank to the fuel/water separator.

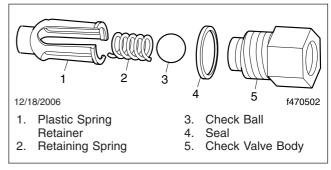


Fig. 3, Check Valve Assembly, Fuel Pro Configurations

To test for proper check valve operation, remove the fuel inlet line, then open the vent cap. Fuel should not flow out of the check valve, although a slight seepage of fuel is normal. If fuel drains back out of the check valve, complete the following procedure.

 Shut down the engine, apply the parking brake, and chock the tires.

WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

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.

Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap and open the drain valve to drain the fuel to just below the collar level, then close the drain valve.
- 4. Place a shop towel under the fuel inlet fitting. Hold the check valve body in place with an openend wrench and, using a flare-nut wrench, carefully remove the fuel inlet fitting. Drain any residual fuel into the container.
- Remove the check valve assembly from the fuel/ water separator housing, see Fig. 3.
- Clean and inspect the check valve body. If the valve body is damaged, or if the ball seat is not smooth, replace the valve. For instructions, see Subject 110.

- 7. If the valve body and ball seat are not damaged, clean the threads on the check valve body, fuel inlet fitting, and the lower housing.
- Apply a soft-set pipe thread sealant to the check valve body threads. Install the check valve body in the fuel/water separator housing. Do not use tape to seal the fuel fittings; it will eventually leak.

Tighten the check valve body 44 to 60 lbf·ft (60 to 81 N·m) on a Fuel Pro fuel/water separator, or 25 to 40 lbf·ft (34 to 54 N·m) on a Diesel Pro fuel/water separator

- 9. Prime the system
 - 9.1 Ensure that the drain valve is closed.
 - 9.2 Remove the vent cap from the clear cover, and fill the housing to the top with clean diesel fuel.
 - 9.3 Install and hand-tighten the vent cap O-ring and vent cap.
 - 9.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
 - 9.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
 - Check for leaks and shut down the engine.

Other Conditions Visible Inside the Cover

The clear filter covers fitted to DAVCO fuel/water separators provide the opportunity to monitor several aspects of fuel condition and engine status, as described in **Table 1**.

Conditions Visible Inside DAVCO Clear Filter Covers				
If You See: What to Do: Comments:				
Amber-colored fuel below the top of the filter element	Nothing, the filter is doing its job	Do not change the filter.		

Conditions Visible Inside DAVCO Clear Filter Covers				
If You See:	What to Do:	Comments:		
Amber-colored fuel with dark patches in places on the filter element	Dark patches indicate bacteria or algae may be present. Use Fleetguard Monitor Kit CC2650 to test for microbiological activity.	It may be necessary to use a microbicide, and suggest vehicle operator carry extra filters.		
Extremely dark or cloudy fuel with thick black film or sludge collecting on the filter element	Black film or sludge on the filter media indicates the presence of asphaltenes. It may be necessary to use an asphaltene conditioner.	Do not assume this is oil from the engine. Monitor the vehicle for oil consumption. Refer to engine manufacturer's service literature for more information.		
Bubbles inside the clear cover	Check for air leaks anywhere in the fuel system. Any leak in any fitting will cause bubbles to appear in the clear cover.	This problem will lead to power complaints; it must be remedied.		
No bubbles in the cover, but the engine is running rough	Check for air leaks between the fuel/water separator outlet port and the fuel pump inlet. Check and tighten all fuel fittings in the area of the leak.	Do not replace the fuel/water separator.		
Coolant in the fluid drained from the fuel/water separator	Check for leaks in the engine, where fuel and coolant are near each other. The most common problem place is the injector cup.	Do not allow the equipment to be operated until the problem is found and repaired.		
Anything not listed here	Call DAVCO at 1-800-328-2611, or email: customerservice@DavcoTec.com.	_		

Table 1, Conditions Visible Inside DAVCO Clear Filter Covers

Electric Heater, Thermoswitch, and Fluid Heater Tests

Any one of several types of heaters and thermoswitches may be fitted to DAVCO fuel/water separators. They include 12 VDC heaters, 120 VAC heaters, combination heater thermoswitches, and fluid heaters. The voltage and wattage ratings are stamped on the hex or the sheath of each component.

Test procedures under these headings apply to the following heater types, as specified:

- Electric Heater
- 12 VDC Thermoswitch
- Combination Heater Thermoswitch
- Fluid Heat

The following equipment is recommended to test DAVCO heaters and thermoswitches:

- A precision low-resistance ohmmeter capable of measuring 0.1 ohm or less
- A clamp-on DC current-flow meter

- A means of chilling a thermoswitch, such as ice, dry ice, or compressed carbon dioxide
- A flameless source of heat, such as an infrared heat lamp
- A vortex tube to heat and cool a thermoswitch

Electric Heater

- Shut down the engine, apply the parking brake, and chock the tires.
- 2. Disconnect the heater from the wiring harness.
- 3. Connect the ohmmeter leads to the pins of the heater (for heaters with one pin, connect to the pin and the bushing).
- 4. Read the resistance and use **Table 2** to determine whether the heater is within the acceptable resistance range.
- 5. Connect the heater wiring harness.

Electric Heater Test Parameters						
Resistance Electric Heater Watts Range: Ohms						
12 VDC (two pin) 250 0.6–0.8						

Electric Heater Test Parameters					
Electric Heater Watts Range: Oh					
12 VDC (single pin)	250	0.4-0.5			
12 VDC (single pin)	150	0.8–1.1			
120 VAC	75	173–203			
120 VAC	37	369-411			

Table 2, Electric Heater Test Parameters

12 VDC Thermoswitch

 Shut down the engine, apply the parking brake, and chock the tires.



Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- Remove the vent cap and open the drain valve to drain the fuel to just below the collar level, then close the drain valve.
- 4. Disconnect the thermoswitch wiring harness, see Fig. 4. Remove the thermoswitch from the fuel/ water separator.

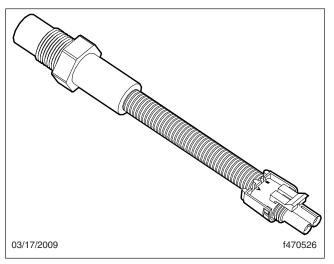


Fig. 4, 12 VDC Thermoswitch

- Connect the ohmmeter leads to the pins of the thermoswitch.
- Lower the thermoswitch temperature to below 40°F (4.4°C). The resistance shown on the ohmmeter should be less than 0.1 ohm.
- 7. Raise the thermoswitch temperature to above 60°F (15.5°C). The resistance should be more than 10 megohms.
- 8. Install the thermoswitch in the fuel/water separator. Connect the thermoswitch wiring harness.
- 9. Prime the system
 - 9.1 Ensure that the drain valve is closed.
 - 9.2 Remove the vent cap from the clear cover, and fill the housing to the top with clean diesel fuel.
 - 9.3 Install and hand-tighten the vent cap.
 - 9.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
 - 9.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
 - Check for leaks and shut down the engine.

Combination Heater Thermoswitch

 Shut down the engine, apply the parking brake, and chock the tires.

A WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap and open the drain valve to drain the fuel to just below the collar level, then close the drain valve.
- Disconnect the heater/thermoswitch unit from the wiring harness, see Fig. 5.
- 5. Connect the ohmmeter leads to the heater/ thermoswitch pins.
- 6. Lower the heater/thermoswitch unit temperature to below 40°F (4.4°C).

The resistance shown on the ohmmeter should be:

- 0.8 to 1.1 ohms for a 12 VDC 150 W unit
- 0.2 to 2.5 ohms for a 24 VDC 250 W unit

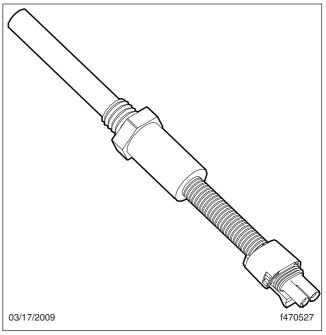


Fig. 5, Combination Heater Thermoswitch

- 7. Raise the heater/thermoswitch unit temperature to above 70°F (21°C). The heater/thermoswitch unit should show an open circuit.
- Install the heater/thermoswitch in the fuel/water separator. Connect the heater/thermoswitch wiring harness.
- 9. Prime the system
 - 9.1 Ensure that the drain valve is closed.
 - 9.2 Remove the vent cap from the clear cover, and fill the housing to the top with clean diesel fuel.
 - 9.3 Install and hand-tighten the vent cap.
 - 9.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
 - 9.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
 - 9.6 Check for leaks and shut down the engine.

Fluid Heat Exchanger

 Shut down the engine, apply the parking brake, and chock the tires.

WARNING

Fluid circulated through the fuel/water separator may be diesel fuel returned from the engine, or engine coolant. Drain the fuel/water separator only when the engine and fluids have cooled. Draining it when the engine is hot could cause severe personal injury due to scalding.

If returning fuel is released into the atmosphere, its vapors can ignite in the presence of any ignition source. Do not expose the fuel to, or work with, the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

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.

2. Put a clean receptacle under the fuel/water separator and attach a piece of hose to the drain valve, to direct fuel into the receptacle.

NOTE: Use a hose with a ½-inch pipe thread to fit the drain valve on a Fuel Pro 382.

- 3. Remove the vent cap and open the drain valve to drain the fuel to just below the collar level, then close the drain valve.
- Disconnect the heating fluid lines from the bottom plate. These will be either engine coolant lines or return fuel lines. Plug engine coolant lines after removing them from the bottom plate of the housing.
- 5. Remove the bottom plate and lower housing O-ring.
- 6. When the fuel entering the fuel/water separator is cold, the thermovalve moves up, allowing warming fluid to enter the heater loop in the heat exchanger. When the fuel is warm, the thermovalve moves down, causing the warming fluid to bypass the heater loop and return directly to the tank. See Fig. 6.

While looking into the fluid port of the bottom plate (Fig. 7), flow cold water over the thermovalve for 30 seconds, then run hot water over the thermovalve to determine whether the thermovalve spool is opening and closing.

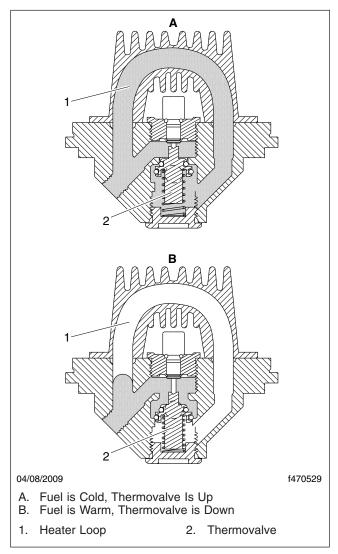


Fig. 6, Heat Exchanger Fluid Flow

- 7. Replace the lower housing O-ring, and install the bottom plate on the fuel/water separator. Install the screws on the bottom plate and tighten them 8 to 10 lbf·ft (11 to 14 N·m).
- 8. Connect the heating fluid lines.
- 9. Prime the system

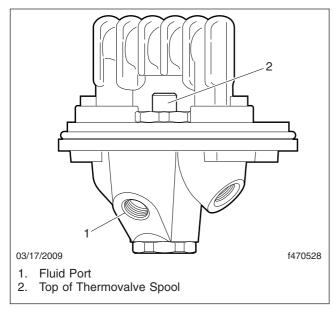


Fig. 7, Fluid Heater Thermovalve Test

- 9.1 Ensure that the drain valve is closed.
- 9.2 Remove the vent cap from the clear cover, and fill the housing to the top with clean diesel fuel.
- 9.3 Install and hand-tighten the vent cap.
- 9.4 Start the engine. When the lubricating oil reaches its normal operating pressure, increase engine speed to high idle for one to two minutes to purge air from the system.
- 9.5 While the engine is running, and after the air is purged from the system, loosen the vent cap until the fuel level falls to just above the collar, then hand-tighten the vent cap.
- Check for leaks and shut down the engine.

