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# ***LPEFI***

## **General Diagnostic Manual**

*2012 Isuzu NPR Trucks with 6.0 Liter Engine  
Mono-Rail System  
(Trinity Industries Tank Design)*



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Bi-Phase Technologies, LLC  
Eagan, Minnesota, U.S.A.

This manual is for general diagnosis that applies to any *LPEFI*<sup>®</sup> system installed on any vehicle. Where there is a difference in components or installation, it will be identified by specific vehicle. The theory and diagnostics for the system are the same for any vehicle that the system might be installed on. However, the system is calibrated to a specific vehicle and some components, specifically injectors, cannot be interchanged.

In this manual you will find different approaches to diagnostics and troubleshooting. We will reference specific OEM repair manuals where a technician may need to obtain the OEM manual to complete the diagnostics. In many cases, the propane injection system may not be the fault and further investigation of the engine control system may be required. Remember the basics when troubleshooting. To prevent the replacement of good components it is necessary to have a general knowledge of both the *LPEFI*<sup>®</sup> system and the vehicle.



“Read all instructions before use to avoid injury”

Anyone who performs repairs to the *LPEFI*<sup>®</sup> system must be trained and certified. This is a propane system and anyone who performs repairs must have knowledge of Liquefied Petroleum Gases and understand safe handling and characteristics of such. Some states may require a license to work on propane vehicles. Consult your state or local authorities or your state propane gas association. Bi-Phase Technologies is not responsible for your oversight to comply with federal, state or local laws regulating the installation or repair of propane gas systems.

The *LPEFI*<sup>®</sup> system is a sequential multi-port fuel injection system that injects propane in a liquid state to the engine. It works the same way as a modern sequential multi-port gasoline fuel injection system and can be diagnosed with the same diagnostic scanners used for gasoline vehicles.

The *LPEFI*<sup>®</sup> system is covered by U.S. and International patents. The *LPEFI*<sup>®</sup> system is also certified to the United States E.P.A. standards.

The information in this manual is believed to be accurate as of its date of publication but it is subject to change. Up-to-date information and changes, if any, can be requested from Bi-Phase Technologies.

In the event of any safety-related changes, Bi-Phase Technologies will notify all customers who returned the warranty registration card for the affected vehicles.

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This is a safety alert symbol. It is used throughout this manual to alert you to potential hazards. Whenever you see this symbol, you should read and obey the safety warnings that follow. Failure to obey these warnings could result in serious personal injury or property damage.

**Warning:**

**Never loosen fittings or vent any propane. Escaping propane can cause frostbite and severe freeze burns. Wear insulated PVC rubber gloves resistant to propane. Goggles for protection against accidental release of pressurized products and thermal protective clothing when handling refrigerated liquids.**

Propane is stored as a liquid. When you release liquid propane, it tries to evaporate as quickly as it can, by absorbing heat from its surroundings. Everything it touches gets chilled to -44 degrees F (-42 degrees C). If liquid propane sprays on your skin, it will freeze it. Anyone who works with liquid propane must wear PVC insulated rubber gloves.

**Danger:**

**Do not remove any valves, bulkheads, or fittings from a tank unless the tank has been drained completely. The pressure inside a propane tank can push a loosened bulkhead or valve out with enough force to cause injury or death.**

Propane is stored under pressure. When you remove a valve or bulkhead from the tank, all of the pressure is released at once in a violent rush. Always drain the tank before you work on it. Failure to do this will result in damage to the tank or valves and can result in severe injury or death. You should drain the tank by the fuel transfer method and/or by using a flare stack in an approved safe manner. Your propane supplier can help you with this.

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**Warning:**

**Keep all sources of ignition away from propane vehicles while the fuel system is being serviced. Even if the tank and fuel lines are empty, there may still be flammable vapors near the vehicle.**

Do not allow smoking, sparks, flames, recent or running vehicles or other sources of ignition when fueling, servicing and vented propane. Failure to do this could result in fire or explosion, causing severe property damage, injury or death.

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**Warning:**

**Do not disconnect any propane hoses unless they have been properly drained completely.**

Propane in the hoses is kept under pressure, even when the engine is off. When you disconnect a hose, the internal pressure is released all at once. Always drain the fuel lines before you disconnect them. Failure to do this can result in damage to the hose fitting and possible injury. See repair procedures in this manual for instructions.

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**Danger:**

**Do not vent or release propane indoors or near sewers, pits or low lying areas. Propane can accumulate in low spots, creating a fire hazard. Propane can also displace oxygen, creating a suffocation hazard.**

Propane is heavier than air. It can fill low, sheltered areas with flammable vapors. If these vapors are ignited, they can create a fire or explosion, causing severe property damage, injury or death. Never release propane near sewers, pits or indoors.

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***Bi-Phase Technologies***  
***LPEFI®***

## **Facts about Propane & Propane Powered Vehicles**

Propane gas is the most widely used alternative fuel, with nearly 4 million vehicles worldwide running on propane. More than 350,000 vehicles run on propane in the U.S. according to the U.S. Department of Energy's Alternative Fuels Data Center.

Propane powered vehicles offer the best combination of durability, performance and driving range.

The first propane powered vehicle ran in 1913.

Bi-Phase Technologies' *LPEFI®* (Liquid Propane Electronic Fuel Injection) system has surpassed other technologies today by introducing liquid fuel injection. This technology improves power, efficiency and operating characteristics. For more information, call for our General Information and Training Manual.

**Safety comes first** is a motto you should always live by. Without knowledge of a product, it is hard to follow this motto. In our manuals we try to stress the need for knowledge and provide warning signs to alert you.

It is your responsibility to know the law. National Fire Protection Association (NFPA) has manuals to help you understand safe handling of many products. We recommend that you obtain and read their NFPA #58, Standard for the Storage and Handling of Liquefied Petroleum Gases.

A number of training programs and efforts have been implemented throughout the country. The National Propane Gas Association has developed a Certified Employee Training Program (CETP), which provides service personnel with a complete technical training curriculum. We encourage you to contact your state propane gas association or the National Propane Gas Association for more information on how you can benefit from such programs. Visit [www.propanesafety.com](http://www.propanesafety.com) or [www.npga.org](http://www.npga.org) for more information.

**(Commercial Propane)**  
**C<sub>3</sub>H<sub>8</sub>**

Specific gravity of liquid (water = 1) at 60 degrees F.	0.504
Initial boiling point at 14.7 psia, in degrees F.	- 44.0
Weight in pounds per gallon of liquid at 60 degrees F.	4.24
Cubic ft. of vapor per gallon at 60 degrees F.	36.38
Cubic ft. of vapor per pound at 60 degrees F.	8.66
Specific gravity of vapor (air = 1) at 60 degrees F.	1.50
Ignition temperature in air, in degrees F.	920 to 1120
Maximum flame temperature in air, in degrees F.	3,595
Limits of flammability in air	
Percent of vapor in air/gas mixture	
Lower	2.15
Upper	9.60
Air/Fuel ratio by volume	15.6:1
Air/Fuel ratio by weight	24:1
Octane number as it relates to gasoline	98 to 102
Heating values	
BTU per cubic foot	2,488
BTU per pound	21,548
BTU per gallon	91,500
Chemical formula	C <sub>3</sub> H <sub>8</sub>
Vapor pressure in psig	
70 degrees F	127
100 degrees F	196
105 degrees F	210



## **Introduction**

This article covers basic description and operation of the *LPEFI®* system. Read this information before diagnosing vehicles or systems with which you are not completely familiar.

