ROUSH®
CLEANTECH

2012

Ford E-150/E-250/E-350/E-450

Liquid Propane Autogas Fuel System

Includes:

E-150/E-250/E-350 Cargo Van & Wagon,
E-150/E-250/E-350 Extended Range Cargo Van & Wagon
and E-450 Custom Body

Rev. August, 2012

SERVICE MANUAL SUPPLEMENT

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FOREWORD

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This manual is intended to provide technicians with the procedures required to maintain and service the unique components of the ROUSH CleanTech Liquid Propane Autogas (LPA) system. Service procedures for other vehicle components may be referenced to, which can be found in the *Ford Workshop Manual* or *Ford Powertrain/Emissions Diagnosis Service Manual.* For access to the Ford manuals, please subscribe to www.motorcraft.com.

WARNING

Technicians working with, or around fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.

INTRODUCTION

GENERAL INFORMATION

Liquid Propane Autogas Fuel System Overview

This manual is a supplement to the regular *Ford Workshop Manual*, covering the unique components of the ROUSH CleanTech Liquid Propane Autogas (LPA) fuel system. Unlike the traditional propane-powered vehicle that supplies propane to the engine in a vapor form, the LPA system delivers, meters and injects a liquid form of propane into the engine.

Similar to a modern gasoline engine, the LPA system stores liquid propane in the fuel tank. Dual in-tank electric fuel pumps circulate the propane through fuel rails which supply fuel to the fuel injectors. The injectors meter and inject liquid propane into each of the original inlet ports on the Ford engine. Fuel that is not used by the injectors will return to the fuel tank through a flow control solenoid.

The ROUSH CleanTech LPA system is fully integrated using Ford's one touch integrated start (OTIS) system. When the ignition key is turned to START and released to the ON position, the LPA system runs a purge process, then the starter engages and the vehicle starts with no further action required from the operator.

Fueling a propane-powered vehicle is noticeably different than on a conventional fueled vehicle. A propane fuel system is completely sealed and the major difference is the screw-on type fill connector used for propane. When fueling, turn connector clockwise to tighten, ensuring a good seal at the fill valve. The tank is equipped with an automatic stop fill device, which only allows the tank to be filled to 80% of the overall tank volume, leaving room for the fuel to expand and contract. At the 80% fill level, the instrument cluster fuel gauge will read full. When using a facility designed for automotive fueling, the fill time is similar to refueling a diesel-powered vehicle.

ROUSH CleanTech Technical Assistance

Call ROUSH CleanTech Customer Service at 1-800.59.ROUSH (597-6874) with any questions regarding ROUSH CleanTech Liquid Propane Autogas systems.

Propane

Propane exists as a gas in its natural state, and like diesel fuel, gasoline or natural gas, is a member of the hydrocarbon family. Propane is a by-product of refined petroleum and natural gas. When stored under pressure, the propane turns into a liquid. Propane is colorless, odorless and non-toxic. Ethyl mercaptan is added to propane during the manufacturing process to give it a distinct, recognizable odor.

Propane is commonly referred to as LPG or LP gas. Like most liquids, liquid propane expands as its temperature increases. This is why a propane tank is only filled to 80% of its liquid capacity. Even with an 80% fill capacity, due to liquid propane's expansion ratio of 1:270 (liquid propane to a gas by volume) and its high BTU rating, a large volume of energy can be stored in a relative small tank under relative low pressure.

Propane also has a very narrow range of flammability with a 2.15% threshold on the low side and a 9.6% threshold on the high side. This means that if the propane-to-oxygen mixture is lower than 2.15% or higher than 9.6%, the mixture is noncombustible.

Propane is heavier than air; therefore, a leak in a propane fuel system can result in gas accumulation in low places, such as sewers, drains or service pits. This can create a fire and health hazard as the propane will displace oxygen, potentially resulting in suffocation. For this reason, additional safety precautions should be observed when working on or around propane-powered equipment or storage tanks.

Propane is stored in the vehicle fuel tank under pressure as a liquid. The pressure in the tank is determined by the temperature of the fuel, ranging from 0 psi (0 kPa) at –44°F (–42°C), to 312 psi (2152 kPa) at 145°F (63°C). The tank has an overpressure safety device which vents the tank at pressures over 312 psi (2152 kPa). ROUSH CleanTech LPA vehicles require HD-5 propane, rated for automotive use. Use of HD-10 or other substandard propane may result in excess contamination of the system and premature failure of the fuel pump, injectors and in-tank filters.

Propane, like other fuels, must be handled safely with knowledge of its characteristics. Training in propane characteristics and handling is available through the Propane Education and Research Council (PERC), 1140 Connecticut Avenue, Washington, DC 20036. Their web address is www.propanecouncil.org.

Fill Stations

Propane is readily available anywhere in the United States. To locate the nearest station, check with http://www.afdc.energy.gov/afdc/locator/stations/.

ROUSH CleanTech recommends facilities designed for automotive refueling. Other locations may have low output pumps, resulting in slow or no fill, or low quality fuel which can result in premature component failure.

⚠ WARNING

ROUSH CleanTech does not approve of any additions to, or modifications of, this fuel system. This fuel system is designed and installed to meet federal standards and engine manufacturer's guidelines. The maintenance provider or modifier assumes all responsibility for the vehicle engine and fuel system if the fuel system is changed or modified. Some states require a special license to perform maintenance or work on propane-powered vehicles. Check with local authorities or your state LP Gas Association for details. All fuel system components must be a minimum of 18 inches from any exhaust system component unless properly shielded. All service, maintenance and repairs performed on LP gas systems must be done by a ROUSH CleanTech-trained and certified service technician as required by state or local regulations.

SAFETY INFORMATION

The National Fire Protection Association (NFPA) publishes a code book of rules that apply to the storage, handling, transportation and use of liquefied petroleum gas (LP-Gas or LPG). The book is known as NFPA 58. It is revised as necessary and published every other year. This code is adopted as law in virtually every political subdivision in the United States. Check with your local authorities for regulations applicable to liquid propane.

Alert Messages

The following alert messages appear from time to time in appropriate places in this manual. Ensure that all personnel in the immediate area are aware of these reminders.

⚠ DANGER

Propane is nontoxic, nonpoisonous, has the lowest flammability range of any alternative fuel and dissipates quickly when released into the atmosphere. When the ratio of propane to air is between 2.2% and 9.6%, propane will burn in the presence of an ignition source at 940°F (504°C) or hotter. Keep away from heat, sparks, flames, static electricity or other sources of ignition. Failure to heed this danger may result in severe personal injury or death.

⚠ DANGER

The fuel supply lines remain pressurized after engine shutdown. Keep away from heat, sparks, flames, static electricity or other sources of ignition. Do NOT enter storage areas or confined space unless they are adequately ventilated. Failure to heed this danger may result in severe personal injury or death.

⚠ DANGER

Do NOT carry lighted smoking materials or smoke while working on fuel system components. Failure to heed this danger could result in severe personal injury or death.

⚠ DANGER

Disconnect the battery ground at the battery to ensure that the vehicle electrical system has no current. Failure to heed this danger could result in severe personal injury or death.

⚠ DANGER

Propane is heavier than air and seeks the lowest available level when released to the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

⚠ DANGER

Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.

⚠ WARNING

Liquid propane is cold. The temperature of propane in its liquid state at atmospheric pressure is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in personal injury.

Installation, Garaging and Training

Chapter 11 of NFPA 58 applies to engine fuel systems using LP-Gas in internal combustion engines, including containers, container appurtenances, carburetion equipment, piping, hose and fittings and their installation. Additionally, this chapter applies to garaging of vehicles and to the training of personnel.

Paragraph 11.2 specifies that each person engaged in installing, repairing, filling or otherwise servicing an LP-Gas engine fuel system shall be trained. Contact the Propane Education and Research Council to learn more about their CETP E-Learning computer-based training program: courtney.gendron@propanecouncil.org, or vincent.sibilia@propanecouncil.org.

Purging and Venting (Tanks and Lines)

Venting of LP-Gas to the atmosphere is covered by paragraphs 7.3.1, General, and 7.3.2, Purging of NFPA 58, 2008 edition. Refer to NFPA 58, Local Codes and Proper Training for specific information relating to safe venting of LPG.

VEHICLE INFORMATION

Build Data

ROUSH CleanTech emissions certification information is recorded on the ROUSH CleanTech vehicle emissions control information (VECI) label. The label is vehicle-specific and is required by law to be on the vehicle to which it is assigned, along with the Ford VECI label.

VEHICLE EMISSIONS CONTROL INFORMATION LABELS

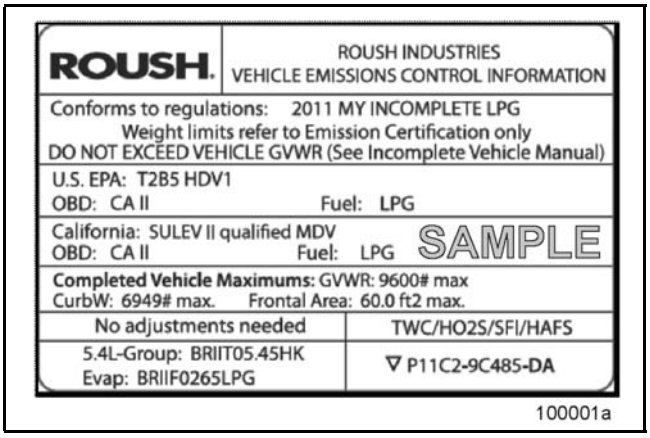


Figure 1 — ROUSH CleanTech VECI Label (Typical)

Figure 2 — Ford VECI Label (Typical)

VECI LABEL LOCATION

The ROUSH CleanTech VECI label appears along with the original Ford VECI label under the hood at the front, passenger side.

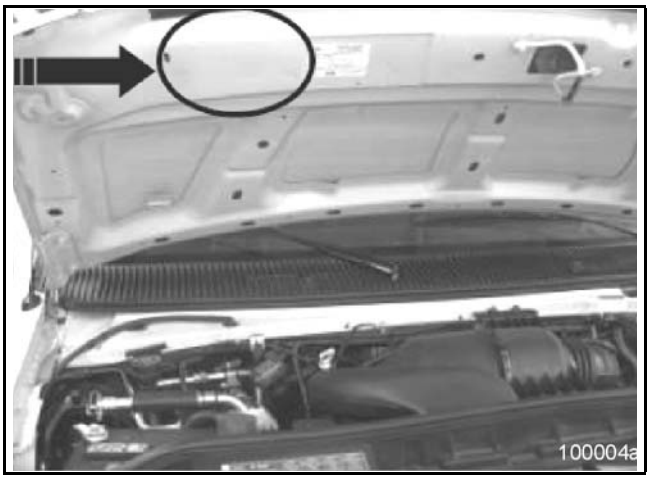


Figure 3 — VECI Label Location

DESCRIPTION AND OPERATION

LIQUID PROPANE AUTOGAS FUEL SYSTEM OVERVIEW

Fuel System Design

Ford 5.4L or 6.8L engine fuel supplies are controlled by the powertrain control module (PCM); however the fuel control calibration has been optimized for propane. The PCM sends commands to the smart relay module (SRM) which controls the fuel system solenoids.

Electronic fuel pump relays (EFPR) control the dual fuel pumps inside the tank to deliver liquid propane to the injectors. From the pumps, the fuel flows through the supply solenoid (on the tank), into the 3/8" fuel supply line, to the supply solenoid on the fuel rail pressure control module (FRPCM), then to the fuel rails and injectors. Excess fuel flows back to the tank through the FRPCM's flow control solenoid (FCS), into the 1/4" fuel return line and through the return check valve on the fuel tank. Fuel pressure is regulated by the FCS which includes a small orifice to restrict return flow in normal conditions; and a bypass circuit to allow maximum fuel flow prior to engine starting or during extremely hot conditions.

The FRPCM also contains a bleed solenoid to control the flow of fuel vapors from the fuel rail to the carbon canister during engine off conditions. The engine's vapor management valve (VMV) controls the purging of the vapor canister, sending the vapors back into the intake manifold for the engine to consume.

The filling process is safeguarded against overfilling by an 80% overflow protection device (OPD) integral to the liquid propane autogas (LPA) system's fuel fill valve on the tank. In order to safely store pressurized liquid propane in the vehicle, the fill system must ensure that the tank is not filled beyond 80% of its total volume. This ensures that sufficient expansion volume is present in case of significant tank temperature changes.

The LPA tank stores the liquid propane under pressure. Internal to the tank are dual electric fuel pumps, fuel pump housing, fuel filters, fuel level sender, fuel fill valve with OPD, bleeder valve (fixed liquid level gauge), supply circuit assembly with excess flow valve, return circuit assembly and a wiring harness.

There are four propane filters in the system. The primary filter is located in the fuel fill line which is intended to filter out the majority of contaminants that may be present in the fuel from the filling station. This filter must be replaced every 50,000 miles. The secondary fuel filter is a sock filter located inside the tank at the bottom (inlets) of the fuel pumps. The third and fourth filters are located after each fuel pump inside the tank, which are to ensure that no contaminants reach the fuel injectors. The in-tank filters are rated for the life of the vehicle.

ROUSH CleanTech LPA vehicles require HD-5 propane, rated for automotive use. Use of HD-10 or other substandard propane may result in excess contamination of the system and failure of the fuel pump, injectors and in-tank filters.

Due to the inherent qualities of propane, a purge strategy must be employed during engine start up. Whenever the fuel pumps are not activated, there is a potential for the liquid propane in the fuel rails to absorb heat from the engine or from ambient temperatures. This heat may cause the fuel to expand rapidly and create vapor in the fuel rails. This vapor, if not purged from the fuel rails, can cause lean fueling or a no-start condition.

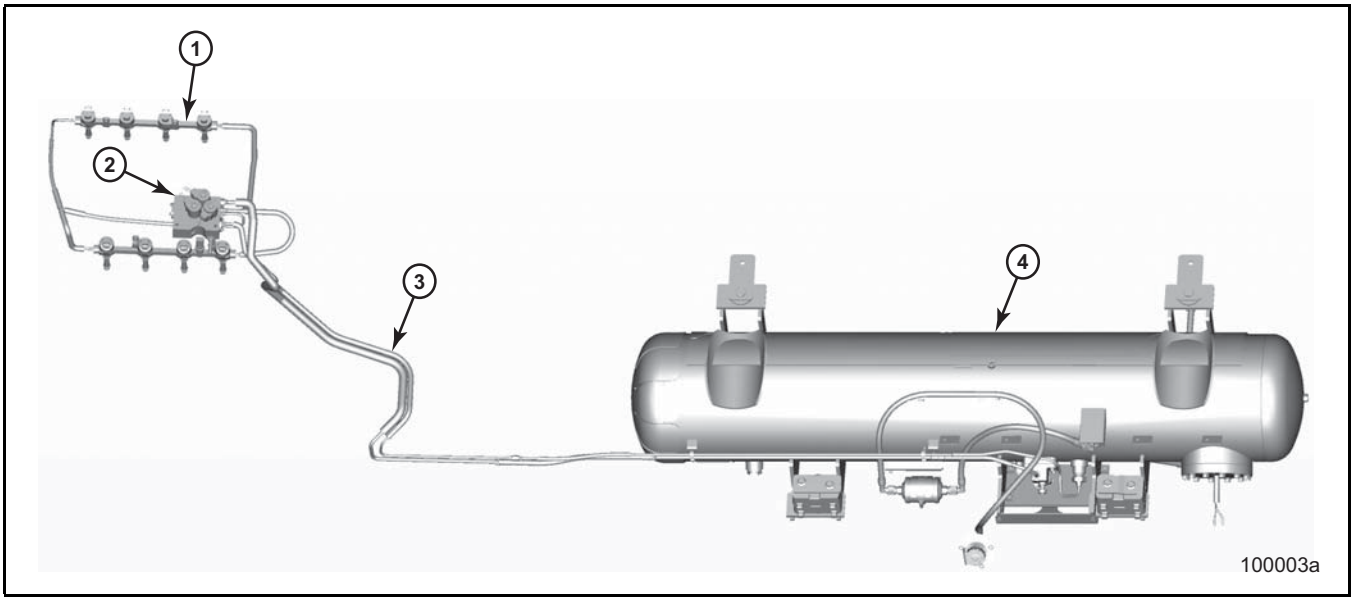


Figure 4 — Fuel System Overview

1. Fuel Rail and Injectors 2. FRPCM	3. Fuel Supply and Return Lines 4. Fuel Tank

Start Sequence

When the engine is not running, the fuel in the rails boils and turns to vapor. For proper engine operation, the vapor must be flushed from the rails prior to starting the engine. This is a fully automated process that is controlled by the PCM. This process takes 2–45 seconds, depending on ambient conditions, engine off time and engine temperature at shutdown. The cycle will begin when the operator turns the key to the crank position and releases the key to the ON position. After receiving the crank request, the PCM initiates the start sequence. During this time, the PCM performs diagnostics on several of the solenoids, as well as flushing the rails of vapor. This is accomplished by monitoring the integrated pressure temperature sensor (IPTS) while opening the various solenoids in the tank and FRPCM in stages, then engaging the fuel pumps. Refer to *LPA Fuel System Components and Function* for a more detailed description of the components.

There are seven distinct stages of the start cycle:

Stage	Name	Description
1	CAN Bus Initialization	For the sequence to work, the PCM and SRM need to be communicating. There is a short delay after key-up to ensure communication has been established.
2	Bleed Diagnostic Pressure Read	The PCM measures the fuel pressure in the rails after a bleed cycle. All solenoids are still closed at this time. If the pressure is too high, the system did not bleed and a fault will set.
3	Open Tank Solenoid	The tank solenoid is energized. The pressure in the rails is measured (again). This pressure will be used later to determine if the FRPCM supply solenoid has properly opened.
4	Open Supply Solenoid	The FRPCM supply solenoid is energized.
5	Flush	The FCS is energized and the fuel pumps are turned on high speed. The IPTS monitors pressure and temperature in the rails to determine when the vapor has been cleared from the rails.
6	Pressure Build	The FCS is de-energized and the pressure is allowed to rise. The IPTS is still monitoring the pressure and temperature in the rails to ensure there is liquid in the rails.
7	Crank	Once the pressure has built in the rails and the IPTS verifies there is liquid in the rails, the starter is engaged.

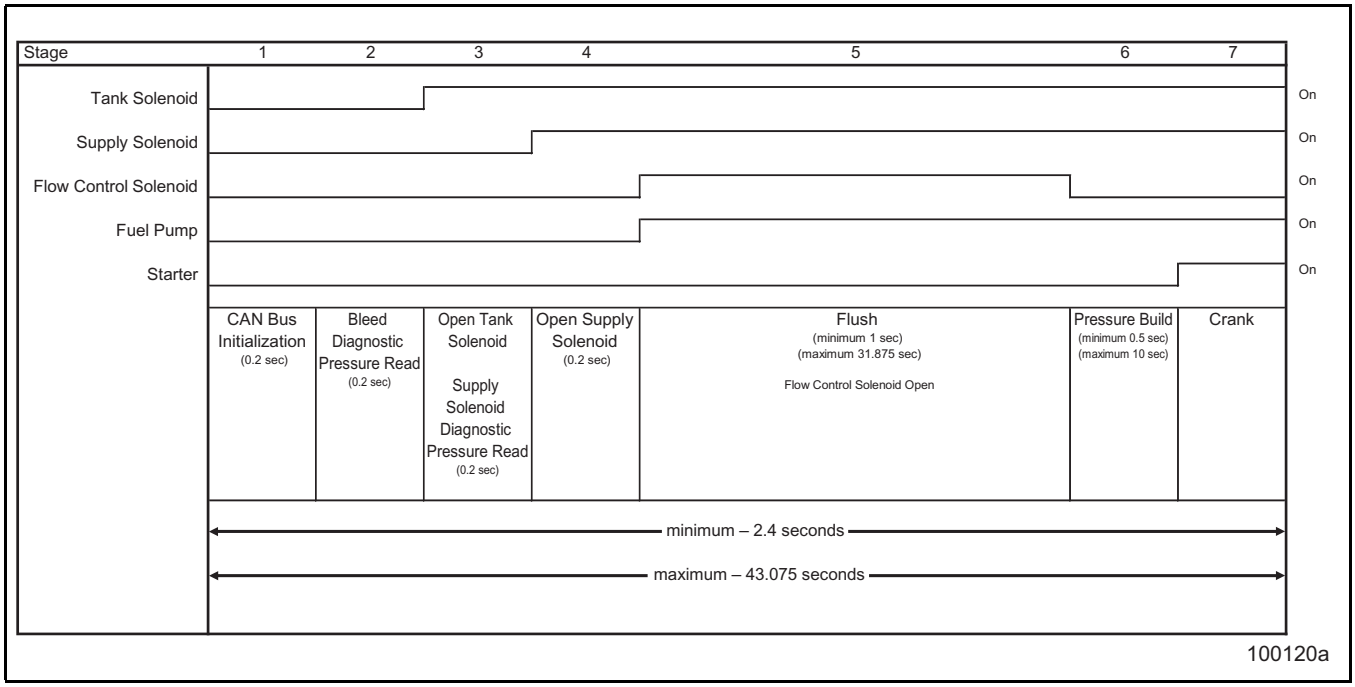


Figure 5 — Vehicle Start Sequence

General Propane Tank Filling Procedure

The most important aspect of filling a propane tank is safety. Understanding the properties and characteristics as well as the safe handling practices of the fuel is required before conducting any propane tank filling actions.

A propane-powered vehicle is equipped with a propane tank built and certified to the regulations of the American Society of Mechanical Engineers (ASME). These tanks have a data plate with pertinent information including the ASME stamp. This plate must be securely attached and legible or the tank should be taken out of service and replaced.

Propane tanks are filled to 80% capacity to allow for the liquid fuel to expand and contract depending on ambient temperatures. All tanks built for use on motor vehicles are equipped with an overflow protection device (OPD). The National Fire Protection Association (NFPA) requires motor vehicle propane tanks be equipped with an OPD to automatically prevent filling the tank beyond the maximum recommended capacity of 80%. This automatic stop fill system prevents overfilling of the fuel tanks. This requirement has been in effect since January 1, 1984.

Propane-Powered Motor Vehicle Filling Overview

The fuel fill system includes the following components:

1. Fuel fill valve, cap and mounting bracket
   - The valve is located behind the fuel door.
2. Fuel fill hoses
3. Fuel fill filter and mounting clamp
4. Fuel tank mounted fill valve containing a mechanical OPD.
5. Fuel tank internal components

During a fill event, the system functions as follows:

1. Customer connects fuel dispensing nozzle to fill valve and activates the fill station pump.
2. Fuel pressure in the fill line causes the remote fill valve, tank fill valve and tank shutoff valve to open. In order for the valves to open, pressure in the fill line must be at least 20 psi higher than tank pressure, otherwise fill is not possible.
3. Once the fuel reaches the 80% fill level, the OPD closes the shutoff valve, not allowing additional fuel to flow into the tank.

NOTE

Some fuel station pumps may have sufficient pressure to allow a small fuel flow into the tank even with the valves closed. The operator should stop the fill as soon as the fuel flow drops noticeably.

Vehicle Filling Procedure

This filling procedure is included for reference only. All personnel conducting fills should receive safety training on proper fill procedures.

⚠ WARNING

For passenger safety, ROUSH CleanTech recommends that all occupants disembark to a safety zone before fuel filling procedures take place. Failure to heed this warning can result in personal injury.

1. Upon entering the propane fueling station, park the vehicle in close proximity to the motor fuel dispensing station.

⚠ WARNING

No smoking or cell phone use allowed. Failure to heed this warning can result in personal injury.

2. Turn off and remove the vehicle ignition key.

⚠ DANGER

Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.

3. Exit the vehicle and ask all passengers to step outside the vehicle.
   a. Some stations may ask all passengers to stand outside the area where the fill process is taking place.
   b. Some stations could be self-service and the driver would perform the filling process; however in this case, the driver has to be trained and certified to obtain an authorized filling station dispenser access card.
4. The attendant may need to inspect the propane tank for corrosion, dents and verify the data plate displays the ASME stamp and other pertinent information is correct. An attendant can refuse to fill your propane tank if it does not pass this inspection. Regular inspection and maintenance of your tank will prevent refusal to fill the tank.
5. Open the fuel door.
6. Verify the dispenser meter is set to zero.
   - If the dispenser is an electronic dispenser, it will set to zero automatically once the transaction has been initiated.
7. Connect the fuel nozzle to the vehicle fueling receptacle.
   - The propane fueling nozzle has to be screwed on securely (clockwise).
     a. Wear protective gloves while fueling a propane tank.

⚠ WARNING

Liquid propane is cold. The temperature of propane when leaked to atmosphere from its liquid state is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from valves. Failure to heed this warning can result in personal injury.

b. Remove the protective cap from the vehicle fueling receptacle.

c. Mate the nozzle coupling to the fueling receptacle.

d. Turn the nozzle coupling in a clockwise direction two or three turns until secure. A soft rubber washer or O-ring seals the connection so over tightening is not required to obtain a good seal.

e. Most nozzles for motor vehicle fueling are much like a gasoline-type nozzle. The nozzles are also minimum-bleed type for safety and to meet hydrocarbon release requirements in certain jurisdictions.

NOTE

It is not necessary or advised to open the remote bleeder valve (if equipped) while filling as this will allow gaseous propane to be released. Some stations require the valve to be opened; this should only be performed by qualified personnel.

8. Turn on the propane dispenser/pump and begin the filling process.
   a. Pay attention and never walk away from the filling process.
   b. When the tank is full, the OPD automatically stops the filling process at the 80% liquid level capacity of the tank.
9. Release or close the fueling nozzle.
   a. Turn off the fuel dispenser/pump.
   b. Carefully and slowly unscrew the fueling nozzle (counterclockwise) to release any residual pressure and remove the nozzle from the vehicle.

NOTE

Some nozzles may have more pressure trapped between the nozzle and the receptacle, so it is necessary to slowly unscrew the connection to allow pressure to bleed off before removing the nozzle completely.

10. Replace the nozzle and fuel transfer hose on the dispenser.
11. Verify there are no leaks at the tank filling receptacle and replace the protective cap.

The fueling process is complete.

⚠ WARNING

During the propane vehicle fueling process, fuel may be emitted to the immediate area. There could be a combustible fuel mixture around this immediate area. The person performing the re-fueling process has total responsibility for safety in the immediate area.

NOTE

- It is unlawful to fill a non-compliant tank or a tank that possesses a safety violation.
- Any person performing the re-fueling process must be trained and certified in the procedures of filling propane tanks and in the procedures of safe handling.

LPA FUEL SYSTEM COMPONENTS AND FUNCTION

Propane Fuel Tank

The LPA system utilizes a cylindrical tank assembly to store the liquid propane. The fuel tank is designed and certified to meet all applicable safety standards required for installation on a motor vehicle. The tank design includes structural mounting brackets, which are used for mounting the tank assembly between the frame rails, in the cargo area or behind the rear axle depending on vehicle application. The tank assembly is secured to the chassis using specially coated and grade-level fasteners.

In addition, the tank is fitted with a pressure relief valve (PRV) that will open if tank pressure exceeds 312 psi (2151 kPa). The excess pressure (propane vapor) is vented off on the street side of the vehicle and the integrity of the tank is protected.

The following components are mounted to the outside of the fuel tank: bleeder valve (fixed liquid level gauge), supply circuit assembly, return circuit assembly, pressure relief valve, fill port and check valve with overflow protection device (OPD) and fuel level sender.

The LPA fuel tank is fitted with a service port flange for accessing the internals of the tank. The following components are located inside the fuel tank: dual electric fuel pumps with an inlet filter, fuel pump outlet filters, jet pump and a wiring harness.

WARNING

When servicing the tank or removing the tank from the vehicle, be sure to reinstall the tank with the original fasteners or new like fasteners. Do not replace the fasteners with a lower grade than originally equipped as this may cause the tank to become dislodged from the vehicle and cause serious damage or injury.

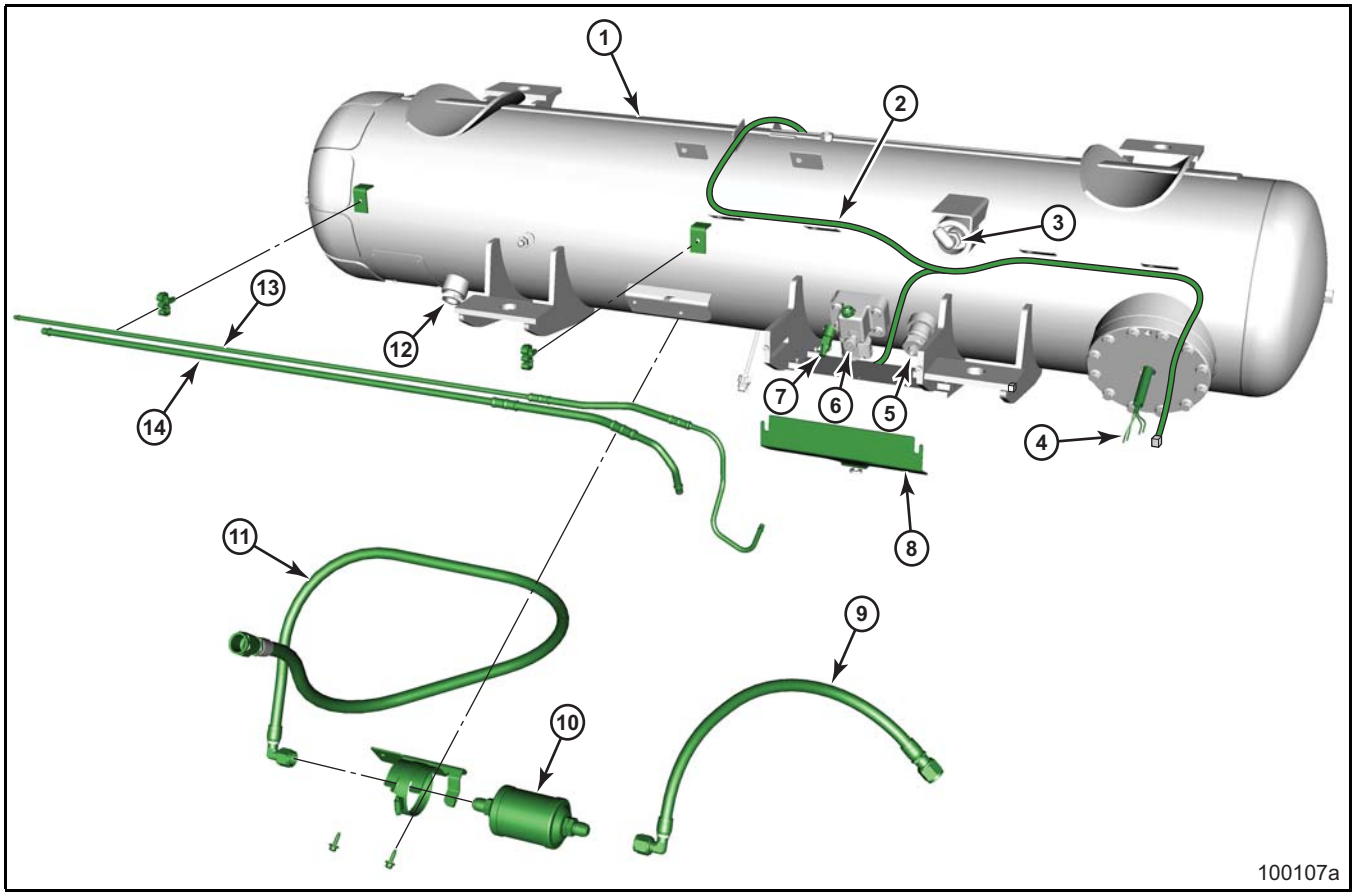


Figure 6 — Underbody Fuel Tank (Typical)

1. Underbody Fuel Tank	8. Supply Valve Cover
2. Tank Outer Wiring Harness	9. Fuel Fill Line (Filter-to-Tank)
3. Fuel Fill Port and Check Valve/OPD	10. Fuel Filter
4. Fuel Pump Harness Connectors	11. Fuel Fill Line (Fill Valve-to-Filter)
5. Return Circuit Assembly	12. Pressure Relief Valve
6. Supply Circuit Assembly	13. Rear Fuel Return Line
7. Fuel Liquid Level Gauge	14. Rear Fuel Supply Line

Tank Fill Valve/Overflow Protection Device

Located where fuel enters into the fuel tank, the fill valve is opened mechanically by the refueling pump pressure during the fill process. It incorporates a backflow check valve and an OPD. The backflow check valve closes when vehicle tank pressure is greater than pressure outside of the tank to prevent fuel from escaping.

Fuel Pumps

The LPA fuel system utilizes two 12-volt in-tank fuel pumps. The fuel pump assembly is mounted to brackets located in the flange of the fuel tank. The pumps and filters are serviceable through the service port flange on the side of the fuel tank.

The in-tank pumps receive a 12-volt supply when the ignition key is switched on and runs a purge cycle for up to 45 seconds. Each pump is controlled by an EFPR, which are controlled by the PCM. The pumps are provided with a constant ground signal. During operation the pump voltage will vary from 7–13.5V.

In-Tank Fuel Filters

There are three in-tank fuel filters. The primary fuel filter is a sock filter located on the bottom of the fuel pumps at the pump inlet ports. The second and third filters are located after each fuel pump inside the tank and are to ensure that no contaminants reach the fuel injectors. These internal tank filters are rated for the full vehicle life and do not require scheduled maintenance.