Water-in-Fuel Sensor Tests

There are two types of Davco water-in-fuel (WIF) sensors. Both operate the same way. One is equipped with a 2-pin Grey Deutsch connector, the other is equipped with a 2-pin Metri-Pack connector. Both are $82k\Omega$. Both are tested in the same manner. See **Fig. 8** for the sensor with the Deutsch connector, and **Fig. 9** for the sensor with the Metri-Pack

connector. The units have a built in resistor that allows the ECM to recognize the sensor. Part of this test checks that resistor.

Testing

- 1. Drain the DAVCO Fuel Pro.
- Disconnect the WIF sensor from the chassis harness.
- 3. Remove the WIF sensor.
- 4. Inspect the WIF sensor.
 - 4.1 Inspect the probe tips for deposits, corrosion, or missing probe tips. Clean the tips as needed, or replace the sensor if it is damaged.
 - 4.2 Inspect the connector terminals for damage or corrosion. Clean or replace as needed.
 - 4.3 Inspect the wiring at the WIF body. Improper harness routing can result in failure at this location.
- 5. Test the WIF sensor at the connector using a Digital Multi-Meter.
 - 5.1 Set the meter to the OHM mode auto range, or select manual mode range $0-100k\Omega$.
 - 5.2 Check the resistance across the pins at the connector.

The WIF sensor resistance value should be $82k\Omega \pm 5\%$ (77.9 $k\Omega$ to $86.1k\Omega$).

If the resistance is outside of specification, replace the sensor.

If the resistance is within specification, the sensor is good and the issue is unrelated to the sensor.

NOTE: The ECM is looking for the $82k\Omega$ load to confirm the sensor is connected. Therefore, with a good WIF sensor an existing WIF-related code can also indicate an issue with chassis wiring.

6. Check the chassis wiring for potential issues.

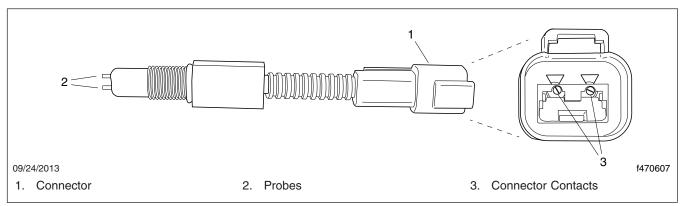


Fig. 8, WIF Sensor with Deutsch Connector

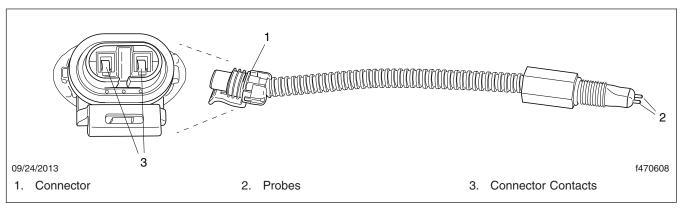


Fig. 9, WIF Sensor with Metri-Pack Connector

Specifications

Component	Fuel Pro 482	Fuel Pro 382		Diesel Pro 243		Diesel Pro 233	
Component	lbf⋅ft (N⋅m)	lbf·ft (N·m)	lbf⋅in (N⋅cm)	lbf⋅ft (N⋅m)	lbf⋅in (N⋅cm)	lbf·ft (N·m)	lbf∙in (N⋅cm)
Inlat Doubleback Value	45 (01)	44–60		12–14		25–40	
Inlet Port/Check Valve	45 (61)	(60–81)	_	(16–19)*	_	(34–54)	_
Water in Fuel Sensor			20–24		20–24		20–24
Water in Fuer Sensor	_	_	(226–271)	_	(226–271)	_	(226–271)
	15–30	15–30		25–40		15 (00)	
Electric Heating Element	(20-41)	(20–41)	_	(34–54)	_	15 (20)	_

^{*} Check valve assembly not connected to inlet port on Diesel Pro 243 configurations.

Table 1, Torque Values

Contents

Subject	Subject Numbe
General Information	
Service Operations	
Removal and Installation	
Filter Element Replacement	
Heater Replacement	
Water Sensor Probe Replacement	
Troubleshooting	300

General Information

General Description

The fuel/water separator is mounted on the frame rail, between the fuel tank and the fuel pump. Fuel drawn to the engine travels through the fuel/water separator, which removes water and solid contaminants. The fuel/water separator includes a spin-on filter element and a sight bowl. See Fig. 1. The fuel/water separator may also be equipped with the following optional components:

- Ignition-controlled heater to melt ice and wax in the fuel
- Water sensor probe to alert the operator to drain the sight bowl
- Manual priming pump to easily prime the fuel/ water separator

Principles of Operation

Diesel fuel enters at the top of the separator and flows down past the heater element, if equipped, to the top of the filter element. As the fuel flows down the sides of the element, the heavier contaminants fall directly to the collection bowl. The filter element itself contains a resin that repels water and forces it to bead and fall to the collection bowl.

Filtered fuel is drawn out through the top of the separator, and the water and solid contaminants remain in the collection bowl. As water collects, it completes the circuit between the two prongs of the water sensor probe, if equipped, and a warning light on the dash alerts the operator to drain the bowl.

The heater is operated by turning on the ignition switch for 5 minutes before starting the engine.

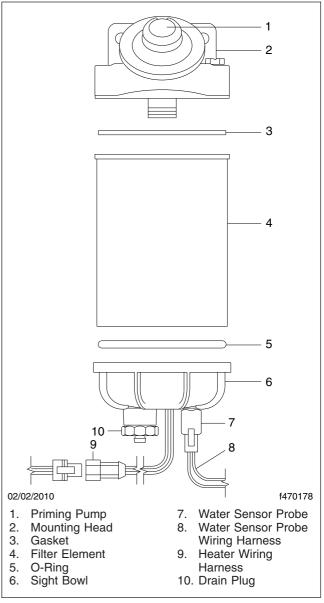


Fig. 1, Fuel/Water Separator Assembly

Removal and Installation

Removal

- Shut down the engine, apply the parking brake, and chock the tires.
 - Open the hood.
- 2. Place a suitable container under the fuel/water 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.

3. Turn the drain plug counterclockwise to open it. If equipped, operate the priming pump. See Fig. 1.

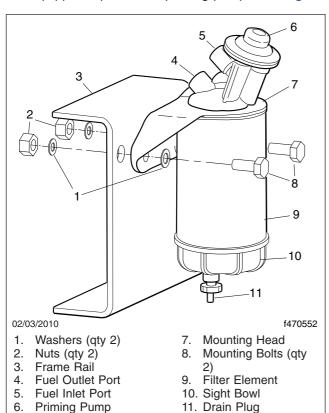


Fig. 1, Fuel/Water Separator Assembly and Installation

4. When the fuel/water separator is completely drained, turn the drain plug clockwise to close it.

A WARNING

Do not expose the fuel to open fire. Do not work with the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

- 5. Disconnect the fuel lines from the fuel/water separator.
- If equipped, disconnect the wiring harnesses from the water sensor probe and the heater element.
- Remove the fuel/water separator mounting bolts, and remove the fuel/water separator from its mounting bracket.

Installation

- 1. Mount the fuel/water separator on the frame rail mounting bracket, and install the mounting bolts. Tighten the bolts 40 lbf·ft (55 N·m).
- 2. Remove the sight bowl and the filter element as a unit from the new fuel/water separator.
- 3. Using clean motor oil or diesel fuel, lubricate the gasket in the top of the filter element.
- Make sure the drain in the sight bowl is closed, then fill the filter element and bowl assembly with clean fuel.
- 5. Install the element and bowl assembly on the mounting head and hand-tighten it until snug.
- 6. If equipped, connect the wiring harnesses to the water sensor probe and the heater.
- 7. Connect the fuel lines to the fuel/water separator. Tighten all fittings finger-tight plus 1/4 turn.
- 8. Prime the fuel/water separator.

If equipped with a priming pump, loosen the drain plug and operate the priming pump until fuel comes out at the drain.

- 9. Start the engine and check for leaks.
- 10. Shut down the engine and repair any leaks.

Filter Element Replacement

Replacement

- Shut down the engine, apply the parking brakes, and chock the tires.
 - Open the hood.
- 2. Place a suitable container under the fuel/water 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.

- 3. Turn the drain plug counterclockwise to open it. If equipped, operate the pump.
- When the fuel/water separator is completely drained, turn the drain plug clockwise to close it.

A WARNING

Do not expose the fuel to open fire. Do not work with the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

- 5. If equipped, disconnect the wiring harnesses from the water sensor probe and the heater. See Fig. 1.
- Spin off the sight bowl and the filter element as a unit. Remove the gasket from the top of the filter element.
- 7. Remove the sight bowl from the filter element. Clean the O-ring seating surface.
- 8. Apply a thin coating of clean diesel fuel or engine oil to the O-ring and the new gasket.
- 9. Spin the sight bowl onto the new filter element and then fill the filter element and sight bowl assembly with clean diesel fuel.
- 10. Spin the entire assembly onto the mounting head and tighten by hand until snug.
- Connect the heater and water sensor wiring harnesses, if equipped.
- 12. Prime the fuel/water separator.

If equipped with a priming pump, loosen the drain plug and operate the priming pump until fuel comes out at the drain.

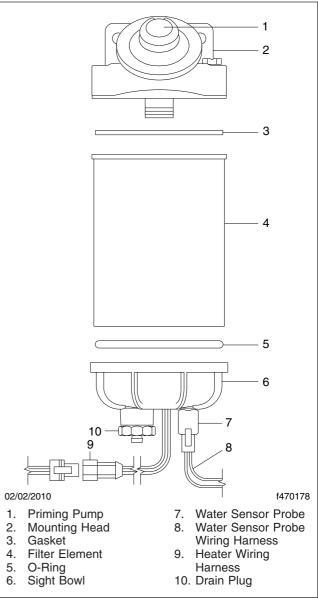


Fig. 1, Fuel/Water Separator Assembly

- 13. Start the engine and check for leaks.
- 14. Shut down the engine and repair any leaks.

Heater Replacement

Replacement

- Shut down the engine, apply the parking brake, and chock the tires.
 - Open the hood.
- 2. Place a suitable container under the fuel/water 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.

- 3. Turn the drain plug counterclockwise to open it. If equipped, operate the priming pump.
- 4. When the fuel/water separator is completely drained, turn the drain plug clockwise to close it.



Do not expose the fuel to open fire. Do not work with the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

5. If equipped, disconnect the wiring harness from the water sensor probe. See Fig. 1.

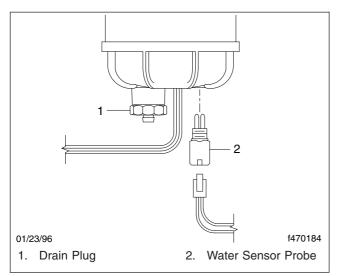


Fig. 1, Water Sensor Probe

Disconnect the heater wiring harness. See Fig. 2.

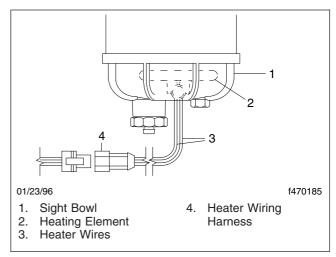


Fig. 2, In-Bowl Heater

- 7. Spin off the sight bowl and the filter element as a unit.
- 8. Remove the sight bowl from the filter element.
- Remove the O-ring from the lip of the new sight bowl. Lubricate the O-ring with a thin film of clean engine oil or diesel fuel and put it back in the sight bowl.
- 10. Install the sight bowl on the bottom of the filter element and hand-tighten until it is snug.
- Make sure the drain in the sight bowl is closed, then fill the filter element and bowl assembly with clean fuel.
- 12. Install the element and bowl assembly on the mounting head and hand-tighten it until snug.
- 13. Connect the heater wiring harness.
 - If equipped, connect the water sensor wiring harness to the water sensor probe.
- 14. Prime the fuel/water separator.