## **The *LPEFI®* System**

The *LPEFI®* system is a direct replacement propane fuel injection system. It replaces the gasoline fuel injection system and works the same as a gasoline fuel injection system with the exception it injects propane, in a liquid state, into the intake port. The gasoline system electronic engine management stays the same and controls the *LPEFI®* system just as it did the gasoline injection system. Onboard diagnostics remain unchanged so the same scan tool and diagnostic approach remains equal to a gasoline system. The only change in electronic engine management is the fuel enrichment strategy on start up. Gasoline needs a very rich fuel mixture to start the engine and differs greatly based on outside ambient temperatures. With propane this fuel enrichment requirement is much less, thus reducing the level of start up emissions compared with gasoline. The *LPEFI®* system accomplishes this start up fuel enrichment strategy by recalibrating the PCM for propane fuel enrichment.

The *LPEFI®* system consists of three main components: the tank, the fuel lines and the injectors. The tank is located to the rear or middle of the vehicle and the lines are routed forward to the engine compartment where the injector rail assemblies are mounted in the same position as the original gasoline injector rails were installed.

## **The Tank (*ASME design, 312.5 p.s.i. working/design pressure*)**

The fuel tank is the most complicated area of the system. It includes an internal electric fuel pump & filter, fuel supply & return valves, baffle that keeps the pump submerged in liquid propane and various other valves, fuel level float assembly, pressure relief valve, overfill prevention device, and liquid service valve. *LPEFI®* vehicles may have one or two tanks. If it is fitted with two tanks, a main tank, which controls all fuel delivery to the injectors and an optional tank, which only transfers fuel to the main fuel tank based on fuel level inputs to a transfer module. The main fuel tank fuel pump increases or boosts the tank pressure by 35 to 50 psi. No matter what the propane tank internal pressure is, the pump boost remains the same. This is how the propane stays a liquid throughout the liquid supply section of the system. The fuel is supplied to the injectors and whether the injector is open or not fuel passes through a cooling bushing in the injector and is returned to the tank. This is called a refrigeration cycle and also aids in maintaining the fuel in a liquid state throughout the supply passageways in the system. Because propane easily vaporizes, when the refrigeration cycle stops (when the engine is turned off) or if the return valve malfunctions closed, the propane will vaporize and cause a loss in power or hard hot restarting. To help in hot restarting, the system goes through a purge cycle for 10 to 15 seconds before every start up attempt. This strategy is built into the system's electronic tank control box. See more about hot restart/hot soak in this manual.

## The Fuel Lines

The fuel lines consist of two flexible hoses, one inside the other, in a concentric arrangement. The nylon inner line supplies liquid propane to the injectors while the area between the outside of the inner line and the larger outer hose is the fuel return passage.

The concentric fuel line design has a number of benefits:

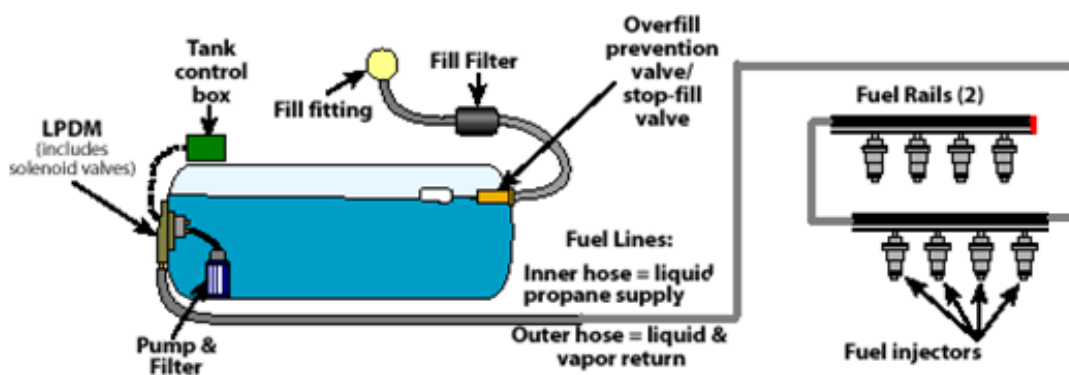
1. Cuts the number of possible leak points in half,
2. Reduces vapor-lock in the supply line by using the return fuel passage as insulation,
3. Postpones the vapor-lock that occurs after a hot engine is shut off,
4. Shortens the purge cycle time needed to restart a hot engine.

## The Injectors

The *LPEFI®* system injectors are designed specifically for liquid propane. They mimic the gasoline fuel injectors that they replace. The injector electrical circuit resistance value is 13-15Ω, similar to a gasoline injector.

Each fuel injector has a supply passage and a return passage. The fuel injector rails have the same concentric design as the fuel lines. The passage in the injector from the supply section to the return section is restricted by a cooling bushing. As liquid propane passes through the cooling bushing, a pressure reduction takes place, which causes the propane to vaporize and effectively cools the area around the supply section. This is called a refrigeration cycle and aids in maintaining the fuel in a liquid state for all driving conditions, regardless of the outside temperature.

The injector delivers propane in a liquid state into the intake port. It vaporizes immediately upon exiting the injector. This rapidly expanding liquid cools the incoming air to the engine often resulting in a little more horsepower than the gasoline system could achieve, not to mention the inherently improved exhaust emissions that propane is known for.



## All Models

### Introduction

The following diagnostic steps may help prevent overlooking a simple problem. The first step in diagnosing any drive-ability problem is verifying the customer's complaint with a test drive under the conditions the problem reportedly occurred.

Always perform a careful and complete visual inspection first. Most engine control problems result from mechanical breakdowns, poor electrical connections or damaged/misrouted vacuum hoses. Before condemning the *LPEFI®* system, perform each test listed in this article.

### Visual Inspection

Visually inspect all electrical wiring, looking for chafed, stretched, cut or pinched wiring. Ensure electrical connectors fit tightly and are not corroded. Visually inspect for any loose or drop harness looms coming in contact with the injector rails or components. Visually inspect all vacuum hoses and ensure they are properly routed – not pinched, cut or disconnected. Visually inspect the secondary ignition wires, spark plugs and ignition coils. Ignition weakness shows up much sooner on propane fueled engines than a gasoline engine. Visually inspect each injector insulator housing for cracks, cuts or o-ring sealing at the manifold or at the top o-ring of the insulator housing (injector repair in this manual). Listen to the fuel pump operation and the opening “click” of the fuel supply valve. Initiate a purge cycle by turning the ignition key to the on position (purge logic chart in this manual).

### Preliminary Checks

Check that the following systems and components are in good condition and operating properly before diagnosing problems in the *LPEFI®* fuel system.