Fuel Level Sender

The tank is fitted with a fuel level sender that consists of an in-tank float arm coupled to an externally mounted variable resistor. This sender provides a fuel level signal to the instrument panel, which utilizes an “anti-slosh” signal conditioner to provide a constant gauge reading. The fuel level sender is serviceable from the top or bottom of the tank depending on vehicle configuration.

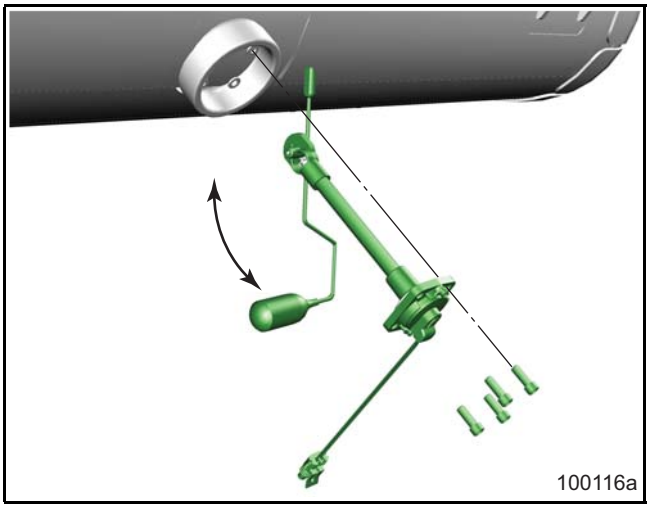


Figure 7 — Fuel Level Sender (Typical)

Tank Bleeder Valve/Fixed Liquid Level Gauge

The bleeder valve/fixed liquid level gauge serves two functions:

- Provides a means to evacuate the tank for tank internal component service procedures.
- Allows annual verification of this function of the OPD.

NOTE

The tank bleeder valve must remain closed during vehicle operation.

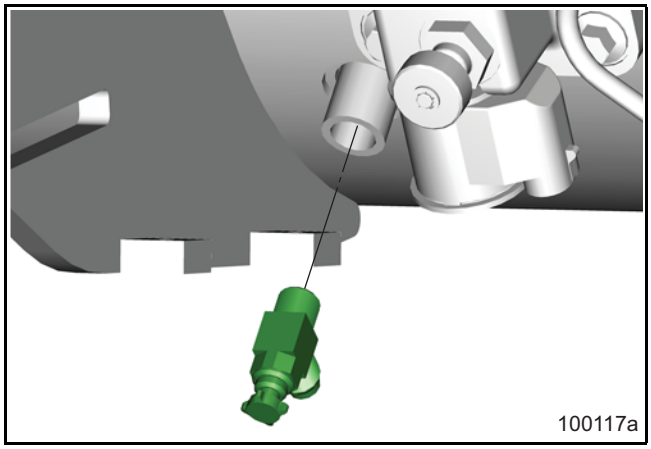


Figure 8 — Tank Bleeder Valve/Fixed Liquid Level Gauge (Typical)

Pressure Relief Valve

The pressure relief valve will activate when tank pressure is above 312 psi (2151 kPa). When the valve is activated, propane vapor will vent through the pressure relief hose (if equipped) and exit the vehicle vent (if equipped) mounted to the body on the street side behind the rear axle. This is a safety feature designed to prevent excessive tank pressure. For the valve to close and stop the tank from venting, the fuel in the tank must cool to reduce pressure to between 281–309 psi (1937–2130 kPa).

NOTE

Some underbody tanks do not have a vent hose and vent directly from the pressure relief valve under the vehicle.

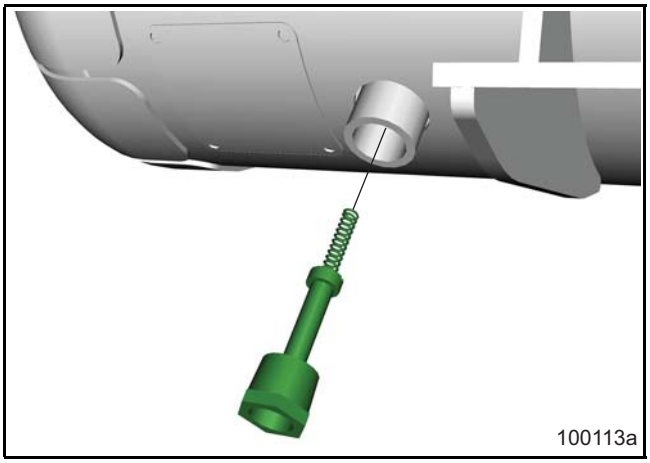


Figure 9 — Pressure Relief Valve (Typical)

Tank Supply Circuit Assembly

The tank supply circuit consists of an excess flow valve (XFV), fuel supply solenoid (automatic shutoff valve) and a manual shutoff valve. The fuel supply solenoid is controlled by the PCM and is activated whenever the start sequence is initiated. The valve contains a Jiffy-Tite quick-connect fitting outside the tank and an SAE hose quick connect inside the tank.

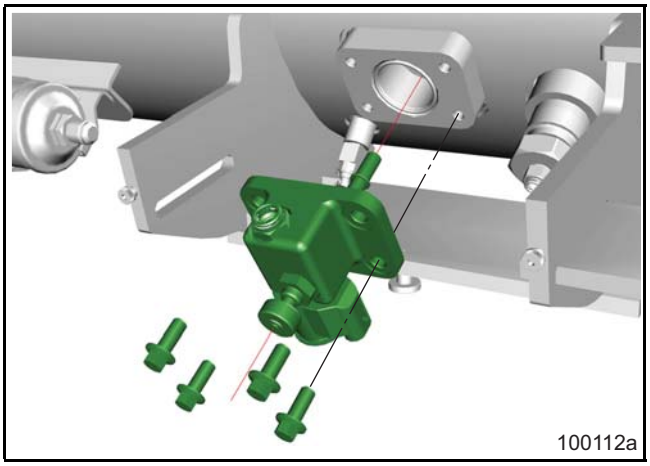


Figure 10 — Tank Supply Circuit Assembly (Typical, Mounting Position Varies)

TANK SOLENOID VALVE

The tank (fuel supply) solenoid is an electrically operated automatic shutoff valve. It is located downstream from the XFV and manual shutoff valve. The tank solenoid is normally in a closed position (de-energized), preventing the flow of fuel to the engine. When the ignition key is turned to the crank position to start the vehicle, power is supplied to the solenoid opening the valve and allowing fuel to flow from the tank to the engine. The tank solenoid will close when the ignition is shut off, or if the engine stalls (with ignition on).

MANUAL SHUTOFF VALVE

The manual shutoff valve is used to seal the outlet of the tank during shipping and service. It is located between the XFV and tank solenoid valve. It is manually operated by turning the knurled knob mounted on the front of the supply circuit assembly. Turning the knob clockwise closes the valve and turning the knob counterclockwise opens the valve (approximately 3.5 turns, stop-to-stop). It must always be open when the vehicle is operating.

EXCESS FLOW VALVE

The XFV is located in the supply fuel path, ahead of the tank solenoid and manual shutoff valve. The valve is intended to shut off fuel flow from the tank in the event of a rapid pressure drop outside the fuel tank. A rapid pressure drop could be caused by a severed line or an inadvertent disconnect without shutting the manual shutoff valve. The XFV does not completely stop flow and will not actuate with smaller leaks, so it should not be relied on for servicing purposes. If the XFV activates, for example, immediately following service where the system may not be primed with fuel, see the *Excess Flow Valve XFV Check* procedure in *Diagnostic Tests and Procedures for Liquid Propane Autogas Fueled Vehicles* of the ROUSH CleanTech *Diagnostic Manual Supplement*.

Fuel Return Valve

The fuel return valve on the tank incorporates a check valve, which prevents fuel from flowing from the tank into the return line. The valve contains a Jiffy-Tite quick-connect fitting outside the tank and an SAE hose quick connect inside the tank.

Fuel Supply and Return Lines

The fuel transfer lines utilized in the LPA fuel system are made of steel-reinforced polytetrafluoroethylene (PTFE) tubing with stainless steel hard line sections to provide long-term protection and service. The 3/8” supply and 1/4” return lines contain Jiffy-Tite quick-connect fittings.

⚠ CAUTION

Special tools are required to properly disconnect the quick-connect fittings. Attempting to remove the lines without these tools can cause damage to the fitting and/or line.

NOTE

When replacing hoses and lines, use ROUSH CleanTech replacement parts made from the same material and size. Always route and secure hoses as originally installed. All hoses and lines must be compliant and labeled per NFPA 58 requirements.

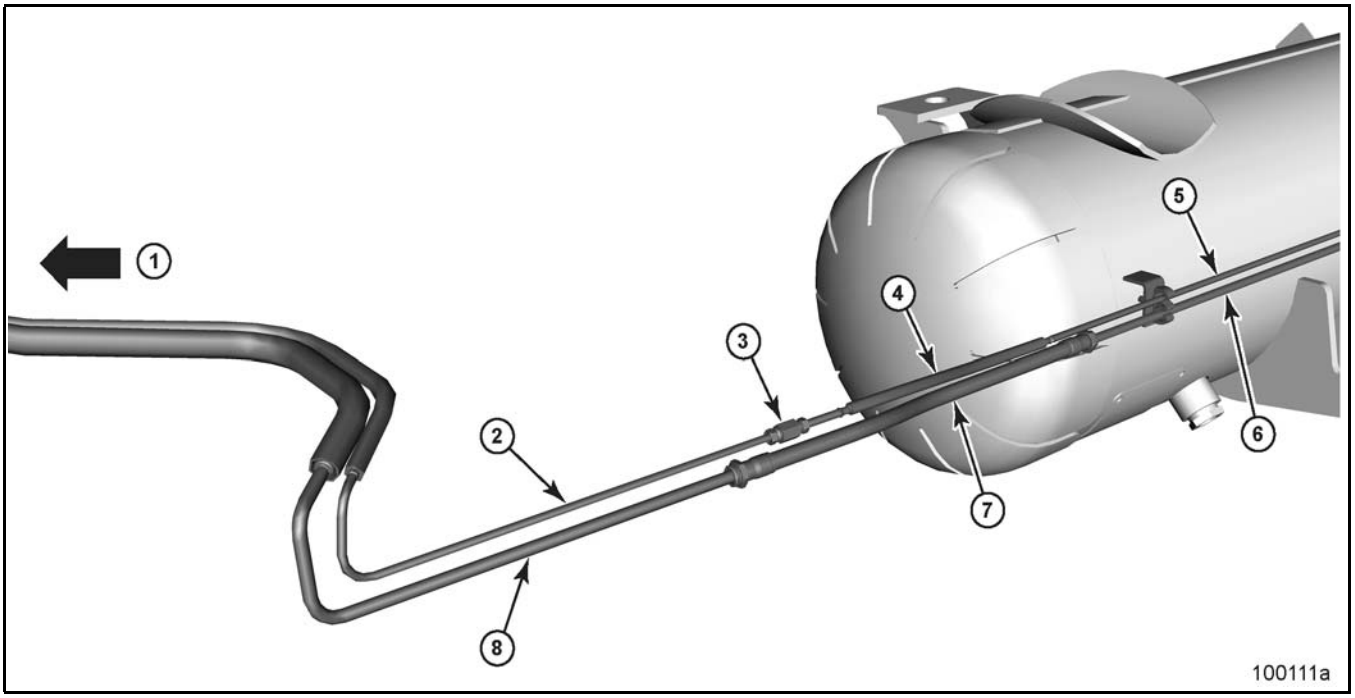


Figure 11 — Fuel Lines (Typical, Under Body Tank Shown)

1. To Fuel Rail Pressure Control Module (FRPCM)	5. Rear Fuel Return Line (1/4”)
2. Forward Fuel Return Line (1/4”)	6. Rear Fuel Supply Line (3/8”)
3. Service Connection	7. Intermediate Fuel Supply Line, Flexible (3/8”)
4. Intermediate Fuel Return Line, Flexible (1/4”)	8. Forward Fuel Supply Line (3/8”)

Fuel Rail Pressure Control Module

The FRPCM is a unit consisting of three normally closed solenoids, a return check valve and a vapor port. The FRPCM is controlled directly by the smart relay module (SRM) which is governed by the PCM. Included in the FRPCM are:

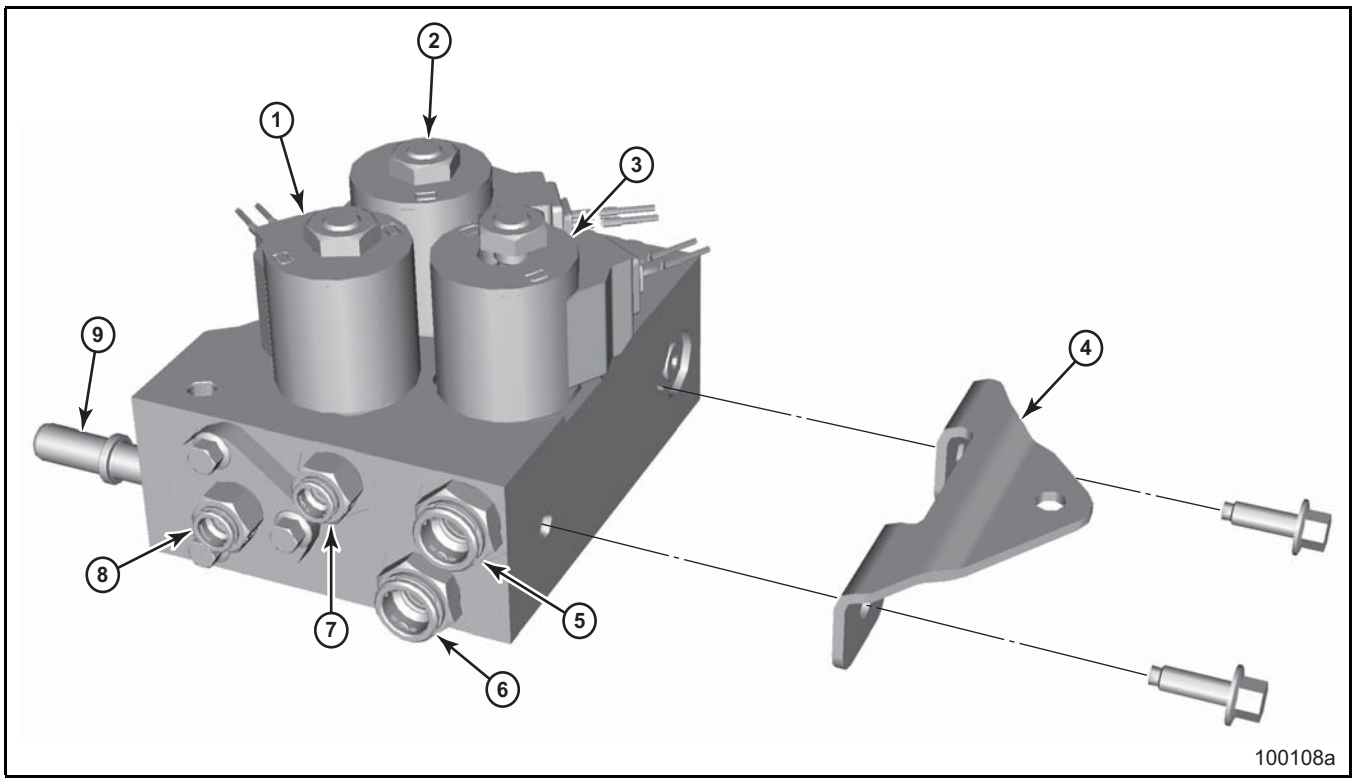


Figure 12 — FRPCM (Typical)

1. Bleed Solenoid 2. Flow Control Solenoid 3. Fuel Supply Solenoid 4. Mounting Bracket (varies by application) 5. Fuel Supply Port	6. Fuel Rail Fuel Supply Port 7. Fuel Rail Fuel Return Port 8. Fuel Return Port with Check Valve 9. Vapor Port

SUPPLY SOLENOID

Open (energized) when the engine is running, the supply solenoid allows fuel to flow from the chassis fuel lines to the fuel rail. The supply solenoid is closed when the engine is turned off, preventing fuel from flowing from the chassis fuel lines to the engine fuel rails.

RETURN CHECK VALVE

Open when the engine is running, the return check valve allows fuel to return from the fuel rails to the chassis fuel lines. The return check valve closes when the engine is turned off, isolating the fuel return line and fuel tank and preventing fuel from backfilling the engine fuel rails.

FLOW CONTROL SOLENOID

The FCS is located in the FRPCM return flow circuit. During normal engine operation, the solenoid is closed. This directs the fuel flow through a metered orifice which results in increased pressure at the fuel rails (similar to a conventional pressure regulator). Prior to engine start and in extremely hot fuel conditions, the FCS opens, which opens a bypass flow circuit around the metered orifice, increasing fuel flow through the rails.

BLEED SOLENOID

Closed when the engine is running, the bleed solenoid seals the fuel rails from the vehicle evaporative emission control system. After the engine is turned off for approximately one hour, the bleed solenoid opens for a calibrated length of time, allowing the fuel pressure to bleed from the fuel rails through a metered orifice and into the carbon canister.

Vapor Canister Assembly

A vapor canister is being utilized to capture and store the fuel vapors remaining in the fuel rails during engine shutdown to eliminate the chance of propane leaking past the fuel injectors.

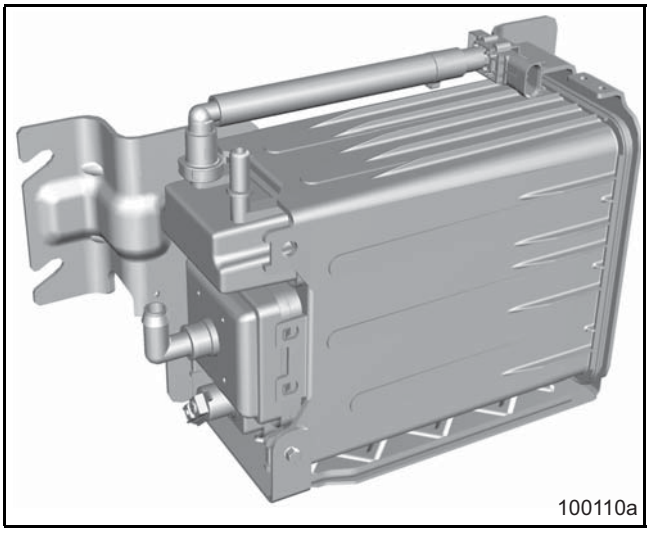


Figure 13 — Vapor Canister Assembly

Vapor Lines

The fuel vapor hoses are flexible with quick-connect fittings, which can be easily disconnected by pinching the connector release points.

Fuel Rail Assemblies

Each fuel rail assembly is mounted to the intake manifold by two brackets and is made up of the following components:

- The fuel injectors are retained in the fuel rails by a C-clip. The injectors are connected to the main engine wiring harness. Fuel metering and injection is controlled by the engine PCM as the injectors are opened and closed by switching the ground internally in the PCM.
- Injector spacers are sealed to the fuel rails and intake manifold injector ports by O-rings and retained to the fuel rails with retention clips.
- Two quick-connect fittings at the end of the rails connect the supply and return lines to the fuel rail assemblies.
- An IPTS is mounted on the left hand rail.

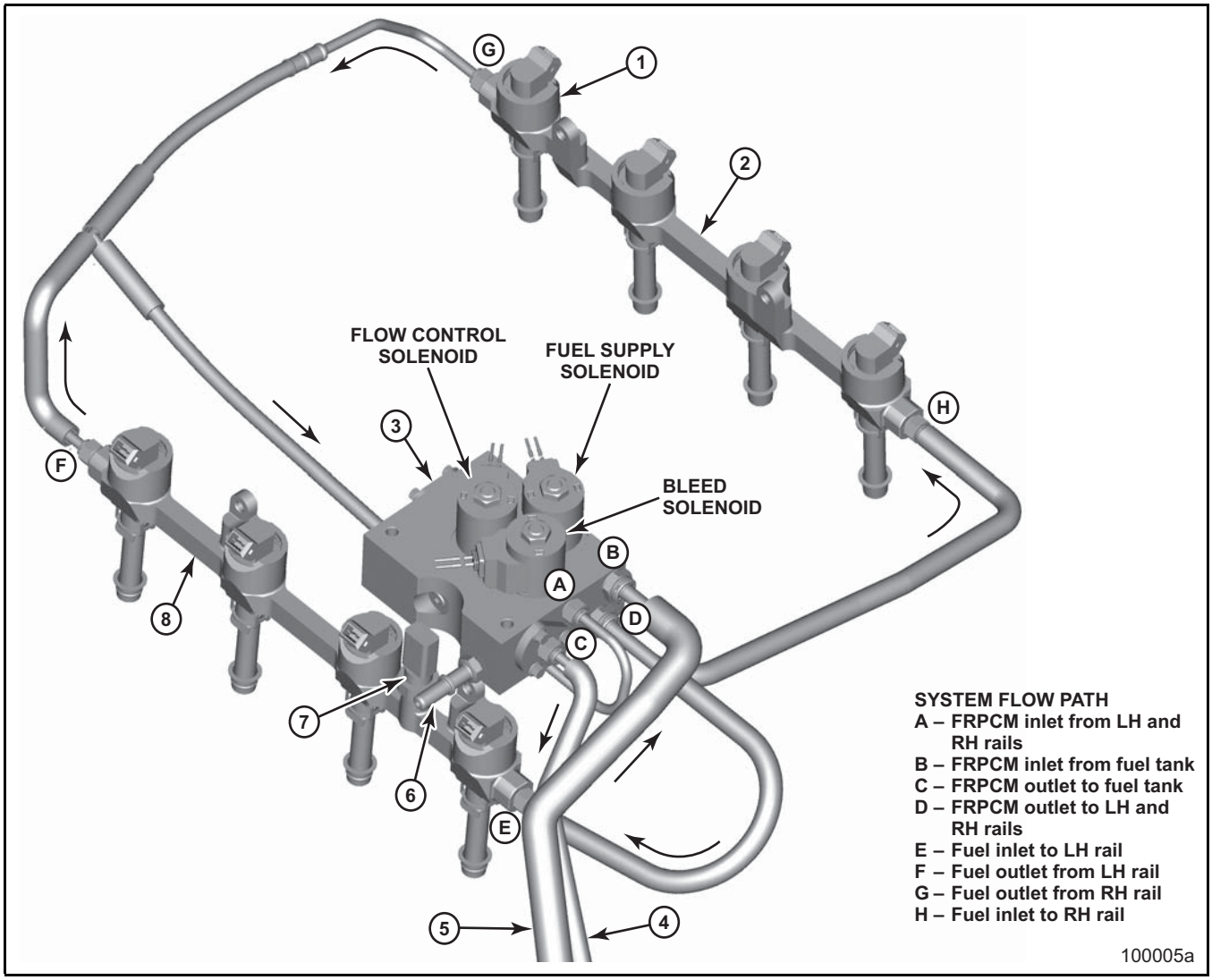


Figure 14 — Fuel Rail and Line Assemblies (Typical, 5.4L Shown)

1. Fuel Injector 2. RH Fuel Rail 3. FRPCM 4. Fuel Return Line	5. Fuel Supply Line 6. Vapor Port to Canister 7. IPTS 8. LH Fuel Rail

Fuel Fill Valve

This fuel fill valve is used to connect the refueling station nozzle to the fill receptacle during filling. It is mounted to a bracket behind the fuel door on the left side of the vehicle and has a screw-on protective dust cap. It contains a backflow check valve to prevent propane in the line from escaping when the dispensing nozzle is removed.

Fill Line

The fill line is a flexible black line with non-serviceable fittings on either end, connecting between the fill valve, in-line fuel filter and the tank fill valve.

Fill Filter

The fill (fuel) filter is mounted in various locations depending on application. In some applications the fuel filter is mounted to the fuel tank on the left side. Other locations are on the left frame rail or on the rear crossmember. These filters are always between the fuel fill valve and the tank fill valve. The filter consists of an internal filtering cartridge capable of filtering out contaminants as small as 5 microns. The filter should be replaced every 50,000 miles.

Remote Bleeder Valve

NOTE

Not all system applications require remote bleeder valves.

The remote bleeder valve is to remain closed during vehicle operation and filling. The remote bleeder valve and bracket assembly is mounted on the inner rear fender support, forward of the rear wheel well on the E-150/250/350 Van/Wagon. It is connected to the tank bleeder valve by a bleeder hose and is used for the same functions as the tank bleeder valve. On other applications, there is no remote bleeder valve or bleeder hose, only a bleeder valve located on the fuel tank.

- The bleeder valve provides a means to evacuate the tank for tank component service procedures.

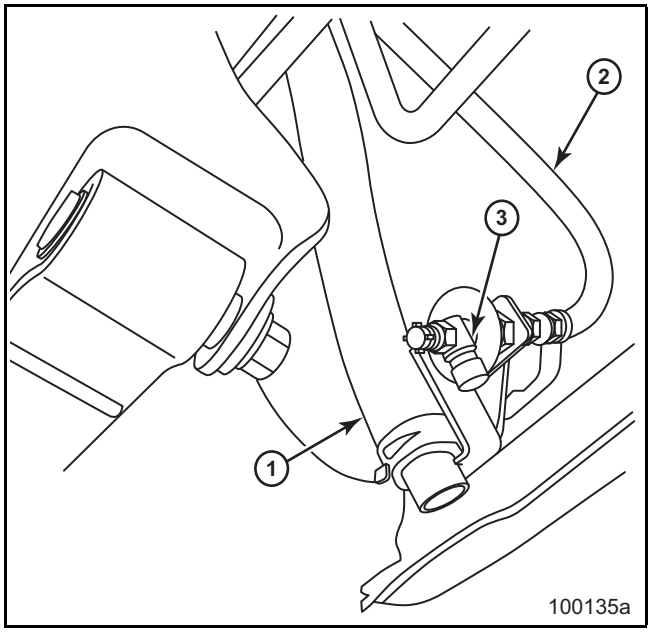


Figure 15 — Remote Bleeder Valve and Bracket Assembly (E-150/250/350 Van/Wagon Shown)

1. Pressure Relief Hose 2. Remote Bleeder Hose	3. Remote Bleeder Valve

Remote Bleeder Hose

The remote bleeder hose (if equipped) is a flexible steel-reinforced line with non-serviceable fittings on either end, connecting the tank bleeder valve to the remote bleeder valve (if equipped). This line is pressurized at all times and should only be serviced after closing the tank bleeder valve and opening the remote bleeder valve (if equipped) to release trapped pressure.

Electronic Fuel Pump Relay

The EFPR controls the fuel pump voltage, which controls the fuel pump duty cycle. Each fuel pump is controlled by a separate EFPR. The EFPRs are mounted to the left frame rail.

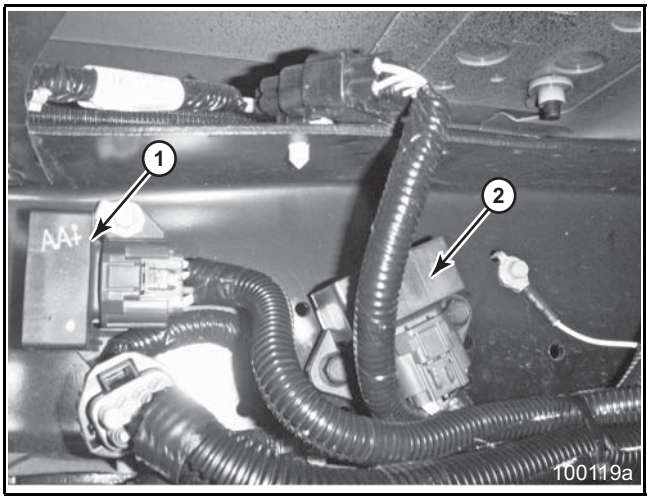


Figure 16 — Electronic Fuel Pump Relays

1. Ford-Installed EFPR	2. ROUSH-Installed EFPR

Smart Relay Module

The SRM is an electronic control module that provides additional input/output features required for the LPA fuel system via the vehicle's controller area network (CAN) bus.

The module is installed on the left front inner fender panel.

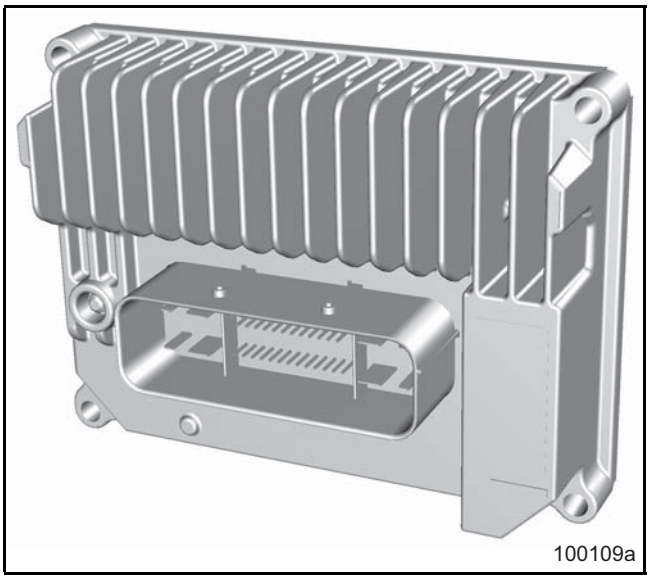


Figure 17 — SRM

LPA INTERFACE FUNCTION

The SRM controls the following functions within the LPA system:

- FRPCM solenoids
- Fuel tank supply solenoid

The SRM supplies the following information to the Ford engine controller:

- Fuel rail pressure
- Fuel rail temperature
- Second fuel pump relay module fault status
- Fuel level

NOTE

Signals supplied to the Ford engine controller will be diagnosed by the engine controller and reported as engine P-codes. Lack of communication between the SRM and the engine controller will also be reported by the engine controller. For additional information, refer to the *Ford Powertrain Control/Emissions Diagnosis Service Manual* at www.motorcraft.com

The SRM also provides fuel level information to the fuel level indicator module (FLIM).

Fuel Level Indicator Module

The FLIM receives a signal from the SRM. The FLIM simulates the output from the OEM flex fuel level sender that is expected by the instrument cluster. The FLIM is diagnosed by the instrument cluster as the fuel level sender.

GLOSSARY

Bleed Solenoid — Closed when the engine is running, sealing the fuel rail from the evaporative system. After the engine is turned off for approximately one hour, the bleed solenoid opens for a calibrated length of time allowing pressure to bleed from the fuel rails

Excess Flow Valve — The XFV is located in the supply fuel path, ahead of the tank solenoid and manual shutoff valve. The XFV is intended to shut off fuel flow from the fuel tank in the event of a rapid pressure drop outside the tank. It is part of the tank supply circuit assembly.

Fill Valve — Serves as the fuel fill inlet to the fuel tank for attachment of the fill station hose. The valve is a one-way single-back check valve that opens during the fuel fill process and closes when fueling is complete to minimize fuel from escaping.

Flow Control Solenoid — Closed when the engine is running, the flow control solenoid (FCS) directs fuel to flow through a metered orifice back to the fuel tank. The solenoid is open prior to cranking the engine to cool the fuel rail and remove any vapor from the rail. The solenoid is opened for approximately 15 seconds after the engine is turned off to allow pressure in the fuel rails to return to the fuel tank. The solenoid may also be opened to flush the fuel rails to make sure that there is liquid fuel in the fuel rails during hot operating conditions. The solenoid is part of the FRPCM.

Fuel Fill Filter — In-line between the fill valve and the fuel tank to filter fuel before entering the fuel tank during the fill process.

Fuel Level Indicator Module — The fuel level indicator module (FLIM) receives voltage input from the SRM and outputs the expected signal to the instrument cluster.

Fuel Level Sending Unit — Located inside of the fuel tank to indicate fuel level. The unit consists of a float on an arm coupled with an externally-mounted resistor.

Fuel Rail Pressure Control Module — The fuel rail pressure control module (FRPCM) consists of three solenoids (supply, flow control and bleed), a return check valve and vapor port controlled by a separate electronic control module. The FRPCM is mounted on the engine.

Fuel Return Check Valve — Makes sure fuel does not escape from fuel tank if there is a leak in the fuel return line external to the tank. It is contained in the return circuit assembly.

Fuel Supply Valve — Opened electrically by the flow control solenoid to provide fuel to the engine. Also incorporates an XFV to minimize fuel escaping if there is a leak in the fuel supply line external to the tank.

Fuel Tank Fill Valve — Located where fuel enters into the fuel tank. During the fill process, the valve is opened by fuel fill pressure. The valve also incorporates double-back redundant check valves that close when fuel tank pressure is greater than the pressure outside of the tank to prevent fuel from escaping.

Integrated Pressure Temperature Sensor — The integrated pressure temperature sensor (IPTS) is mounted on the fuel rail, and used to monitor pressure and temperature of the fuel.

Manual Shutoff Valve — Manually operated valve that is used to seal the outlet of the fuel tank during shipping or service. The valve should always be open when the vehicle is operating. The valve is part of the tank supply circuit assembly.

Overflow Protection Device — The overflow protection device (OPD) is part of the fuel tank fill valve, a lever-actuated valve that shuts off filling when the fuel in the tank is at the 80% level. The lever is actuated by a float mechanism that is raised by the fuel.

Pressure Relief Valve — Automatically opens to relieve excessive pressure inside of the fuel tank.

Return Check Valve — Open when the engine is running, the return check valve allows fuel from the fuel rails to return to the chassis fuel lines. The check valve closes when the engine is turned off, preventing fuel from backfilling the fuel rails. The check valve is part of the FRPCM.

Smart Relay Module — The smart relay module (SRM) controls the actuation of the three solenoid valves in the FRPCM. The SRM receives the signal from the fuel level sending unit and broadcasts the signal to the PCM and the instrument cluster by way of the FLIM. The SRM also reads the IPTS and sends the information to the PCM via the CAN bus.