If equipped with a priming pump, loosen the drain plug and operate the priming pump until fuel comes out at the drain.

- 15. Start the engine and check for leaks.
- 16. Shut down the engine and repair any leaks.

Water Sensor Probe Replacement

Replacement

- Apply the parking brakes, shut down the engine, and chock the tires.
 - Open the hood.
- 2. Place a suitable container under the fuel/water 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.

- 3. Turn the drain plug counterclockwise to open it. If equipped, operate the priming pump.
- When the fuel/water separator is completely drained, turn the drain plug clockwise to close it.



Do not expose the fuel to open fire. Do not work with the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

5. Disconnect the water sensor wiring harness from the water sensor probe. See **Fig. 1**.

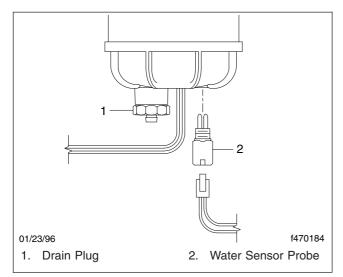


Fig. 1, Water Sensor Probe

Spin off the sight bowl and filter element as a unit.

- Unscrew the water sensor probe from the base of the sight bowl.
- 8. Install a new water sensor probe in the base of the sight bowl.
- Make sure the drain plug in the base of the sight bowl is closed snugly.
- Fill the filter element and sight bowl assembly with clean diesel fuel.
- Install the element and bowl assembly on the mounting head and hand-tighten it until snug.
- Connect the water sensor wiring harness to the water sensor probe.
- 13. Prime the fuel/water separator.

If equipped with a priming pump, loosen the drain plug and operate the priming pump until fuel comes out at the drain.

- 14. Start the engine and check for leaks.
- 15. Shut down the engine and repair any leaks..

Troubleshooting

Problem—Air Leaking into the Fuel System

Problem—Air Leaking into the Fuel System				
Possible Cause Remedy				
The drain is not closed.	Tighten the drain valve.			
The sight bowl or filter element is loose.	Hand-tighten the sight bowl or filter element until snug.			
There are loose, broken, or clogged fuel fittings, valves, or filters.	Tighten, clean, or repair the fuel fittings, valves, or filters as needed.			

Problem—High Water Light Does Not Illuminate For 2 to 5 Seconds When Ignition is Turned to ACCESSORY

Problem—High Water Light Does Not Illuminate For 2 to 5 Seconds When Ignition is Turned to ACCESSORY				
Possible Cause Remedy				
Wiring connections are loose.	Tighten connections as needed.			
Fuel/water separator is not grounded.	Check that power is on, and the fuel/water separator is grounded.			
Wiring is damaged.	Check for damaged wiring and replace as needed. See EZWiring for a diagram of the sensor circuit.			
Water sensor probe is damaged.	Replace the water sensor probe. See Subject 130 for instructions.			

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General Information

General Description

IMPORTANT: The liquefied natural gas (LNG) fuel system should be routinely inspected for gas leakage. Always use a natural gas detector to check the fuel tank, fuel filtering and regulating mechanisms, and fuel lines. Repair or replace any lines, devices, or connections that are leaking.

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 will rise and disperse. Cold atmospheric conditions may prevent natural gas from disbursing quickly when released in large amounts.

Natural gas is nontoxic, but can cause asphyxiation at high enough concentrations simply by excluding adequate oxygen to sustain life.

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.

The LNG fuel system consists of:

- A fuel tank that stores LNG at an extremely low temperature
- Pressure relief and manual fuel shutoff valves
- A vaporizor or heat exchanging device that changes LNG to gaseous form
- A filling connection with a check valve that prevents the gas from flowing back out of the fuel filling line
- A pressure control regulator that reduces the high fuel tank pressure to the lower pressure needed for the engine
- A gas-air mixer to produce a flammable mixture for the engine
- An economizer, or pressure control regulator, that opens at pressures above 120 psi (827 kPa) to reduce pressure in the fuel tank
- A dash-mounted fuel contents gauge that indicates the fuel supply in the tank

If a natural-gas-fueled vehicle is involved in an accident and the fuel tank is damaged, remove the tank from service and have it inspected and repaired by

the tank manufacturer. Repair or replace any damaged or leaking fuel lines, fittings, or other components. Install parts and components in accordance with the manufacturer's instructions.

Related Information and Websites

Detailed LNG fuel system component repair, replacement, and troubleshooting information can be obtained from the fuel system manufacturer's website: www.nexgenfueling.com.

Chart Inc. 407 7th Street NW New Prague, MN 56071 1-800-838-0856

The National Fire Protection Association website provides additional information about LNG and LNG fuel systems: www.nfpa.org.

Safety Precautions

Safety Precautions

A DANGER

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

Liquefied natural gas (LNG) vapors are highly flammable. Whenever a leak is suspected, immediately shut off all engines and ignition sources. Avoid causing sparks, and stay away from arcing switches and equipment. Extinguish cigarettes, pilot lights, flames, and other sources of ignition in the area and adjacent areas. Immediately provide extra ventilation to the area. Do not start any equipment until the gas leak is corrected and the area cleared of LNG.

Natural gas is nontoxic, but can cause asphyxiation at high enough concentrations simply by excluding adequate oxygen to sustain life.

Periodic inspections of the LNG tank are required by law to ensure continued safety. Each fuel tank should be visually inspected at specified intervals for external damage and deterioration. See the *Business Class M2® Maintenance Manual* for inspection schedule information.

If a tank receives an impact, or has deep scratches or gouges, it should be inspected before refilling. The inspection should be performed by a qualified person, in accordance with the tank manufacturer's established inspection criteria.

Always use a natural gas detector to test the system for leaks, whether an odor is present or not. A bubble solution can be used to pinpoint the exact location of leaks.

Servicing Precautions

Observe the following safety precautions when servicing LNG-powered vehicles:

- Always purge the fuel lines and tank before performing maintenance or repairs on the fuel system. This can be done by either transferring LNG in the fuel tank to an approved cryogenicrated container, or by running the vehicle until the tank is empty and the engine stops.
- Close the fuel tank shutoff valves before performing maintenance and repairs. Open the

valves only if LNG is needed to operate the engine or to check for leaks.

- Repair work on an LNG fuel system should be performed only by qualified technicians trained in automotive LNG system repair.
- Always tighten fasteners and fuel connections to the required torque specification. Overtightening or undertightening could cause leaks.
- Cover eyes and exposed skin with cryogenicrated protective devices when working on the fuel system or fueling the vehicle.

Workshop Precautions

Do not store an LNG vehicle indoors for any extended period of time.

Observe the following safety precautions when LNG vehicles are inside a workshop:

- Use only safety fluorescent extension shop lights when working around LNG fuel systems.
- Ensure the shop ceiling is equipped with a vent system that will allow gas to escape and dissipate.
- Ensure the shop is equipped with an alarm system that activates when gas concentration in the air becomes dangerous.
- Have CO₂ fire extinguishers (ABC minimum) located in a highly visible and easily accessible location.
- Permit no smoking or other ignition sources within thirty feet of an LNG vehicle.
- Avoid open flames or sparks near an LNG vehicle.
- Check the fuel tank pressure gauge periodically 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 outdoors immediately.

Major Repair and Replacement of Parts

If a natural-gas-fueled vehicle is involved in an accident, remove the fuel tank from service and have

Safety Precautions

them inspected by a qualified technician. Replace any leaking or damaged fuel tanks and fuel lines; repair or replace leaking or damaged fittings. Install parts and components in accordance with the manufacturer's instructions.

Any and all replacement parts (valves, fittings, tubing, etc.) of the LNG fuel system must be designed specifically for LNG use, and must be approved for use by the fuel system manufacturer.

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

Gas Detection System

A gas detection system is used in all Daimler Trucks LNG-fueled vehicles. The system has a sensor 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 system is meant to serve as a supplemental warning only. It is not intended to replace standard safety practices that should be conducted around flammable gases.

IMPORTANT: To function properly, the gas detection 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 batteries only when necessary, and do not leave the batteries disconnected for extended periods of time.

Tank De-Fueling

De-Fueling

WARNING

Liquefied natural gas (LNG) vapors are highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

IMPORTANT: Follow all local, state, and federal guidelines regarding usage and venting of LNG.

Purging the fuel system and fuel tank can be done by either transferring LNG in the fuel tank to an approved cryogenic-rated container, or by running the vehicle until the tank is empty and the engine stops.

Detailed LNG tank de-fueling information and procedures can be obtained from the fuel system manufacturer: www.nexgenfueling.com.

Chart Inc. 1300 Airport Drive Ball Ground, GA 30107 770-479-6531

Tank Removal and Installation

Removal

If there is any damage to the liquid natural gas (LNG) tank, replace it.

A WARNING

Do not expose the fuel to open fire. Do not work with the fuel system near open flame or intense heat. To do so could cause fire, possibly resulting in serious personal injury or property damage.

Figure 1 shows a typical LNG tank installation.

- Disconnect the electrical connectors from the tank.
- 6. Before removing the fuel tank bands, measure and record the distance from the forward edge of the fuel tank to the edge of the forwardmost band isolator. See Fig. 2.
- 7. To prevent the fuel tank from rolling during and after removal, nail 2-by-4 or 4-by-4 wooden blocks to the top of a pallet about 18 inches (46 mm) apart, then place the pallet on the forks of a fork lift. See Fig. 3.

Move the fork lift and pallet into place to support

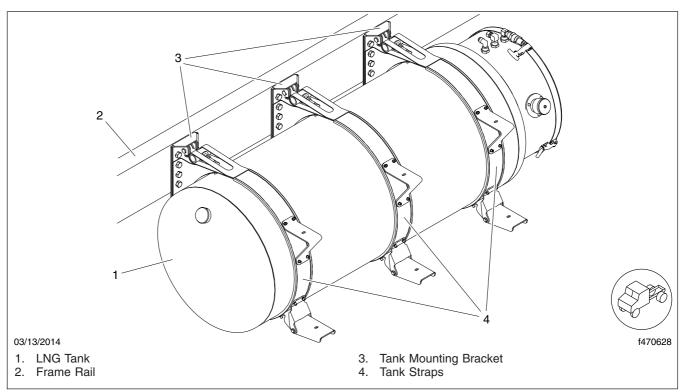


Fig. 1, LNG Tank Installation (left side shown)

- 1. Remove the access steps as needed.
- 2. Close the fuel shutoff valve on tanks that are not being removed.
- De-fuel the tank to be removed. For more information, see Subject 110.
- Disconnect the fuel lines from the tank. Cap or plug the open lines and fittings to prevent contamination.

the fuel tank.

8. Loosen the jam nut on each tank band eye bolt. Remove the jam nut, inner hexnut, and washer. See Fig. 4.

Drop the tank bands and isolators. Leave the tensioner lug inside the band.