1. Battery condition
2. State of tune (ignition system)
3. All wiring and vacuum connections
4. Air cleaner and ducting
5. Cooling system

### Mechanical Inspection



**Warning: DO NOT use the ignition switch during compression test on fuel injected vehicles. Use a remote starter to crank the engine. Fuel injectors on many models are triggered by the ignition during cranking mode, which can cause a flammable fuel mixture in the intake manifold when performing a compression test.**

---

**Compression** – Check engine mechanical condition with a compression gauge, vacuum gauge or an engine analyzer. Compression pressures are considered within specifications if the lowest reading cylinder is within 75 percent of the highest reading cylinder.

### **Mechanical Inspection, cont'd**

**Exhaust system back pressure** – The exhaust system can be checked with a vacuum or pressure gauge. Remove the O<sub>2</sub> sensor and connect a 0-5 psi pressure gauge. Run the engine at 2500 RPMs and if the exhaust back pressure is greater than 1¼ to 2 psi., the exhaust system or catalytic converter is plugged. If a vacuum gauge is used, connect the vacuum gauge hose to an intake manifold port and start the engine. Observe the vacuum gauge. Open the throttle part way and hold steady. If the vacuum gauge reading slowly drops after stabilizing, the exhaust system should be checked for a restriction. Also, if the vacuum gauge will not drop below 3" Hg on a wide open throttle condition or WOT loaded condition, check the exhaust system for restriction. Leaks in the exhaust system, if upstream from an O<sub>2</sub> sensor, can also cause fuel control problems due to oxygen dilution in the exhaust, which causes inaccurate O<sub>2</sub> sensor response.

### **Fuel System**

**Engine does not crank** – Check for hydrostatic lock (water or liquid in a cylinder). Repair as needed. Check for starting and charging system problems.

#### **Engine cranks but will not start**

1. Check fuel tank contents and fuel gauge accuracy
2. Check ignition system for good secondary current at the spark plugs – if no spark exists or if spark is weak, repair ignition system problem first
3. Check fuel lines and fittings for leaks – if no leaks are found, check fuel delivery system for proper pressure; check for +12 volts to fuel delivery system
4. Check for defective fuel injector; a leaking fuel injector could cause a rich (flooded) condition and cause a no-start; initiate a purge cycle and after the purge cycle is complete listen at the intake manifold for injector leaks; open the throttle plate, smell and listen, pull the PCV valve and smell and listen, lift the injector rail out of the manifold (without disconnecting fuel line) and visually inspect
5. Check the ECT, coolant temperature sensor – confirm the ECT is in proper working condition and; if the sensor is faulty



**Warning:** Always relieve fuel pressure before disconnecting any fuel injection related component. **DO NOT** allow uncontrolled fuel release. Never loosen fittings or vent any propane unless you are wearing insulated PVC rubber gloves; escaping liquid propane can cause frostbite and severe freeze burns. Do not disconnect any propane hoses or remove any injectors unless the fuel lines have been properly drained completely. Never release fuel indoors or in an area where vapors could accumulate – source of ignition could ignite the air fuel mixture and cause severe injury and property damage.

### **Fuel Pressure Release**

To prevent the fuel pump and fuel supply valve from opening during repair, disconnect battery and/or electronic tank control box – always disconnect negative battery terminal first.

1. Remove the fuel system Schrader Valve cap on the LPDM
2. The fuel pressure test gauge has a long drain hose; route the drain hose to a flare stack or other receptacle for flammable propane vapor; never release propane indoors
3. Install the brass collar from the fuel pressure test gauge to the Schrader Valve, with the grooved end facing out

**Fuel Pressure Release, cont'd**

4. Make sure the small thumb valve next to the gauge on the Bi-Phase gauge set is closed
5. Connect the test gauge to the collar; this connection will press the center pin on the Schrader Valve releasing propane into the hose; this is a sensitive connection and must be confirmed; if the pressure gauge does not react or reacts slowly, push in on this connection to confirm it has penetrated the center pin of the Schrader Valve; the brass collar has some adjustments and may also require oiling the o-ring occasionally
6. Open the valve near the pressure gauge to drain the propane through the long hose; note that the Schrader Valve does not drain the tank – it only drains the main fuel line and the injectors
7. When the gauge reads “0” and there is no pressure exiting the end of the hose, you may disconnect the fuel lines or injectors as needed (*more detailed procedures and photos on page 36*)



**Warning: Do not remove the LPDM or any tank valves from the tank at this time. Propane tank is under pressure. The procedure described previously only drains the fuel lines for service. Serious injury or death could occur.**

**Fuel Pressure**

Internal tank pressure must be established first. Use the 3-switch diagnostic box from Bi-Phase Technologies, turn on the fuel supply valve rocker switch and push the fuel return valve “push” switch. Hold down the fuel return valve switch for 30 seconds or until fuel pressure stabilizes. This is internal tank pressure. When checking fuel pressures over a given time always recheck internal tank pressure due to changes in ambient temperature.

When diagnosing the system it is very important to consider this information as it affects the accuracy of your diagnosis. **Boost Pressure = 35 to 50 p.s.i.** (*pressure over internal tank pressure*)

**Fuel pressure with return valve open (all models)** – With the return valve open or during a purge cycle the fuel pressure will be 5 to 15 psi below normal operating pressure (*internal tank pressure plus boost pressure*). Should the pressure drop more than 15 psi. evacuate the fuel in the fuel lines (*reference the procedures in this manual*), remove the primary hose and inspect the white nylon inner liquid supply line in the primary hose at the LPDM. It could require that you visually inspect all hoses for proper inner liquid supply line length.

Fuel pressure should always be confirmed first. If fuel pressure is not within specification the system will malfunction. Fuel pressure can cause many types of drive ability complaints.

### Concentric Fuel Lines

As previously discussed, the fuel lines of the *LPEFI®* system are a concentric design. They permit fuel supply and fuel return to be accomplished inside one fuel hose. There are many benefits to this design as mentioned in the theory section of this manual.

The sealing of the white nylon inner line to all the specific components of the system is very critical. If this seal is lost, damaged or not made the vehicle will experience hard starting when hot, reduced power under load, unbalanced injectors (rail to rail or bank to bank) and in extreme cases a no-start condition.

It is very difficult to install the lines and caution should be taken when assembling the concentric fuel lines that connect from the LPDM and the injector rails. The inner lines are small and easily crimped (kinked) during installation to the fuel rail. Also damage to the O ring seal in the rail may occur. It is recommended to coat the metal hose end fitting and the white nylon inner line with clean motor oil before attempting installation. If the white nylon inner line is crimped during installation or repair of the system a new hose assembly must be obtained. The white nylon inner line is custom fit to each larger outer hose. Do not assemble the hose with a crimped inner line; it will cause drive-ability problems. Years of process development have caused the installation to be more difficult. However, at this time there is no other way to rely on a proper fit and reliability.

Each white nylon inner line is sealed by a single o-ring located below the inner line alignment bushing (finger bushing). This is found in each hose port whether it is the LPDM, or the injector rail end fitting. See illustration below.