Supply Solenoid — A solenoid that is open (energized) when the engine is running, allowing fuel to flow from the fuel lines to the fuel rails. The solenoid is closed when the engine is turned off, preventing fuel from flowing from the fuel tank to the fuel rails. The solenoid is part of the FRPCM.

Tank Supply Circuit Assembly — Mounted directly on the fuel tank and serves as the main interface between the tank and engine. The assembly consists of the fuel tank solenoid, the XFV and the manual shutoff valve.

MAINTENANCE

MAINTENANCE PROCEDURES

Maintenance Requirements

Refer to the *ROUSH CleanTech Supplemental Owner's Guide* for recommended service intervals and required maintenance.

Intake Air Filter Inspection

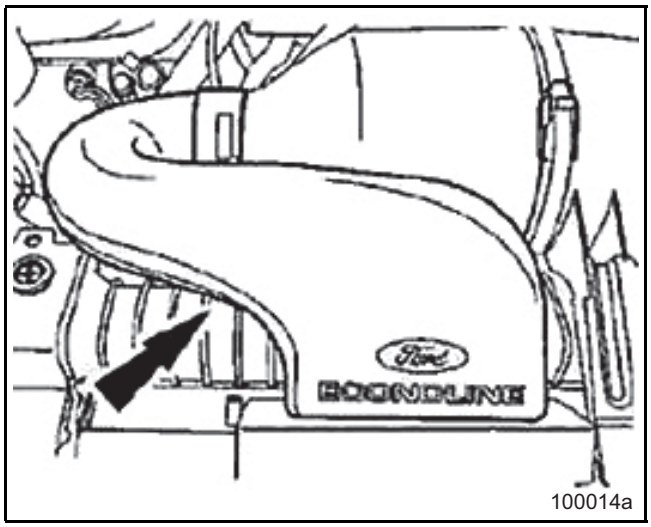


Figure 18 — Intake Air Duct and Filter Housing (Typical)

This intake air filter assembly is common to base Ford vehicles. Refer to the appropriate *Ford Workshop Manual* for service.

In-Line Fuel Filter Replacement

DANGER

A trace amount of propane fuel will be released on loosening the fittings. It will settle to the lowest available surface before it dissipates into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

1. Purge residual fuel from the fuel fill line by loosening the line fitting.
2. Disconnect the fuel fill line from the fuel filter inlet.

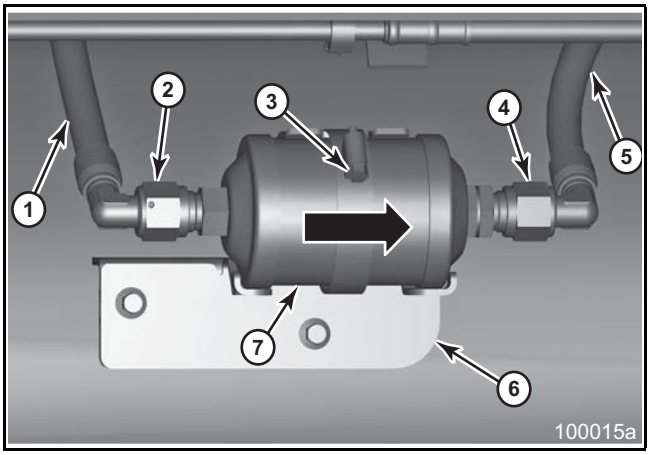


Figure 19 — In-Line Fuel Filter (Typical)

1. Fuel Fill Line (Fill Valve-to-Filter) 2. Inlet Line Nut 3. Filter Retention Clamp 4. Outlet Line Nut	5. Fuel Fill Line (Filter-to-Tank) 6. Fuel Fill Bracket 7. Fuel Filter

3. Disconnect the fuel fill line from the fuel filter outlet.
4. Loosen the clamp retaining the fuel filter in place.
5. Remove and discard the filter.
6. Place a new fuel filter in position on the filter bracket and tighten the retaining clamp to 4–5 N•m (35–44 lb-in).
7. Connect the fuel fill lines to the filter inlet and outlet. Tighten the line fittings to 41–49 N•m (30–36 lb-ft).

REPAIR PROCEDURES

PREPARING VEHICLE FOR SERVICE

Alert Messages

The following alert messages appear from time to time in appropriate places in this manual. Ensure that all personnel in the immediate area are aware of these messages. These messages consist of **Dangers**, **Warnings** and **Cautions**. Other messages may appear as **Notes**.

⚠ DANGER

Propane is nontoxic, nonpoisonous, has the lowest flammability range of any alternative fuel and dissipates quickly when released into the atmosphere. When the ratio of propane to air is between 2.2% and 9.6%, propane burns in the presence of an ignition source at 940°F (504°C).

Gasoline auto-ignition occurs at a much lower temperature: 430–500°F (221–260°C) or hotter. Keep away from heat, sparks, flames, static electricity or other sources of ignition. Failure to heed this danger can result in severe personal injury or death.

⚠ DANGER

Fuel supply lines remain pressurized after engine shutdown. Keep away from heat, sparks, flames, static electricity or other sources of ignition. Do NOT enter storage areas or confined spaces unless they are adequately ventilated. Failure to heed this danger can result in severe personal injury or death.

⚠ DANGER

Propane is heavier than air and seeks the lowest available level when released to the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

⚠ WARNING

Liquid propane is cold. The temperature of propane in its liquid state is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in personal injury.

NOTE

Identify the condition (good, stuck open, stuck closed or inoperable) of each solenoid valve prior to venting the fuel tank to ensure that the solenoid valves are not the reason for vehicle service and unnecessarily venting the tank.

Manual Fuel Shutoff

NOTE

This procedure ensures that no propane leaves the fuel tank during service activities.

1. For E-150/250/350 vehicles, remove the supply valve cover on the side of the tank by loosening the two Allen-head screws and remove the thumb screw.

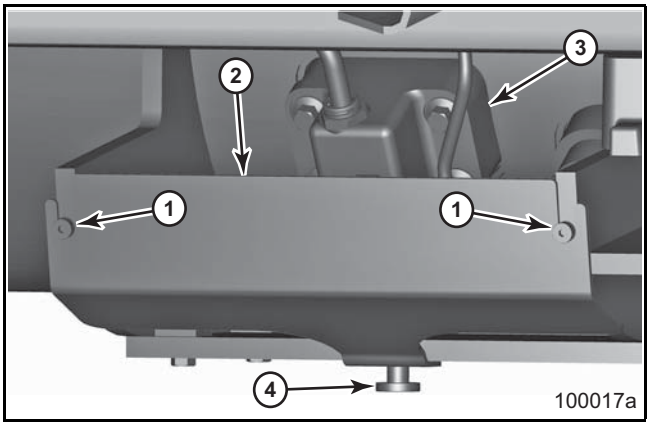


Figure 20 — E-Series Supply Valve Cover

1. Allen-head Screws 2. Supply Valve Cover	3. Fuel Supply Valve 4. Thumb Screw

2. For E-150/250/350 Extended Range and E-450 vehicles, remove the manual shutoff valve access plug on the side of the tank.

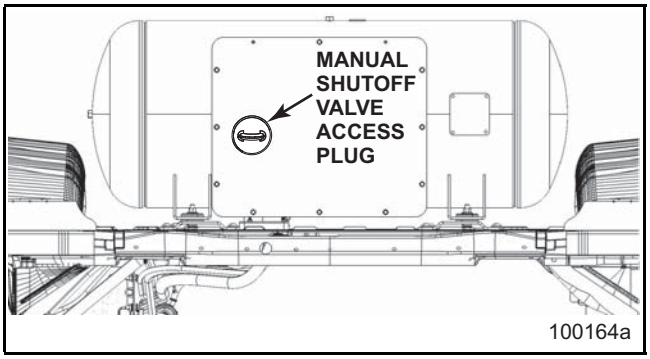


Figure 21 — E-150/250/350 Manual Shutoff Valve Access Plug

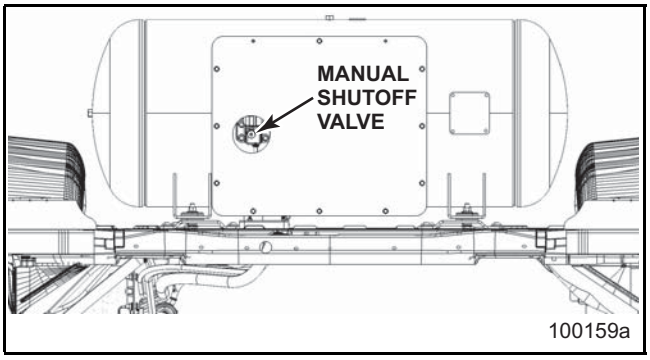


Figure 22 — E-150/250/350 Plug Removed

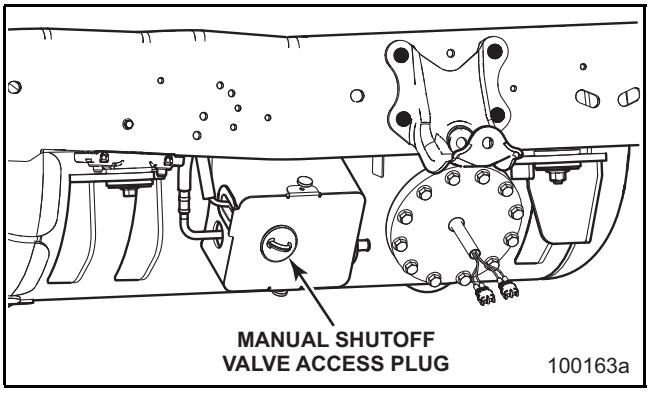


Figure 23 — E-450 Manual Shutoff Valve Access Plug

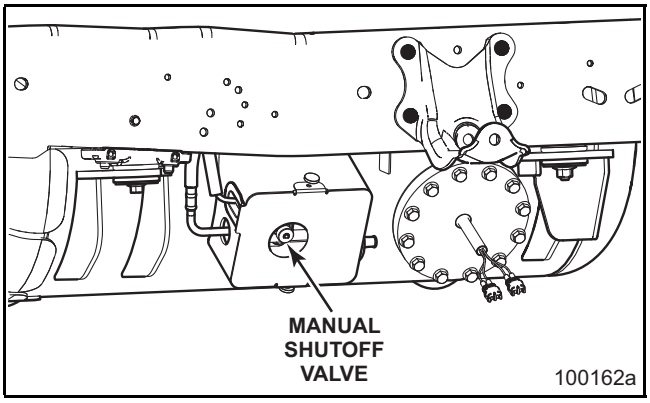


Figure 24 — E-450 Plug Removed

3. With the supply valve cover or manual shutoff valve access plug removed, locate the manual shutoff valve. Turn the knurled knob clockwise until it stops and is fully closed. The propane supply from the tank is now shut off.

NOTE

The manual shutoff valve can be hard to turn. From fully open to fully closed is approximately 3-1/2 turns.

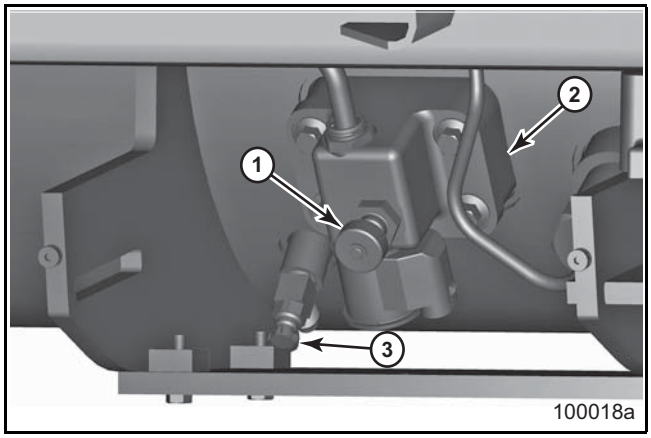


Figure 25 — Manual Shutoff Valve (Typical)

1. Manual Shutoff Valve 2. Fuel Supply Valve	3. Bleeder Valve

Supply Valve Cover or Tank Cover Plate

NOTE

To access fuel system components, remove the supply valve cover or tank cover plate as necessary.

1. For E-150/250/350 vehicles, remove the supply valve cover on the side of the tank, by loosening the two Allen-head screws and remove the thumb screw.

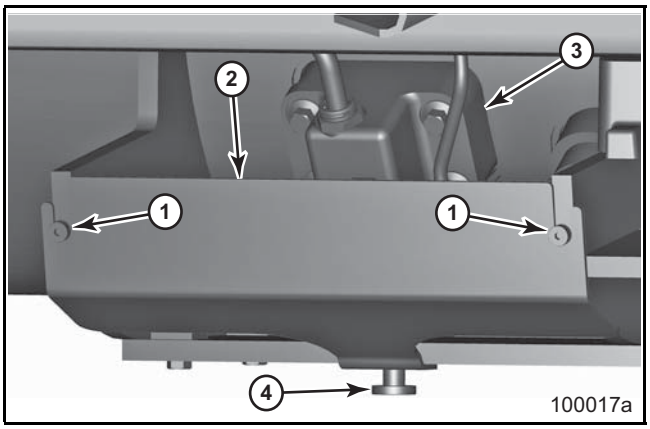


Figure 26 — E-Series Supply Valve Cover

1. Allen-head Screws 2. Supply Valve Cover	3. Fuel Supply Valve 4. Thumb Screw

For E-150/250/350 Extended Range vehicles, remove the twelve bolts and remove the tank cover plate.

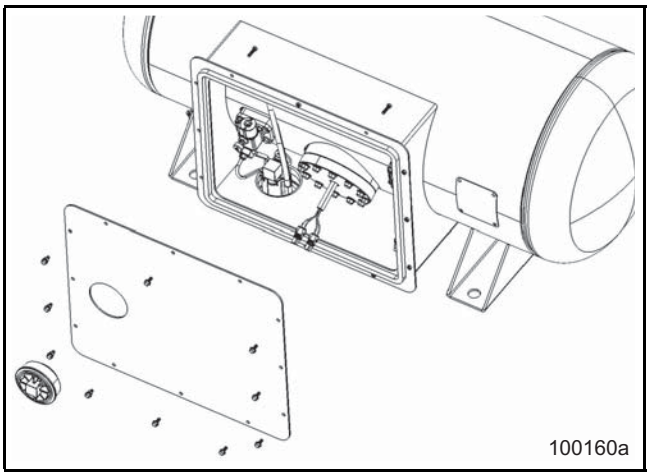


Figure 27 — E-150/250/350 Extended Range Tank Cover Plate

For E-450 vehicles, remove the two thumb screws and the supply valve cover. Later versions of supply valve covers have only one thumb screw, located at the bottom of the cover.

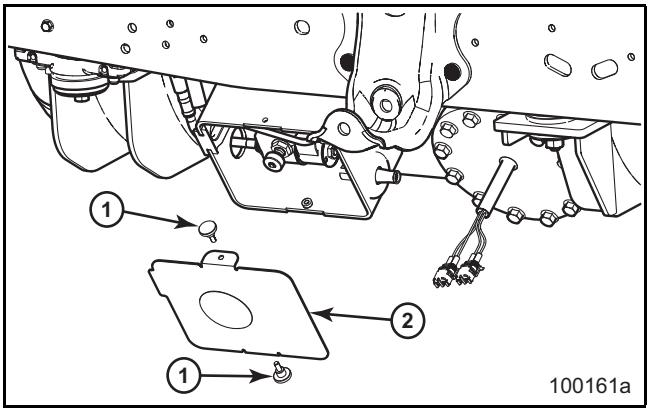


Figure 28 — E-450 Supply Valve Cover

1. Thumb Screw(s)	2. Supply Valve Cover

2. To install, reverse the removal procedure. Tighten fasteners to specification. Refer to *Specifications* for more information.

Fuel Line Purging and Fuel Tank Draining Procedures

During any fuel system maintenance or repair in which the fuel pressure must be released from the system or the system completely evacuated, use the following procedures.

⚠ DANGER

Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.

⚠ DANGER

LPG is under pressure, wear adequate eye protection. When LPG is discharged into the atmosphere, the rapid change in pressure can cause a refrigerant condition in the fuel (quick cooling) and can harm your skin or cause serious burns much like frostbite. Always wear appropriate protective gloves. Failure to heed this warning can result in serious

personal injury.

DANGER

Propane is heavier than air and seeks the lowest available level when released to the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

WARNING

When releasing the fuel pressure, be sure to place the discharge point of the drain hose in a safe area free from any combustible material or ignition source. Be sure that no one is in the immediate area of the discharge hose. Failure to heed this warning can cause severe personal injury.

WARNING

Liquid propane is cold. The temperature of propane in its liquid state at atmospheric pressure is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in personal injury.

FUEL LINE PURGING

Clearing the propane out of the fuel lines (purging) is required before working on many fuel system components. Following the suggested techniques for purging the fuel lines will reduce the amount of vapor released harmlessly into the atmosphere and will produce the least risk to life and property.

1. Close the manual shutoff valve on the tank supply valve. Refer to *Figure 25 — Manual Shutoff Valve (Typical)*.
2. Remove the Ford fuel pump fuse. This disconnects the power to the fuel pumps.

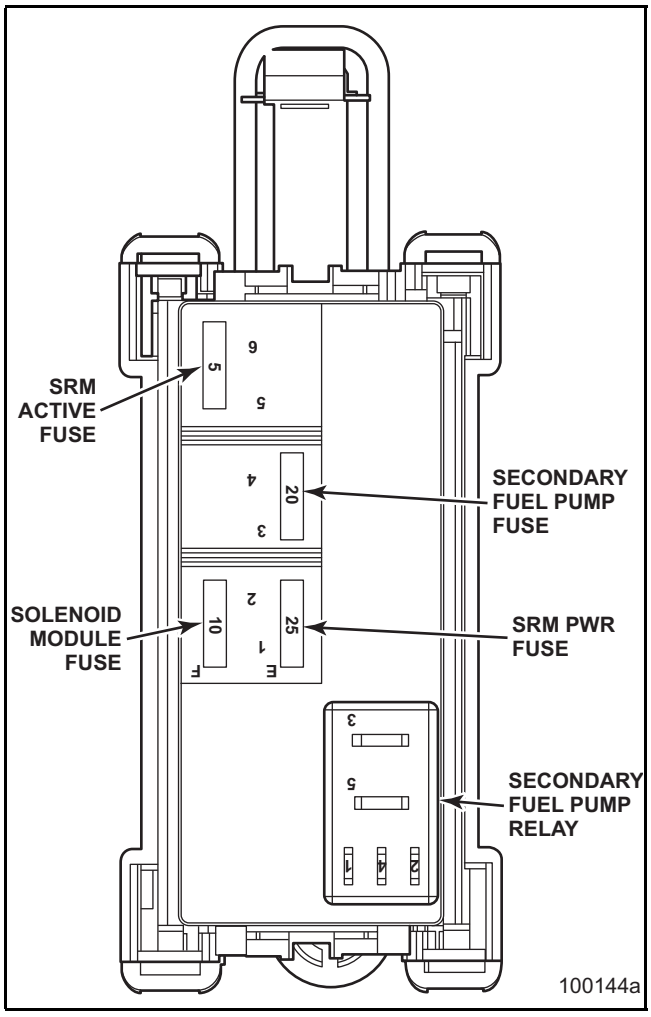


Figure 29 — Fuse Box

3. Start the engine and let it run until it stalls. This purges the fuel supply line of liquid propane.
4. Energize all of the fuel rail pressure control module (FRPCM) solenoids for 20 minutes.
5. Measure fuel pressure to ensure that the fuel rails are purged of propane (less than 25 psi [172 kPa]).
6. Disconnect the negative battery cable from the battery.
7. Relieve pressure in the fuel return line by slowly loosening the threaded union in the return line under the vehicle.

⚠ WARNING

Liquid propane is cold. The temperature of propane in its liquid state at atmospheric pressure is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in severe personal injury.

8. Tighten the fuel return line threaded union to 18–22 N•m (13–16 lb-ft).

⚠ WARNING

When releasing the fuel pressure, be sure to keep the discharge point of the line or hose in a safe area free from any combustible material or ignition source. Be sure that no one is in the immediate area of the discharge hose. Failure to heed this warning can cause severe personal injury.

NOTE

There may still be a small amount of propane in the lines after completing this procedure. Open the lines slowly and cautiously to bleed off any remaining propane.

FUEL TANK DRAINING

⚠ DANGER

Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme care and caution may lead to serious accidents which can result in property damage, personal injury or death.

⚠ DANGER

Propane is nontoxic, nonpoisonous, has the lowest flammability range of any alternative fuel and dissipates quickly when released into the atmosphere. Propane vapor is heavier than air and seeks the lowest point. When the ratio of propane to air is between 2.2% and 9.6%, propane burns in the presence of an ignition source at 940°F (504°C) or hotter. Keep away from heat, sparks, flames, static electricity or other sources of ignition. Failure to heed this danger can result in severe personal injury or death.

The fuel tank on an LPA fuel system utilizes two electric fuel pumps to deliver fuel to the fuel injectors during normal operation. If you are shipping the tank, servicing one of the valves or to service in-tank components, you must follow the procedures listed below.

⚠ DANGER

Draining the LPA tank should be performed by a trained technician only. When draining a fuel tank, use all the following precautions to prevent serious personal injury, death or property damage.

⚠ DANGER

Propane is heavier than air and seeks the lowest available level when released to the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

⚠ WARNING

Liquid propane is cold. The temperature of propane in its liquid state at atmospheric pressure is –44°F (–42°C). Wear eye and ear protection during venting and repair operations. Keep moisture away from the valves. Failure to heed this warning can result in personal injury.

- **Wear protective eye wear, gloves and clothing.**
- **Perform the process in a well-ventilated area only.**
- **Remove all potential ignition sources from the area.**
- **Use only the recommended processes.**
- **Use the proper tools.**
- **Drain the tank on the vehicle into a tank of equivalent or larger capacity.**

USING IN-TANK PUMPS

Use of the in-tank pumps to drain the tank is an acceptable method assuming at least one of the two pumps and the supply valve are functioning normally.

NOTE

This method will not completely drain the tank and a final process of venting the tank will still be required. In some areas it is not allowed or may not be safe to vent the fuel to the atmosphere. In this case, the fuel must be burned off.

1. Move the vehicle to a well-ventilated area free of any external ignition sources.
2. Place the tank in which the fuel is to be captured close to the tank to be drained.
3. Remove the supply valve cover or tank cover on the side of the tank, as needed.
4. Purge the fuel lines. Refer to the *Fuel Line Purging* procedure in this section.
5. Disconnect the 3/8” fuel supply line from the hard line on the tank (or directly from the tank) using the appropriate disconnect tool.
6. Connect a fuel transfer hose to the receiving tank fill valve or other appropriate valve.
7. Connect the transfer hose to the fuel supply line of the tank to be drained.
8. Disconnect the fuel pump wire harness in vehicle and connect a switch to the fuel pump wire connectors.
9. Open the manual shutoff valve on the tank to be drained.
10. Open the automatic fuel supply valve on the tank to be drained, this requires 12V power to the supply solenoid.

11. Turn the switch on the jumper harness to the ON position. You should hear the pumps in the fuel tank running and fuel will begin to transfer to the capture fuel tank.
12. When the liquid propane level in the fuel tank drops below the fuel pump's pickup tube, the pump will make a different sound. Turn the switch to OFF to stop the pumps.
13. The remaining fuel in the tank will now need to be evacuated through the bleeder valve.
14. Manually close the shutoff valve on the fuel tank.
15. Loosen the fuel transfer hose and bleed off the fuel pressure.

⚠ WARNING

Fuel may be under pressure in the transfer line; use caution when disconnecting the fittings, slowly loosen the fittings and use gloves and protective eye wear. Failure to heed this warning can result in personal injury.

16. Disconnect the transfer hose from the receiving tank and place the other end of the transfer hose in a safe, well-ventilated location away from any area where the fuel could create a volatile condition.
17. Slowly open the manual shutoff valve and allow the tank to vent until the pressure has been released completely from the tank. Most fuel valves are rated to pass 2.3 to 3.3 gallons per minute (5.22–7.49 liters per minute) before the excess flow rating is exceeded and could close. If the excess flow closes during this operation, simply close the manual shutoff valve and reopen it slowly.

NOTE

The tank can be evacuated using a flare stand, if the service center is equipped with a stand and has received the proper training.

18. If using a flare stand to burn off the remaining fuel in the tank, this would require approximately a 50 ft (15.2 m) clearance from the vehicle, other vehicles, any building or any combustible materials. Slowly open the valve on the flare stand and light the escaping gas; open the valve little by little to decrease the time to evacuate.

NOTE

Some states and municipalities may have regulations regarding the release of LPG into the atmosphere. Check with your local fire marshal or your local LPG supplier prior to venting or burning off a tank.

19. When the pressure in the tank has reduced to a point that it does not support the flame, turn the liquid supply valve off and disconnect the hoses. Open the remote bleeder valve to vent the remaining pressure to the atmosphere.

⚠ WARNING

Do not have any sources of ignition within a minimum of 50 ft (15.2 m) from the area. Failure to heed this warning can result in personal injury.

20. Once the tank has vented, close the supply valve and bleeder valve on the tank.

NOTE

If you have any questions or concerns or you are unqualified to perform the process of venting the tank, contact your local fuel system provider or ROUSH CleanTech at (800) 59-ROUSH (597-6874).

FUEL SYSTEM COMPONENT SERVICE

Fuel Tank — E-150, E-250 and E-350

WARNING

Care must be taken while working with liquid propane. All steps must be followed to prevent personal injury and component damage.

NOTE

Locate a suitable place to put the fuel tank so that it can be worked on after being removed from the vehicle. The tank might also require temporary storage in preparation for shipment.

1. Purge the propane from the fuel lines and drain the fuel tank. Refer to *Fuel Line Purging and Fuel Tank Draining Procedures* in *Preparing Vehicle for Service*.
2. Purge residual fuel from the fuel lines by loosening one of the fittings.
3. Bleed the fuel fill lines before removal.
4. Disconnect the fuel fill line from the inlet of the fuel filter.

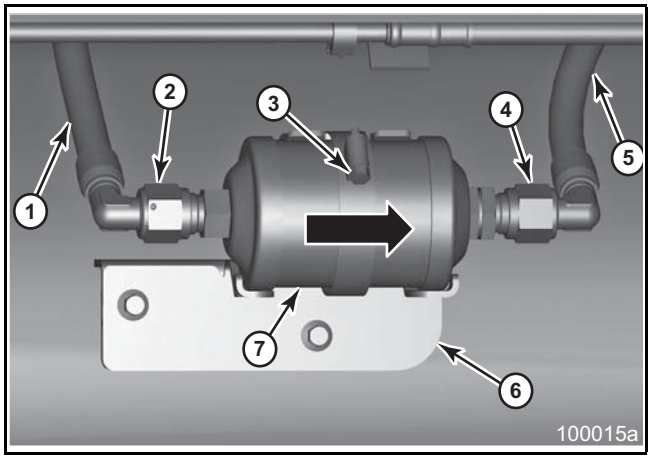


Figure 30 — Fuel Fill Lines and Filter (Typical)

1. Fuel Fill Line (From Fuel Fill Valve) 2. Filter Inlet Fitting 3. Filter Clamp 4. Filter Outlet Fitting	5. Fuel Fill Line (To Mechanical Fill Valve on Tank) 6. Filter Bracket (On Tank) 7. Fuel Filter

5. Disconnect the fuel tank fuel supply line and fuel return line from the intermediate flex fuel supply line and intermediate flex fuel return line.

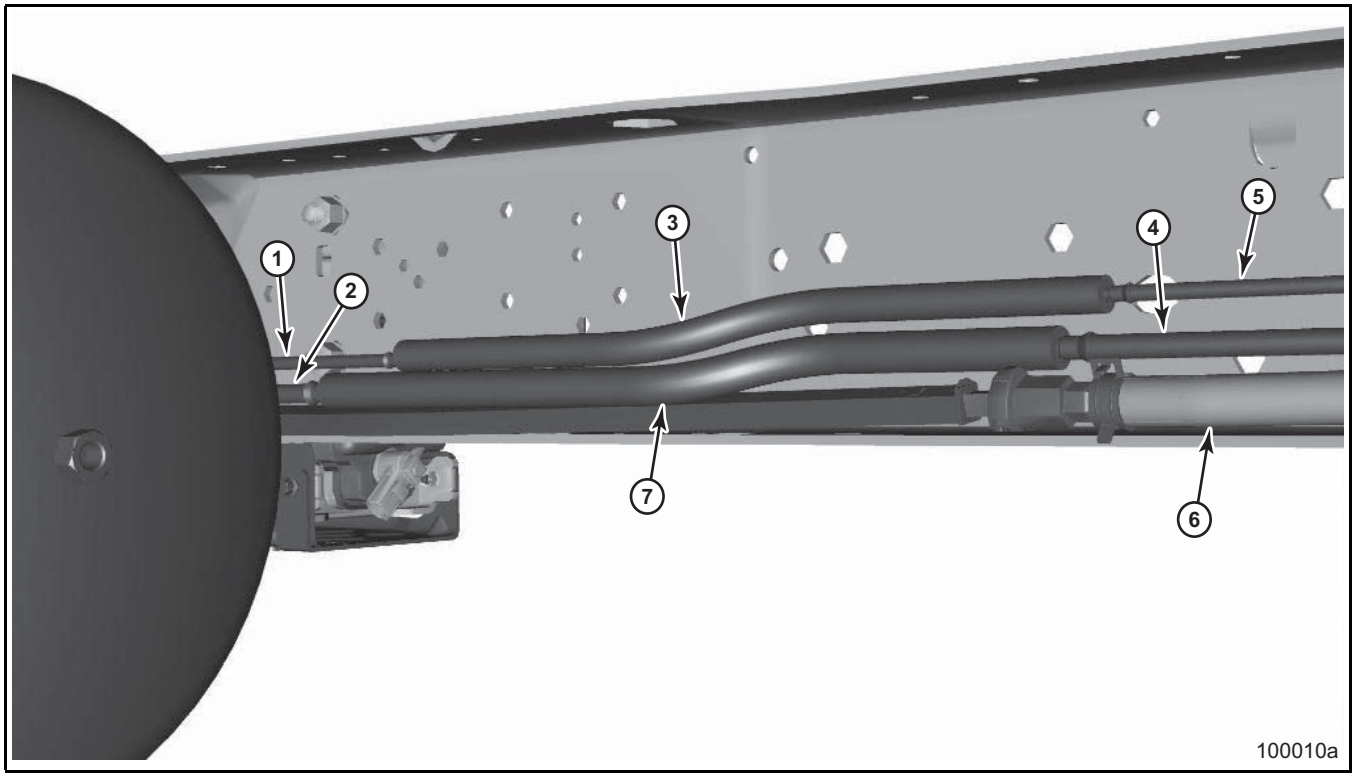


Figure 31 — Intermediate (Flex) Fuel Supply and Fuel Return Lines

1. Rear Fuel Return Line 2. Rear Fuel Supply Line 3. Intermediate (Flex) Fuel Return Line 4. Forward Fuel Supply Line	5. Forward Fuel Return Line 6. Vapor Management Line (from Engine) 7. Intermediate (Flex) Fuel Supply Line

⚠ WARNING

Take care when using lifting devices during service and maintenance procedures to avoid serious personal injury and damage to components. Inspect all lifting straps to make sure they are not damaged. Do not subject lifting straps to shocks or drop-loading.

6. Obtain a hoist capable of safely lifting 1,000 lb (373 kg). Attach the hoist to the fuel tank using lifting straps. Support the tank while removing the tank mounting fasteners.
7. Remove the nuts, bolts and steel washers attaching the tank to the left frame rail and to the front and rear crossmembers. Remove the mounting isolators and crush limiters as necessary.

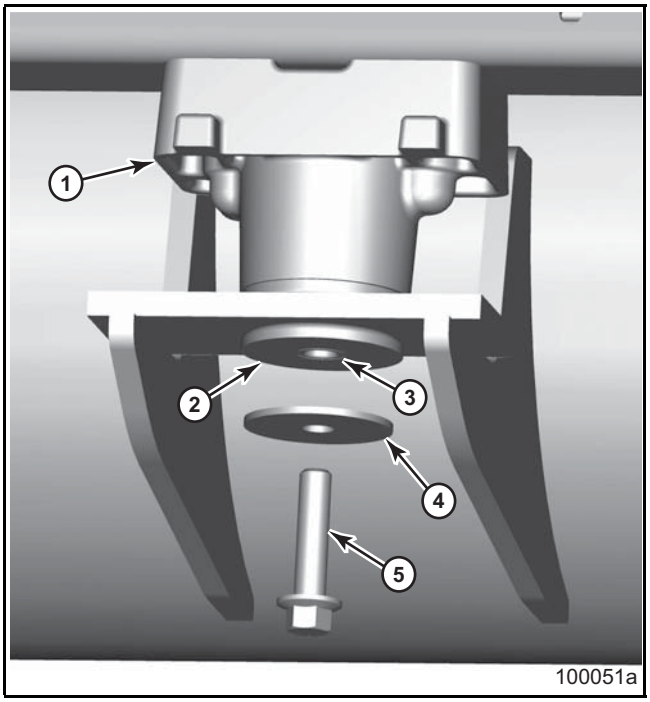


Figure 32 — Tank Outboard Front Frame Bracket Bolt and Washer

1. Tank Outboard Front Frame Bracket 2. Mounting Isolator	3. Crush Limiter 4. Steel Washer 5. Bolt

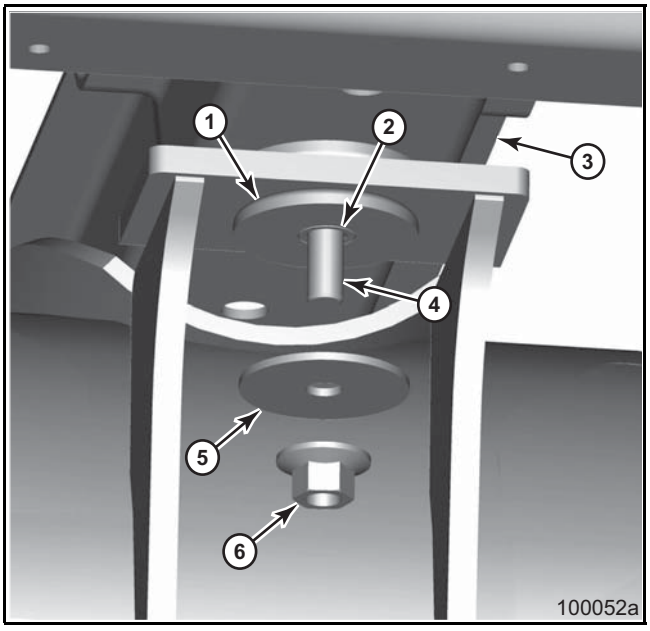


Figure 33 — Crossmember Tank Mounting Nut and Washer

1. Mounting Isolator 2. Crush Limiter 3. Tank Front Crossmember	4. Bolt 5. Steel Washer 6. Nut

8. With the help of an assistant, lower the tank approximately 12–18” (305-457 mm) to gain access to the fuel tank electrical connections.
9. Cut the tie straps and then disconnect the fuel tank electrical connectors.