9. Remove the fuel tank.

Tank Removal and Installation

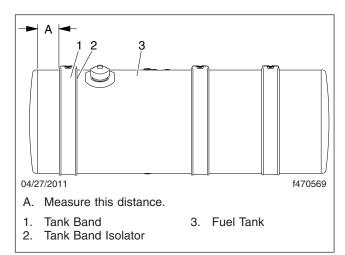


Fig. 2, Distance From Forward Edge of Fuel Tank to Isolator (diesel tank shown)

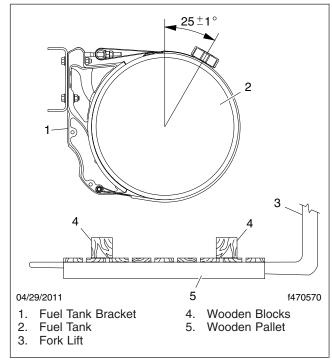


Fig. 3, Fuel Tank Orientation and Support (diesel tank shown)

 After removing the tank, inspect the tank bands, isolators, and brackets for damage. Replace worn or damaged parts with new parts.

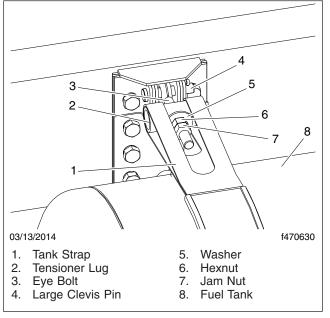


Fig. 4, Fuel Tank Band Assembly

Installation

- 1. Using the fork lift and pallet, put the fuel tank in its approximate installed position. See **Fig. 3**.
- 2. Install the forward tank band and band isolator loosely.
 - 2.1 Holding the tank on the forklift, attach the band and isolator to the eye bolt.
 - 2.2 Install a hardened flatwasher and the inner hexnut, but do not tighten it yet.
- 3. Adjust the tank position until the distance between the forward edge of the tank and the tank band is equal to the distance measured in Fig. 2.

NOTICE -

Fuel tanks can be damaged by direct isolator pressure on the tank weld seam, and by overtightening the fuel tank bands. Be sure the weld seam aligns with reliefs in the isolators and that the bands are tightened to specification.

 Install the other tank band around the tank. Insert the isolators under the brackets so that the relief in each isolator aligns with the tank longitudinal weld seam.

Tank Removal and Installation

- 5. Tighten the inner hexnuts alternately in stages, until each is tightened 32 lbf-ft (44 N·m).
- 6. Install a jam nut on each hexnut, then tighten each jam nut 32 lbf·ft (44 N·m).
- 7. Make certain the fuel lines are clean, then install them on the fuel tank fittings.
- 8. Install the access steps.
- Fill the fuel tank. For more information, see Subject 110.
- 10. Check for leaks. Repair as needed.

Welding an LNG Vehicle

Welding

MARNING WARNING

Liquefied natural gas (LNG) vapors are highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

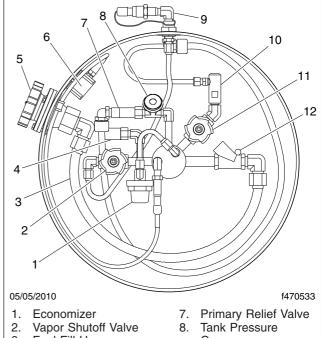
- NOTICE -

Welding an LNG fuel tank could damage the tank vacuum insulation and/or void the warranty. Consult the tank manufacturer (www.nexgenfueling-.com or 770-479-6531) before welding an LNG tank.

IMPORTANT: Follow all local, state, and federal guidelines regarding usage and venting of LNG.

- 1. Park the vehicle on a level surface, shut down the engine and set the parking brake. Chock the
- 2. Ensure the vehicle is parked in a well-ventilated area. Do not park the vehicle in an area where natural gas can accumulate.
- 3. De-fuel the LNG tank. See Subject 110 for more information.
- 4. Close the fuel shutoff and vapor shutoff valves. See Fig. 1.
- 5. Use a natural gas detector to test the area around the vehicle for natural gas.
- 6. Shut down all vehicle electrical systems.
- 7. Cover the LNG tank and fuel lines with a metal shield or welding blankets to prevent sparks or residue from falling on LNG equipment.
- 8. Complete all necessary welding, then remove the protective welding blankets or metal shield.
- 9. Start up the vehicle electrical systems.
- 10. Fill the LNG tank with fuel.

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.



- Fuel Fill Hose
- 4. Secondary Relief Valve (red cap)
- Fuel Fill Fitting
- 6. Fuel Level Sender
- Gauge
- Fill Vent Fitting
- 10. Excess Flow Valve
- 11. Fuel Shutoff Valve (liquid)
- 12. Fill Check Valve

Fig. 1, Fuel Tank Plumbing Components

- Remove the fuel fill fitting dust cap. See Fig. 2.
- 10.2 Using compressed nitrogen or a wire brush, remove any dirt, debris, or water that may have collected in the fuel fill fitting and the station dispensing nozzle.
- 10.3 Connect the station fueling nozzle to the tank fuel fill fitting.
- 10.4 Connect an electrical ground clamp and cable to the fuel tank.

IMPORTANT: An LNG tank 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

Welding an LNG Vehicle

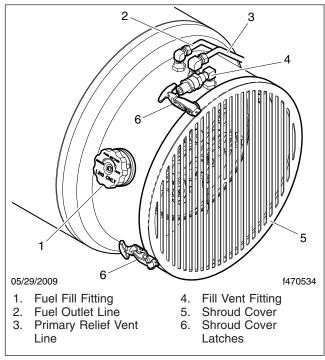


Fig. 2, LNG Fuel Tank

down, connect a vent line to the fill vent fitting to capture escaping vapor, then open the shroud cover and open the vapor shutoff valve.

10.5 Open the station's fill valve, if equipped, and start fueling. Monitor the flow or line pressure as filling progresses.

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 continue fueling the tank to full.

- 10.6 When a rapid pressure rise or flow rate drop is observed, close the station's fill valve, if equipped.
- 10.7 Disconnect the station hose from the tank fuel fill fitting.
- 10.8 Disconnect the electrical ground clamp and cable from the fuel tank.

- 10.9 Install the dust cap on the tank fuel fill fitting.
- 11. Open the fuel shutoff and vapor shutoff valves. See Fig. 1.

LNG System

Refer to the system manufacturer's service literature for system troubleshooting information.

If a natural-gas-fueled vehicle is involved in an accident and the fuel tank is damaged, remove the tank from service and have it inspected and repaired by the tank manufacturer. Repair or replace any damaged or leaking fuel lines, fittings, or other components. Install parts and components in accordance with the manufacturer's instructions.

AMGaDS III Plus Gas Detection System

A WARNING

Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

Natural gas powered vehicles are equipped with a natural gas leak detection system. One sensor is located in the cab overhead panel in the control panel, the other sensor is located on the frontwall in the engine compartment. The system is powered directly from the vehicle batteries and is active at all times, unless the batteries are disconnected. When the system has power, and is operating normally with all sensors confirmed operational, and no leaks detected, the green "Power" LED, and the large green light are on. When the presence of gas is detected in any zone, an indicator LED will illuminate depending on the level of gas detected. If a problem with a sensor or wiring occurs, a "Fault" LED will illuminate for the zone that is affected. When a fault is present, no detection is operational in that zone. The following troubleshooting tables show all the different possible light combinations, what they indicate, the troubleshooting procedures, and the suggested remedy. For vehicle-specific wiring diagrams, refer to G06-89262 in EZWiring™.

IMPORTANT: Before performing any troubleshooting, allow the system 60 seconds to complete the initialization process.

Green "Power" Light On



Front Panel Indication	Troubleshoot	Remedy
The green "Power" LED on the main panel and the large green LED are on. The system has power and is operating normally. In this state the panel and all sensors are confirmed operational.	System is operating normally.	No repair needed.

No Lights on Front Panel



Front Panel Indication	Troubleshoot	Result	Remedy
		Yes	Go to next the step.
	Are all of the connectors plugged in at the back of the panel?	No	Plug in the connector. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Is there power (9-14 vdc) and ground at	Yes	Replace the panel.
	the panel?	No	Go to the next step.
	Check the terminal on the back of the panel for loose or improperly installed pins. Were there any bad pins?	Yes	Repair and Go to next the step. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
No lights are illuminated on		No	Go to the next step.
the panel. The panel has no power. No gas detection or warning is possible.	Is the fuse blown or missing at the power-net distribution box (PNDB)?	Yes	Replace the fuse. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next the step.
	Does the circuit have continuity or high resistance?	Yes	If it has continuity, and still has no power go to PNDB troubleshooting.
		No	If there is no continuity, or high resistance Go to next the step.
	Check connectors at the fire wall and PNDB.	Yes	Replace the damaged cable(s).
	Have any of the cables been pinched, cut, or damaged?	No	Contact the vendor.

Amber "Sensor Fault" Light On



Troubleshoot Front Panel Indication Result Remedy Repair as needed. If the problem is resolved, no further work is needed. If Check the sensor connections at the Yes the problem still exists, go to the next back of the panel and at the sensors. step. Are the connectors loose or damaged? No Go to next the step. Repair as needed. If the problem is resolved, no further work is needed. If The amber "Sensor Fault" Check the pins in the connectors on the Yes the problem still exists, go to the next panel and in the sensors. Are the pins light indicates that there is a step. loose or damaged? problem in the zone specified. In this case zone 1 and 2. No Go to next the step. When a fault light is on, If the fault moves with the cable, detection is not possible in If both "Sensor Fault" lights are on, skip Yes proceed to the next step. any zones where a fault is this step and proceed to the next step. present. If it stays, replace the panel. If the Swap the zone that is reporting a problem is resolved, no further work is sensor fault by switching the connectors No needed. If the problem still exists, go to at the rear of the panel. Did the other light illuminate? the next step. Yes Replace the harness. Check for continuity in the harness. Is there high resistance in the sensor Replace the sensor, unless it is both, No harness? then replace the panel.

Amber "Trace" Light Flashing



Front Panel Indication	Troubleshoot	Result	Remedy
1 Tont Faner mulcation	111111111111111111111111111111111111111	Hesuit	nemedy
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	not venting or leaking. Is there a gas leak?	No	Go to next the step.
The flashing amber "Trace" light indicates that a trace amount of gas (greater than 20% and less than 50%) has been detected in the specified zone, in this case zone 2.	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next the step.
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next the step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed.
	check continuity and resistance in the	Yes	Replace the sensor.
	sensor harness. Is the harness good?	No	Replace the harness.

WARNING

The following tests should only be performed after determining that it is safe to do so.

Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG, etc.).

Have the problem repaired by qualified personnel before further operation of the vehicle.

Do not perform "SIGNIFICANT" and "Trace" diagnosis, until the non-presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.

Red "SIGNIFICANT" Light, Amber "Trace" Lights, and Buzzer 1



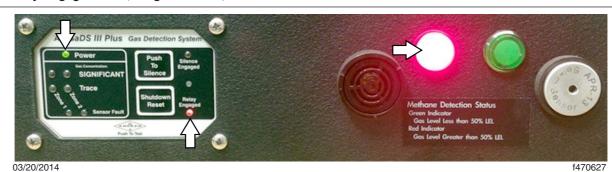
Front Panel Indication	Troubleshoot	Result	Remedy
	Is the "Amerex Push to Test" button	Yes	Let go.
The red "SIGNIFICANT" light	being held?	No	Go to next the step.
and amber "Trace" lights and buzzer 1 indicate that a significant level of combustible gas (greater than 50% lower explosive limit	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
(LEL)) has been detected in the applicable zone. In this case zone 2.	not venting or leaking. Is there a gas leak?	No	Go to next the step.
Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG, etc.).	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next the step.
Have the problem repaired by qualified personnel before	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.
further operation of the vehicle.		No	Go to next the step.
Do not perform "SIGNIFICANT" and "Trace" diagnosis, until the non- presence of gas is confirmed and the panel has had constant power for 60	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
seconds of calibration.	Check continuity and resistance in the	Yes	Replace the sensor.
	sensor harness. Is the harness good?	No	Replace the harness.