Injector rail end fitting & hose  
utilizing quick disconnect  
much like gasoline

## Fuel Injectors

### Fuel Injector check

1. Connect a tachometer to the engine; run the engine at idle; disconnect and reconnect injectors individually (*this may also be accomplished with a scan tool*); if each injector causes a momentary drop in engine speed of at least 100 RPMs, injectors are giving proper fuel delivery; RPM drop should only be momentary as the IAC (idle air control) will attempt to reestablish correct idle RPM
2. Replace any injectors that do not cause sufficient drop in engine speed; when test is complete, turn engine off; to check curb idle, refer to the emission control specification on the decal in the engine compartment or the OEM service manual for the particular vehicle
3. With the system pressurized listen, smell, spray with leak detection fluid and visually inspect injectors for fuel leaks from the injector tip and housing; open the throttle plate to listen and smell, or without disconnecting the fuel lines lift the injector rail out of the intake manifold to visually verify that no injector leaks fuel; if an injector sprays fuel or leaks externally without an electrical demand, the injector must be replaced
4. The fuel injector housing is a heat insulator and is installed over the injector itself, even though it may look as one piece; the injector insulator housing is sealed onto the injector with one or two o-rings, depending on the design revision level of the injector; the early single o-ring sealed injector housing may lose its seal causing a vacuum leak; an injector should hold a vacuum if checked from the bottom of the housing with a hand operated vacuum pump (reference injector repair in this manual)
5. The fuel injectors are calibrated for each specific engine; injectors are also assembled on each rail within a specific range of flow; if an injector from a different engine family is installed it could cause an out-of-balance situation and set a diagnostic trouble code in the PCM

**Fuel injector circuit** – Disconnect all injector harness connectors. Use a digital ohmmeter to check resistance across the terminals of each injector. The nominal resistance for each injector is 12.6 to 13.8Ω. An acceptable range is 12Ω to 15Ω, but not to exceed 2Ω between the lowest reading injector to the highest reading injector. If there is greater than 2Ω difference, choose and replace the highest or lowest resistance injector, whichever corresponds, to achieve a range inside 2Ω. If the resistance test proves an open circuit the injector must be replaced. Refer to the OEM service manual and wiring diagram for more information if the wiring harness is at fault.

## Ignition Checks

(Note: On many newer vehicles if an ignition failure occurs, the ignition system may continue to operate with limited ability. Diagnostic trouble codes should be present if this occurs and the engine may be hard to start. The ignition timing will also be fixed or no change in timing with RPM or load changes.)

### Initial Inspection

1. Visually inspect ignition system components and wiring for evidence of damage or loose connections; check condition of spark plugs, spark plug wires and distributor cap and rotor (if equipped); repair or replace damaged components
2. Ensure idle speed and ignition timing is correct; check all components that could affect ignition timing; refer to OEM specifications
  - Crankshaft position sensor
  - Camshaft position sensor and/or sensor timing
  - Crankshaft end play
  - Timing belt or timing chain condition, worn timing gears, chain or belt can cause erratic timing
  - MAP or MAF sensor signals

For more detailed information refer to the OEM repair manual
3. Ensure spark plug wires are properly connected and routed in correct firing order

**Ignition Checks, cont'd**

4. **Check for spark** – Disconnect a spark plug wire from a spark plug; connect a spark plug tester between the spark plug wire and ground; crank engine and check for a strong consistent spark; repeat test for each spark plug wire; if no spark is present check ignition coil primary wiring, coil output or refer to OEM repair manual; if spark appears to be inconsistent do the same as previously mentioned, but confirm the condition of the spark plug wire and repeat test; an ignition scope analyzer is also recommended for checking ignition condition; an approved spark plug tester must be used to prevent damage to ignition control components
5. Using a digital ohmmeter check the resistance of each spark plug wire; high tension wire resistance should be 4000 to 7000Ω per foot; replace as necessary
6. **Check power to coil** – Disconnect primary wiring to coil/coils; turn on ignition and measure voltage of primary positive voltage wire to coil connector; if less than 10 volts repair battery condition or primary positive voltage wire
7. **Check coil/coils** – Disconnect coil, using a digital ohmmeter measure resistance of ignition coil between primary wire terminals; measure resistance between ignition coil's secondary terminals and positive primary terminal; refer to appropriate OEM repair manual for exact resistance values



## **Introduction**

The *LPEFI®* system was developed and designed for use on modern sequential fuel injected gasoline engines. The design intent was to allow direct replacement of the gasoline fuel system to the *LPEFI®* system with no change in the original gasoline electronic engine control strategy or onboard diagnostics. With this said, it is very important that a technician understands electronic engine management theory. In this section we will not attempt to write the book on electronic engine control or self-diagnostics, but briefly explain some theory and operation of the general idea of electronic engine management and some areas that will help in the diagnosis of the *LPEFI®* system. For details on specific vehicles you should refer to the OEM repair manuals.

## **Electronic Engine Management**

**Power-train control module** – The PCM monitors engine operating conditions by input received from engine sensors. Control output actuators supply the function of fuel supply, incoming air, timing, ignition, EGR, evaporative emission control to provide the demanded operating condition the driver or the PCM desires based on the inputs from the engine sensors. The implementation of electronic engine management brought many benefits:

1. Improved exhaust emissions,
2. Improved power,
3. Improved fuel economy,
4. Improved durability & reliability, and
5. On-board self diagnostics.

Since the first generations of electronic engine management, about 1980, many improvements have been made. Today all vehicle manufacturers comply with the standards of OBD II (on-board diagnostics second generation). OBD II did drastically change the way electronic engine management is carried out but it did not change the original input versus output control strategy. It did require that the names for sensors and actuators used are common from manufacturer to manufacturer, the same data link connector be used and a generic list of trouble codes and data are retrievable by aftermarket diagnostic scan tools. In addition, more monitors were added to track degradation of emission control components and warning flags that would turn on the malfunction indicator lamp for things like cylinder misfire or catalytic converter failure. Manufacturers began implementation of OBD II as early as 1994 on select vehicles with a goal to be completed with light duty trucks by 1996. Today, they are still adding to it and implementing it on heavier vehicles.

The engine control system consists of the PCM, relays, modules, sensors, switches and actuators. The PCM sends out electrical reference signals to engine sensors and then analyzes the return signals. The engine sensors supply specific information to the PCM, in the form of electrical signals, to determine engine operating conditions.

In the event of a sensor or actuator failure, the PCM initiates an alternative strategy or failure mode to allow the vehicle to maintain drive ability. In the event of PCM failure a limited operating strategy will be activated. This provides minimal engine operation and any self-test or feedback systems will stop. The malfunction indicator lamp will come on and stay on until the vehicle is repaired or until the PCM has determined that all signals have returned within operating limits and then the PCM will resume normal operation.

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input devices used on a specific model refer to the appropriate OEM repair manual and wiring diagrams.