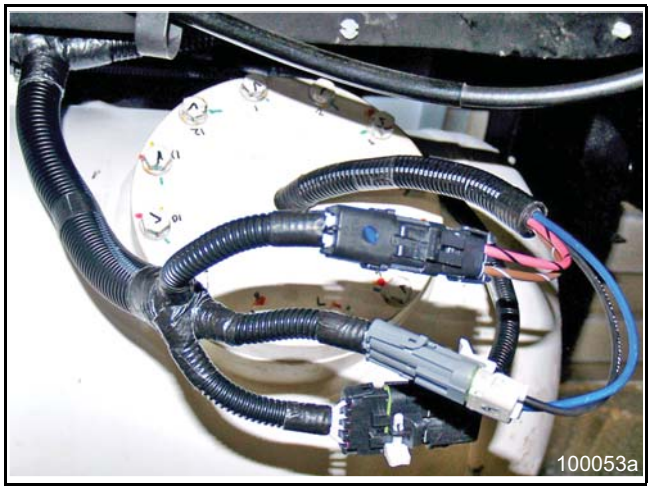


Figure 34 — Fuel Tank Electrical Connectors (Typical)

10. Lower the tank from under the vehicle and place it on a suitable surface.

⚠ CAUTION

The rear fuel supply and return lines can remain attached to the tank at this point. Use caution to avoid damage to the fuel lines when resting the tank on any surface. Failure to heed this caution can result in component damage.

11. Detach the hoist and remove the lifting straps.
12. Remove the convolute tubing from the fuel lines.
13. Remove the convolute tubing from the fuel fill line and the electrical cables.
14. Disconnect the rear fuel supply line from the quick-connect fitting in the fuel supply valve and the rear fuel return line from the quick-connect fitting in the fuel return valve.

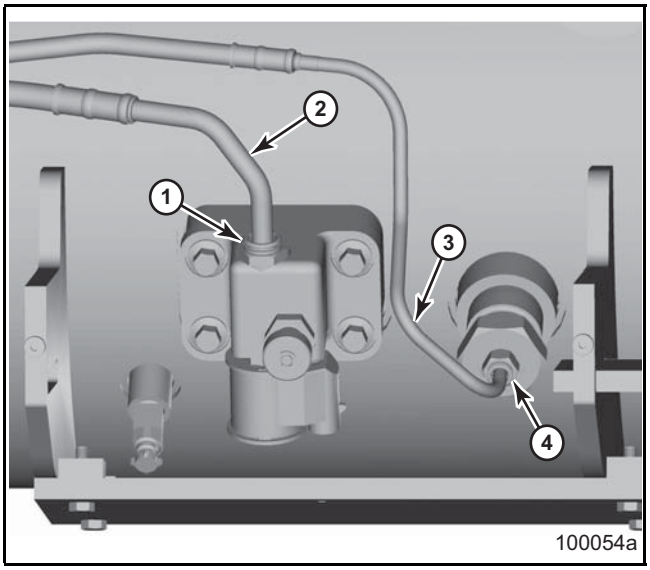


Figure 35 — Rear Fuel Line Connections on Tank

1. Fuel Supply Valve Fitting 2. Rear Fuel Supply Line	3. Rear Fuel Return Line 4. Fuel Return Valve Fitting

15. Disconnect the rear fuel supply and rear fuel return lines from the retention clips on the tank.

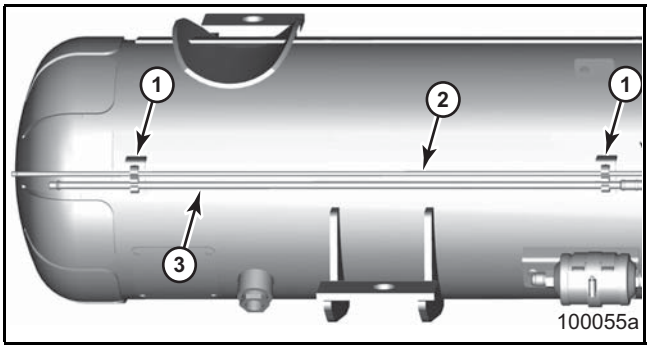


Figure 36 — Rear Fuel Lines in Retention Clips

1. Double-Snail Retention Clips 2. Rear Fuel Return Line	3. Rear Fuel Supply Line

16. Disconnect the fuel fill line from the edge clip zip tie on the tank strap bracket.
17. Disconnect the fuel fill line from the fuel filter and from the mechanical fill valve on the tank.

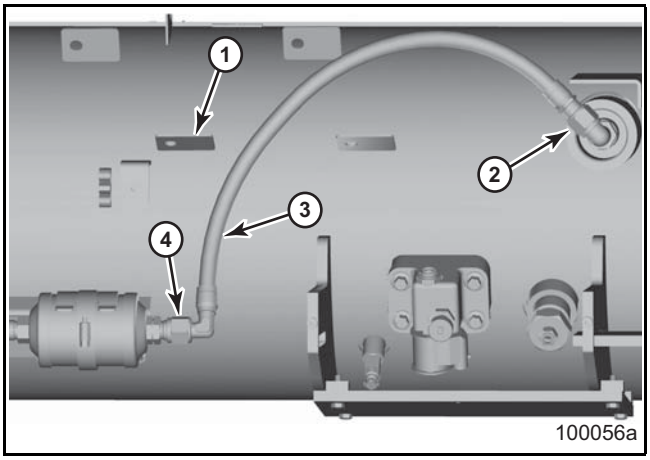


Figure 37 — Fuel Fill Line (Filter-to-Tank) (Typical)

1. Bracket with Edge Clip Secures Line 2. Fitting at Manual Fill Valve	3. Fuel Fill Line (Filter-to-Tank) 4. Fitting at Fuel Filter

18. To install the fuel tank, reverse the removal procedure. Tighten all nuts, bolts, fittings and connections to specification. Refer to *Specifications* for more information.

NOTE

After all fuel system components have been installed and tightened to specification, the system must be bleed, filled with propane and checked for leaks. Refer to *Preparing Vehicle For Use After Service*.

Fuel Tank — E-150, E-250 and E-350 Extended Range

NOTE

Locate a suitable place to put the fuel tank so that it can be worked on after being removed from the vehicle. The tank might also require temporary storage in preparation for shipment.

⚠ WARNING

Care must be taken while working with liquid propane. All steps must be followed to prevent personal injury and component damage.

1. Remove the tank cover plate. Refer to *Supply Valve Cover or Tank Cover Plate* for more information.
2. Purge the propane from the fuel lines and drain the fuel tank. Refer to *Fuel Line Purging and Fuel Tank Draining Procedures* in *Preparing Vehicle for Service*.
3. Purge residual fuel from the fuel lines by loosening one of the fittings.
4. Cut the tie straps and then disconnect the fuel tank electrical connectors.

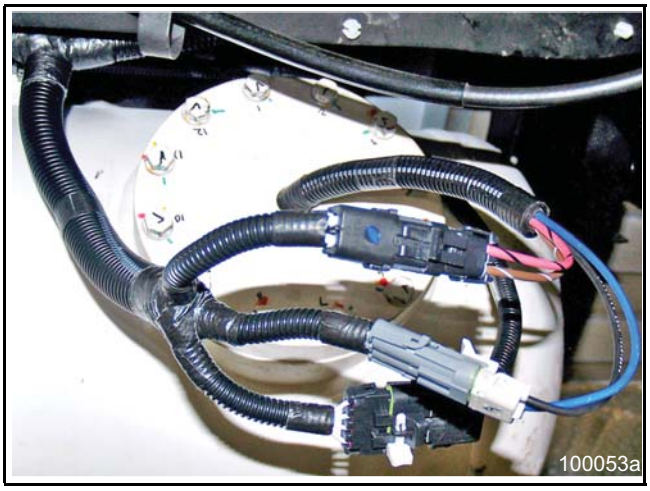


Figure 38 — Fuel Tank Electrical Connectors (Typical)

5. Disconnect and position aside the fuel fill line, bleed line, pressure relief hose, fuel supply line and fuel return line.

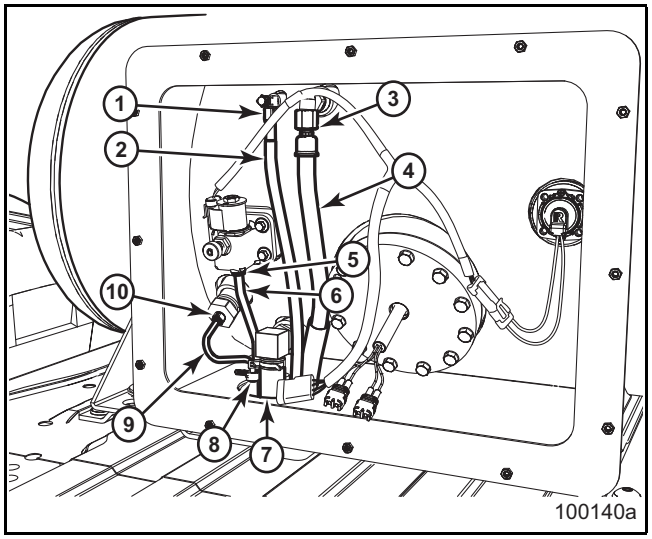


Figure 39 — Fuel Supply and Return Line Disconnect

1. Hose Fitting	6. Fuel Supply Line
2. Remote Bleed Valve Line	7. Pressure Relief Hose
3. Crimp Hose Fitting	8. Retaining Clip
4. Fuel Fill Line	9. Fuel Return Line
5. Jiffy-Tite Fitting	10.Fuel Return Line

6. Release the fuel supply and return lines from the clips on the frame rail.

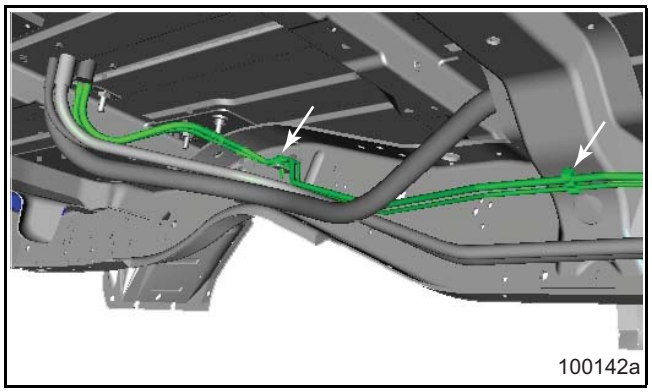


Figure 40 — Frame Rail Fuel Supply and Return Lines

7. Push the fuel fill line, bleed line, pressure relief hose, fuel supply and return lines through the pass-through opening.

⚠ WARNING

Take care when using lifting devices during service and maintenance procedures to avoid serious personal injury and damage to components. Inspect all lifting straps to make sure they are not damaged. Do not subject lifting straps to shocks or drop-loading.

8. Obtain a hoist capable of safely lifting 1,000 lb (373 kg). Attach the hoist to the fuel tank using lifting straps. Support the tank while removing the tank mounting fasteners.
9. Remove the nuts, bolts and steel washers attaching the tank to the left frame rail and to the front and rear crossmembers. Remove the mounting isolators and crush limiters as necessary.

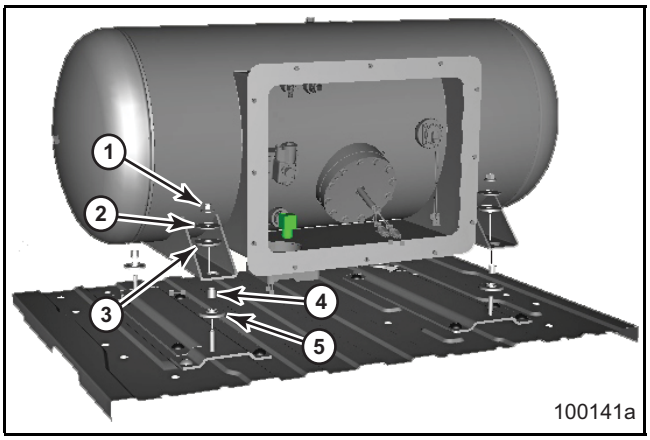


Figure 41 — Tank Mounting Nut and Washer

1. Nut 2. Steel Washer 3. Mounting Isolator	4. Crush Limiter 5. Mounting Isolator

10. With the help of an assistant, raise the tank approximately 12–18” (305–457 mm) to clear the mounting brackets and remove the tank from the vehicle.
11. Detach the hoist and remove the lifting straps.
12. To install the fuel tank, reverse the removal procedure. Tighten all nuts, bolts, fittings and connections to specification. Refer to *Specifications* for more information.

NOTE

After all fuel system components have been installed and tightened to specification, the system must be bleed, filled with propane and checked for leaks. Refer to *Preparing Vehicle For Use After Service*.

Fuel Tank — E-450 Aft-Axle

WARNING

Care must be taken while working with liquid propane. All steps must be followed to prevent personal injury and component damage.

NOTE

Locate a suitable place to put the fuel tank so that it can be worked on after being removed from the vehicle. The tank might also require temporary storage in preparation for shipment.

1. Purge the propane from the fuel lines and drain the fuel tank. Refer to *Fuel Line Purging and Fuel Tank Draining Procedures* in *Preparing Vehicle For Service*.
2. Purge residual fuel from the fuel lines by loosening one of the fittings.
3. Disconnect the fuel fill line from the fuel fill valve assembly on the fuel tank.

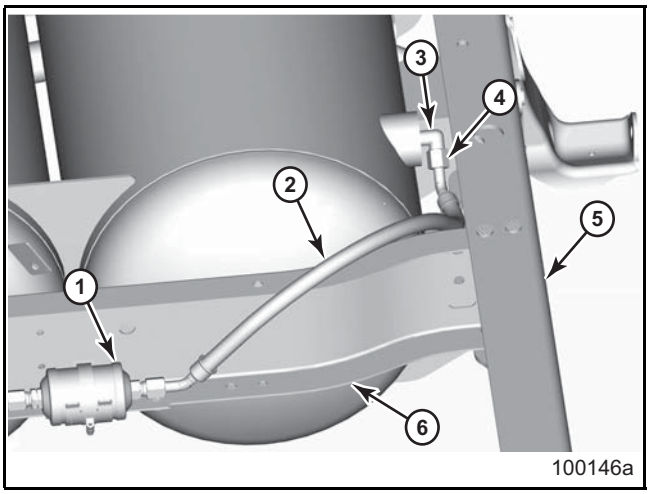


Figure 42 — Fuel Fill Line at Fuel Fill Valve Assembly

1. Fuel Filter 2. Fuel Fill Line 3. Fuel Fill Valve Assembly	4. Fuel Fill Line Fitting 5. Right Frame Rail 6. Rear Crossmember

4. Remove the supply valve cover. Refer to *Supply Valve Cover or Tank Cover Plate* for more information.
5. Disconnect the fuel supply line from the supply valve quick-connect fitting and the fuel return line from the return valve quick-connect fitting. Use the appropriate 1/4” or 3/8” Jiffy-Tite disconnect tool as needed. Refer to *Tools and Equipment, Special Tools* for more information.

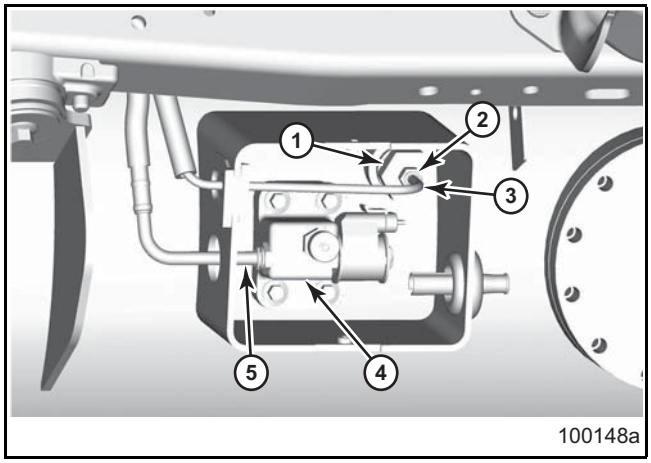


Figure 43 — Fuel Supply and Fuel Return Line Disconnect

1. Return Valve 2. Quick-Connect Fitting 3. Fuel Return Line	4. Fuel Supply Valve 5. Fuel Supply Line

6. Move the fuel lines out of the way through the fuel supply valve cage. Separate the grommet from the cage as needed.

WARNING

Take care when using lifting devices during service and maintenance procedures to avoid serious personal injury and damage to components. Inspect all lifting straps to make sure they are not damaged. Do not subject lifting straps to shocks or drop-loading.

7. Obtain a hoist capable of safely lifting 1,000 lb (373 kg). Attach the hoist to the fuel tank using lifting straps. Support the tank while removing the tank mounting fasteners.
8. Remove the three nuts, two bolts and three steel washers attaching the tank to the left frame rail and to the right frame rail. Remove the mounting isolators and crush limiters as necessary.

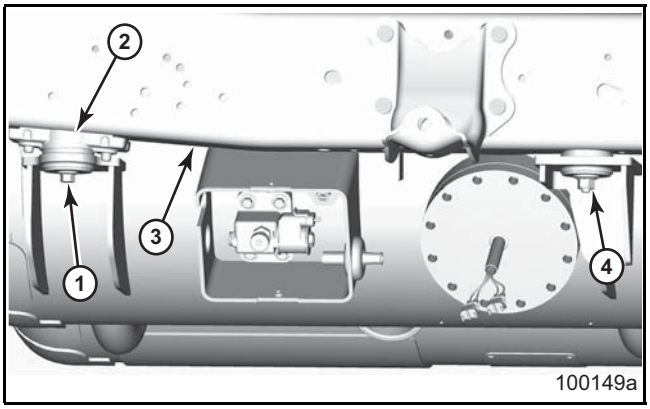


Figure 44 — Left-Side Tank Frame Mounting Fasteners

1. Tank-to-Bracket Bolt (at Front) 2. Tank Frame Mounting Bracket	3. Left Frame Rail 4. Tank Mounting Nut (at Rear)

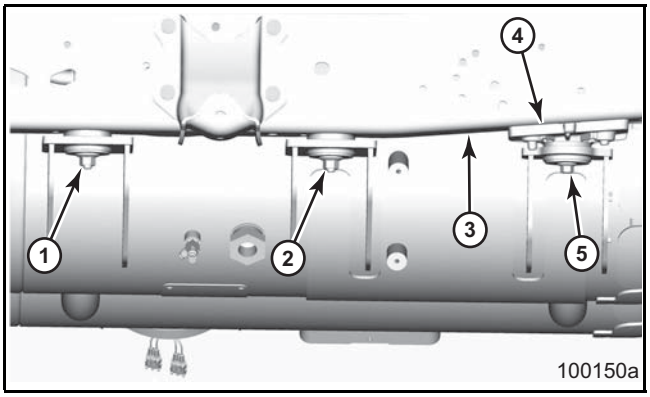


Figure 45 — Right-Side Tank Frame Mounting Fasteners

1. Tank Mounting Nut (at Rear) 2. Tank Mounting Nut (at Middle) 3. Right Frame Rail	4. Tank Frame Mounting Bracket 5. Tank-to-Bracket Bolt (at Front)

9. With the help of an assistant, lower the tank approximately 12–18” (305-407 mm) to gain access to the fuel tank electrical connections.
10. Cut the tie straps and then disconnect the fuel tank electrical connectors.

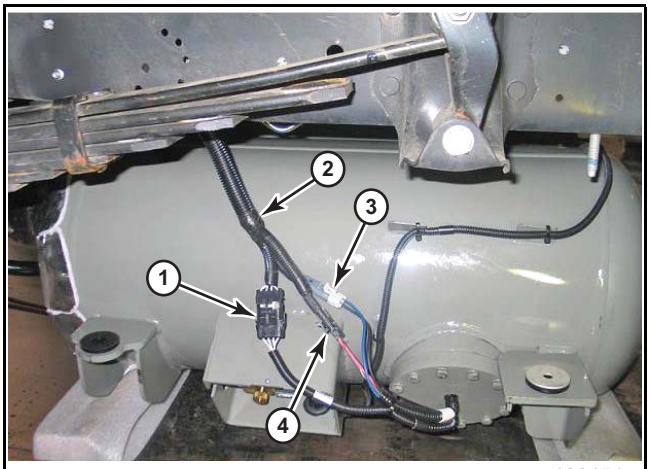


Figure 46 — Fuel Tank Electrical Connectors

1. Supply Solenoid and Sender Harness (4 pin) 2. Rear Frame Harness	3. Fuel Pump 2 Harness Connector (2 pin) 4. Fuel Pump 1 Harness Connector (2 pin)

11. Lower the tank from under the vehicle and place it on a suitable surface.

⚠ CAUTION

The rear fuel supply and return lines can remain attached to the tank at this point. Use caution to avoid damage to the fuel lines when resting the tank on any surface. Failure to heed this caution can result in component damage.

12. Detach the hoist and remove the lifting straps.
13. If tank component replacement is necessary, refer to the appropriate *Repair Procedures* section for more information.
14. To install the fuel tank, reverse the removal procedure. Make all electrical connections and use new tie straps to secure components. Tighten all nuts, bolts, fittings and connections to specification. Refer to *Specifications* for more information.

NOTE

After all fuel system components have been installed and tightened to specification, the system must be bleed, filled with propane and checked for leaks. Refer to *Preparing Vehicle For Use After Service*.

Fuel Tank Pressure Relief Valve

REMOVAL

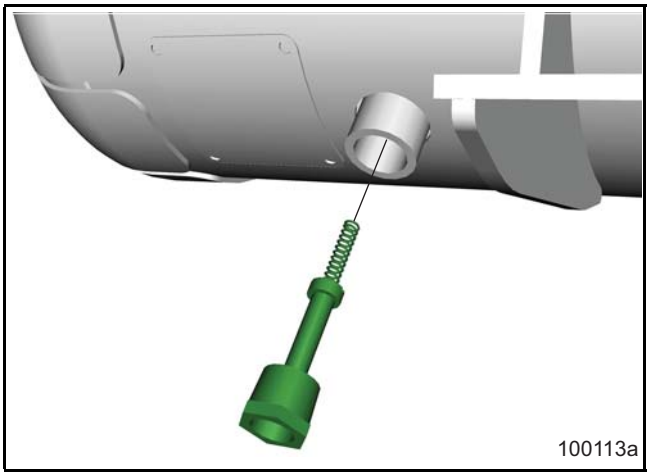


Figure 47 — Fuel Tank Pressure Relief Valve (Typical)

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging Procedure* for more information.
2. Drain the propane from the fuel tank. Refer to the *Fuel Tank Draining Procedure* for more information.

⚠ WARNING

Make sure the tank has been completely drained before removing any of the supply valve components. Failure to heed this warning can result in serious personal injury or damage to components.

3. Remove the negative battery cable from the battery.
4. Remove the pressure relief valve from the tank.

INSTALLATION

1. Install the replacement fuel tank pressure relief valve (thread sealant is pre-applied) into the threaded coupling and tighten the relief valve to 120 N•m (89 lb-ft) minimum, plus 180-degrees rotation.
2. Purge the fuel tank. Refer to the *Fuel Tank Purging Procedure* for more information.
3. Reconnect the battery negative cable to the battery.
4. Fill tank with 10 gallons (38 L) of propane.
5. After all service is complete, the fuel system must be primed. Refer to *Fuel Delivery System Priming Procedure* for more information.

Fuel Supply Valve Assembly

⚠ WARNING

Make sure the tank has been completely drained before removing any of the supply valve components. Failure to heed this warning can result in serious personal injury or damage to components.

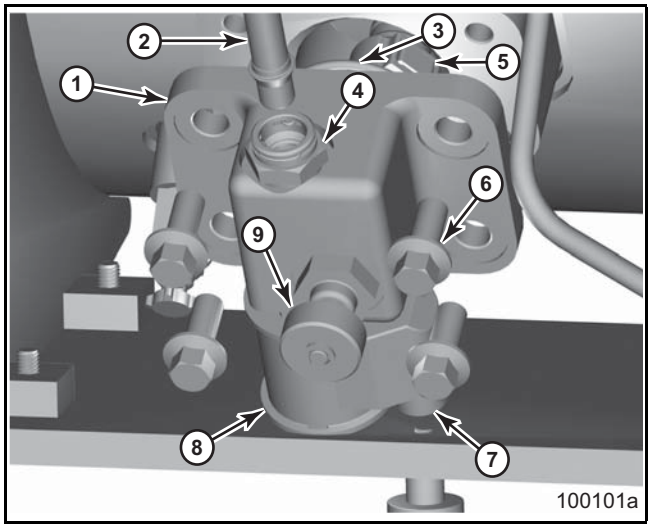


Figure 48 — Fuel Supply Valve Assembly (Typical)

1. Fuel Supply Valve 2. Rear Fuel Supply Line 3. O-ring 4. Quick-Connect Fitting 5. Internal Fuel Pump Supply Line Quick-Connect Fitting	6. Fuel Supply Valve Bolt (4) 7. Solenoid Electrical Connection 8. Fuel Supply Valve Solenoid 9. Manual Shutoff Valve

REMOVAL

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging Procedure* for more information.
2. Drain the propane from the fuel tank. Refer to the *Fuel Tank Draining Procedure* for more information.
3. Remove the negative battery cable from the battery.
4. Disconnect the rear fuel supply line from the clips on the tank line brackets.

5. Disconnect the intermediate flex line from the rear fuel supply line on the tank using the appropriate Jiffy-Tite disconnect tool. Refer to *Tools and Equipment, Special Tools* for more information.
6. Disconnect the rear fuel supply line at the fuel supply valve quick-connect fitting using the appropriate Jiffy-Tite disconnect tool. Refer to *Tools and Equipment, Special Tools* for more information.
7. Disconnect the fuel supply valve solenoid electrical connection.
8. Open the bleeder valve to make sure there is no remaining pressure in the tank.
9. Remove the four bolts securing the fuel supply valve to the tank.
10. Pull the fuel supply valve assembly away from the tank.
11. Disconnect the internal fuel pump supply line by depressing the tabs on either side of the quick-connect fitting and pull the fitting off the excess flow valve stem.

NOTE

Retain the fuel pump supply line and quick-connect fitting with a clip to prevent it from slipping back into the fuel tank.

12. Remove and discard the O-ring from the bottom of the fuel supply valve.

INSTALLATION

NOTE

When replacing the fuel supply valve assembly, the tank-to-valve O-ring must be replaced.

1. Inspect the O-ring sealing surface and remove any debris.
2. Apply O-ring lubricant to the O-ring and install onto the fuel supply valve.
3. Lubricate the tip of the excess flow valve stem with a small amount of motor oil.
4. Connect the internal fuel pump supply line quick-connect fitting onto the flow valve stem until fully engaged and secure. Give the line a firm pull to ensure that the quick-connect fitting is secure.
5. Position the fuel supply valve assembly to the seat on the tank.
6. Install the four bolts to secure the fuel supply valve and hand tighten.
7. Tighten the four bolts using the following sequence and torques:
   a. Initial Torque: Tighten in 1-4-2-3 pattern to 2.5 ±0.5 N•m (22 ±4.4 lb-in).
   b. Final Torque: Tighten in 1-4-2-3 pattern to 25 ±5 N•m (18 ±4 lb-ft).

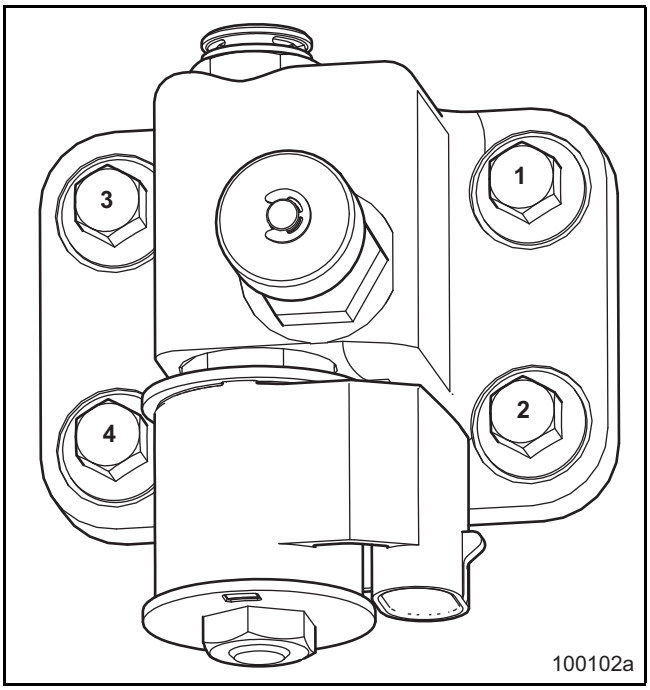


Figure 49 — Tighten in 1-4-2-3 Pattern (Typical)

8. Apply a small amount of motor oil to the tip of the rear fuel supply line.
9. Install the rear fuel supply line into the quick-connect fitting on the valve until fully engaged and secure.
10. Close the bleeder valve.
11. Connect the wiring harness to the fuel supply valve connection.
12. Connect the rear fuel supply line to the mounting bracket clips on the tank.
13. Connect the intermediate flex line to the rear fuel supply line until fully engaged and secure.
14. Purge the fuel tank. Refer to the *Fuel Tank Purging Procedure* for more information.

15. Connect the negative battery cable to the battery.
16. Fill the tank with 5 gallons (19 L) of propane.
17. Check the fuel supply valve for leaks using an electronic leak detector or leak detection solution.
18. Open the manual shutoff valve and start the engine.
19. Check the fuel line connections for leaks.
20. Install the supply valve cover. Refer to *Supply Valve Cover or Tank Cover Plate* for more information.
21. After all service is complete, the fuel system must be primed. Refer to the *Fuel Delivery System Priming Procedure* for more information.

Fuel Return Circuit Assembly

DANGER

A trace amount of propane fuel is released when loosening the fittings. Propane settles to the lowest available surface before dissipating into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.
2. Drain the propane from the fuel tank. Refer to the *Fuel Tank Draining* procedure for more information.
3. Remove the negative battery cable from the battery.
4. Disconnect the rear fuel return line from the quick-connect fitting in the fuel return circuit assembly using a Jiffy-Tite disconnect tool. Refer to *Tools and Equipment, Special Tools* for more information.

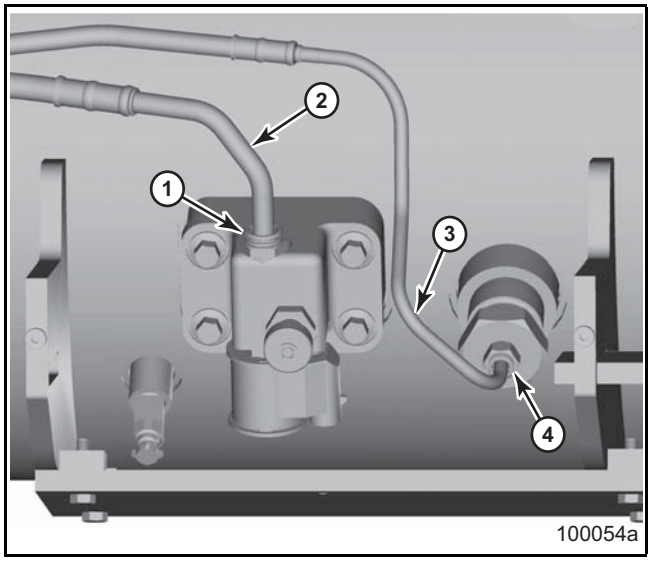


Figure 50 — Rear Fuel Line Connections on Tank (Typical)

1. Fuel Supply Valve Fitting 2. Rear Fuel Supply Line 3. Rear Fuel Return Line	4. Fuel Return Circuit Assembly Quick-Connect Fitting

5. Remove the fuel return circuit assembly from the tank.
6. To install the fuel return circuit assembly, reverse the removal procedure. Tighten assembly bolts to 120 N•m (81 lb-ft) plus 1/2 turn (do not back off bolts after tightening). Make sure fuel lines are fully engaged into quick-connect fittings.
7. After all service is complete, the fuel system must be primed. Refer to the *Fuel Delivery System Priming Procedure* for more information.