Red "SIGNIFICANT" Light, Amber "Trace" Lights, and Buzzers 1 and 2



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Front Panel Indication	Troubleshoot	Result	Remedy
The red "Significant" light and amber "Trace" lights along with buzzers 1 and 2 indicate	Is the "Amerex Push to Test" button being held and has it been held continuously for 15 seconds causing the relay to trip?	Yes	Release the button, and press the "Shutdown/Reset" button to reset the relay. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
that a significant level of		No	Go to next the step.
combustible gas (greater than 50% LEL) has been detected in the applicable zone, in this case zone 2.	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
Remove all personnel from the area. Ventilate the area.	not venting or leaking.	No	Go to next the step.
Manually shut off the source	Is there a gas leak?	140	do to flext the step.
of gas (propane/CNG/LNG, etc.). Have the problem repaired by qualified personnel before further operation of the vehicle. The large red LED and buzzer 2 indicates the significant gas detection has been present for over 15 seconds and the	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	repair, etc.	No	Go to next the step.
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.
relay has engaged.		No	Go to next the step.
Do not perform "SIGNIFICANT" and "Trace" diagnosis, until the non- presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.	Swap the zone that is reporting a	Yes	If the fault moves with the cable proceed to the next step.
	sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
occommon delibration	Check continuity and resistance in the	Yes	Replace the sensor.
	sensor harness. Is the harness good?	No	Replace the harness.

Red "Relay Engaged" LED, Large Red LED, and Buzzer 2



For the state of t					
Front Panel Indication	Troubleshoot	Result	Remedy		
	Has the "Amerex Push to Test" button been pressed and held for 15 seconds causing the relay to trip?	Yes	Press the "Shutdown/Reset" button. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.		
		No	Go to next the step.		
The red "Relay Engaged" LED and the large red LED along with buzzer 2 indicates that a significant level of gas (greater than 50%) was detected at some point.	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.		
	not venting or leaking. Is there a gas leak?	No	Go to next the step.		
The significant gas level is no longer present, as the "SIGNIFICANT" LED and "Trace" LED are no longer illuminated. The panel relay has engaged and must be reset by pressing the "Shutdown/ Reset" button. Do not troubleshoot the system until the reason for the significant alarm is understood.	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.		
		No	Go to next the step.		
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.		
		No	Go to next the step.		
	Swap the zone that is reporting a	Yes	If the fault moves with the cable, proceed to the next step.		
	sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.		
	Check continuity and resistance in the	Yes	Replace the sensor.		
	sensor harness. Is the harness good?	No	Replace the harness.		

Fireboy Methane Fume Detector System

General Information

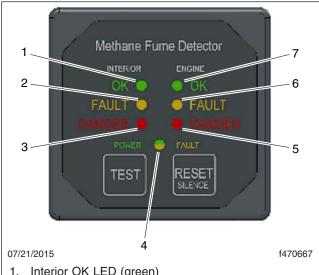
The Fireboy Methane Fume Detector vapormonitoring system utilizes advanced technology for detection of methane fumes. It has two sensors and has both visual and audible alarms that trigger at 20% and 50% of the LEL (Lower Explosive Limit) of methane respectively. A test switch is provided to test LED and output operation. System operation and correct sensor operation are continually monitored and LEDs are provided for fault detection. The display has an internal relay for automatic control of an external device up to 1 amp maximum fuse capacity. See Fig. 1.

Troubleshooting



Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

Natural gas powered vehicles are equipped with a natural gas leak detection system. One sensor is located in the cab overhead panel in the control panel. the other sensor is located on the frontwall in the engine compartment. The system is powered directly from the vehicle batteries and is active at all times, unless the batteries are disconnected. When the system has power, and is operating normally with all sensors confirmed operational, and no leaks detected, the green "Power" LED, and the large green light are on. When the presence of gas is detected in

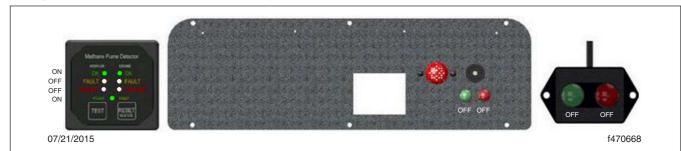


- 1. Interior OK LED (green)
- Interior Fault LED (yellow)
- Interior Danger LED (red)
- Test Button
- Engine OK LED (green)
- Engine Fault LED (yellow)
- Engine Danger LED (red)
- Reset/Silence
- Power/Fault LED (green/yellow)

Fig. 1, Methane Fume Detector Dash Display

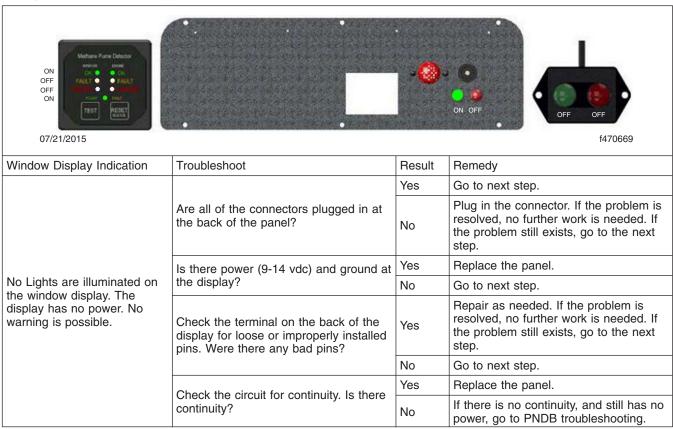
any zone, an indicator LED will illuminate depending on the level of gas detected. If a problem with a sensor or wiring occurs, a "Fault" LED will illuminate for the zone that is affected. When a fault is present, no detection is operational in that zone. The following troubleshooting tables show all the different possible light combinations, what they indicate, the troubleshooting procedures, and the suggested remedy. For vehicle-specific wiring diagrams, refer to G06-92425 in EZWiring™.

No Lights on Front Panel and Window Display

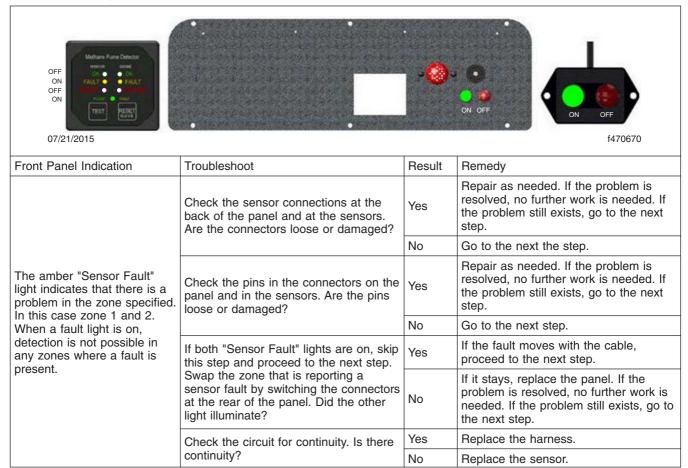


Front Panel Indication	Troubleshoot	Result	Remedy
	Are all of the connectors plugged in at	Yes	Go to next step.
		No	Plug in the connector. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Is there power (9-14 vdc) and ground at	Yes	Replace the panel.
	the panel?	No	Go to next step.
No lights are illuminated on	Check the terminal on the back of the panel for loose or improperly installed pins. Were there any bad pins?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
the panel. The panel has no		No	Go to next step.
power. No gas detection or warning is possible.	Is the fuse blown or missing at the power-net distribution box (PNDB)?	Yes	Replace the fuse. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next step.
	Check the circuit for continuity.	Yes	If there is no continuity, and still has no power go to PNDB troubleshooting.
		No	If there is no continuity, or high resistance go to the next step.
	Check connectors at the fire wall and	Yes	Replace the damaged cable(s).
	PNDB. Have any of the cables been pinched, cut, or damaged?	No	Contact the vendor.

No Lights on Window Display



Amber "Fault" Light On



A WARNING

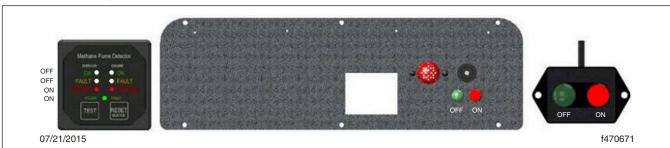
The following tests should only be performed after determining that it is safe to do so.

Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG, etc.).

Have the problem repaired by qualified personnel before further operation of the vehicle.

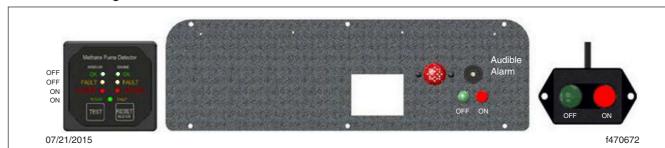
Do not perform "DANGER" diagnosis, until the non-presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.

Red "DANGER" Light On



E. I. B I. I. I II.		D	In
Front Panel Indication	Troubleshoot	Result	Remedy
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are not venting or leaking. Is there a	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	gas leak?	No	Go to the next the step.
The red "DANGER" light indicates that a trace amount of gas (greater than 20% and less than 50%) has been detected in the specified	Are there any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next the step.
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
zone.		No	Go to the next the step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Check the circuit for continuity. Is there	Yes	Replace the sensor.
	1 0	No	Replace the harness.

Red "DANGER" Light and Buzzer On



Front Panel Indication	Troubleshoot	Result	Remedy
	Is the "Test" button being held?	Yes	Let go.
	is the Test button being held:	No	Go to the next the step.
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are not venting or leaking. Is there a	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	gas leak?	No	Go to the next the step.
The red "DANGER" light and buzzer indicate that a significant level of combustible gas (greater than 50% lower explosive limit (LEL)) has been detected in the applicable zone.	Are there any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next the step.
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next the step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Check the circuit for continuity. Is there	Yes	Replace the sensor.
	continuity?	No	Replace the harness.

47.04

Compressed Natural Gas Fuel System

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General Information

General Description

IMPORTANT: The compressed natural gas (CNG) fuel system should be routinely inspected for gas leakage. Use a natural gas detector to check fuel cylinders, fuel filtering and regulating mechanisms, and fuel lines. Replace leaking fuel cylinders; repair or replace any lines, devices, or connections that are leaking.

CNG is made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure. When vaporized at ambient temperatures, natural gas is less dense than air, and it will rise and disperse. Cold atmospheric conditions may prevent natural gas from disbursing quickly when released in large amounts.

Natural gas is nontoxic, but can cause asphyxiation at high enough concentrations simply by excluding adequate oxygen to sustain life.

Commercial CNG normally contains an odorproducing chemical. However, a natural gas detector is recommended for leak checking.

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.

The CNG fuel system consists of:

- Fuel cylinders that store CNG at high pressure
- 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
- A high-pressure fuel filter
- A pressure control regulator that reduces the high fuel cylinder pressure to the lower pressure needed for the engine
- A gas-air mixer to produce a flammable mixture for the engine
- A dash-mounted fuel contents gauge that indicates the available fuel supply in the cylinders

Related Information and Websites

Detailed CNG fuel system repair, replacement, and troubleshooting information can be obtained from the fuel system manufacturer.

Agility Fuel Systems 1815 E Carnegie Avenue Santa Ana, CA 92705 949-267-7738

www.agilityfuelsystems.com

Agility Customer Support, 949-267-7745.