**Electronic Engine Management, cont'd**

Some common input devices

- Crankshaft position sensor
- Camshaft position sensor
- Engine coolant temperature sensor
- Inlet air temperature sensor
- Oxygen sensor
- Throttle position sensor
- Mass air flow sensor
- Manifold absolute pressure sensor
- Vehicle speed sensor
- EGR position sensor
- Knock sensor

Output signals are signals that send a demand to an actuator; some common actuators

- Fuel injectors
- Fuel pump
- Idle air control or idle speed control
- EGR control
- Canister purge control solenoid
- Spark control
- MIL (malfunction indicator lamp)
- Transmission controls

There are many more inputs and outputs, these are some common ones. Vehicles are equipped with different combinations of computer-controlled components. Not all vehicles are equipped with the same components. Always refer to the specific OEM repair manuals and information.

**Self-Diagnostics**

With the capability to see data through the use of a scan tool and to verify areas of trouble by checking for diagnostic trouble codes, today's electronics have given us more ways to verify where and what the problem might be. Each vehicle manufacturer has written steps in troubleshooting a vehicle. If the scan tool leads you to a specific trouble area refer to the OEM written test to troubleshoot accurately. Some aftermarket manuals are very good in diagnosing electronic engine controls.

To prevent the replacement of good components and wasting precious time, verify engine condition and basic tune-up requirements before condemning electronic engine control components. If your scan tool immediately warns of a bad sensor, check it first but remember that an out-of-tune engine or an engine with internal mechanical deficiencies can trigger diagnostic trouble codes.

DTCs, diagnostic trouble codes, are generated when there is a gross error with a sensor signal, input or output signal or the PCM can no longer control something, meaning fuel mixture, timing, EGR, canister purge and so on. Many times a DTC is generated but the fault is not necessarily the same as the DTC. For example, a vacuum leak may cause an oxygen sensor activity code or a fuel control code. In this situation the vacuum leak is the problem but it affected the electronic control of fuel which could cause you to replace an injector if you did not check thoroughly or even the replacement of an oxygen sensor.

Always remember the basics and eliminate all the easy things first.

### Self-Diagnostics, cont'd

Retrieving DTCs, diagnostic trouble codes, is always a good place to start when trouble shooting a problem. If there are multiple DTCs, you need to evaluate them and troubleshoot with the first DTC listed. Write down all the DTCs listed and investigate what each one stands for. Open up the data information available and investigate the area of concern established by the DTCs listed. See if there is any correlation between the DTC and the data associated with it. Many times you may find that the data reveals proper function and there is no reason for generating a DTC. If this is the case, look at the freeze frame data, if available, and see under what conditions the DTC was generated. This will help in diagnosing the problem. The data information is very helpful. First, you can look at sensor and actuator activity live. This is very effective diagnostics. Today, it is very important that a technician knows and understands on-board diagnostics. It can save time and money, which benefits both the technician and the customer.

When diagnosing the *LPEFI®* system, there are some PID values you may want to look at from the data stream.

- ECT (engine coolant temperature)
- IAT (intake air temperature)
- IAC (idle air control)
- STFT B1 and B2 (short term fuel trim bank 1 and bank 2)
- LTFT B1 and B2 (long term fuel trim bank 1 and bank 2)
- PW B1 and B2 (average injector pulse width bank 1 and bank 2)
- 02S11 (oxygen sensor bank 1 front sensor)
- 02S21 (oxygen sensor bank 2 front sensor)

It is very important that you know the meaning of the PID (parameter identification) names in the data stream and understand the values displayed. In this manual we will only talk about a few of these terms. Refer to OEM repair manual for a more detailed explanation. Many of the PID addresses are easy to identify but some of the acronyms are confusing, and having an OEM repair manual or Mitchell manual is very helpful. The more you work with electronic diagnostics the more familiar you will become.

### Important PIDs, Explanation

**ECT** (engine coolant temperature) – The data is displayed as degrees F or C depending on your selection for English or metric display. Engine coolant temperature is important because the learning function of the computer does not begin until the engine reaches a programmed temperature. This temperature may vary depending on vehicle model. For example a Ford may not begin to learn until the temperature reaches 165 degrees F. Always perform final diagnosis when the engine is at full operating temperature.

**IAT** (intake air temperature) – The data is displayed as degrees F or C depending on your selection for English or metric display.

**IAC** (idle air control) – The data is displayed in % or counts. % is the percent of time it is on, 50% would be half open or 75% would  $\frac{3}{4}$  open. Counts would be the same, the higher the count the more open the valve is. This could be important when a vacuum leak is suspected. Always refer to the OEM repair manual for the operating range as each model varies.

**STFT B1 or B2** (short term fuel trim) – This is displayed either in positive or negative percentages (%) or in counts. Short term fuel trim is adjustments to fuel delivery, as it is happening at the moment you look at it. The closer to 0% or 128 counts the better the fuel control is. A negative percentage indicates a rich condition and the fuel control is subtracting fuel or adjusting the fuel delivery leaner while a positive percentage is a lean condition and fuel control is adding fuel or adjusting the fuel delivery richer.

## **Important PIDs, Explanation**

### **STFT B1 or B2, cont'd**

If it is displayed in counts the range for counts is 0 to 255. The middle of the range is 128 and any reading less than 128 is a rich condition while any reading greater than 128 is a lean condition. This does not mean the engine is running rich or lean, but means that fuel delivery is rich/lean and fuel control is adjusting from that point to optimize fuel delivery for emissions, economy and drive ability. If the range of control reaches the limit, lean or rich, then the engine is running lean or rich and the computer can no longer control the fuel mixture and a DTC will be logged in the computer's memory. If the computer recognizes this in a second drive cycle it will illuminate the MIL, (malfunction indicator lamp or check engine light). The STFT has a back up to extend its range of control. It is called LTFT, long term fuel trim, and if the STFT is controlling too far to the lean or rich side of the middle of the range of control, the LTFT will learn and allow the STFT to control closer to the middle of the range. This allows the STFT to have a much longer time period of control. This allows the degradation of the air filter, the fuel filter, fuel injectors, engine oil contamination, PCV, fuel pump and anything that can affect fuel and air delivery. For example, when a very dirty air filter is replaced the fuel control will readjust over time or the same with a fuel filter or the same after an injector is replaced.