Bleeder Valve

REMOVAL

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.
2. Drain the propane from the fuel tank. Refer to the *Fuel Tank Draining* procedure for more information.
3. Remove the negative battery cable from the battery.
4. Remove the bleeder valve from the tank.

INSTALLATION

1. Apply pipe thread sealant (Loctite® 567) only to the threads going into the tank.
2. Install the replacement bleeder valve into the tank. Tighten the bleeder valve to 20 ±4.0 N•m (15 ±3 lb-ft) minimum, plus rotation until correct orientation. Align nozzle opening to bottom.

NOTE

Do not loosen the bleeder valve to orient it. Tighten clockwise only.

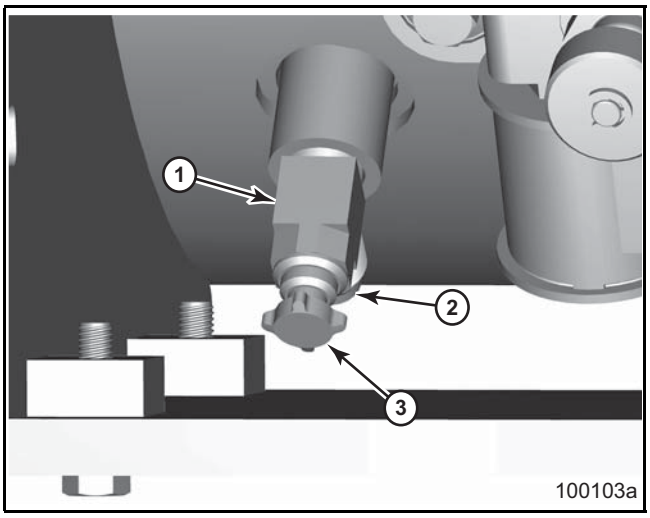


Figure 51 — Bleeder Valve (Typical)

1. Bleeder Valve (Next to Fuel Supply Valve)	2. Tighten to this Orientation 3. Bleeder Valve Knob

3. Purge the fuel tank. Refer to the *Fuel Tank Purging Procedure* for more information.
4. Connect the negative battery cable to the battery.
5. Fill the tank and check the bleeder valve for leaks using an electronic leak detector or leak detection solution.
6. Install the supply valve cover. Refer to *Supply Valve Cover or Tank Cover Plate* for more information.
7. After all service is complete, the fuel system must be primed. Refer to the *Fuel Delivery System Priming Procedure* for more information.

Fuel Pump Assembly and Filters (In-Tank)

It is recommended to remove the tank from the vehicle. Refer to the appropriate *Fuel Tank* procedure for more information.

REMOVAL

1. Purge the fuel lines. Refer to the *Fuel Line Purge* procedure for more information.
2. Drain the fuel tank. Refer to the *Fuel Tank Draining* procedure for more information.

⚠ CAUTION

Make sure the negative ground cable is disconnected from the battery. Failure to heed this caution can result in component damage.

3. Remove the fuel tank service cover from the tank, loosening the 12 bolts in a cross pattern. Remove the bolts and cover.
4. Remove and inspect the service cover O-ring.

NOTE

It is recommended to replace the tank service cover O-ring whenever the cover is removed.

5. Reach into the fuel tank and disconnect the fuel pump electrical connectors.

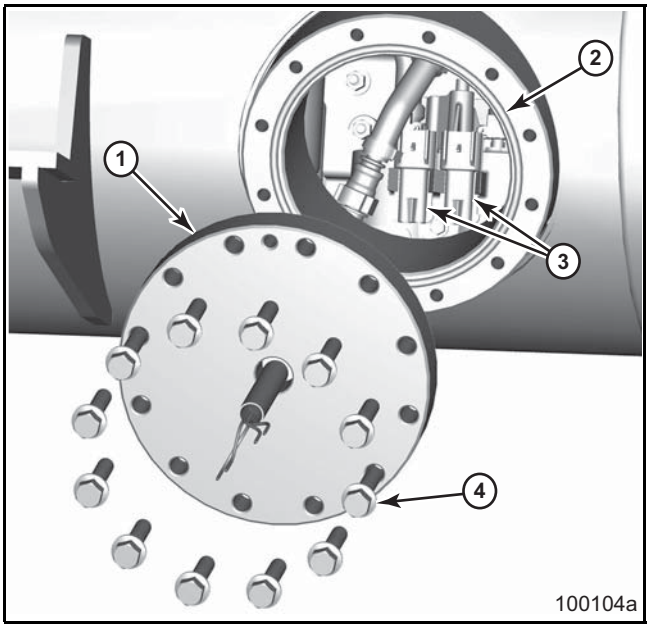


Figure 52 — Fuel Tank Service Cover (Typical)

1. Fuel Tank Service Cover 2. Service Cover O-ring	3. Fuel Pump Electrical Connectors 4. Service Cover Bolt (12)

6. Cut the tie strap securing the fuel hoses.
7. Release the quick-connect fittings from the fuel filter outlets and from the fuel supply hose (from fuel supply valve). Remove the hose assembly.
8. Release the quick-connect fittings from the fuel filter inlets and jet pump body.
9. Remove the center bolt and the two M6 hex flange nuts securing the fuel pump assembly to the bracket.
10. Remove the fuel pump assembly from the fuel tank.

NOTE

The fuel pumps are only serviced as an assembly.

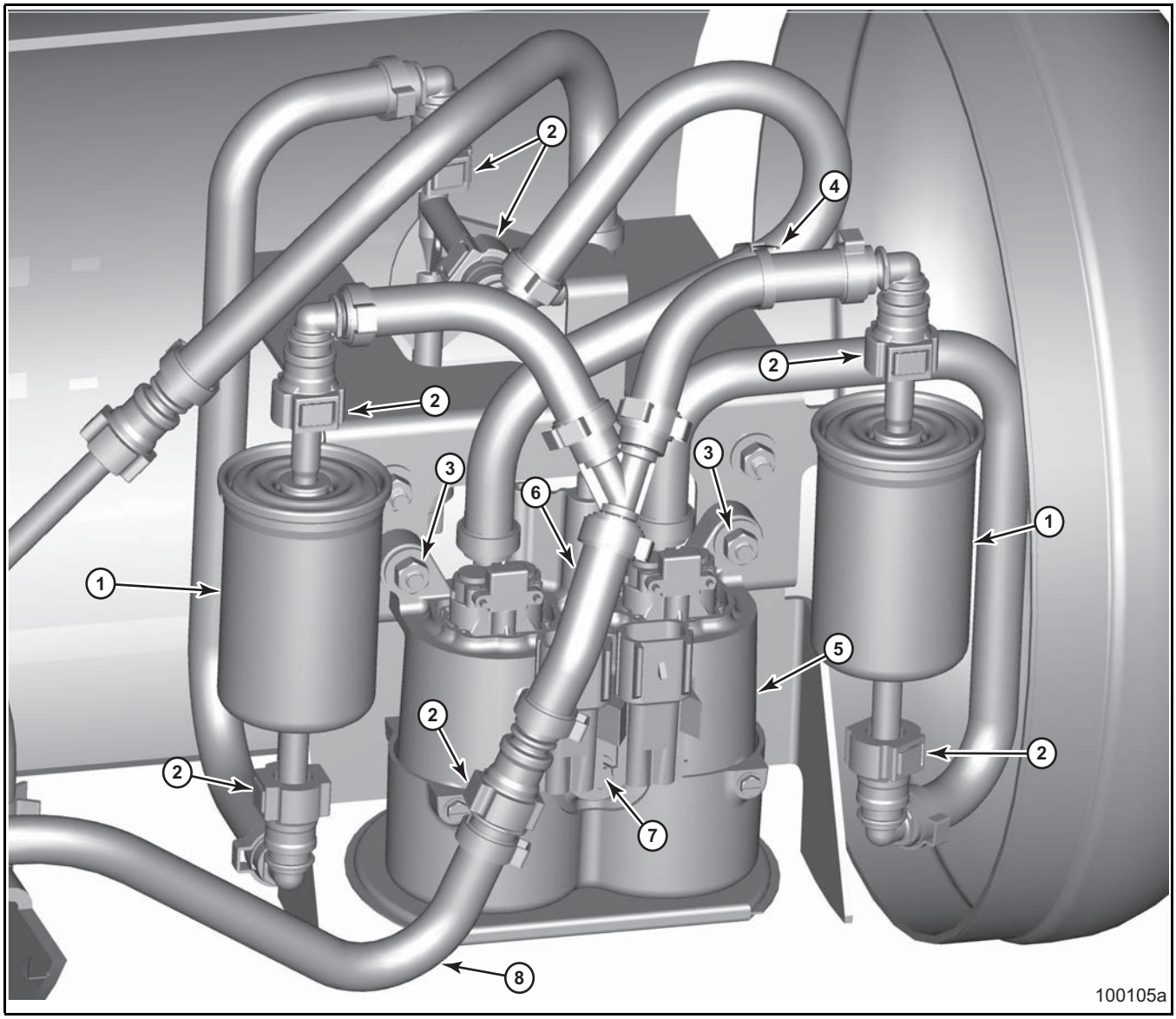


Figure 53 — Fuel Pump Assembly, Hoses and Filters

1. Fuel Filter 2. Quick-Connect Fitting (7) 3. M6 Hex Flange Nut (2) 4. Tie Strap	5. Fuel Pump Assembly 6. Fuel Supply Hose (Filter Outlet) 7. Center Bolt 8. Hose to Fuel Supply Valve

INSTALLATION

1. Attach the replacement fuel pump assembly to the bracket. Install the center bolt and tighten to 5.8 ±0.3 N•m (51 ±2.7 lb-in). Install the two M6 hex flange nuts and tighten to 8.5 ±0.5 N•m (75 ±4.4 lb-in).
2. Attach the quick-connect fittings to the fuel filter inlets and jet pump body.
3. Attach the quick-connect fittings to the fuel filter outlets and to the fuel supply hose (to fuel supply valve).
4. Connect the fuel pump electrical connectors.
5. Secure the hoses with a new tie strap.
6. Lubricate the fuel tank service cover O-ring with a small amount of O-ring lubricant and position it on the tank. Position the service cover onto the tank and install the 12 bolts to secure the cover. Tighten the cover bolts in a cross pattern as indicated.

NOTE

It is recommended to replace the tank service cover O-ring whenever the cover is removed.

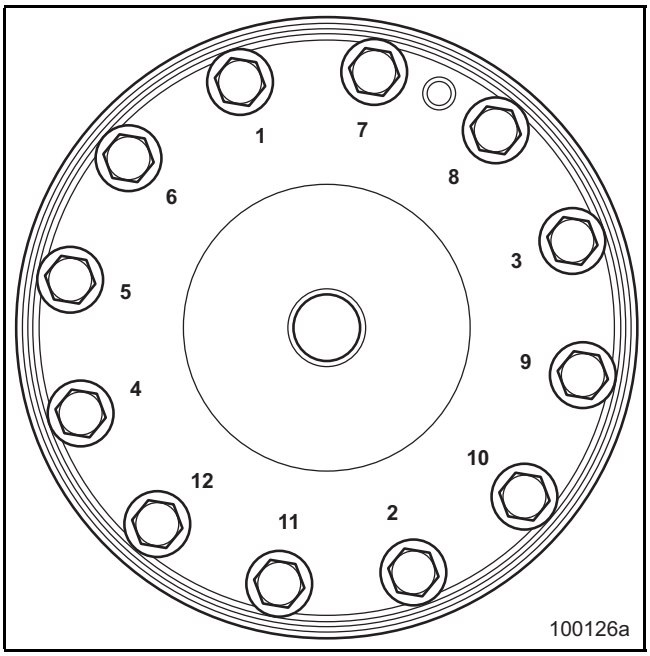


Figure 54 — Fuel Tank Service Cover Tightening (Typical)

Step 1 — Tighten bolts 1–4 to 2–3 N•m (18–27 lb-in) Step 2 — Tighten bolts 1–4 to 38.6–42.6 N•m (28–31 lb-ft) Step 3 — Tighten bolts 5–12 to 38.6–42.6 N•m (28–31 lb-ft)

7. Purge the fuel tank. Refer to the *Fuel Tank Purging* procedure for more information.
8. Reconnect the battery negative cable to the battery.
9. Fill the tank with 5 gallons (19 L) of propane.
10. Check the edge of the service cover for leaks using an electronic leak detector or leak detection solution.
11. Start the engine.
12. Check the fuel line connections for leaks.
13. Install the fuel supply valve cover and hand tighten the thumb screw and tighten the Allen-head screws, as applicable.
14. After all service is complete, the fuel system must be primed. Refer to the *Fuel Delivery System Priming Procedure* for more information.

Fuel Level Sender

REMOVAL

1. Purge the propane from the fuel lines and tank. Refer to the *Fuel Line Purging and Fuel Tank Draining Procedures* for more information.
2. Remove the negative battery cable from the battery.
3. Disconnect the wiring harness connector from the fuel level sender connector.
4. Remove the four screws securing the fuel level sender to the bottom right of the fuel tank.
5. Slide the fuel level sender out of the fuel tank.

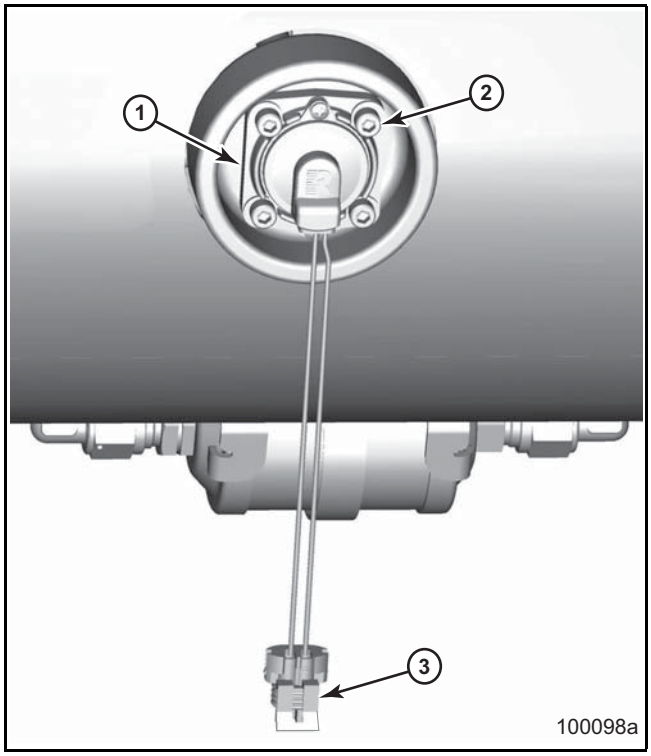


Figure 55 — Fuel Level Sender (Typical)

1. Fuel Level Sender 2. Screws (4)	3. Fuel Level Sender Harness Connector

INSTALLATION

1. Install the replacement fuel level sender into the tank, aligning it properly. The float assembly of the sender must be hanging downward.

NOTE

The wire leads of the fuel level sender must be oriented toward the bottom of the tank.

2. Apply one drop of semi-permanent thread locker (Loctite® 242 or equivalent) to each screw.
3. Secure the fuel level sender to the tank with the four screws. Hand tighten the screws.

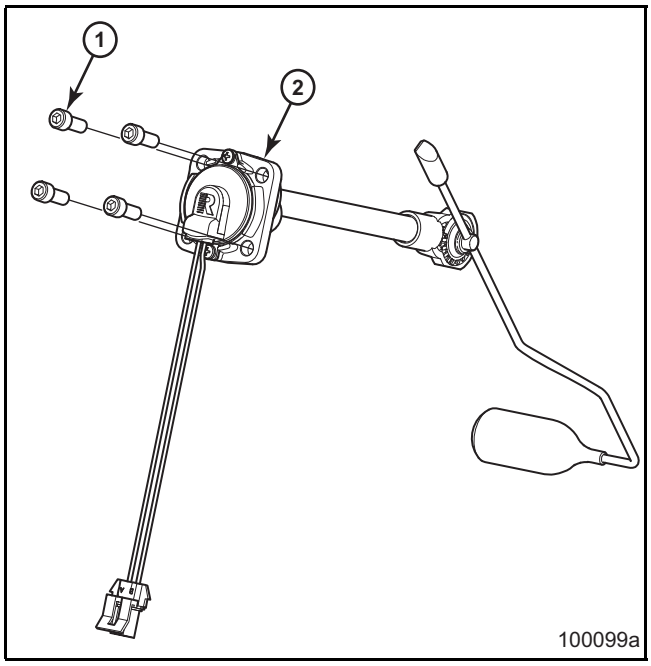


Figure 56 — Fuel Level Sender (Typical)

1. Screws (4)	2. Fuel Level Sender

4. Tighten the screws in three steps using a cross pattern until all screws are secure.
   a. Tighten the four screws in a cross pattern to 1.7 N•m (15 lb-in).
   b. Tighten the four screws in a cross pattern to 2.8 N•m (25 lb-in).
   c. Tighten the four screws in a cross pattern to 4.0–5.6 N•m (35–50 lb-in).

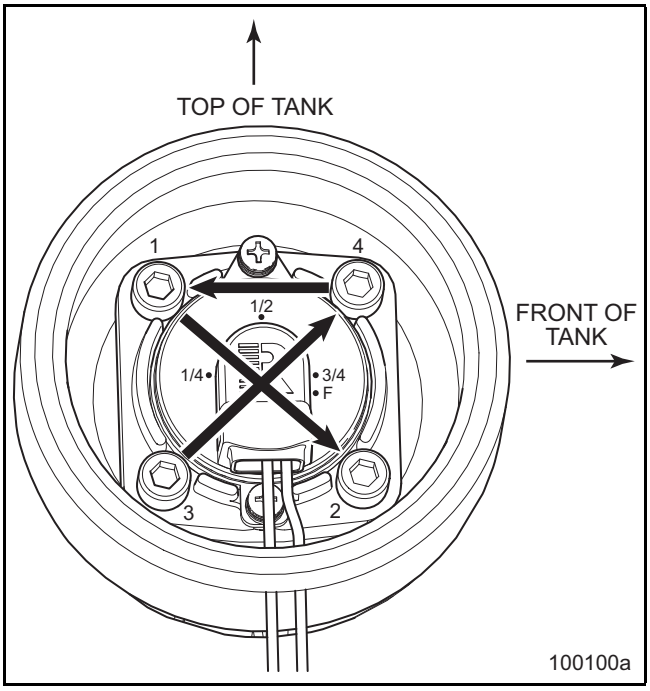


Figure 57 — Fuel Level Sender Tightening Sequence (Typical)

5. Connect the wiring harness connector to the fuel level sender connector.
6. Purge the fuel tank after servicing the fuel level sender.

NOTE

The fuel tank must be purged because it was opened during fuel level sender service. Refer to the *Fuel Tank Purging Procedure* for more information.

7. Connect the battery negative cable to the battery.
8. Fill the tank with 5 gallons (19 L) of propane.
9. Open the manual fuel shutoff valve.
10. Check for leaks at the fuel tank.
11. Start the engine.
12. Leak check all fuel lines, fittings and joints with an electronic leak detector or leak detection solution.
13. After all service is complete, the fuel system must be primed. Refer to the *Fuel Delivery System Priming Procedure* for more information.

Fuel Tank Wiring

Two wiring harnesses are used on the fuel tank assembly. The fuel pump harness connects the in-tank pumps and routes outside the tank through the tank service cover where it connects to the rear wiring harness. The solenoid harness connects the fuel supply valve solenoid and fuel level sender on the tank to the rear wiring harness.

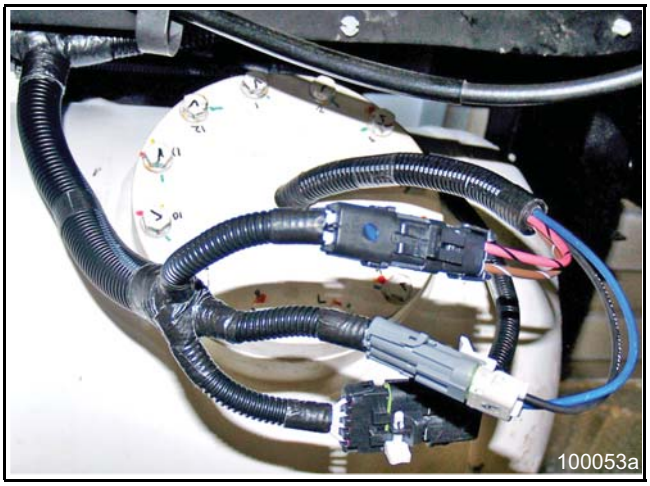


Figure 58 — Fuel Tank Electrical Connectors (Typical)

Mechanical Fill Valve/Overflow Protection Device

DANGER

A trace amount of propane fuel is released when loosening the fittings. Propane settles to the lowest available surface before dissipating into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

REMOVAL

WARNING

Make sure the tank has been completely drained before removing any fuel tank components. Failure to heed this warning can result in serious personal injury or damage to components.

1. Purge the propane from the fuel lines and tank. Refer to *Fuel Line Purging and Fuel Tank Draining Procedures* for more information.
2. Remove the negative battery cable from the battery.
3. Remove the fuel fill line from the mechanical fill valve 90-degree elbow.

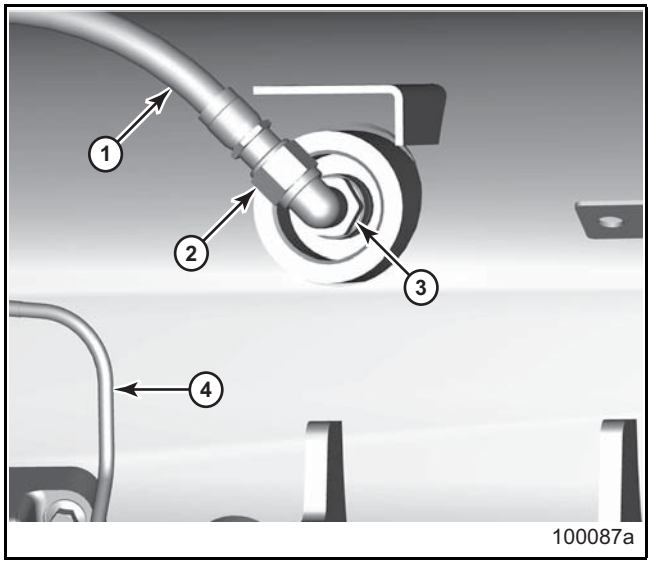


Figure 59 — Mechanical Fill Valve (Typical)

1. Fuel Fill Line from Filter Outlet 2. Fill Line Fitting	3. Mechanical Fill Valve (with 90-Degree Elbow) 4. Rear Fuel Return Line

4. Separate the 90-degree elbow from the mechanical fill valve.
5. Remove the mechanical fill valve from the tank.

INSTALLATION

1. Install the mechanical fill valve into the fuel tank and tighten the valve to 75 N•m (55 lb-ft) minimum. After reaching the minimum torque, further tighten the valve until the mark or notch is oriented vertically.

⚠ CAUTION

The valve must NOT be tightened to align the notch vertically any more than one full turn after the initial minimum torque is achieved. Only rotate the valve enough to obtain the vertical orientation of the notch. Do NOT rotate the valve counterclockwise (or loosen) to orient the notch. If the valve has been tightened (rotated) more than one full turn after reaching initial torque, damage to the valve can occur. Replace the valve with a new valve.

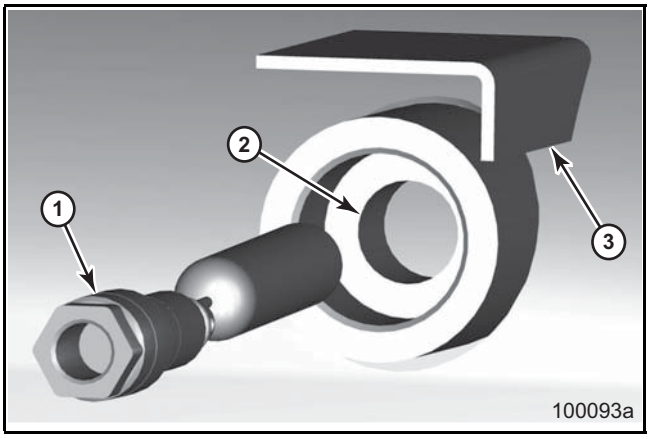


Figure 60 — Mechanical Fill Valve Installation (Typical)

1. Mechanical Fill Valve 2. Fill Valve Opening in Tank	3. Shield

NOTE

A mark or notch on the mechanical fill valve must face vertically upwards for the valve to work properly when installed and tightened to specification. The notch provides for ease of visibility during installation and is located on the face of the valve at the hex end. Use the notch to correctly orient the valve.

NOTE

For ease of visibility, highlight the mark at the end of the fitting with a marker before it is installed.

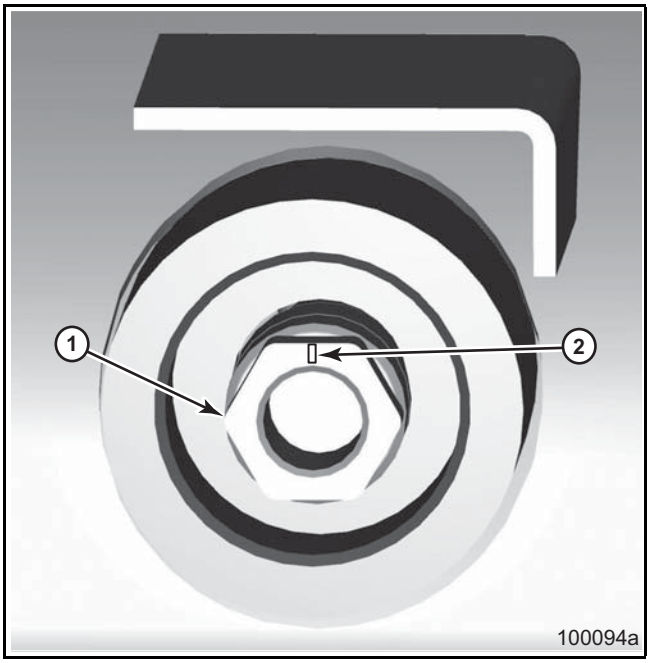


Figure 61 — Mechanical Fill Valve Orientation (Typical)

1. Mechanical Fill Valve	2. Notch on Face of Fill Valve Must Be Oriented Vertically

2. Clean the threads of the 90-degree elbow and apply pipe thread sealant (Loctite® 567 or equivalent) to the threads of the elbow.
3. Install the 90-degree elbow into the mechanical fill valve and tighten to 31 N•m (23 lb-ft) minimum. Further tighten the elbow until it is oriented as shown (approximately 45 degrees) to align with the fuel fill line.

⚠ CAUTION

Use a backup wrench on the mechanical fill valve to prevent the valve from rotating when tightening the 90-degree elbow. The elbow must NOT be tightened any more than one full turn after the initial minimum torque is achieved. Only rotate the elbow enough to obtain the 45-degree orientation. Do NOT rotate the elbow counterclockwise (or loosen) to orient the elbow. If the elbow has been tightened (rotated) more than one full turn after reaching initial torque, damage to the mechanical fill valve can occur. Replace the valve with a new valve.

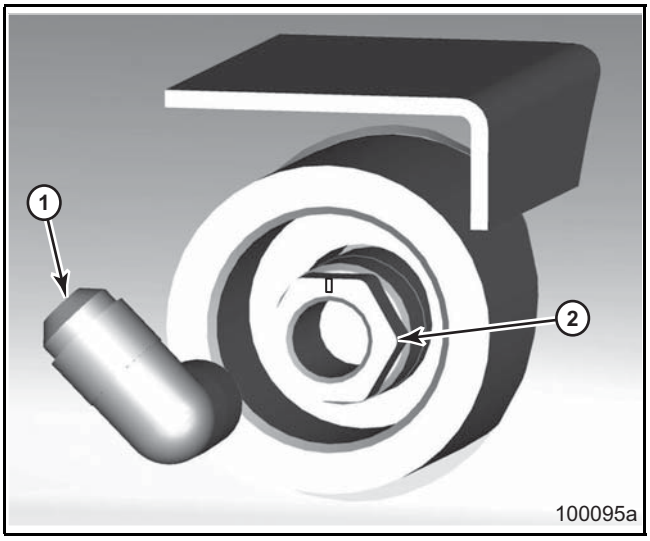


Figure 62 — 90-Degree Elbow Installation

1. 90-Degree Elbow Fitting	2. Mechanical Fill Valve

Figure 63 — 90-Degree Elbow Orientation

4. Connect the fuel fill line (from fuel filter outlet) to the 90-degree elbow and tighten to 45 N•m (33 lb-ft).

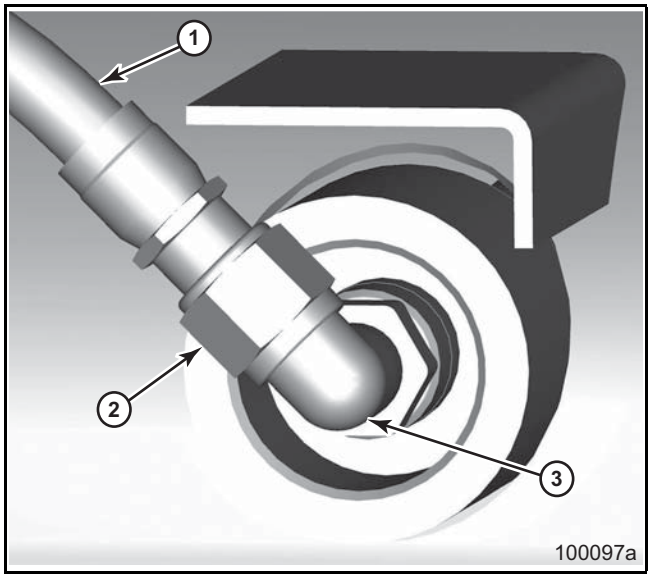


Figure 64 — Fuel Fill Line (Typical)

1. Fuel Fill Line from Fuel Filter Outlet 2. Fuel Fill Line Fitting	3. 90-Degree Elbow Fitting

5. Purge the fuel tank. Refer to the *Fuel Tank Purging Procedure* for more information.
6. Connect the negative battery cable to the battery.
7. Fill the tank and leak check the valve and fittings using an electronic leak detector or leak detection solution.

Fuel Fill Line (Filter-to-Tank)

DANGER

A trace amount of propane fuel is released when loosening the fittings. Propane settles to the lowest available surface before dissipating into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

1. Close the manual shutoff valve on the tank. Refer to *Operating the Manual Shutoff Valve* for more information.
2. Disconnect the fuel fill line from the fuel filter outlet fitting.

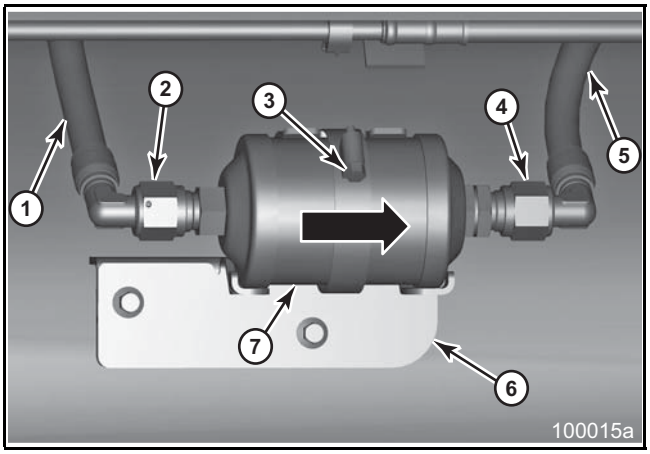


Figure 65 — Fuel Fill Line at Filter Outlet (Typical)

1. Fuel Fill Line (From Fuel Fill Valve) 2. Filter Inlet Fitting 3. Filter Clamp 4. Filter Outlet Fitting	5. Fuel Fill Line (To Mechanical Fill Valve on Tank) 6. Filter Bracket (on Tank) 7. Fuel Filter

3. On some vehicles, it might be necessary to remove the fuel tank to perform this procedure. Refer to the appropriate *Fuel Tank* procedure.
4. Disconnect the fuel fill line from the mechanical fill valve fitting.
5. Remove edge clip tie strap securing the fuel fill line to the tank bracket.