Information about Cummins CNG engines can be accessed at: Cummins Westport http://www.cumminswestport.com

The following documents and websites provide additional information about CNG and CNG fuel systems:

- NFPA 52 Vehicular Gaseous Fuel Systems Code, 2010: www.nfpa.org
- Society of Automotive Engineers Recommended Practice for Compressed Natural Gas Vehicle Fuel: standards.sae.org/ j1616_199402/
- Compressed Gas Association: www.cganet.com

Safety Precautions

Safety Precautions

WARNING

Compressed natural gas is highly flammable. Failure to observe the following precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

Whenever gas is smelled, immediately shut off all engines and ignition sources. Avoid causing sparks, and stay away from arcing switches and equipment. Extinguish cigarettes, pilot lights, flames, and other sources of ignition in the area and adjacent areas. Immediately provide extra ventilation to the area. Do not start any equipment until the gas leak is corrected and the area cleared of natural gas.

Periodic inspections of the compressed natural gas (CNG) fuel cylinders are required by law to ensure continued safety. Each fuel cylinder should be visually inspected at specified intervals for external damage and deterioration. See the *Business Class M2 Maintenance Manual* for inspection schedule information.

If a cylinder receives an impact or has deep scratches or gouges, it should be inspected before refilling. The inspection should be performed by a qualified person, in accordance with the manufacturer's established inspection criteria and Compressed Gas Association procedures.

Always use a natural gas detector to check for leaks.

Servicing Precautions

Observe the following safety precautions when servicing CNG-powered vehicles:

- Always purge the fuel lines before performing maintenance or repairs on a CNG fuel system.
 Do not transfer CNG from one vehicle to another, as a buildup of static electricity could cause a spark and ignite the fuel.
- Only vent CNG outdoors in a safe location.
- Close the fuel cylinder shutoff valves before performing maintenance and repairs. Open the valves only if CNG is needed to operate the engine or to check for leaks.

- Repair work on a CNG fuel system should be performed only by qualified technicians trained in automotive CNG system repair.
- Always tighten fasteners and fuel connections to the required torque specification. Overtightening or undertightening could cause leaks.
- Cover eyes and exposed skin when working on a CNG fuel system or fueling a CNG vehicle.

Workshop Precautions

Do not store a CNG vehicle indoors for any extended period of time.

Observe the following safety precautions when CNG vehicles are inside a workshop:

- Use only safety fluorescent extension shop lights.
- Ensure the shop ceiling is equipped with a vent system that will allow gas to escape and dissipate.
- Ensure the shop is equipped with an alarm system that activates when gas concentration in the air becomes dangerous.
- Have CO₂ fire extinguishers (ABC minimum) located in a highly visible and easily accessible location.
- Permit no smoking or other ignition sources within thirty feet of a CNG vehicle.
- Avoid open flames or sparks near a CNG vehicle.
- Close the fuel cylinder shutoff valves when storing the vehicle inside. Open the valves only if CNG is needed to operate the engine or to check for leaks.

Major Repair and Replacement of Parts

Replace any leaking or damaged fuel cylinders and fuel lines; repair or replace leaking or damaged fittings. Install parts and components in accordance with the manufacturer's instructions.

Any and all replacement parts (valves, fittings, hoses, etc.) of the CNG fuel system must be designed specifically for CNG automotive use, and must be offi-

Safety Precautions

cially approved and rated for the pressures and conditions that pertain.

Gas Detection System

A gas detection system is used in all Daimler Trucks CNG-fueled vehicles. The system has a sensor 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 system is meant to serve as a supplemental warning only. It is not intended to replace standard safety practices that should be conducted around flammable gases.

IMPORTANT: To function properly, the gas detection 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 batteries only when necessary, and do not leave the batteries disconnected for extended periods of time.

Fuel Cylinder Venting

Venting

A WARNING

Compressed natural gas is highly flammable. Do not attempt to transfer compressed natural gas (CNG) from one vehicle to another with out an appropriate NG transfer line, as a buildup of static electricity could cause a spark and ignite the fuel, which could cause severe bodily injury, death, or property damage.

IMPORTANT: Only vent compressed natural gas (CNG) outdoors in a safe location.

The fuel cylinder shutoff valves are installed in line from top to bottom. Closing a fuel cylinder shutoff valve will cut off the flow of CNG from that cylinder and all of the fuel cylinders positioned above it in the storage box.

Compressed natural gas can be vented from the fuel cylinders in two ways.

- Run the engine until it stops.
- Open the CNG bleed valve on the manifold.

If only one cylinder needs to be purged, close the fuel shutoff valves on the fuel cylinders positioned above it. Then, either run the engine until the cylinders are empty and the engine stops, or open the bleed valve and allow the CNG to vent. At this time, all CNG in the venting cylinder and the cylinders in line below it will have vented.

CNG Fuel Tank Removal and Installation

WARNING

Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

NOTE: The tanks can be removed with CNG present in the tanks. Tanks must be stored outdoors, or in an approved facility with proper ventilation, and a natural gas safety monitoring sys-

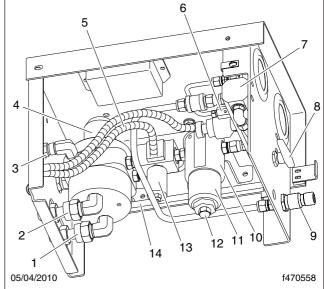
Back-of-Cab-Mounted Tank Removal

- 1. Park the vehicle on a level surface, shut down the engine, and set the parking brakes. Chock the tires.
- 2. Depressurize the CNG system. Follow the instructions in Subject 110.

IMPORTANT: Some residual pressure and gas from the low-pressure side of the system may escape when loosening the fittings. Be prepared for this, and observe all safety precautions.

NOTE: The fuel management module (FMM), coolant hoses, natural gas fuel lines, and wire harnesses are located in the lower area of the cabinet on vehicles with only a back-of-cab installation. See Fig. 1.

- 3. Disconnect CNG fuel lines.
- 4. Cap or plug all open fuel lines and fittings to prevent system contamination.
- 5. Position the lifting device as needed and connect the chain or sling to the evelets on the top of the cabinet. Apply enough pressure to prevent the cabinet from tipping when loosened.
- 6. Remove the mounting bracket bolts. See Fig. 2.
- 7. Using safe lifting procedures with a forklift or hoist, lift the tank up off the frame rails and out or backwards to clear the chassis.



- Coolant Inlet Port
- Coolant Outlet Port
- Pressure Relief Valve
- 4. Pressure Regulator
- Wiring Harness
- Manifold Bleed Valve
- Manifold
- 8. Manual Fuel Shut-Off Valve
- 9. Fuel Fill Port 10. Filter Housing
- 11. Filter Bowl
- 12. Filter Drain Plug
- 13. Solenoid Valve
- 14. Fuel Line To Cylinders

Fig. 1, Back-of-Cab Plumbing and Wiring

Back-of-Cab Mounted Tank Installation

- 1. Using an appropriate lifting device, position the cabinet on the frame rails and align the mounting bracket holes on the cabinet with the holes in the mounting brackets on the frame rails.
- 2. While still supported with the lifting device, install the mounting bolts with washers from the bottom of the cabinet. See Fig. 2. Tighten the nuts 160 lbf.ft (217 N·m).
- 3. Remove lifting device.
- 4. Connect the coolant hoses.
- 5. Connect the CNG fuel lines. Tighten the fittings to the specifications shown in Table 1.

CNG Fuel Tank Removal and Installation

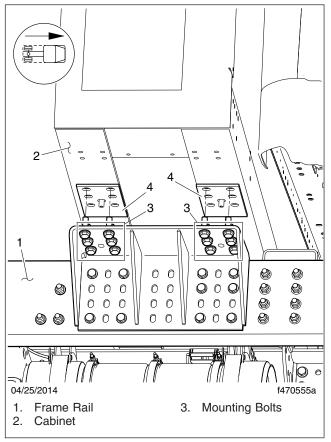


Fig. 2, Back-of-Cab Cabinet Installation

SAE Torque Specifications: O-Ring Boss Fittings			
Fitting Size	Torque: Ibf·ft (N·m)		
7/16-20	15 (20)		
1/2-20	18 (24)		
9/16-18	26 (35)		
3/4-16	51 (69)		
7/8-14	74 (100)		
1-1/16-12	125 (169)		

Table 1, SAE Torque Specifications: O-ring Boss Fittings

- 6. Connect the wiring harnesses.
- 7. Secure any mounting that was removed.
- 8. Pressurize the system.

9. Check for leaks per the manufactures specifications. Repair any leaks as needed.

Welding a CNG Vehicle

WARNING

Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

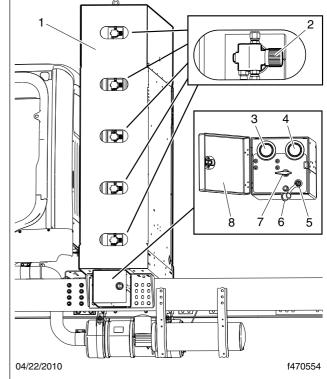
Welding

IMPORTANT: Follow all local, state, and federal guidelines regarding usage and venting of compressed natural gas (CNG).

- Park the vehicle on a level surface, shut down the engine and set the parking brake. Chock the tires.
- 2. Close the CNG fuel cylinder shutoff valves. See Fig. 1.
- 3. Start the engine and let it idle until the fuel lines are empty and the engine stops. The gauges on the fuel panel should now read at or near 0 psi (0 kPa).
- Close the manual fuel shutoff valve on the fuel panel.
- 5. Remove and save the two capscrews that secure the access cover to the fill panel, then remove the access cover. See Fig. 2.
- 6. Slowly open the bleed valve on the manifold to relieve remaining fuel pressure within the system. See Fig. 3.

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.

- 7. Disconnect the wiring harness from the solenoid valve.
- Use a remote 12-volt power source to activate the solenoid valve to drain any compressed natural gas remaining in the fuel system between the solenoid valve and the engine.



- 1. Fuel Cylinder Storage Box
- Fuel Cylinder Shutoff Valves (5 valves on a 5-tank system)
- 3. High-Pressure Gauge
- 4. Low-Pressure Gauge
- 5. Fuel Fill Port
- 6. Dust Cap
- 7. Manual Shutoff Valve
- 8. Fuel Panel Access Door

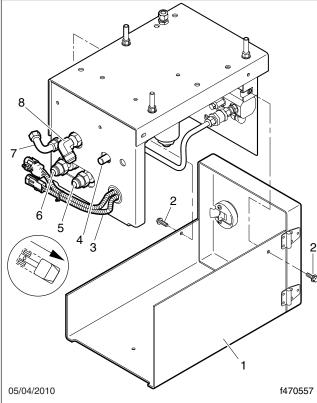
Fig. 1, CNG Fuel Cylinder Storage Box (5-cylinder system shown)

NOTICE -

Disconnect the battery power and ground cables and any electronic control units (ECUs) installed on the vehicle. Electric currents produced during electric welding can damage various electrical components on the vehicle, such as alternator diodes and ECUs. Freightliner vehicle components that typically use ECUs include electronic engine, electronic automatic transmission, and antilock braking system (ABS).

For any ECU with a battery power harness, disconnect its ground terminal from the chassis ground, and disconnect its power terminal from

Welding a CNG Vehicle



NOTE: CNG fuel panel may be located on the right side of the vehicle.

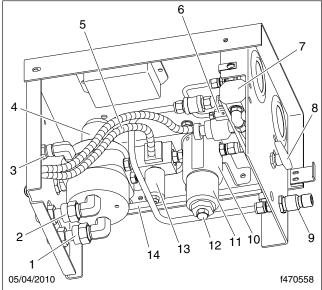
- 1. Fuel Panel Access Cover
- 2. Capscrews (qty 2)
- 3. Wiring Harness
- 4. Pressure Relief Valve and Cap
- 5. Coolant Outlet Line
- 6. Coolant Inlet Line
- 7. Fuel Inlet Line (from fuel cylinders)
- 8. Fuel Outlet Line (to engine)

Fig. 2, CNG Fuel Panel Assembly

the battery positive post, or disconnect the main connection at the ECU.