**LTFT** (long term fuel trim) – This is displayed in either positive or negative percentages (%) or in counts. It is also shown for bank one and bank two. Long term fuel trim is adjustments to fuel delivery over time. The closer to 0% or 128 counts the better the fuel control is. A negative percentage indicates a rich condition and the fuel control is subtracting fuel or adjusting the fuel delivery leaner, while a positive percentage is a lean condition and fuel control is adding fuel or adjusting the fuel delivery richer. If it is displayed in counts the range for counts is 0 to 255. The middle of the range is 128 and any reading less than 128 is a rich condition while any reading greater than 128 is a lean condition. This does not mean the engine is running rich or lean, but means that fuel delivery is rich/lean and fuel control is adjusting from that point to optimize fuel delivery for emissions, economy and drive ability. If the range of control reaches the limit, lean or rich, then the engine is running lean or rich and the computer can no longer control the fuel mixture and a DTC will be logged in the computer's memory. If the computer recognizes this in a second drive cycle it will illuminate the MIL, (malfunction indicator lamp or check engine light). LTFT levels adjust over time as previously mentioned and causes or allows the STFT to maintain control closer to the middle of the control range. This allows rapid changes to fuel control for better response and performance. The LTFT is like a fine-tuning function. This gives the STFT a much longer time period of control. This allows the degradation of the air filter, the fuel filter, fuel injectors, engine oil contamination, PCV, fuel pump and anything that can affect fuel and air delivery. For example, when a very dirty air filter is replaced, the fuel control will readjust over time or the same with a fuel filter or the same after an injector is replaced. If the battery is changed or disconnected it will reset fuel trim and a learning process could take a few hundred miles. However, for diagnosis purposes bringing the vehicle to full operating temperature and a short drive will give you an idea of where the controls stabilize. Anytime the STFT values are stabilized close to the middle of the range of control the LTFT values should be accurate. If the air filter is clean, the engine oil is not contaminated and the engine condition is good the LTFT values are a good indicator of how well the injectors are calibrated. It is also helpful to review the LTFT values at different load conditions, such as cruising at 45 mph or at a wide open throttle situation. If power seems low and wide open throttle values are very lean this would give you something to look for.

### **Important PIDs, Explanation, cont'd**

The *LPEFI*® system will not have LTFT values as good or as close to the middle of the control range as gasoline injectors. What we want to look for when diagnosing the *LPEFI*® system is for the values to be within 10% or about 40 counts of each other. For instance -2% bank one and -8% bank two would be okay. It is normal to also see LTFT values at -17% on either bank but we would not want to see a richer condition or -20% numbers. If the LTFT values are on the leaner end of the control range, other problems may exist if the value is higher than +12% or 176 counts. Four counts equal approximately 1%.

**PW** (injector pulse width) – The length of time the injector solenoid is energized or the injector is open, displayed in milliseconds and averaged for each bank of the engine. Naturally the injector pulse width is lower at idle than it is at cruise and higher than cruise during a loaded condition. Comparing the PW values could identify an area of concern. For example, if you identified a weak injector during the fuel injector check in the basic diagnostic procedure section of this manual, it could show up here by displaying a different PW on the bank that had the weak injector. Most of the time, injector pulse width will be between 2 and 5 milliseconds at idle. The scan tool only displays an average pulse width for each bank of cylinders. Each bank is normally within a few tenths of each other. If not, refer to checking fuel injectors in basic diagnostic procedures.

**O2S11 or HO2S11** – Oxygen sensor or heated oxygen sensor bank one sensor one

**O2S21 or HO2S21** – Oxygen sensor or heated oxygen sensor bank two sensor one

Most oxygen sensors today are equipped with an internal heater to speed up the amount of time it takes for electronic engine management to reach closed loop. An oxygen sensor is not active until it reaches a temperature of approximately 570 degrees F. Oxygen sensors create voltage and can be called a galvanic battery. A low voltage signal is a lean fuel mixture indication and a high voltage signal is a rich fuel mixture indication. The maximum voltage an oxygen sensor will generate is approximately 1000 millivolts or one volt. The oxygen sensor actually measures oxygen content in the exhaust stream. If a rich mixture exists, there is a lack of oxygen compared to the outside ambient atmosphere. This lack of oxygen causes the oxygen sensor to create voltage. If the amount of oxygen in the exhaust stream is equal to the amount in the atmosphere, no voltage will be generated. Oxygen sensors are sensitive to silicones and could become coated and decrease the reaction time or activity. Oxygen sensor signal is something worth verifying and not only at idle, but at different engine load conditions. Most vehicles today consider an oxygen sensor signal of 0.45 volts as stoichiometric. The fuel control is based on oxygen sensor voltage and if fuel control is working properly, oxygen sensor voltage will move below and above the 0.45 volts. The number of times in a given period that the oxygen sensor signal crosses above or below the 0.45 volts is called cross counts and the PCM monitors this activity to know how fuel control is functioning as well as for fuel delivery decisions.