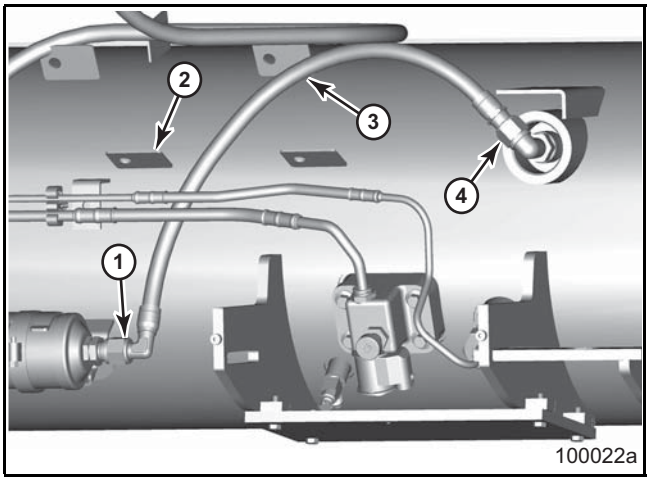


Figure 66 — Fuel Fill Line at Mechanical Fill Valve and Bracket (E-Series Under Vehicle Tank Shown)

1. Fitting at Fuel Filter Outlet 2. Bracket Secures Line with Edge Clip	3. Fuel Fill Line 4. Fitting at Mechanical Fill Valve Elbow

6. Remove the fuel fill line.
7. To install the line, reverse the removal procedure. Tighten the fill line fittings at the fuel filter and at the mechanical fill valve on the tank to specification as indicated.
   - Steel-to-Steel, 57 ±4 N•m (42 ±3 lb-ft)
   - Steel-to-Brass, 45 ±4 N•m (33 ±3 lb-ft)

Fuel Fill Line (Fuel Fill Valve-to-Filter)

⚠ DANGER

A trace amount of propane fuel is released when loosening the fittings. Propane settles to the lowest available surface before it dissipates into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

1. Disconnect the fuel fill line from the inlet end of the fuel filter.

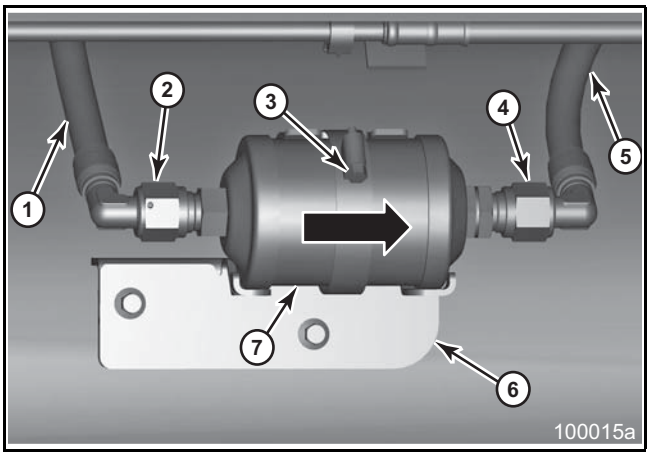


Figure 67 — Fuel Fill Line at Filter Inlet (Typical)

1. Fuel Fill Line (From Fuel Fill Valve) 2. Filter Inlet Fitting 3. Filter Clamp 4. Filter Outlet Fitting	5. Fuel Fill Line (To Mechanical Fill Valve On Tank) 6. Filter Bracket (On Tank) 7. Fuel Filter

2. Disconnect the fuel fill line from the fuel fill valve at the fitting behind the valve bracket inside the fill door.

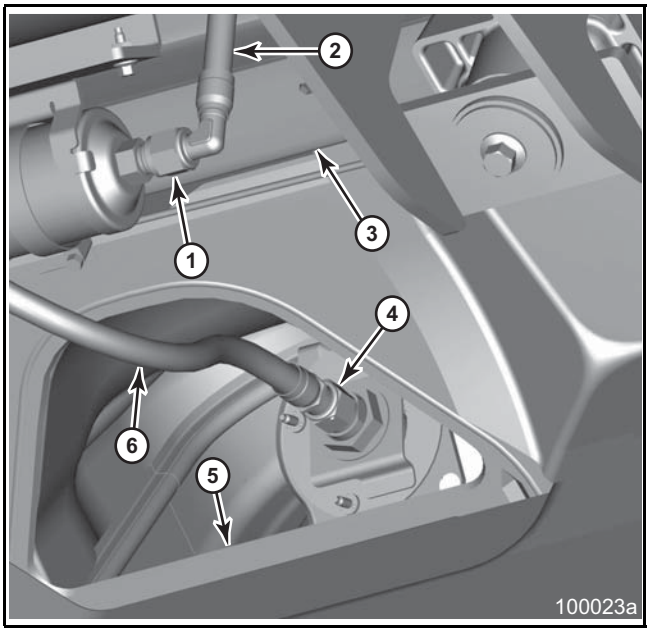


Figure 68 — Fuel Fill Line at Fuel Fill Valve Fitting (Typical)

1. Fuel Fill Line Fitting at Filter Inlet 2. Fuel Fill Line Inside Frame Rail 3. Frame Rail	4. Fuel Fill Line Fitting at Fuel Fill Valve 5. Vehicle Floor Opening 6. Filter Fill Line to Fuel Fill Valve

3. Detach the fuel fill line from the edge clip and bracket under the floor. The fill line runs over the frame rail to the inside. Routing varies with application.

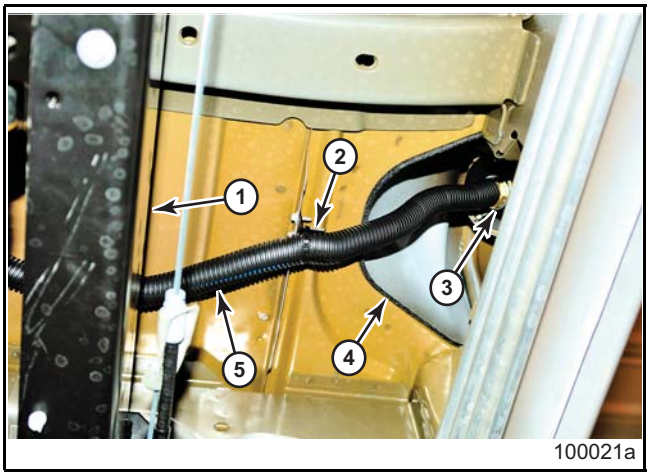


Figure 69 — Fuel Fill Line, Bracket and Edge Clip (E-Series Shown)

1. Left Frame Rail 2. Edge Clip on OEM Bracket Under Floor 3. Fill Line Connection at Fuel Fill Valve	4. Vehicle Floor Opening 5. Fuel Fill Line and Convolute over Frame Rail

4. Detach the fuel fill line from the edge clips and brackets on the fuel tank.

NOTE

E-Series Extended Range filter and fill line are attached to the rail frame only. E-450 cutaway filter and line are attached to the rear crossmember.

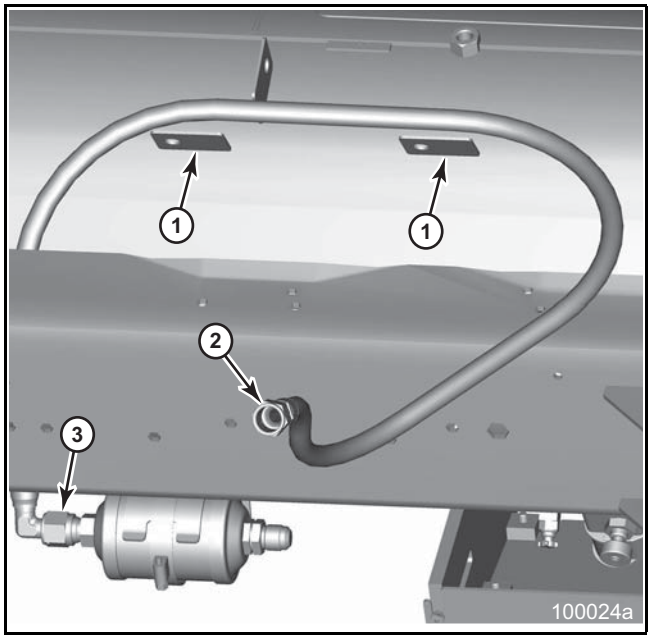


Figure 70 — Fuel Fill Line and Edge Clips (E-Series Under Vehicle Shown)

1. Edge Clip Secures Line to Bracket (2) 2. Fitting at Fuel Fill Valve	3. Fitting at Fuel Filter Inlet

5. Remove the fuel fill line.
6. To install the line, reverse the removal procedure. Tighten the fill line fittings at the fuel filter and at the fuel fill valve to specification.
   - Steel-to-Steel, 57 ±4 N•m (42 ±3 lb-ft)
   - Steel-to-Brass, 45 ± 4N•m (33 ±3 lb-ft)

Fuel Fill Valve

DANGER

A trace amount of propane fuel is released when loosening the fittings. Propane settles to the lowest available surface before it dissipates into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

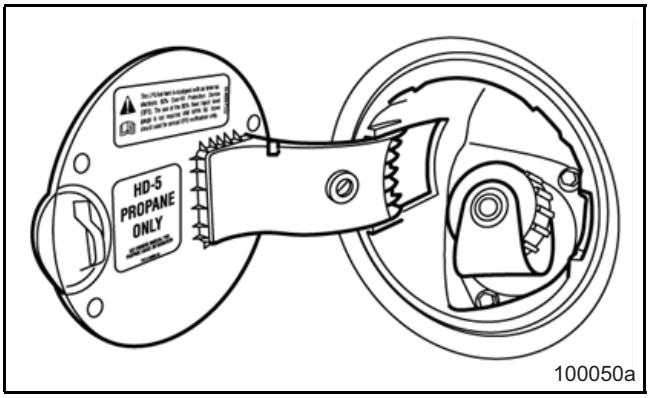


Figure 71 — Fuel Filler Door and Fill Valve with Cap (Typical)

1. Disconnect the fuel fill line at the end of the fuel fill valve.

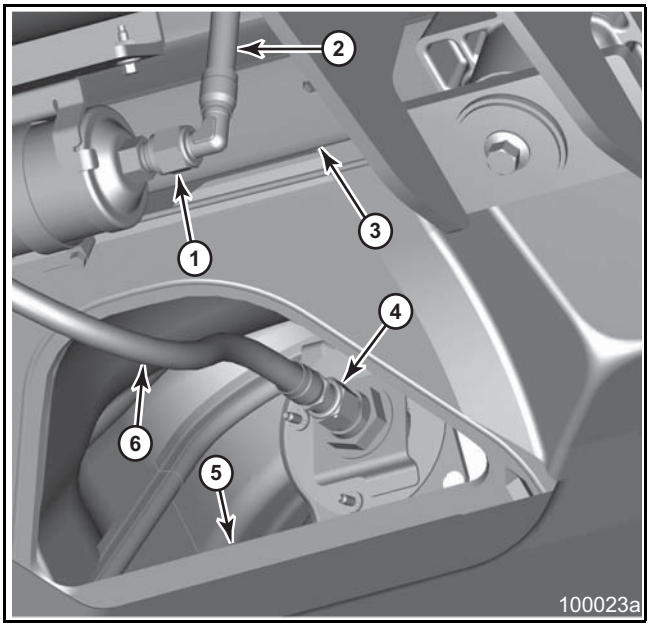


Figure 72 — Fuel Fill Line at Fuel Fill Valve Fitting (Typical)

1. Fuel Fill Line Fitting at Filter Inlet 2. Fuel Fill Line Inside Frame Rail 3. Frame Rail	4. Fuel Fill Line Fitting at Fuel Fill Valve 5. Vehicle Floor Opening 6. Filter Fill Line up to Fuel Fill Valve

2. Remove the three M5 x 16 bolts securing the fuel fill valve and mounting bracket to the bracket in the fuel filler door opening.

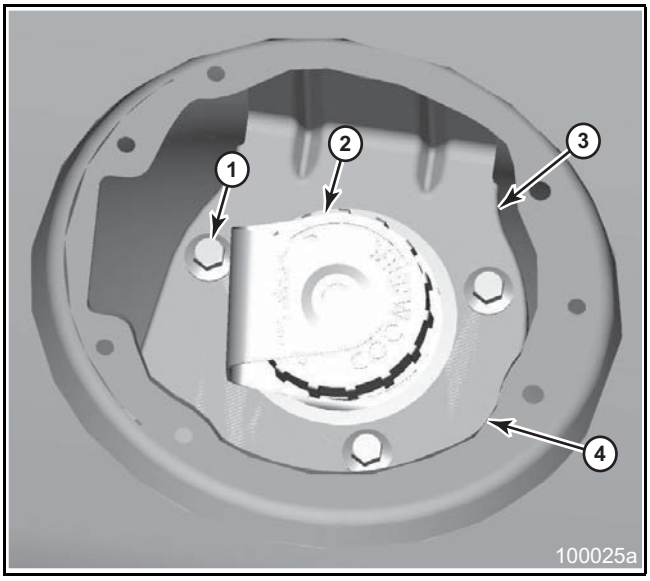


Figure 73 — Fuel Fill Valve Assembly (Typical)

1. M5 x 16 Bolt (3) 2. Fuel Fill Valve Cap	3. Fuel Fill Valve Assembly Bracket 4. Fill Door Opening

3. Remove the fuel fill valve and bracket assembly.
4. Remove the fill valve-to-mounting bracket nut and separate the valve and washer from the bracket.

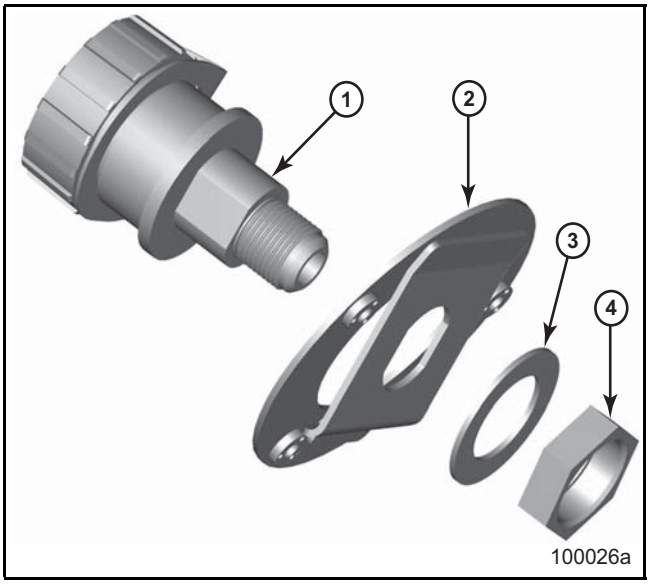


Figure 74 — Fuel Fill Valve, Mounting Bracket, Washer and Nut

1. Fuel Fill Valve 2. Mounting Bracket	3. Washer 4. Nut

5. To prepare the fuel fill valve, reverse the disassembly procedure. Tighten the nut on the fuel fill valve and bracket until secure.
6. To install the fuel fill valve, reverse the removal procedure. Tighten the fill line fitting at the fuel fill valve to specification. Refer to *Specifications.*

In-Line Fuel Filter

⚠ DANGER

A trace amount of propane fuel will be released on loosening the fittings. It will settle to the lowest available surface before it dissipates into the atmosphere. Keep heat, sparks, flames, static electricity or other sources of ignition out of the area when venting or purging the fuel lines or tank. Failure to heed this danger can result in severe personal injury or property damage.

1. Purge residual fuel from the fuel fill line.
2. Disconnect the fuel fill line from the fuel filter inlet.
3. Disconnect the fuel fill line from the fuel filter outlet.
4. Loosen the clamp retaining the fuel filter.
5. Remove and discard the filter.

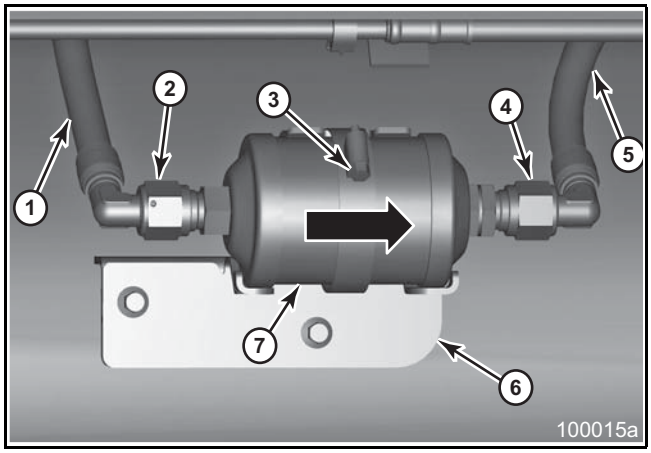


Figure 75 — Fuel Filter (Typical)

1. Fuel Fill Line (From Fuel Fill Valve) 2. Filter Inlet Fitting 3. Filter Clamp 4. Filter Outlet Fitting	5. Fuel Fill Line (To Mechanical Fill Valve On Tank) 6. Filter Bracket (On Tank) 7. Fuel Filter

6. Position the replacement fuel filter into the clamp on the filter bracket and tighten the clamp to 4–5 N•m (35–44 lb-in).

NOTE

Make sure to install the filter in the correct direction; inlet to fill line from fill valve and outlet to fill line from mechanical fill valve on tank.

7. Connect the fuel fill lines to the filter inlet and outlet. Tighten the line fittings to specification as indicated.
   - Steel-to-Steel, 57 ±4 N•m (42 ±3 lb-ft)
   - Steel-to-Brass, 45 ±4 N•m (33 ±3 lb-ft)

Forward and Intermediate Fuel Supply and Return Lines

NOTE

The fuel supply and fuel return lines quick connected into the fuel tank are serviceable only with the fuel tank removed.

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.
2. Close the manual fuel shutoff valve on the tank. Refer to *Operating the Manual Shutoff Valve*.
3. Disconnect the tank fuel supply line from the intermediate flex fuel supply line at the quick-connect coupling.
4. Disconnect the tank fuel return line from the intermediate flex fuel return line at the quick-connect fitting.

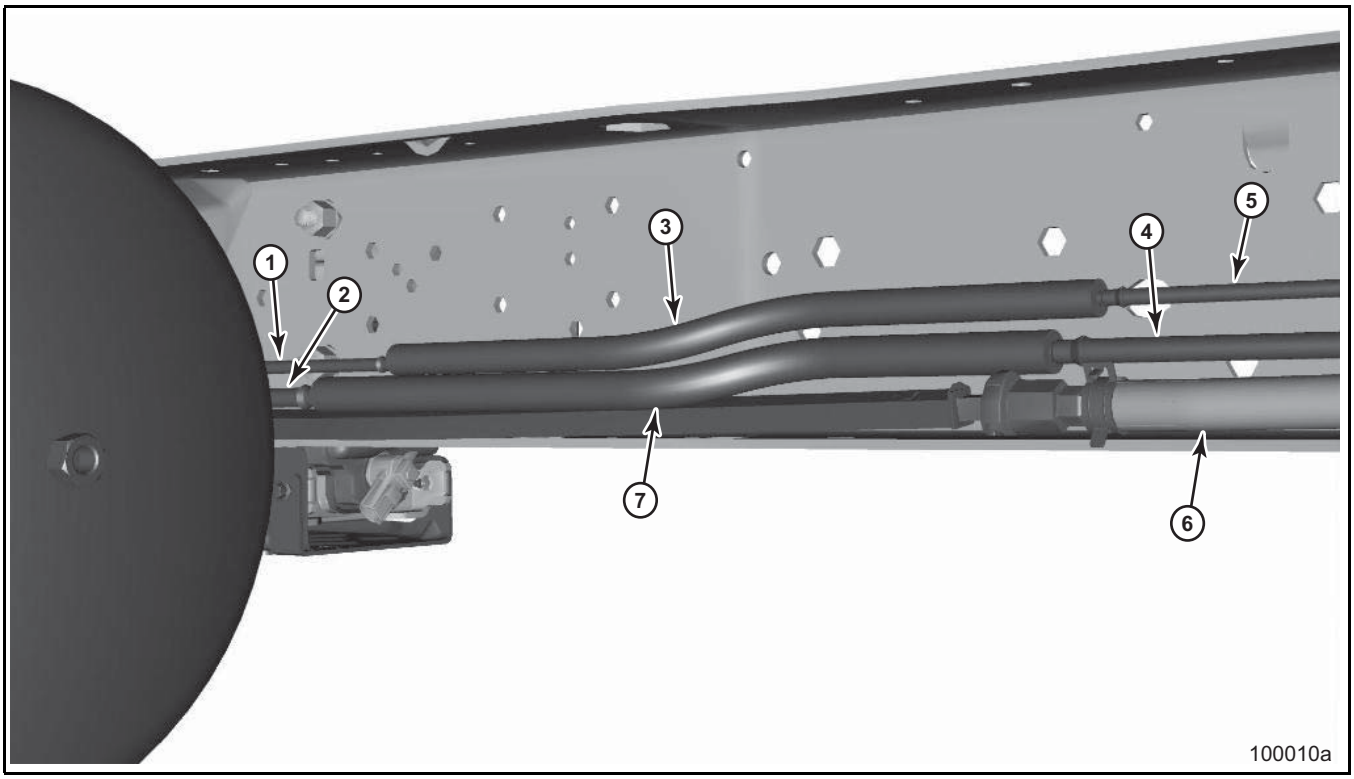


Figure 76 — Intermediate (Flex) Fuel Supply and Intermediate (Flex) Fuel Return Lines (Between Forward and Rear Lines)

1. Rear Fuel Return Line 2. Rear Fuel Supply Line 3. Intermediate (Flex) Fuel Return Line 4. Forward Fuel Supply Line	5. Forward Fuel Return Line 6. Vapor Management Line (From Engine) 7. Intermediate (Flex) Fuel Supply Line

5. Disengage the fuel lines from the retention clips on the frame rail, exhaust heat shield and bell housing fuel and vapor line retention bracket.
6. Disconnect the forward fuel supply line from the upper right port of the FRPCM using the appropriate Jiffy-Tite disconnect tool. Refer to *Tools and Equipment, Special Tools* for more information.

NOTE

If removal of the quick-connect fitting is necessary, replace with a new fitting.

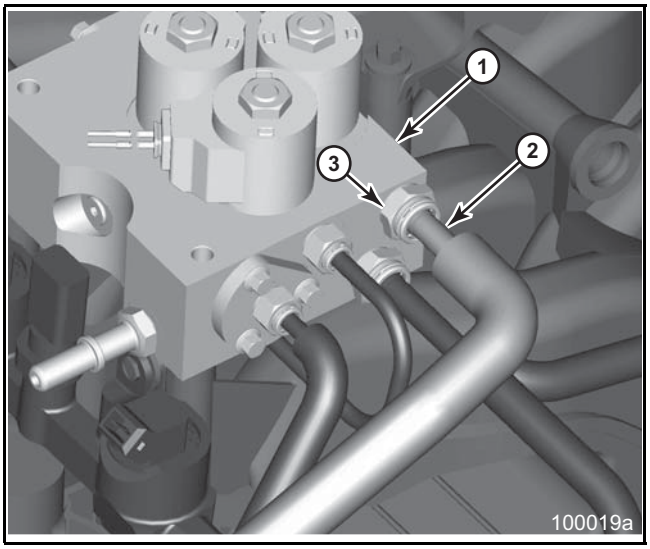


Figure 77 — Forward Fuel Supply Line at FRPCM (Typical)

1. FRPCM 2. Forward Fuel Supply Line	3. Quick-Connect Fitting

7. Disconnect the forward fuel return line from the lower left port of the FRPCM using the appropriate Jiffy-Tite disconnect tool. Refer to *Tools and Equipment, Special Tools* for more information.

CAUTION

Do NOT disturb or remove the brass check valve (or three fasteners) attached to the body of the FRPCM. Only remove the quick-connect fitting from the check valve. Failure to heed this caution can damage or contaminate the check valve internal rubber seal or sealing surfaces and cause check valve malfunction.

NOTE

If removal of the quick-connect fitting is necessary, replace with a new fitting.

NOTE

A malfunctioning check valve can illuminate the malfunction indicator lamp (MIL) due to a general bleed fault. Refer to *Diagnostic Trouble Codes* in the *Ford E150/E-250/E-350 Liquid Propane Autogas Fuel System Diagnostic Manual* for more information.

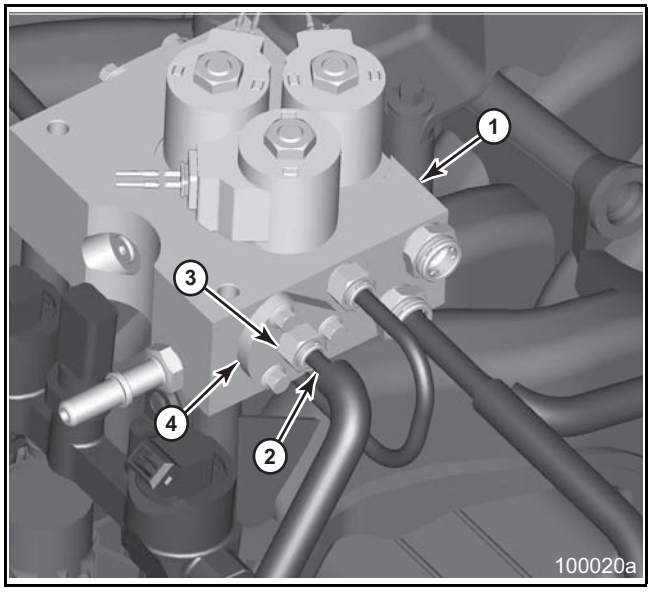


Figure 78 — Forward Fuel Return Line at FRPCM (Typical)

1. FRPCM 2. Forward Fuel Return Line	3. Quick-Connect Fitting 4. Brass Check Valve

8. Remove the forward fuel lines from the retention clips on the frame rail, heat shield and from the retention bracket on the bell housing. Unbend the tab to release the lines.

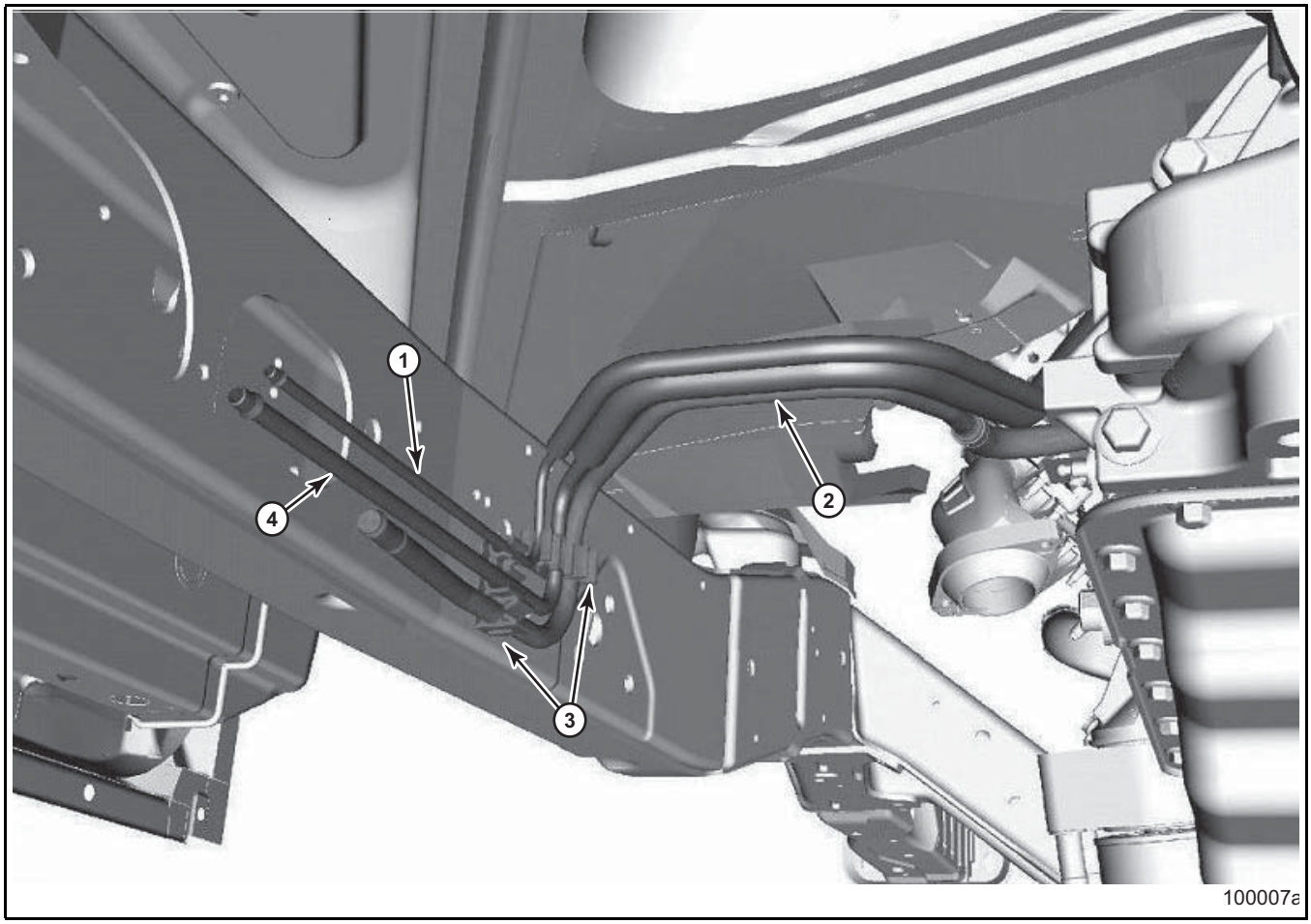


Figure 79 — Forward Fuel Supply, Forward Fuel Return and Vapor Lines (Typical)

1. Forward Fuel Return Line 2. OEM Vapor Line	3. Retention Clips 4. Forward Fuel Supply Line

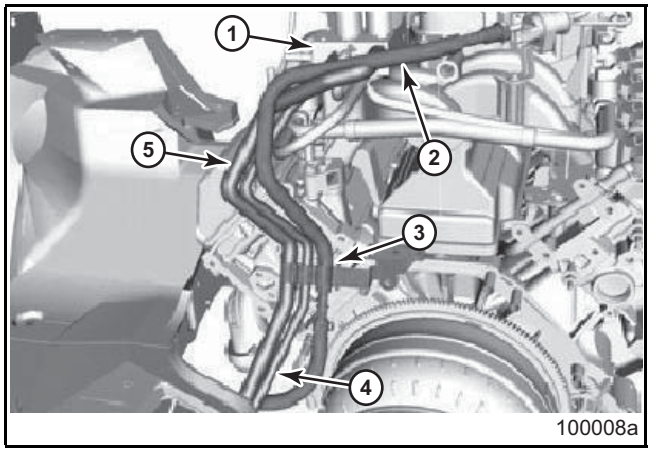


Figure 80 — Forward Lines at Rear and Top of Engine (Typical)

1. FRPCM 2. Vapor Line 3. Retention Bracket	4. Forward Fuel Return Line 5. Forward Fuel Supply Line

9. Reverse the procedure to install the fuel lines. Make sure all fuel lines are retained correctly and all quick-connect fittings are firmly engaged.

Fuel Rail Pressure Control Module

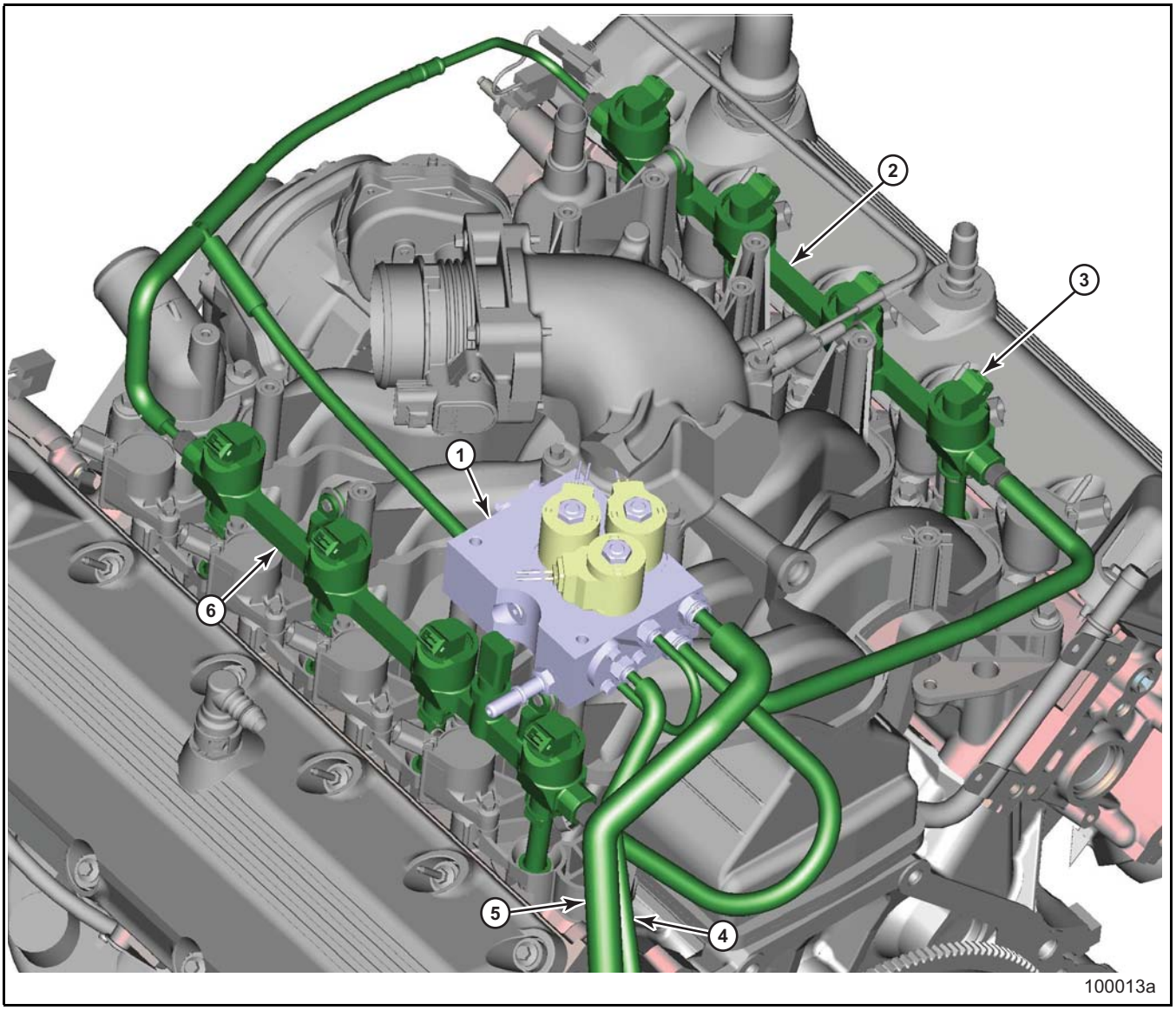


Figure 81 — Fuel Rail Pressure Control Module (FRPCM)

1. FRPCM 2. RH Fuel Rail 3. Fuel Injector (8)	4. Fuel Return Line 5. Fuel Supply Line 6. LH Fuel Rail

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.
2. Close the manual shutoff valve on the tank. Refer to *Operating the Manual Shutoff Valve* for more information.
3. Disconnect the FRPCM electrical connector.
4. Disconnect the forward fuel supply line from the upper right port of the FRPCM.
5. Disconnect the fuel supply line and tee assembly from the lower right port of the FRPCM.
6. Disconnect the fuel return line and tee assembly from the upper left port of the FRPCM.
7. Disconnect the forward fuel return line from the lower left port of the FRPCM.
8. Disconnect the VMV 90-degree fitting from the FRPCM vacuum port.