- Shut down all vehicle electrical systems and disconnect the battery.
- Let the vehicle sit in a well-ventilated area for at least 10 minutes.

IMPORTANT: Do not weld in areas directly adjacent to CNG tanks. Avoid direct heat exposure on tanks.



- 1. Coolant Inlet Port
- 2. Coolant Outlet Port
- 3. Pressure Relief Valve
- 4. Pressure Regulator
- 5. Wiring Harness
- 6. Manifold Bleed Valve
- 7. Manifold
- 8. Manual Fuel Shutoff Valve
- 9. Fuel Fill Port
- 10. Filter Housing
- 11. Filter Bowl
- 12. Filter Drain Plug
- 13. Solenoid Valve
- 14. Fuel Line to Cylinders

Fig. 3, CNG Fuel Panel Components

- 11. Cover the CNG tanks and fuel lines with a metal shield or welding blankets to prevent sparks or residue from contacting CNG equipment.
- 12. Complete all necessary welding, then remove the protective welding blankets or metal shield.
- Start up the vehicle electrical system and connect the battery.
- 14. Connect the electrical harness to the solenoid valve.
- 15. Close the bleed valve on the manifold and open the manual fuel shutoff valve on the fuel panel.
- 16. Open the fuel cylinder shutoff valves.
- 17. Start the engine and check for gas leaks in the fuel system.

Welding a CNG Vehicle

Using a methane detector, leak test all fuel system components. A bubble solution can be used to pinpoint the exact location of leaks.

Repair or replace any leaking components.

18. Using the two capscrews removed previously, install the access cover on the fill panel.

CNG System

See Fig. 1 for a schematic of CNG fuel system components.

See Fig. 2 for a flow chart to troubleshoot problems with an engine running lean.

See Fig. 3 for a flow chart to troubleshoot a faulty dash-mounted fuel gauge reading.

See Fig. 4 for a flow chart to troubleshoot a compressed natural gas leak in the fuel system.

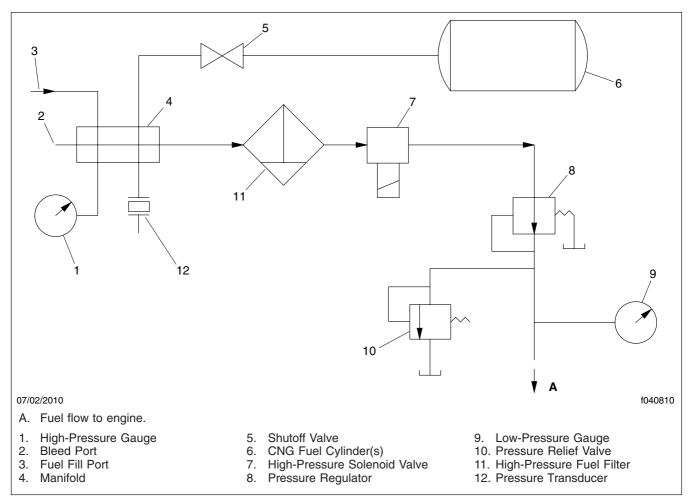


Fig. 1, CNG Fuel System Schematic (typical)

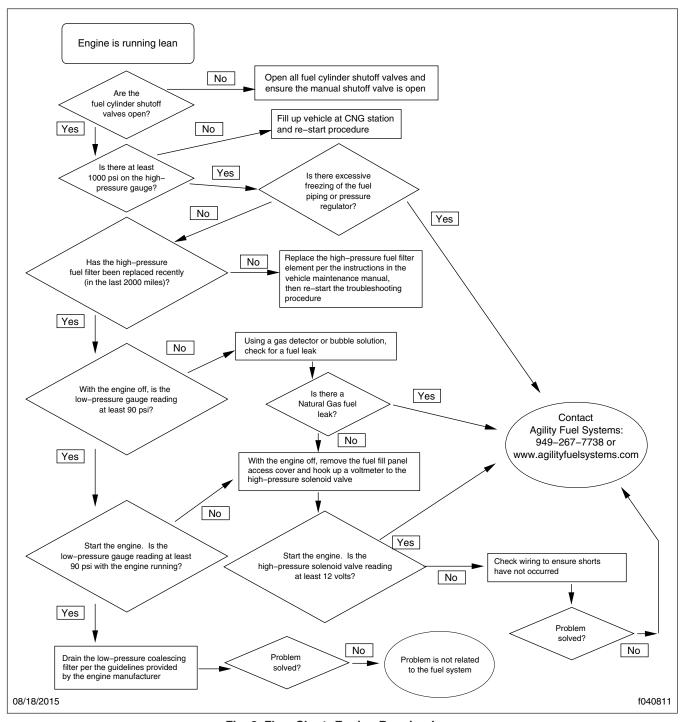


Fig. 2, Flow Chart: Engine Running Lean

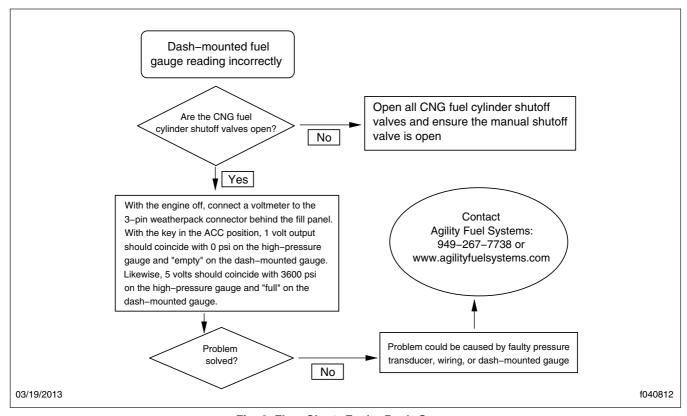


Fig. 3, Flow Chart: Faulty Dash Gauge

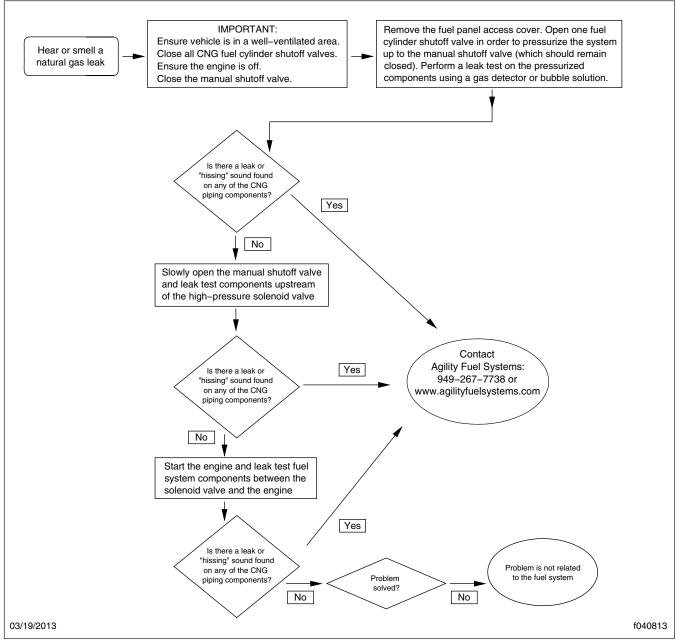


Fig. 4, Flow Chart: Gas Leak

AMGaDS III Plus Gas Detection System

WARNING

Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

Natural gas powered vehicles are equipped with a natural gas leak detection system. One sensor is located in the cab overhead panel in the control panel, the other sensor is located on the frontwall in the engine compartment. The system is powered directly from the vehicle batteries and is active at all times, unless the batteries are disconnected. When the sys-

tem has power, and is operating normally with all sensors confirmed operational, and no leaks detected, the green "Power" LED, and the large green light are on. When the presence of gas is detected in any zone, an indicator LED will illuminate depending on the level of gas detected. If a problem with a sensor or wiring occurs, a "Fault" LED will illuminate for the zone that is affected. When a fault is present, no detection is operational in that zone. The following troubleshooting tables show all the different possible light combinations, what they indicate, the troubleshooting procedures, and the suggested remedy. For vehicle-specific wiring diagrams, refer to G06-89262 in EZWiring™.

IMPORTANT: Before performing any troubleshooting, allow the system 60 seconds to complete the initialization process.

Green "Power" Light On



Front Panel Indication	Troubleshoot	Remedy
The green "Power" LED on the main panel and the large green LED are on. The system has power and is operating normally. In this state the panel and all sensors are confirmed operational.	System is operating normally.	No repair needed.

No Lights on Front Panel



Front Panel Indication	Troubleshoot	Result	Remedy
		Yes	Go to the next step.
	Are all of the connectors plugged in at the back of the panel?	No	Plug in the connector. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Is there power (9-14 vdc) and ground at	Yes	Replace the panel.
	the panel?	No	Go to the next step.
	Check the terminal on the back of the panel for loose or improperly installed pins. Were there any bad pins?	Yes	Repair and go to the next step. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
No lights are illuminated on		No	Go to the next step.
the panel. The panel has no power. No gas detection or warning is possible.	Is the fuse blown or missing at the power-net distribution box (PNDB)?	Yes	Replace the fuse. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next step.
	Does the circuit have continuity or high resistance?	Yes	If it has continuity, and still has no power go to PNDB troubleshooting.
		No	If there is no continuity, or high resistance go to the next step.
	Check connectors at the fire wall and PNDB.	Yes	Replace the damaged cable(s).
	Have any of the cables been pinched, cut, or damaged?	No	Contact the vendor.

Amber "Sensor Fault" Light On



Front Panel Indication	Troubleshoot	Result	Remedy
	Check the sensor connections at the back of the panel and at the sensors. Are the connectors loose or damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next step.
The amber "Sensor Fault" light indicates that there is a problem in the zone specified.	Check the pins in the connectors on the panel and in the sensors. Are the pins loose or damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
In this case zone 1 and 2.		No	Go to the next step.
When a fault light is on, detection is not possible in any zones where a fault is	If both "Sensor Fault" lights are on, skip this step and proceed to the next step Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step
présent.		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Check for continuity in the harness. Is	Yes	Replace the harness.
	there high resistance in the sensor harness?	No	Replace the sensor, unless it is both, then replace the panel.

Amber "Trace" Light Flashing



Front Panel Indication	Troubleshoot	Result	Remedy
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	not venting or leaking. Is there a gas leak?	No	Go to the next step.
The flashing amber "Trace" light indicates that a trace amount of gas (greater than 20% and less than 50%) has been detected in the specified zone, in this case zone 2.	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	repair, etc.	No	Go to the next step.
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed.
	check continuity and resistance in the	Yes	Replace the sensor.
	sensor harness. Is the harness good?	No	Replace the harness.

A WARNING

The following tests should only be performed after determining that it is safe to do so.

Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG, etc.).

Have the problem repaired by qualified personnel before further operation of the vehicle.

Do not perform "SIGNIFICANT" and "Trace" diagnosis, until the non-presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.

Red "SIGNIFICANT" Light, Amber "Trace" Lights, and Buzzer 1



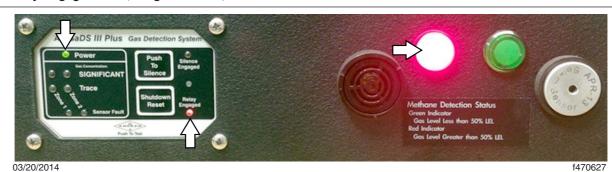
Front Panel Indication	Troubleshoot	Result	Remedy
	Is the "Amerex Push to Test" button	Yes	Let go.
The red "SIGNIFICANT" light and amber "Trace" lights and buzzer 1 indicate that a significant level of combustible gas (greater than 50% lower explosive limit	being held?	No	Go to the next step.
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
(LEL)) has been detected in the applicable zone. In this case zone 2.	not venting or leaking. Is there a gas leak?	No	Go to the next step.
Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG,	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
etc.).	repair, etc.	No	Go to the next step.
Have the problem repaired by qualified personnel before	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.
further operation of the vehicle.		No	Go to the next step.
Do not perform "SIGNIFICANT" and "Trace"	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step
diagnosis, until the non- presence of gas is confirmed and the panel has had constant power for 60		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
seconds of calibration.	Check continuity and resistance in the	Yes	Replace the sensor.
	sensor harness. Is the harness good?	No	Replace the harness.