### 3 Switch Box



### Test Switches



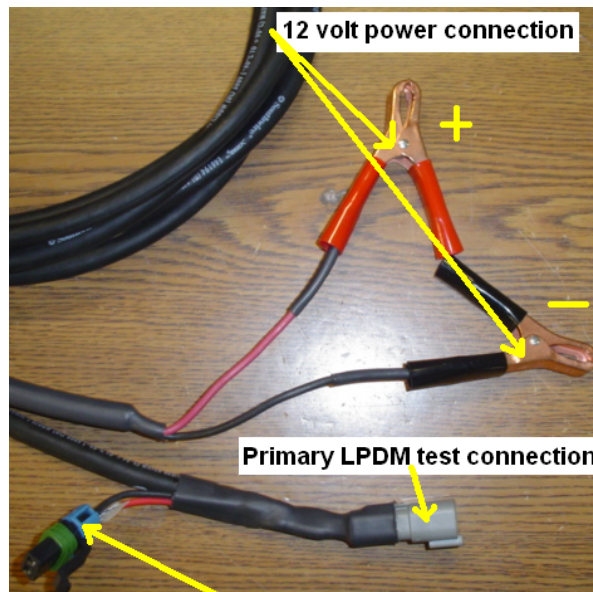
Switches shown in the off position

Supply Solenoid Test Switch

Pump Test Switch

Return Solenoid Test Momentary Switch

### 3 Switch Box Connectors

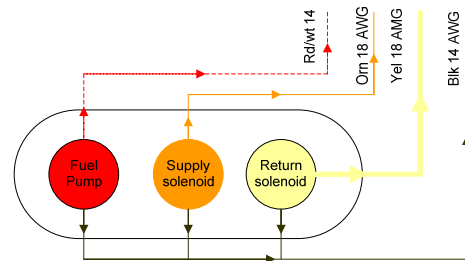
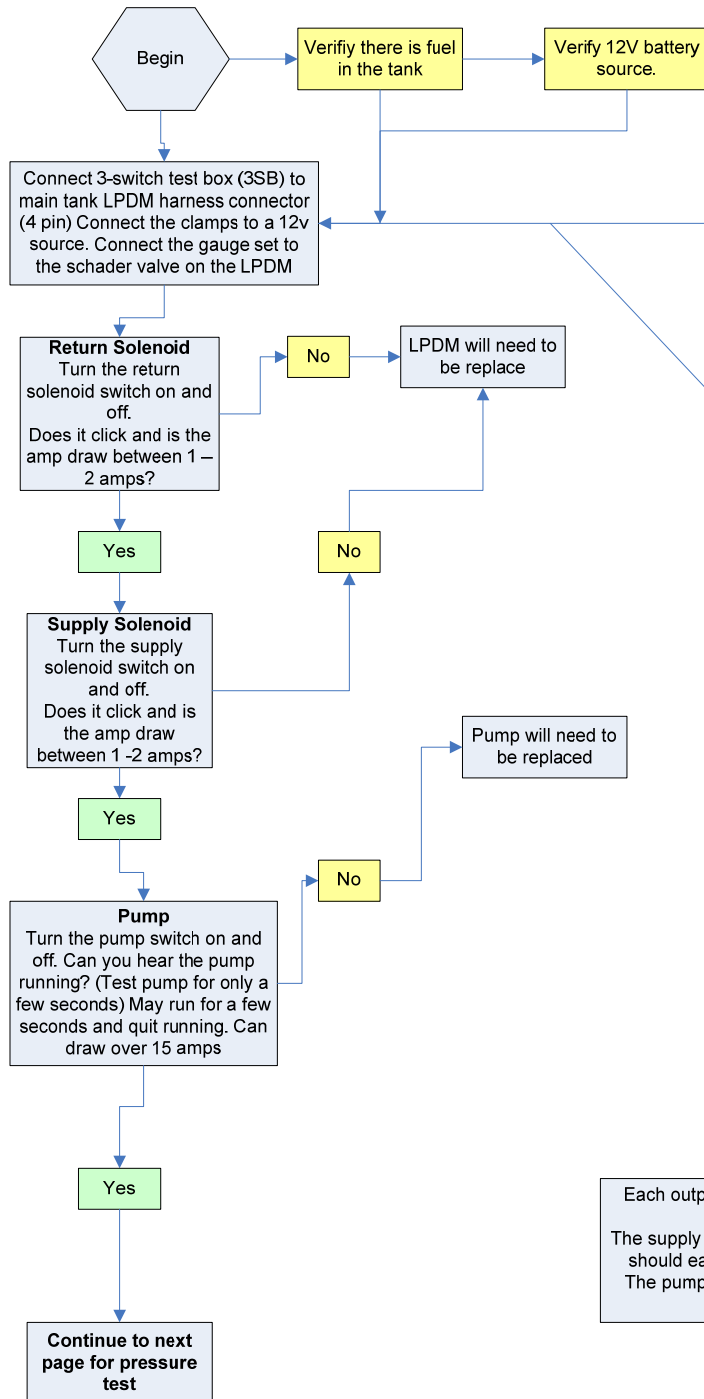


12 volt power connection

Primary LPDM test connection

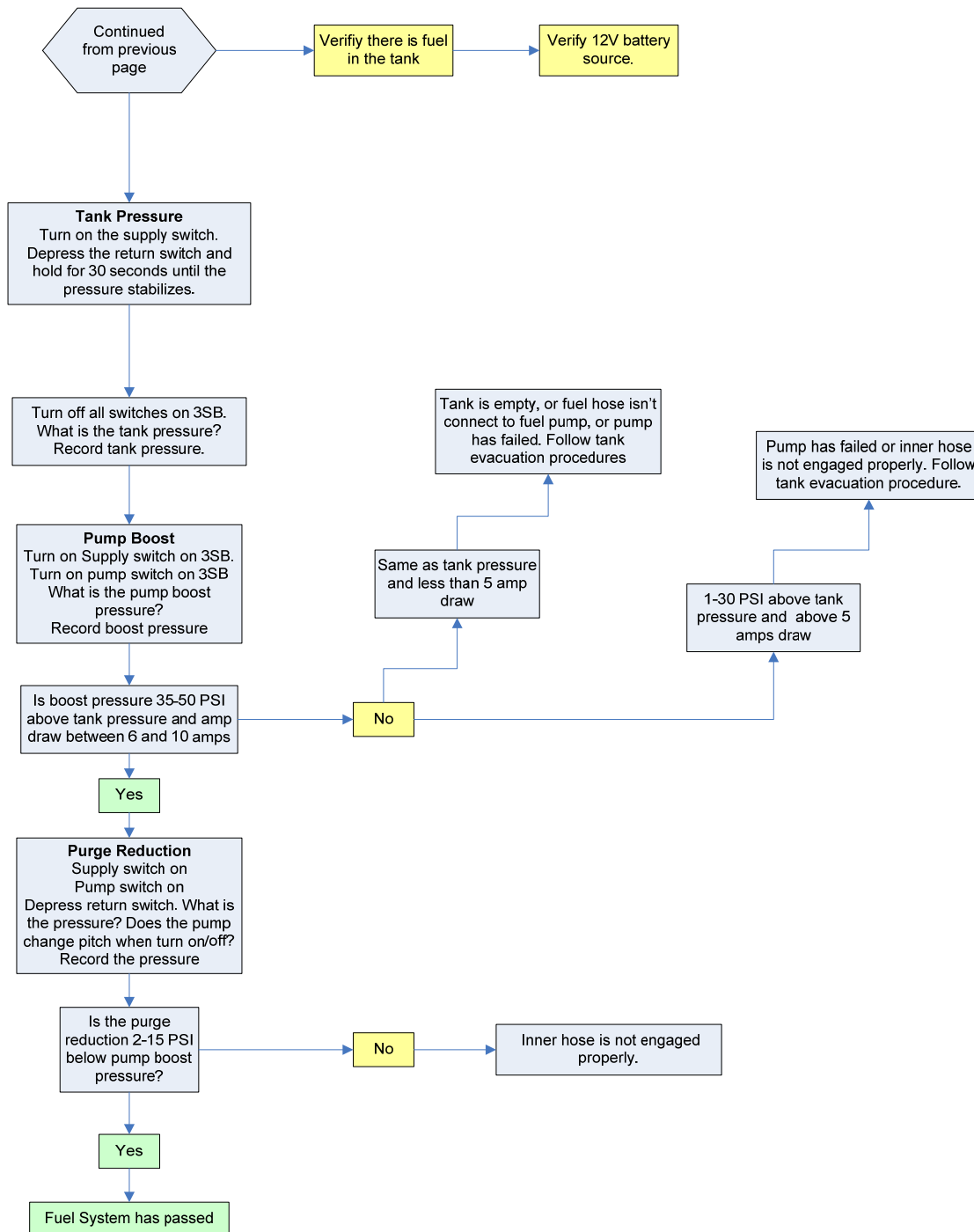
Auxillary tank LPDM test connection

## LPDM Diagnostic Flow Chart



Each output from the 3SB should produce +12v when it is active (expect for the ground wire).  
 The supply solenoid (orange wire) and return solenoid (yellow wire) should each have 5 -10 ohms resistance to ground (black wire)  
 The pump (red/white stripe) should have 1-4 ohms resistance to ground (black wire)

## LPDM Diagnostic Flow Chart





## Amperage Test

Connect a "3-switch box" to the LPDM, either using the yellow 3-switch box with inline ammeter or the black 3-switch box with integrated ammeter. The following test is based on a truck with a fully charged battery and with the engine off. If the engine is running or you are charging the battery, the voltage will be higher and the resulting amperage will be higher. A low battery will give lower amperage values.