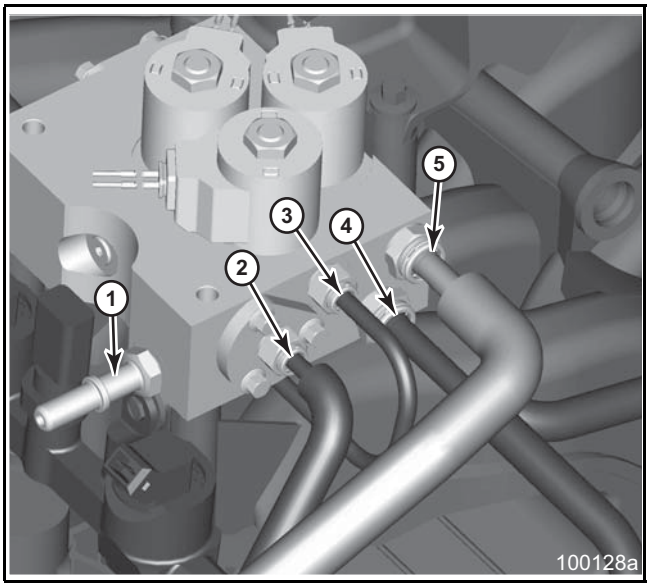


Figure 82 — FRPCM Line Connections

1. Vacuum Port 2. Forward Fuel Return Line 3. Fuel Return Line and Tee Assembly	4. Fuel Supply Line and Tee Assembly 5. Forward Fuel Supply Line

9. Remove the bolts securing the FRPCM and brackets. Remove the FRPCM.
10. Reverse the procedure to install the FRPCM. Tighten the FRPCM and bracket bolts to specification. *Refer to Specifications*.

Fuel Rail Service

⚠ CAUTION

When removing or replacing any fuel delivery components which include fuel rails, injectors or fuel lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always make sure your hands are clean when handling fuel injection components to prevent contamination. Contamination can cause injectors to stick, leak or become damaged, delivering incorrect amounts of fuel and cause the fuel control system to be non-compliant.

NOTE

Always cap any open ports after disconnecting fuel lines, removing the injectors or fuel rails to prevent contamination.

LEFT HAND FUEL RAIL

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.

⚠ CAUTION

The fuel rail is under high pressure. Care should be taken when releasing pressure to avoid personal injury.

⚠ CAUTION

Make sure the battery ground wires are disconnected before proceeding. Failure to heed this caution can cause component damage.

2. Disconnect the mass air flow (MAF) sensor electrical connector.
3. Remove the throttle body inlet hose.
4. Disconnect the heated positive crankcase ventilation (PCV) hose from the intake manifold.
5. Disconnect the IPTS electrical connector.
6. Disconnect the fuel injector electrical connectors (jumper harnesses).
7. Disconnect the fuel rail return line and tee assembly at the front end of the LH fuel rail.

NOTE

The fuel rail return line and tee assembly connects the two fuel rails at the front with a tee connection to the FRPCM fuel return port. The fuel rail supply line and tee assembly connects the two fuel rails at the rear with a tee connection to the FRPCM fuel supply port.

8. Disconnect the fuel rail supply line and tee assembly at the rear end of the LH fuel rail.

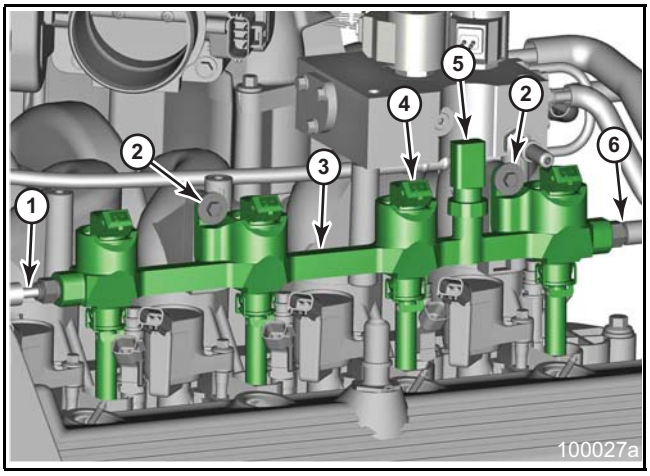


Figure 83 — Left Hand Fuel Rail (Typical)

1. Fuel Rail Return Line and Tee Assembly at Quick-Connect 2. Fuel Rail Bolt (2) 3. LH Fuel Rail 4. Fuel Injector Connector (4)	5. IPTS Electrical Connector 6. Fuel Rail Supply Line and Tee Assembly at Quick-Connect

9. Remove the LH fuel rail and injector assembly.
10. To install the LH fuel rail, reverse the removal procedure. Lubricate fuel injector lower O-rings using O-ring lubricant.
11. After all fuel system component service, perform the fuel system priming procedure. Refer to the *Fuel Delivery System Priming Procedure* for more information.

RIGHT HAND FUEL RAIL

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.

⚠ WARNING

The fuel rail is under high pressure. Care should be taken when releasing pressure to avoid personal injury.

2. Disconnect the PCV hose from the throttle body elbow.
3. Disconnect the fuel injector electrical connectors (jumper harnesses).
4. Disconnect the fuel rail return line and tee assembly at the front end of the RH fuel rail.

NOTE

The fuel rail return line and tee assembly connects the two fuel rails at the front with a tee connection to the FRPCM fuel return port. The fuel rail supply line and tee assembly connects the two fuel rails at the rear with a tee connection to the FRPCM fuel supply port.

5. Disconnect the fuel rail supply line and tee assembly at the rear end of the RH fuel rail.

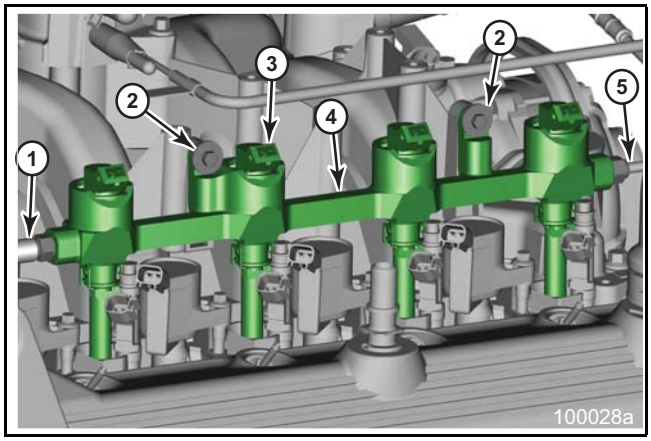


Figure 84 — Right Hand Fuel Rail (Typical)

1. Fuel Rail Supply Line and Tee Assembly at Quick-Connect 2. Fuel Rail Bolt (2) 3. Fuel Injector Connector (4)	4. RH Fuel Rail 5. Fuel Rail Return Line and Tee Assembly at Quick-Connect

6. Remove the RH fuel rail and injector assembly.
7. To install the RH fuel rail, reverse the removal procedure. Lubricate fuel injector nozzle lower O-rings using O-ring lubricant.
8. After all fuel system component service, perform the fuel system priming procedure. Refer to *Fuel Delivery System Priming Procedure* for more information.

Fuel Injectors

WARNING

The fuel rail is under high pressure. Care should be taken when releasing pressure to avoid personal injury.

CAUTION

When removing or replacing any fuel delivery components which include fuel rails, injectors or fuel lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always make sure your hands are clean when handling fuel injection components to prevent contamination. Contamination can cause injectors to stick, leak or become damaged, delivering incorrect amounts of fuel and cause the fuel control system to be non-compliant.

NOTE

It is not recommended on E-Series vehicles to service the injectors on the vehicle. Clean the area thoroughly and blow the area clean with compressed air before starting.

1. Purge the propane from the fuel lines. Refer to *Fuel Line Purging* for more information.

CAUTION

Make sure the battery ground wires are disconnected before proceeding. Failure to heed this caution can result in component damage.

2. Remove the LH or RH fuel rail to access the fuel injector to be removed. Refer to *Left Hand Fuel Rail* or *Right Hand Fuel Rail* in the *Fuel Rail Service* section.

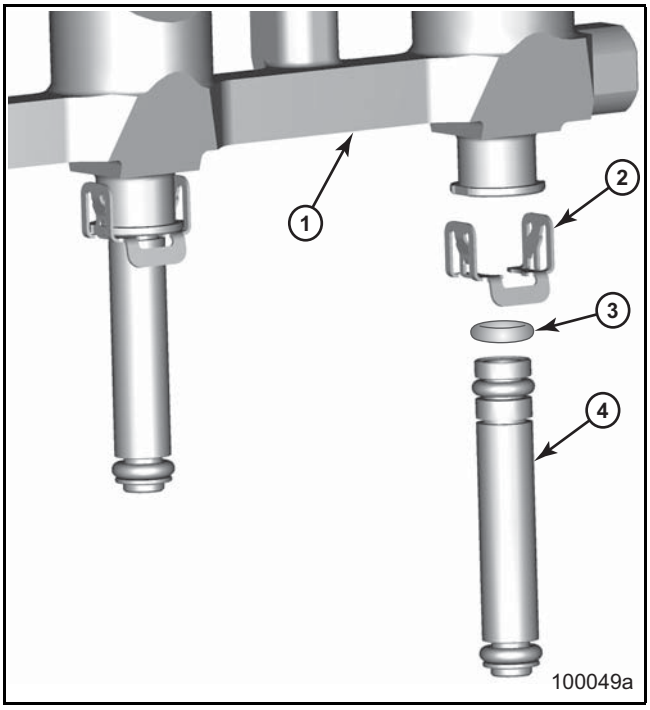


Figure 85 — Right Hand Fuel Rail and Injectors (Typical)

1. Fuel Rail Assembly	3. Top Sealing O-ring
2. Retaining Clip	4. Fuel Injector Nozzle

3. Remove the fuel injector nozzle below the injector to be serviced. Make sure the top sealing O-ring is removed and in good condition. Replace as necessary.
4. Using a twisting motion, pull the fuel injector nozzle out of the fuel rail (a pair of pliers might be necessary to help remove the nozzle). Use care to prevent damage to the fuel injector nozzle.
5. Lubricate top sealing O-ring and nozzle upper O-ring. Install the replacement fuel injector nozzle into the fuel rail. Make sure clip is engaged and is retaining fuel injector nozzle.
6. Lubricate lower nozzle O-ring and install onto fuel injector nozzle.
7. Repeat steps as needed for the remaining fuel injectors.
8. Install the LH or RH fuel rail as needed after fuel injector replacement. Refer to *Left Hand Fuel Rail* or *Right Hand Fuel Rail* in the *Fuel Rail Service* section.

Integrated Pressure Temperature Sensor

1. Purge the propane from the fuel lines. Refer to the *Fuel Line Purging* procedure for more information.

⚠ WARNING

The fuel rail is under high pressure. Care should be taken when releasing pressure to avoid personal injury.

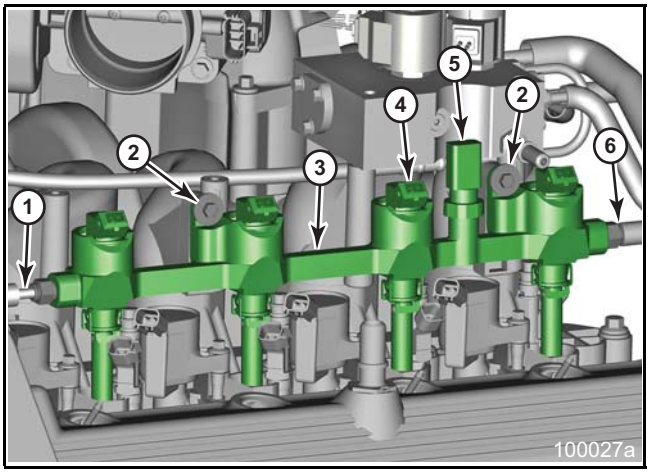


Figure 86 — Left Hand Fuel Rail (Typical)

1. Fuel Rail Return Line and Tee Assembly at Quick-Connect 2. Fuel Rail Bolt (2) 3. LH Fuel Rail 4. Fuel Injector Connector (4)	5. Integrated Pressure Temperature Sensor (IPTS) 6. Fuel Rail Supply Line and Tee Assembly at Quick-Connect

2. Disconnect the electrical connector from the IPTS.
3. Remove the IPTS from the left hand fuel rail.
4. Reverse the procedure to install the IPTS. Tighten to 7 ±1 N•m (62 ±9 lb-in).

Vapor Canister Assembly

REMOVAL

1. Disconnect vapor purge hose from the canister by disconnecting the quick-connect fitting.
2. Disconnect fresh air hose from the canister by disconnecting the quick-connect fitting.
3. Disconnect the electrical connectors from the fuel tank pressure (FTP) sensor and the electrical connector from the canister.
4. Disconnect the FTP sensor hose by disconnecting the quick-connect fitting.
5. Remove the two bolts securing the FTP sensor to the rearward bracket.
6. Remove the canister-to-bracket mounting bolts and remove the canister.
7. Remove the bracket-to-frame rail mounting bolts and remove the brackets.

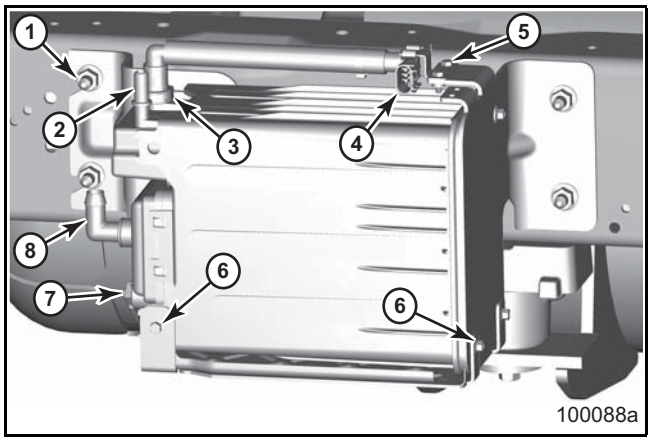


Figure 87 — Vapor Canister Assembly (Typical)

1. Bracket-to-Frame Rail Bolt (4) 2. Vapor Purge Hose Connection 3. FTP Sensor Hose Connection 4. FTP Sensor Electrical Connector	5. FTP-to-Bracket Bolt (2) 6. Bracket-to-Canister Bolt (6) 7. Canister Electrical Connector 8. Fresh Air Hose Connection

INSTALLATION

1. Install the canister mounting brackets onto the frame rail and tighten the bolts to specification.
2. Place the canister onto the mounting brackets and tighten bolts to specification as indicated.
   - Tighten M6 bolts to 6.0 ±0.3 N•m (53 ±2.6 lb-in)
   - Tighten thread cutting bolts to 2.75 ±0.25 N•m (24 ±2.2 lb-in)
3. Install the fresh air hose to the canister.
4. Install the vapor purge hose onto the canister.

5. Install the FTP sensor hose onto the canister.

NOTE

Make sure the quick-connect fittings are fully engaged into the canister fittings.

6. Install the FTP sensor to the rearward bracket and tighten the bolts to specification.
7. Plug in the canister and FTP sensor electrical connectors.

Smart Relay Module

The LPA fuel system includes a smart relay module (SRM). The SRM serves several functions:

- Reads IPTS and transmits values to the PCM.
- Reads fuel level sender and broadcasts the value to the instrument cluster and the PCM.
- Monitors the second fuel pump monitor line and transmits the status to the PCM.
- Receives solenoid state commands from the PCM and opens and closes the solenoids accordingly.

REMOVAL

1. Disconnect the negative battery cable from the battery.
2. Remove the three bolts securing the degas bottle and swing the degas bottle aside.
3. Disconnect the main harness connector at the SRM.

⚠ CAUTION

Do NOT pry on the locking lever or damage can occur. If the lever does not move freely, push in on the top of the connector to reduce the load.

4. Remove the four mounting bolts.
5. Remove the SRM from the bracket on the inner fender.

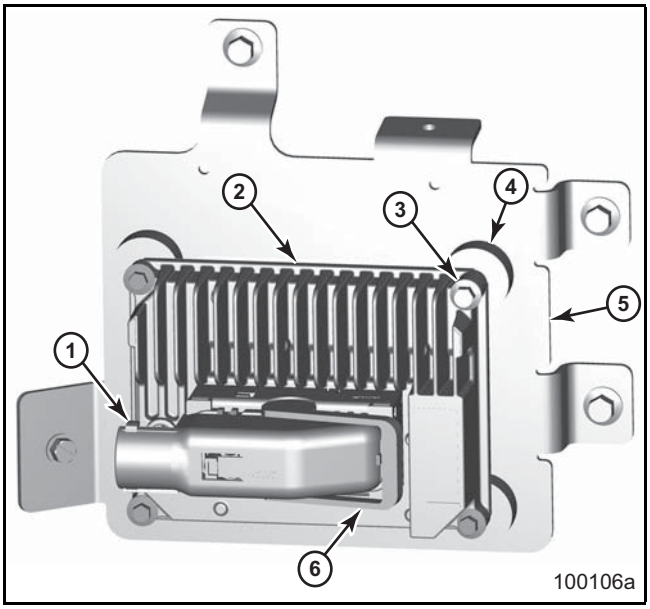


Figure 88 — SRM Mounting (Typical)

1. Main Harness Connector 2. SRM 3. Mounting Bolts (4)	4. Isolator (4) 5. SRM Mounting Bracket 6. Harness Lock

INSTALLATION

1. Position the SRM to the isolators and install the four bolts. Tighten the bolts to 11.5 ±0.5 N•m (102 ±4 lb-in).
2. Connect the main harness connector to the SRM. Push the harness lock until it locks in place. Make sure the harness is secure.
3. Position the degas bottle, install the three bolts and tighten to 8–12 N•m (6–9 lb-ft).
4. Connect the negative battery cable to the battery.

Fuel Level Indicator Module

The fuel level indicator module (FLIM) receives an output signal from the SRM and converts it to a signal that mimics the OEM flex fuel level sender.

REMOVAL

1. Disconnect the negative battery cable from the battery.
2. Disconnect the FLIM electrical connector.
3. Cut the tie strap and remove the FLIM.

INSTALLATION

1. Connect the FLIM electrical connector.
2. Position the FLIM to the underhood harness and secure it with a replacement tie strap to the harness.
3. Connect the negative battery cable to the battery.

PREPARING VEHICLE FOR USE AFTER SERVICE

Operating the Manual Shutoff Valve

1. After fuel system service is complete, open the manual shutoff valve on the tank by turning it counterclockwise until it stops.

NOTE

The manual shutoff valve can be hard to turn. From fully open to fully closed is approximately 3-1/2 turns.

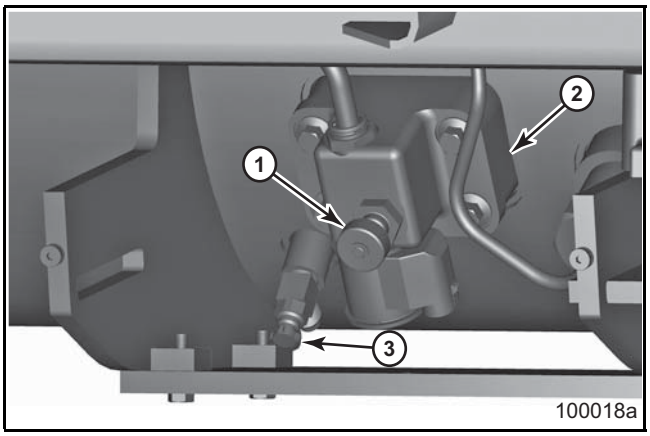


Figure 89 — Manual Shutoff Valve (Typical)

1. Manual Shutoff Valve 2. Fuel Supply Valve	3. Bleeder Valve

2. Follow the *Fuel Tank Purging Procedure* and the *Fuel Delivery System Priming Procedure* in this section.
3. Leak check the fuel lines and fuel rails with an electronic leak detector or leak detection solution. Repair as necessary.
4. Install the supply circuit cover back onto the tank.
5. Start and run the engine and check for diagnostic trouble codes. Repair as necessary.

NOTE

Starting the engine for the first time after the fuel supply line has been evacuated may cause the excess flow valve to close, which may cause the engine to run rough or stall. If this occurs, turn off the ignition and wait about 30 seconds, then restart. This may have to be repeated multiple times until the fuel supply line comes up to pressure.

For any questions, please contact ROUSH CleanTech Customer Service at 800-59-ROUSH (597-6874).

Fuel Tank Purging Procedure

The following procedure is required to purge the air from the fuel tank after servicing.

1. Fill the tank with 0.3 (3/10) gallon (1.1 L) of propane and cycle the ignition key to the crank position and then to the off position. **(Do not allow the vehicle to start during this step.)**
2. Inspect and monitor the tank for any leaks.
3. Open the bleeder valve for 20 minutes or until propane stops bleeding, whichever comes first. Close the bleeder valve.
4. Fill the tank with 5 gallons (19 L) of propane.

NOTE

When filling an empty tank, start filling at a slow rate to build up pressure inside the tank. An initial fast fill may trip the overflow protection device (OPD), creating a slow or no fill condition.

5. Perform a final leak inspection at all fuel fill and fuel line connections to ensure no leaks are present. Use an electronic leak detector or leak detection solution.
6. Install the supply valve cover onto the tank and hand tighten the thumb screws. Applications vary. Refer to *Supply Valve Cover or Tank Cover Plate* for more information.

Fuel Delivery System Priming Procedure

After performing any fuel system service work, air enters the system through open connections and ports. You need to prime the fuel system to expel all air from the fuel lines and rails.

1. Make sure the battery is connected.
2. Check to make sure there is fuel in the tank and that the manual shutoff valve is open.
3. Turn the key to the key on engine off (KOEO) position (not the start position) and wait 30 seconds.
4. Turn the key off.
5. Repeat Steps 3 and 4 a total of three times.
6. Turn the key to the start position. The engine will automatically crank to start.

NOTE

If the engine fails to start, the excess flow valve (XFV) may have been tripped. Refer to the *Excess Flow Valve. Check* procedure in the *Diagnostic Tests and Procedures* section of the *Diagnostic Manual*.

SPECIFICATIONS

SPECIFICATIONS

Engine Specifications — 5.4L

ROUSH CleanTech LPA Conversion Ford 5.4L Engine

Bore x Stroke	90.2 mm x 105.8 mm
Compression Ratio	9.0:1
Displacement	5.4 Liters
Engine Architecture	V8 SOHC
Fuel System	Port Fuel Injection/Liquid Propane Autogas
Peak Power Rating	255 HP
Peak Torque Rating	350 lb-ft
Transmission	Four-Speed Automatic with Overdrive
Valve Operation	Variable Cam Timing
Valve Count	Two per cylinder
Valve Head Diameter	Intake: 44.5 mm (1.751 in) Exhaust: 34.0 mm (1.336 in)
Equipment	
Air Conditioning	Standard
Heavy Duty Payload Package	Optional
Tires and Wheels	Variable with option package
Trailer Tow Package	Required

Engine Specifications — 6.8L

ROUSH CleanTech LPA Conversion Ford 6.8L Engine

Bore x Stroke	90.2 mm x 105.8 mm
Compression Ratio	9.2:1
Displacement	6.8 Liters
Engine Architecture	V10 SOHC
Fuel System	Port Fuel Injection/Liquid Propane Autogas
Peak Power Rating	362 HP
Peak Torque Rating	457 lb-ft
Transmission	Five-Speed Automatic with Overdrive
Valve Operation	Fixed Cam Timing
Valve Count	Three per cylinder
Valve Head Diameter	Intake: 33.62–33.98 mm (1.324–1.338 in) Exhaust: 37.32–37.68 mm (1.469–1.483 in)
Equipment	
Air Conditioning	Standard
Heavy Duty Payload Package	Optional
Tires and Wheels	Variable with option package
Trailer Tow Package	Required

Chassis Specifications

NOTE

Vehicle dimensions are as quoted in the *Ford Owner's Guide,* except that options are available only as shown in the following table.

Model	Cab/Body Type	Wheelbase
E-150	Regular Van, Cargo/Wagon	138”
E-250	Regular Van, Cargo/Wagon	138”
E-350	Regular Van, Cargo/Wagon	138”
E-250	Extended Range Van, Cargo/Wagon	138”
E-350	Extended Range Van, Cargo/Wagon	138”
E-450	Cutaway/Stripped Chassis, Custom Body	158” DRW 176” DRW

Fastener Torque Specifications — E-150/250/350

Description	N•m	Lb-Ft	Lb-In
FRPCM-to-Bracket M6 Bolt	8–12	6–9	—
FRPCM-to-Intake Manifold M6 Bolt	8–12	6–9	—
Fuel Rail Crossover Lines and Tee Fittings	Quick-Connect	Quick-Connect	—
Fuel Fill Line Fittings (at Fuel Fill Valve and Fuel Filter)			—
Steel-to-Steel Steel-to-Brass	53–61 41–49	39–45 30–36	—
Fuel Fill Line Fitting (at Fuel Filter)	41–49	30–36	—
Fuel Fill Line Fitting (at Tank Fill Valve 90° Elbow)	45	33	—
Fuel Filter and Bracket Assembly M6 Bolt	20–30	15–22	—
Fuel Filter-to-Bracket Clamp	4–5	—	35–44
Fuel Line Support Bracket-to-Frame M8 Nut	20–30	15–22	—
Fuel Rail Mounting M6 Bolt	8–12	6–9	—
Fuel Supply and Return Line Fittings	Quick-Connect	Quick-Connect	—
Fuel Lines at FRPCM	Quick-Connect	Quick-Connect	—
Fuel Tank Crossmember Mounting Bracket (Front/Rear) M8 Bolt	20–30	15–22	—
Fuel Tank Crossmember Mounting Bracket (Front/Rear) M12 Nut	80–90	59–66	—
Fuel Tank M12 Mounting Bolt at Frame Rail Bracket (Front/Rear)	80–90	59–66	—
Fuel Tank Mounting Bracket at Frame Rail M10 Bolt (Front/Rear)	40–55	30–41	—
Fuse Box-to-Bracket Screw	Hand Tight	—	—
Smart Relay Module Screw	Hand Tight	—	—
Tank Service Cover Bolt (12)			
Step 1: Tighten bolts 1–4 in order	2–3	—	18–27
Step 2: Tighten bolts 1–4 in order	38.6–42.6	28–31	—
Step 3: Tighten bolts 5–12 in order	38.6–42.6	28–31	—
Fuel Fill Valve Bracket M5 Bolt (3)	5–7	—	44–62

Description	N•m	Lb-Ft	Lb-In
Fill Valve-to-Bracket Nut	Hand Tight	—	—
Pressure Relief Valve, minimum torque plus 180-degrees rotation	120	89	—
Fuel Level Sender Screw (4)			
Step 1: Tighten in cross pattern to:	1.7	—	15
Step 2: Tighten in cross pattern to:	2.8	—	25
Step 3: Tighten in cross pattern to:	4.0–5.6	—	35–50
Mechanical Fill Valve, minimum plus vertical alignment	75	55	—
Integrated Pressure Temperature Sensor	6–8	—	53–71
Electronic Fuel Pump Relay (at Frame Rail)	20–30	15–22	—
Vapor Canister-to-Bracket			
M6 Bolt Thread Cutting Bolts Canister Bracket-to-Frame Rail M10 Bolt	7–8 2–3 46–52	5–6 1–2 34–38	— — —
Smart Relay Module (4)	11–12	8–9	97–106
Fuel Supply Valve, tighten in cross pattern	Initial 2.5 ±0.5 Final 25 ±5	— Final 18 ±4	Initial 22 ±4.4 —
Fuel Supply Valve Cover			
M5 Thumb Screw Allen-Head Screws (2)	Hand Tight Snug	Hand Tight Snug	—
Fuel Tank Return Valve, minimum torque plus 180-degrees rotation	120	89	—
Bleeder Valve (at Tank), minimum torque plus rotation to align	16–22	12–16	—
Remote Bleeder Valve (at Nozzle Bracket), minimum torque plus rotation to align	16–22	12–16	—
Remote Bleeder Line (to Valve at Tank and Bracket)	16–22	12–16	—
Outlet Nozzle Bracket (to rear inner fender)	20–30	15–22	—
Fuel Pump Assembly-to-Bracket			
M6 hex flange nuts Center Bolt	8.5 ±0.5 5.8 ±0.3	— —	75 ±4.4 51 ±2.7
Transmission Dipstick Bracket M6 Bolt	8–12	6–9	—

Fastener Torque Specifications — E-150/250/350 Extended Range

Description	N•m	Lb-Ft	Lb-In
FRPCM-to-Bracket M6 Bolt	8–12	6–9	—
FRPCM-to-Intake Manifold M6 Bolt	8–12	6–9	—
Fuel Rail Crossover Lines and Tee Fittings	Quick-Connect	Quick-Connect	—
Fuel Fill Line Fittings (at Fuel Fill Valve and Fuel Filter)			
Steel-to-Steel Steel-to-Brass	53–61 41–49	39–45 30–36	— —
Fuel Fill Line Fitting (at Fuel Filter)	41–49	30–36	—
Fuel Fill Line Fitting (at Tank Fill Valve 90° Elbow)	45	33	—
Fuel Filter and Bracket Assembly M6 Bolt	20–30	15–22	—
Fuel Filter-to-Bracket Clamp	4–5	—	35–44
Fuel Line Support Bracket-to-Frame M5 Bolt	5–7	4–5	44–62
Fuel Rail Mounting M6 Bolt	8–12	6–9	—

Description	N•m	Lb-Ft	Lb-In
Fuel Supply and Return Line Fittings	Quick-Connect	Quick-Connect	—
Fuel Lines at FRPCM	Quick-Connect	Quick-Connect	—
Fuel Tank Mounting Bracket (Bracket-to-Floor) M12 Bolt (10)	80–90	59–66	—
Fuel Tank Mounting Bracket (Tank-to-Bracket) M12 Nut (4)	80–90	59–66	—
Floor Pass-through Assembly M6 Bolts (4)	8–12	6–9	—
Fuel Tank Cover Bolt (12)	—	1/m	1/m
Fuse Box-to-Bracket Screw	Hand Tight	—	—
Smart Relay Module Screw	Hand Tight	—	—
Tank Service Cover Bolt (12) Step 1: Tighten bolts 1–4 in order Step 2: Tighten bolts 1–4 in order Step 3: Tighten bolts 5–12 in order	 2–3 38.6–42.6 38.6–42.6	 — 28–31 28–31	 18–27 — —
Fuel Fill Valve Bracket M5 Bolt (3)	5–7	—	44–62
Fill Valve-to-Bracket Nut	Hand Tight	—	—
Pressure Relief Valve, minimum torque plus 180-degrees rotation	120	89	—
Fuel Level Sender Screw (4) Step 1: Tighten in cross pattern to: Step 2: Tighten in cross pattern to: Step 3: Tighten in cross pattern to:	 1.7 2.8 4.0–5.6	 — — —	 15 25 35–50
Mechanical Fill Valve, minimum plus vertical alignment	75	55	—
Integrated Pressure Temperature Sensor	6–8	—	53–71
Electronic Fuel Pump Relay (at Frame Rail)	20–30	15–22	—
Vapor Canister-to-Bracket M6 Bolt Thread Cutting Bolts Canister Bracket-to-Frame Rail M10 Bolt	 7–8 2–3 46–52	 5–6 1–2 34–38	 — — —
Smart Relay Module (4)	11–12	8–9	97–106
Fuel Supply Valve, tighten in cross pattern	Initial 2.5 ±0.5 Final 25 ±5	— Final 18 ±4	Initial 22 ±4.4 —
Fuel Tank Return Valve, minimum torque plus 180-degrees rotation	120	89	—
Bleeder Valve (at Tank), minimum torque plus rotation to align	16–22	12–16	—
Remote Bleeder Valve (at Nozzle Bracket), minimum torque plus rotation to align	16–22	12–16	—
Remote Bleeder Line (to Valve at Tank and Bracket)	16–22	12–16	—
Outlet Nozzle Bracket (to rear inner fender)	20–30	15–22	—
Fuel Pump Assembly-to-Bracket M6 hex flange nuts Center Bolt	 8.5 ±0.5 5.8 ±0.3	 — —	 75 ±4.4 51 ±2.7
Transmission Dipstick Bracket M6 Bolt	8–12	6–9	—