Red "SIGNIFICANT" Light, Amber "Trace" Lights, and Buzzers 1 and 2



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Front Panel Indication	Troubleshoot	Result	Remedy	
The red "Significant" light and amber "Trace" lights along with buzzers 1 and 2 indicate	Is the "Amerex Push to Test" button being held and has it been held continuously for 15 seconds causing the relay to trip?	Yes	Release the button, and press the "Shutdown/Reset" button to reset the relay. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
that a significant level of		No	Go to the next step.	
combustible gas (greater than 50% LEL) has been detected in the applicable zone, in this case zone 2. Remove all personnel from	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
the area. Ventilate the area.	not venting or leaking.	No	Go to the next step.	
Manually shut off the source	Is there a gas leak?		de te the next step.	
of gas (propane/CNG/LNG, etc.). Have the problem repaired by qualified personnel before further operation of the vehicle. The	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
large red LED and buzzer 2		No	Go to the next step.	
indicates the significant gas detection has been present for over 15 seconds and the	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.	
relay has engaged.	parier and sensors. Are they damaged?	No	Go to the next step.	
Do not perform "SIGNIFICANT" and "Trace"	Swap the zone that is reporting a	Yes	If the fault moves with the cable proceed to the next step	
diagnosis, until the non- presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.	sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
	Check continuity and resistance in the	Yes	Replace the sensor.	
	sensor harness. Is the harness good?	No	Replace the harness.	

Red "Relay Engaged" LED, Large Red LED, and Buzzer 2



Front Panel Indication	Troubleshoot	Result	Remedy	
	Has the "Amerex Push to Test" button been pressed and held for 15 seconds causing the relay to trip?	Yes	Press the "Shutdown/Reset" button. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
		No	Go to the next step.	
The red "Relay Engaged" LED and the large red LED along with buzzer 2 indicates	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
that a significant level of gas (greater than 50%) was	not venting or leaking.		Siep.	
detected at some point.	Is there a gas leak?	No	Go to the next step.	
The significant gas level is no longer present, as the "SIGNIFICANT" LED and "Trace" LED are no longer illuminated. The panel relay has engaged and must be reset by pressing the "Shutdown/	Are any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass repair, etc.	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
		No	Go to the next step.	
	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed.	
Reset" button. Do not		No	Go to the next step.	
troubleshoot the system until the reason for the significant alarm is understood.	significant	Yes	If the fault moves with the cable, proceed to the next step	
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.	
	Check continuity and resistance in the	Yes	Replace the sensor.	
	sensor harness. Is the harness good?	No	Replace the harness.	

Fireboy Methane Fume Detector System

General Information

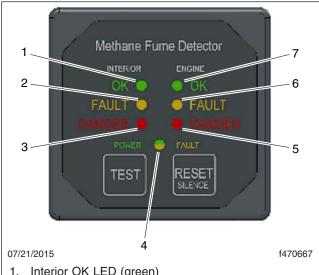
The Fireboy Methane Fume Detector vapormonitoring system utilizes advanced technology for detection of methane fumes. It has two sensors and has both visual and audible alarms that trigger at 20% and 50% of the LEL (Lower Explosive Limit) of methane respectively. A test switch is provided to test LED and output operation. System operation and correct sensor operation are continually monitored and LEDs are provided for fault detection. The display has an internal relay for automatic control of an external device up to 1 amp maximum fuse capacity. See Fig. 5.

Troubleshooting



Compressed natural gas is highly flammable. Refer to the safety precautions listed in Subject 100 before servicing the vehicle. Failure to observe these precautions could lead to the ignition of the natural gas, which could cause severe bodily injury, death, or property damage.

Natural gas powered vehicles are equipped with a natural gas leak detection system. One sensor is located in the cab overhead panel in the control panel. the other sensor is located on the frontwall in the engine compartment. The system is powered directly from the vehicle batteries and is active at all times, unless the batteries are disconnected. When the system has power, and is operating normally with all sensors confirmed operational, and no leaks detected, the green "Power" LED, and the large green light are on. When the presence of gas is detected in

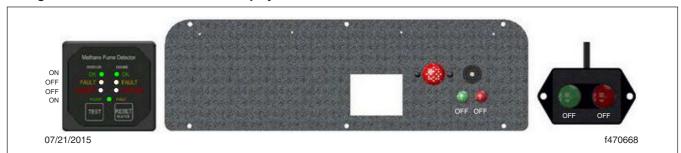


- 1. Interior OK LED (green)
- Interior Fault LED (yellow)
- Interior Danger LED (red)
- Test Button
- Engine OK LED (green)
- Engine Fault LED (yellow)
- Engine Danger LED (red)
- Reset/Silence
- Power/Fault LED (green/yellow)

Fig. 5, Methane Fume Detector Dash Display

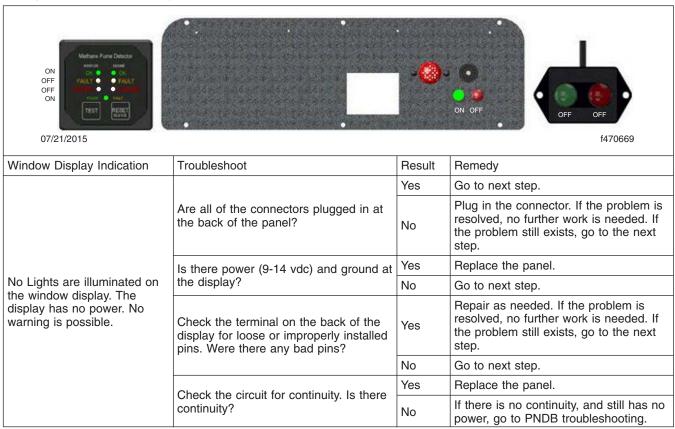
any zone, an indicator LED will illuminate depending on the level of gas detected. If a problem with a sensor or wiring occurs, a "Fault" LED will illuminate for the zone that is affected. When a fault is present, no detection is operational in that zone. The following troubleshooting tables show all the different possible light combinations, what they indicate, the troubleshooting procedures, and the suggested remedy. For vehicle-specific wiring diagrams, refer to G06-92425 in EZWiring™.

No Lights on Front Panel and Window Display

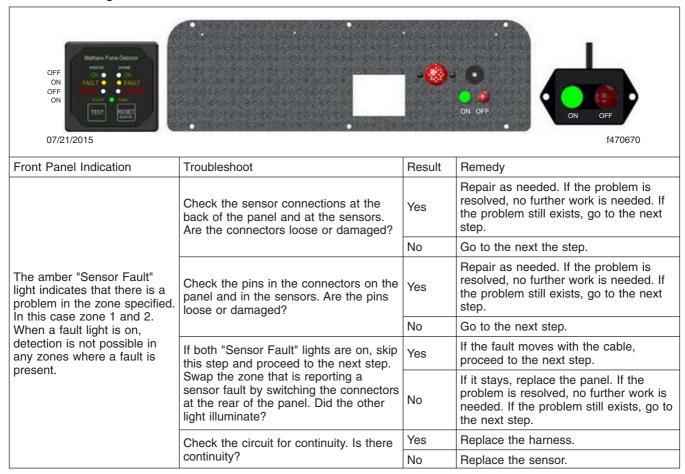


Front Panel Indication	Troubleshoot	Result	Remedy
		Yes	Go to next step.
	Are all of the connectors plugged in at the back of the panel?	No	Plug in the connector. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Is there power (9-14 vdc) and ground at	Yes	Replace the panel.
	the panel?	No	Go to next step.
No lights are illuminated on	Check the terminal on the back of the panel for loose or improperly installed pins. Were there any bad pins?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
the panel. The panel has no		No	Go to next step.
power. No gas detection or warning is possible.	Is the fuse blown or missing at the power-net distribution box (PNDB)?	Yes	Replace the fuse. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to next step.
	Check the circuit for continuity.	Yes	If there is no continuity, and still has no power go to PNDB troubleshooting.
		No	If there is no continuity, or high resistance go to the next step.
	Check connectors at the fire wall and	Yes	Replace the damaged cable(s).
	PNDB. Have any of the cables been pinched, cut, or damaged?	No	Contact the vendor.

No Lights on Window Display



Amber "Fault" Light On



A WARNING

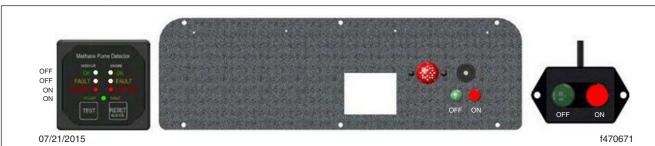
The following tests should only be performed after determining that it is safe to do so.

Remove all personnel from the area. Ventilate the area. Manually shut off the source of gas (propane/CNG/LNG, etc.).

Have the problem repaired by qualified personnel before further operation of the vehicle.

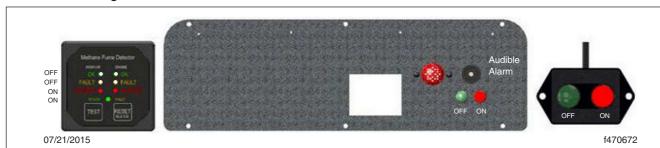
Do not perform "DANGER" diagnosis, until the non-presence of gas is confirmed and the panel has had constant power for 60 seconds of calibration.

Red "DANGER" Light On



Front Panel Indication	Troubleshoot	Result	Remedy
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are not venting or leaking. Is there a	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	gas leak?	No	Go to the next the step.
	Are there any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
The red "DANGER" light	repair, etc.	No	Go to the next the step.
indicates that a trace amount of gas (greater than 20% and less than 50%) has been detected in the specified	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
zone.		No	Go to the next the step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Check the circuit for continuity. Is there	Yes	Replace the sensor.
	continuity?	No	Replace the harness.

Red "DANGER" Light and Buzzer On



Front Panel Indication	Troubleshoot	Result	Remedy
	Is the "Test" button being held?	Yes	Let go.
	is the Test button being held:	No	Go to the next the step.
	Using an approved NG testing method, check all fuel fittings and fuel lines for leaks. Verify that pressure relief devices are not venting or leaking. Is there a	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	gas leak?	No	Go to the next the step.
The red "DANGER" light and	Are there any nuisance gases present? Nuisance gases can be caused by cleaners, paint, polish, lacquer, gasoline, strong adhesives, fiberglass	Yes	Clear the area of contaminants and check again. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
buzzer indicate that a significant level of	repair, etc.	No	Go to the next the step.
combustible gas (greater than 50% lower explosive limit (LEL)) has been detected in the applicable zone.	Check the connectors and pins on the panel and sensors. Are they damaged?	Yes	Repair as needed. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
		No	Go to the next the step.
	Swap the zone that is reporting a sensor fault by switching the connectors at the rear of the panel. Did the other light illuminate?	Yes	If the fault moves with the cable, proceed to the next step.
		No	If it stays, replace the panel. If the problem is resolved, no further work is needed. If the problem still exists, go to the next step.
	Check the circuit for continuity. Is there	Yes	Replace the sensor.
	continuity?	No	Replace the harness.