Fastener Torque Specifications — E-450 DRW Custom Body

Description	N•m	Lb-Ft	Lb-In
FRPCM-to-Bracket M6 Bolt	8–12	6–9	—
FRPCM-to-Intake Manifold M6 Bolt	8–12	6–9	—
Fuel Rail Crossover Lines and Tee Fittings	Quick-Connect	Quick-Connect	—
Fuel Fill Line Fittings (at Fuel Fill Valve and Fuel Filter)			
Steel-to-Steel	53–61	39–45	—
Steel-to-Brass	41–49	30–36	—
Fuel Fill Line Fitting (at Fuel Filter)	41–49	30–36	—
Fuel Fill Line Fitting (at Tank Fill Valve 90° Elbow)	53–61	39–45	—
Fuel Filter and Bracket Assembly-to-Rear Crossmember M6 Bolt	8–12	6–9	—
Fuel Filter-to-Bracket Clamp	4–5	—	35–44
Fuel Line Support Bracket-to-Frame M6 Bolt	8–12	6–9	—
Fuel Rail Mounting M6 Bolt	8–12	6–9	—
Fuel Supply and Return Line Fittings	Quick-Connect	Quick-Connect	—
Fuel Lines at FRPCM	Quick-Connect	Quick-Connect	—
Fuel Tank Frame Mounting Bracket M12 Bolt (4)	100–110	74–81	—
Fuel Tank Mounting M12 Bolt/Nut (2 Rear, 1 Middle)	100–110	74–81	—
Fuel Tank Mounting M12 Bolt (2 Front)	100–110	74–81	—
Fuse Box-to-Bracket Screw	Hand Tight	—	—
Smart Relay Module Screw	Hand Tight	—	—
Tank Service Cover Bolt (12)			
Step 1: Tighten bolts 1–4 in order	2–3	—	18–27
Step 2: Tighten bolts 1–4 in order	38.6–42.6	28–31	—
Step 3: Tighten bolts 5–12 in order	38.6–42.6	28–31	—
Fuel Fill Valve Bracket M5 Bolt (3)	5–7	—	44–62
Fill Valve-to-Bracket Nut	Hand Tight	—	—
Pressure Relief Valve, minimum torque plus 180-degrees rotation	120	89	—
Fuel Level Sender Screw (4)			
Step 1: Tighten in cross pattern to:	1.7	—	15
Step 2: Tighten in cross pattern to:	2.8	—	25
Step 3: Tighten in cross pattern to:	4.0–5.6	—	35–50
Mechanical Fill Valve, minimum plus vertical alignment	75	55	—
Integrated Pressure Temperature Sensor	7 ±1	—	62 ±8.8
Electronic Fuel Pump Relay (at Frame Rail)	8–12	6–9	—
Vapor Canister-to-Bracket			
M6 Bolt Thread Cutting Bolts Canister Bracket-to-Frame Rail M10 Bolt	6.0 ±0.3 2.75 ±0.25 65 ±13.3	53 ±2.6 24 ±2.2 48 ±9.8	— — —
Smart Relay Module (4)	11.5 ±0.5	—	102 ±4
Fuel Supply Valve, tighten in cross pattern	Initial 2.5 ±0.5 Final 25 ±5	— Final 18 ±4	Initial 22 ±4.4 —

Description	N•m	Lb-Ft	Lb-In
Fuel Supply Valve Cover			
M5 Thumb Screw (2)	Hand Tight	Hand Tight	—
Fuel Tank Return Valve, minimum torque plus 180-degrees rotation	120	89	—
Bleeder Valve, minimum torque plus rotation to align	20 ±4	15 ±3	—
Fuel Pump Assembly-to-Bracket			
M6 hex flange nuts	8.5 ±0.5	—	75 ±4.4
Center Bolt	5.8 ±0.3	—	51 ±2.7

TOOLS

TOOLS AND EQUIPMENT

Special Tools

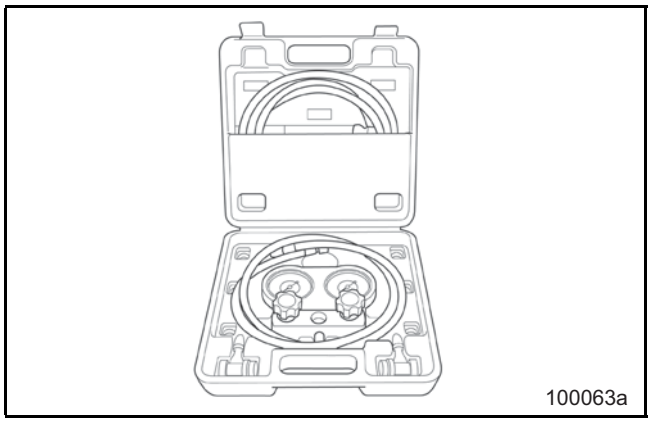


Figure 90 — Fuel Pressure (A/C Manifold) Gauge Kit (0–500 psi)

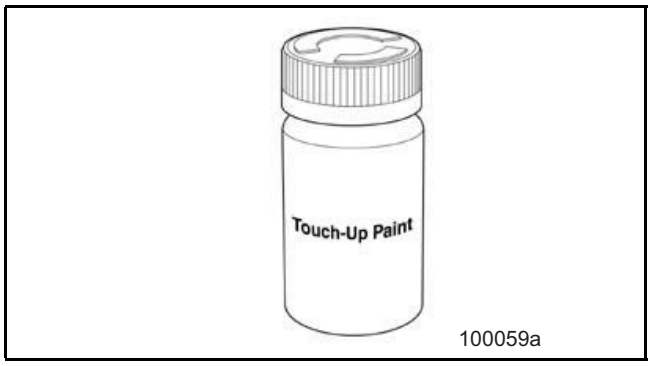


Figure 91 — Touch-Up Paint

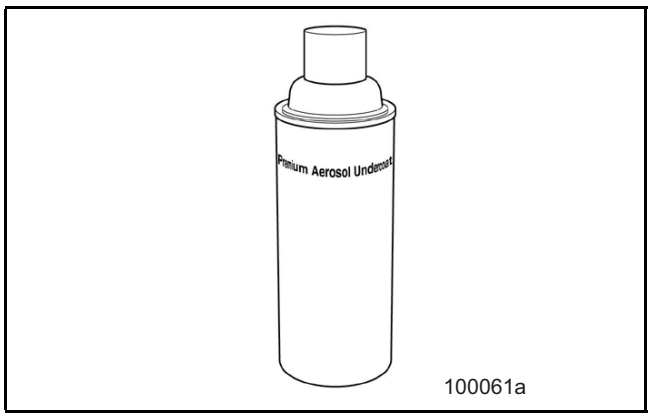


Figure 92 — Premium Aerosol Undercoating

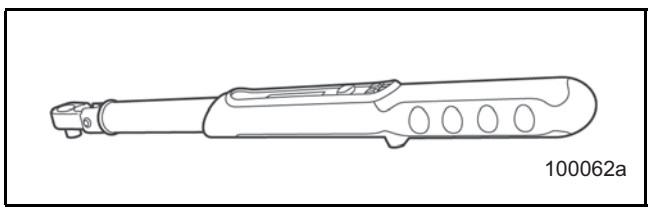


Figure 93 — Torque Wrench (Two Required, 22 N•m and 200 N•m)

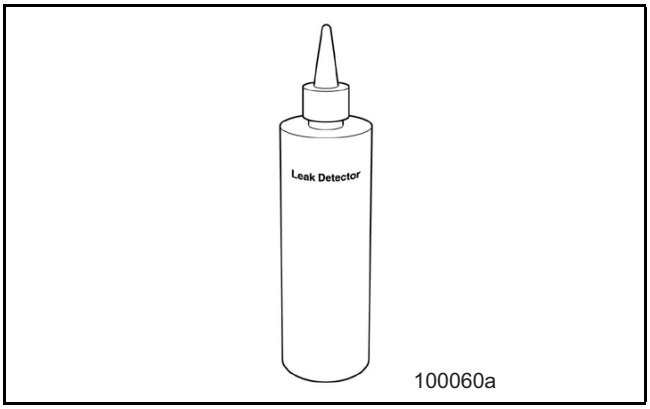


Figure 94 — Liquid Leak Detector

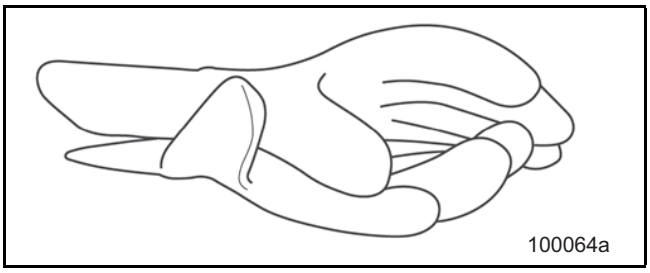


Figure 95 — Gloves (Approved for Propane)

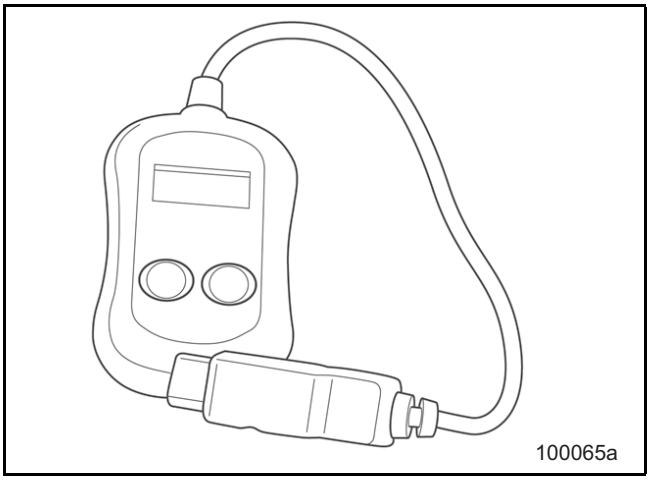


Figure 96 — Scan Tool (OBD-II)

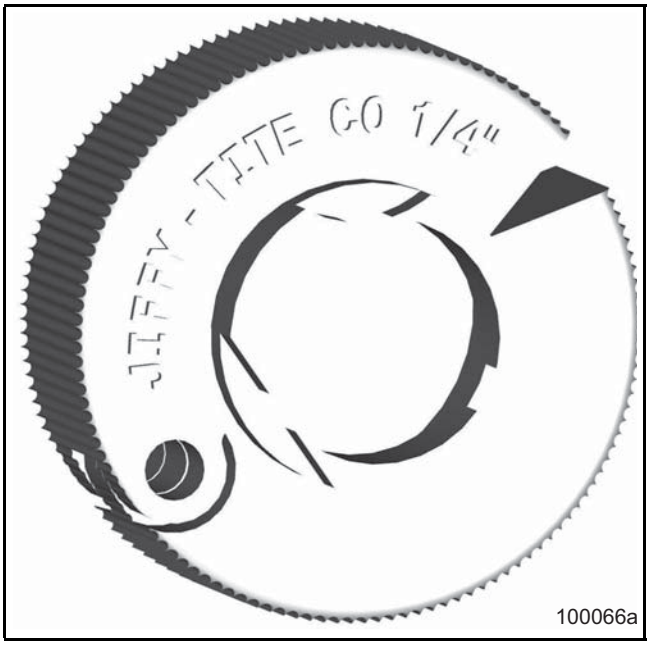


Figure 97 — Jiffy-Tite Disconnect Tool, 1/4" or 3/8"

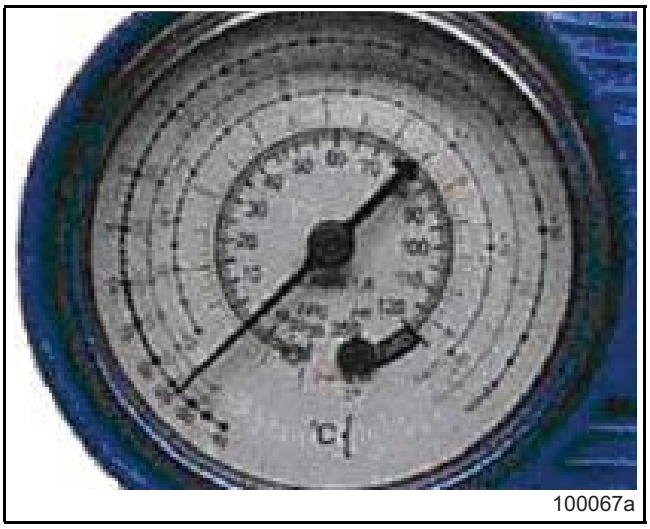


Figure 98 — Vacuum Gauge

Figure 99 — Vacuum Pump

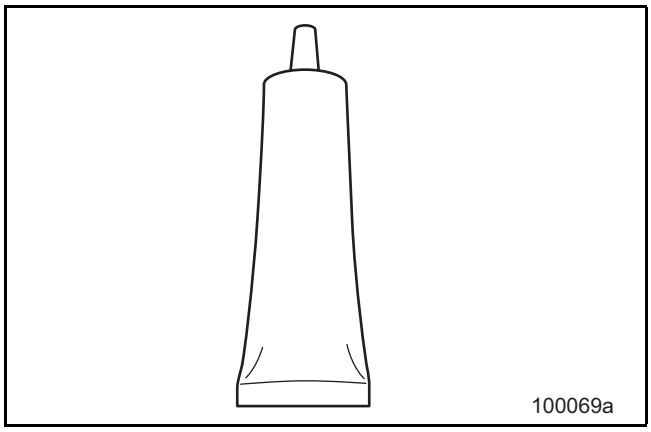


Figure 100 — Dielectric Grease

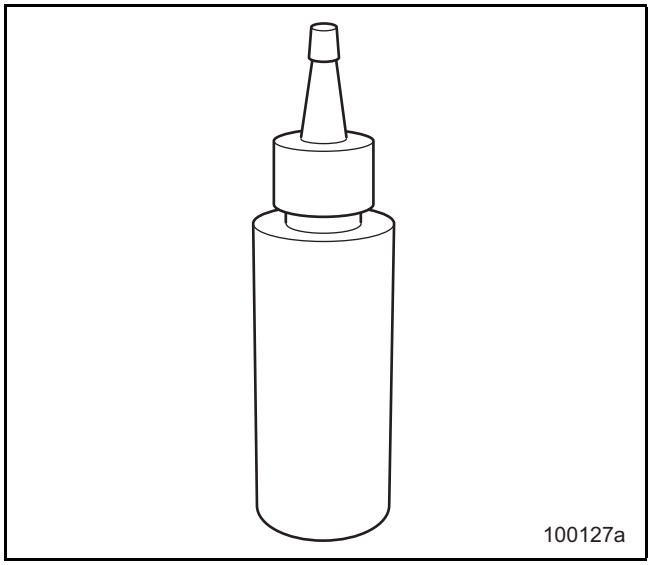


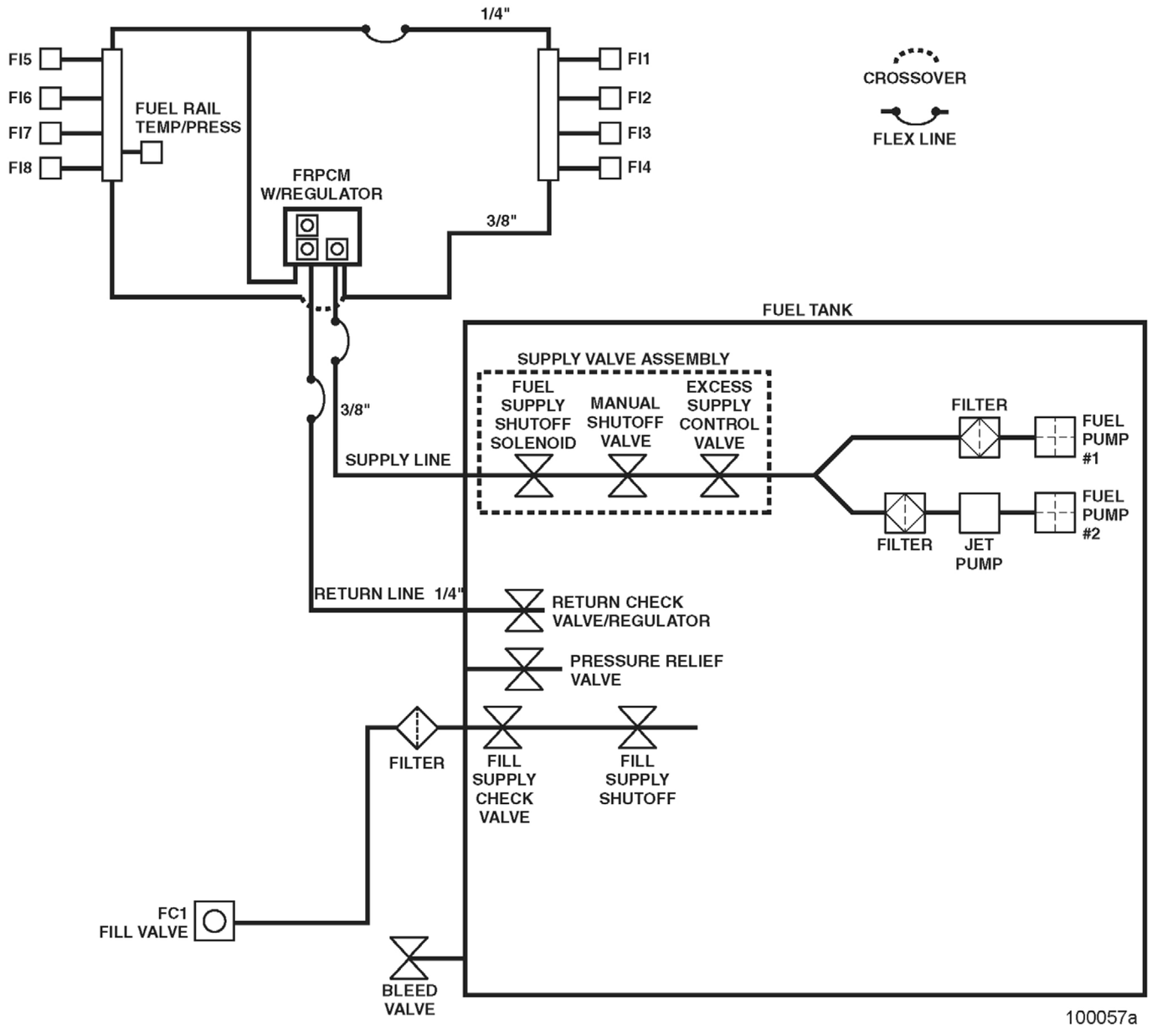
Figure 101 — O-Ring Lubricant

Acceptable O-ring lubricants are:

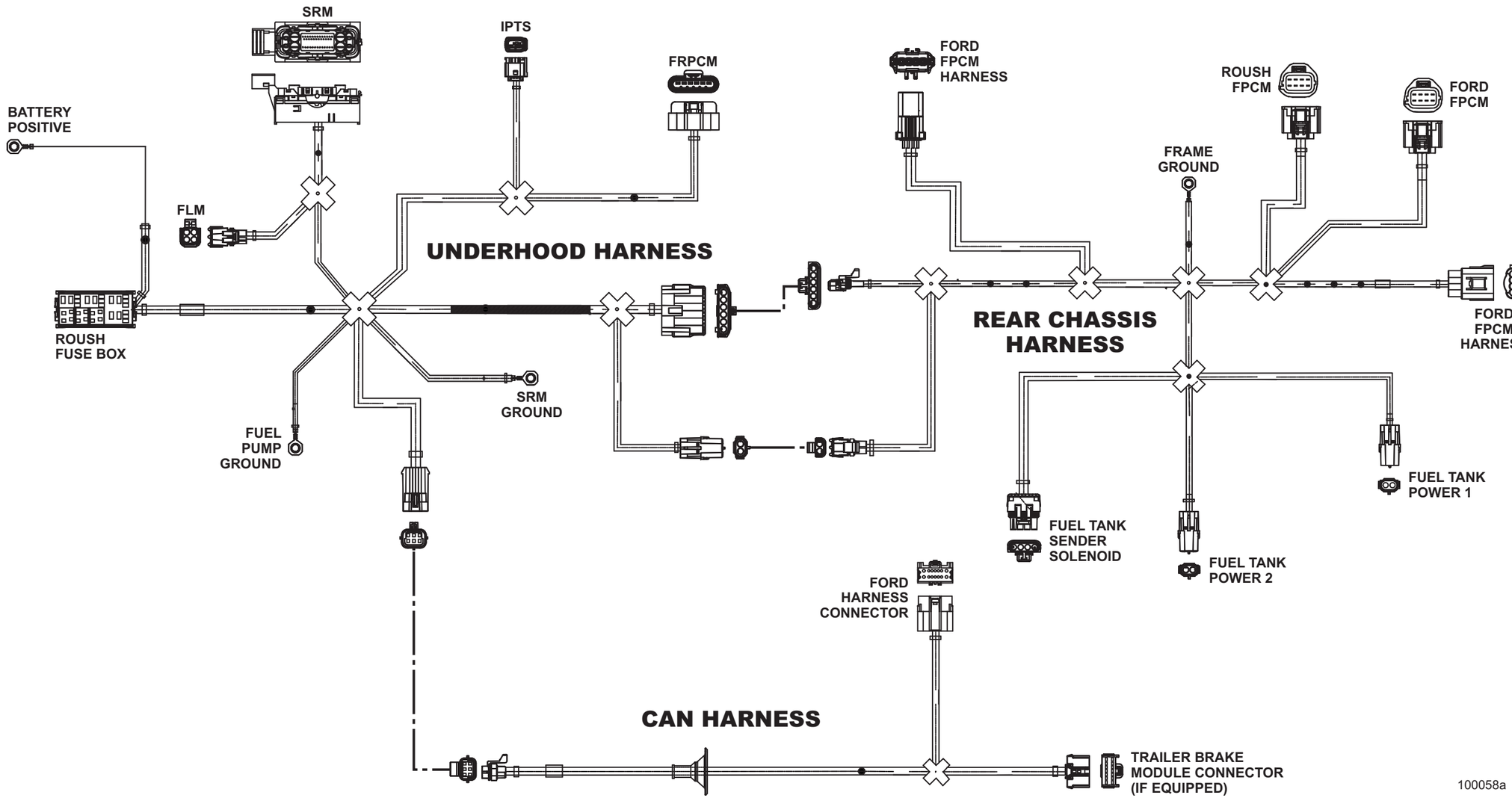
- Dedicated O-ring lubricant
- Motor oil
- Machine oil (Mobil® DTE 25, or equivalent)

SCHEMATICS

E-Series Fuel System Flow Diagram



E-Series Engine and Chassis Wiring Harness (Typical)

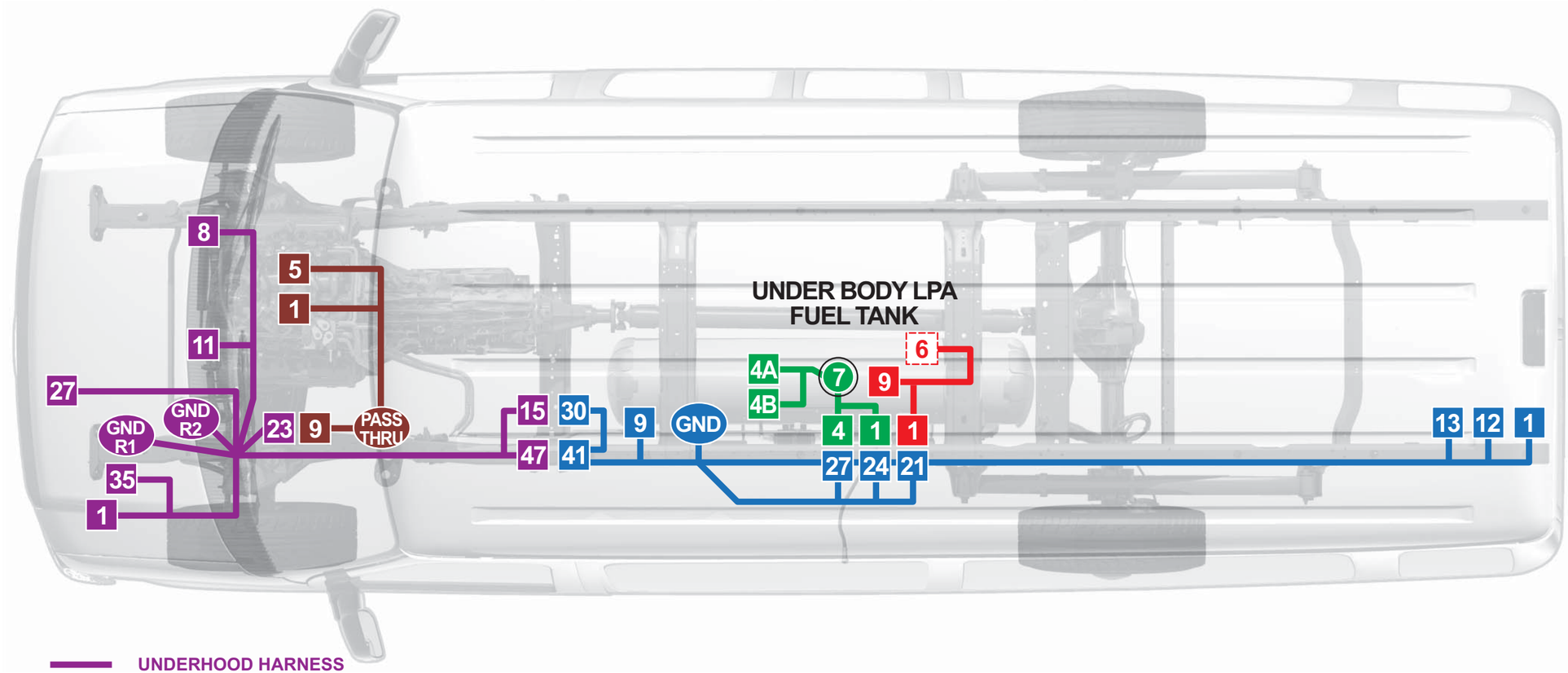


100058a

E-150/250/350 Wiring Harness and Connector Layout

E-150/250/350 WIRING HARNESSES AND CONNECTOR LAYOUT

APPROXIMATE LOCATION OF LPA SYSTEM HARNESSES AND CONNECTORS



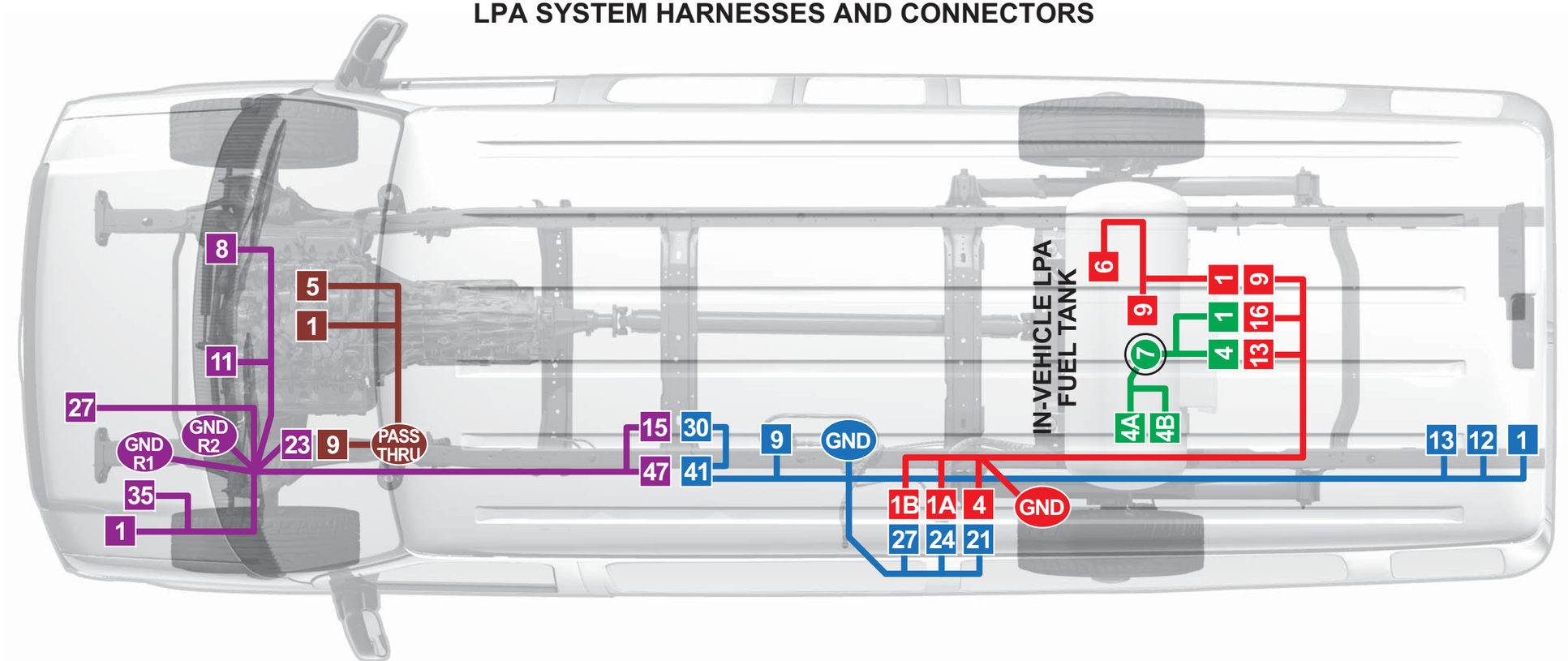
*Refer to *LPA System Wiring Diagram and Electrical Schematics* in *Diagnostic Tests and Procedures*.

100129a

E-250/350 Extended Range Wiring Harnesses and Connector Layout

E-150/250/350 EXTENDED RANGE WIRING HARNESSES AND CONNECTOR LAYOUT

APPROXIMATE LOCATION OF LPA SYSTEM HARNESSES AND CONNECTORS



UNDERHOOD HARNESS
CAN HARNESS
REAR FRAME HARNESS
IN_TANK HARNESS
SOLENOID HARNESS
IN-BED FUEL TANK JUMPER

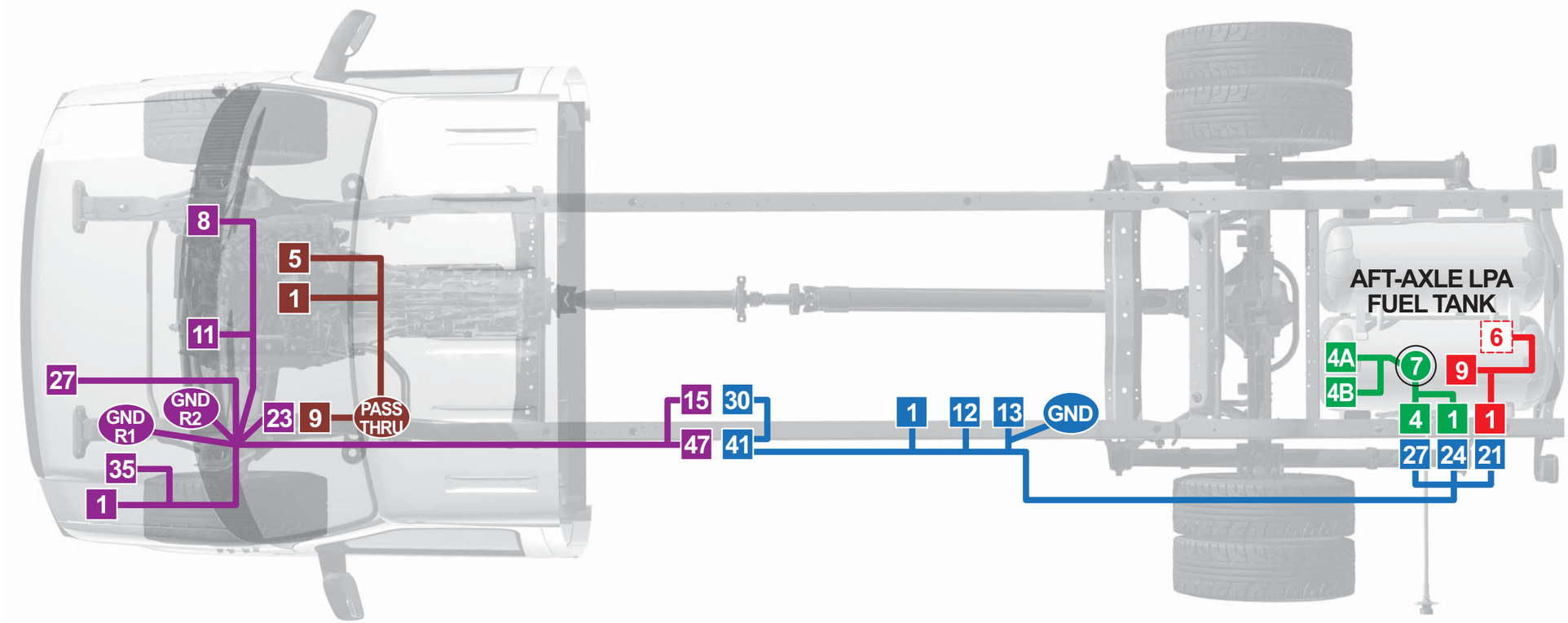
*Refer to *LPA System Wiring Diagram and Electrical Schematics* in *Diagnostic Tests and Procedures*.

100152a

E-450 Extended Range Wiring Harnesses and Connector Layout

E-450 WIRING HARNESSES AND CONNECTOR LAYOUT

APPROXIMATE LOCATION OF LPA SYSTEM HARNESSES AND CONNECTORS



UNDERHOOD HARNESS
CAN HARNESS
REAR FRAME HARNESS
IN_TANK HARNESS
SOLENOID HARNESS
IN-BED FUEL TANK JUMPER

*Refer to *LPA System Wiring Diagram and Electrical Schematics* in *Diagnostic Tests and Procedures*.

100153a

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