"3-Switch" positions			Things to notice	Current	Fuel pressure	Mode of operation	Discussion
Sup.	Ret.	Pump					
off	off	on	Pump running slowly, heavy load/low pitch/growl	above 13A	tank pressure or lower	hydro-locked (deadheaded)	Pump is pushing against a closed supply valve. The internal bypass valve relieves pressure above 50 p.s.i.
			Pump running fast (free running)	2-5A	tank pressure	<b>Failure:</b> Bypass valve is stuck open or pump hose disconnected	Output of pump is leaking inside the tank and pump can not build pressure. Pump could also be getting weak.
on	off	on	Solenoid clicks, then pump sounds normal	10-13A	tank pressure plus pump boost	Normal running mode	As fuel is pumped through the fuel rails and back to the tank, it pushes the return valve open. The return valve is not electrically activated during normal run mode
on	off	on	no click; pump runs slowly	above 15A	tank	<b>Failure:</b> Supply valve not opening	Pump is deadheading. If the supply valve is not opening there is a mechanical problem with the supply valve or an electrical problem within the control module, the wire or solenoid coil. The solenoid coil should draw 1 to 1.5 amps.
on	on	on	pump sounds normal	8-11A	drops slightly 5-15 p.s.i. lower than operating pressure	Purging	Fuel is pumped through fuel rails and back to the tank. Return valve is open allowing freeflow back into the tank.
on	off	on		little change, 8-13A	little change, possibly greater than 60 p.s.i. boost	<b>Failure:</b> Return valve not opening, stuck closed, restricted	Normal running mode. May experience poor hot re-starting or no re-start when hot. May run for a while and start running poorly then die due to no fuel returning to the tank, (no refrigeration cycle)

### **LPEFI® Purge Logic**

Vehicle Operating mode	Sequence of conditions	Tank outputs		
		Supply Valve	Return Valve	Pump
Idle Mode  <div>Engine off</div>	Both solenoid valves are de-energized (closed) causing them to prevent flow of fuel in the system. The pump is off. Idle mode ends at the start of a purge or run mode.	Off	Off	Off
Purge Mode  <div>Door open or key to on position</div>	Both solenoids and the pump are energized. The pump causes liquid fuel to be forced into the fuel system under pressure and back to the tank. Purge mode is used to clear the supply side of the fuel system of propane vapor. It provides liquid propane to the injectors for proper engine operation. Purge mode is timed via a factory-preset value. The value could differ from one application to another. Purge mode ends when either the time expires or the key signal causes a transition to running mode.	On	On	On
Running Mode  <div>Engine running</div>	The supply solenoid (open) and the pump energized and the return solenoid de-energized (closed). A 12 volt signal from the PCM establishes running mode. Removal of the 12 volt signal from the PCM input ends running mode.	On	Off	On

## Introduction

Before diagnosing symptoms or intermittent faults, perform steps in basic diagnostic procedures and appropriate self-diagnostics with a scan tool. Use this section to diagnose problems existing when DTCs, diagnostic trouble codes, are not present.

Symptom checks can direct the technician to malfunctioning component(s) for further diagnosis. A symptom should lead to a specific component test and/or adjustment.

## Symptoms

Symptom checks cannot be used properly unless the problem occurs while the vehicle is being tested. To reduce diagnostic time, ensure basic diagnostic procedures and self-diagnostics were performed before diagnosing a symptom. Some symptoms are:

- No crank
- Hard start cold/long crank
- Hard start hot/long crank
- No start/normal crank
- Low idle speed
- High idle speed
- Rough idle
- Stalls but restarts (hot or cold)
- Stalls but does not restart
- Stalls during acceleration
- Stalls during deceleration
- Stalls during steady speed driving
- Stalls after vehicle stops
- Stalls when put in gear
- Stalls while idling
- Starts but stumbles and stalls
- Hesitates
- Surges
- Backfires, misfires or cuts out during acceleration
- Backfires, misfires or cuts out during deceleration
- Bucks & jerks
- Engine knocks or rattles, spark knocks
- Loss of power during cruise or all the time
- Loss of power during heavy load condition, wide open throttle
- Poor fuel economy
- Failed emissions

- Runs rough all the time
- High oil consumption
- Engine runs hot
- Engine runs cold
- Fire comes out of exhaust

## LPEFI® Specific Symptoms

- Smell of propane
- Slow fuel filling or no fill
- Unable to evacuate fuel lines through Schrader Valve
- No fuel transfer from optional secondary transfer tank
- Noisy fuel pump or noise in tank
- Fuel pump does not shut off
- No purge cycle
- Injector leaks with no electrical command
- Injector insulator housing cracked or not sealing (vacuum leak)

## Symptom Diagnosis

### No Crank

- Check battery connections
- Check the start motor
- Check appropriate fuses and fuse links
- On A/T models check park/neutral safety switch
- On M/T models check clutch switch
- Check starter circuitry
- Check for seized/hydro locked engine
- Check flywheel
- Check ignition switch

### Hard start cold/long crank

- Check battery charge condition
- Check ignition primary voltage during crank & secondary wiring
- Check for vacuum leaks
- Check fuel pressure (pump boost)
- Check injectors for leakage, causing a rich/flooded condition
- Check air cleaner & incoming air ducts
- Check engine mechanical condition, compression

### **Symptom Diagnosis, cont'd**

#### **Hard start hot/long crank**

- Check battery charge condition
- Check ignition primary voltage during crank & secondary wiring
- Check for vacuum leaks
- Check fuel pressure (pump boost)
- Check injectors for leakage, causing a rich/flooded condition
- Check air cleaner & incoming air ducts for restriction
- Check nylon inner liquid supply fuel lines and the o-ring seals for the nylon inner line
- Check engine mechanical condition, compression test

#### **No start/normal crank**

- Check battery charge condition & fuel level
- Check the LPEFI® system 30-amp fuse
- Check ignition primary voltage during crank & secondary wiring
- Check for vacuum leaks
- Check fuel pressure including operation of pump and supply & return valves
- Check wiring at electronic tank control box
- Check injectors for leakage, causing a rich/flooded condition
- Check air cleaner & incoming air ducts for restriction
- Check injector wiring harness & individual injector connectors
- Check injector power wire voltage
- Check that injectors are delivering fuel
- Injector diagnosis

#### **Low idle speed**

- Check idle air control wiring harness connector or ETC, if equipped
- Check base timing
- Check engine mechanical condition, compression test
- Confirm IAC/ETC controls idle speed
- Check and/or adjust minimum idle, refer to OEM repair manual for specification
- Check air cleaner and incoming air ducts

#### **High idle speed**

- Check IAC/ETC wiring harness connector
- Check base timing
- Confirm IAC/ETC controls idle speed
- Check for vacuum leaks
- Check intake manifold gasket for vacuum leaks
- Check and/or adjust minimum idle, refer to OEM repair manual for specification

- Check EGR valve
- Check throttle linkage
- Check throttle plate for a closing obstruction
- Check incoming air intake ducts
- Check PCV
- Check canister purge vacuum lines & evaporative emissions lines, if equipped before the LPEFI® system installation

#### **Rough idle**

- Check ignition secondary wiring
- Check spark plugs
- Check for vacuum leaks
- Check PCV
- Check air cleaner and incoming air ducts & sealing around MAF sensor
- Check fuel injector wiring harness and individual injector electrical connectors
- Check fuel system operating pressure
- Check fuel injectors, conduct balance test as described in basic diagnostic procedures
- Check engine mechanical condition, compression test
- Check cooling fan blades for cracks or bends
- Check for broken engine mounts
- Check all wiring connectors for intermittent failure/disconnect
- Check for flooded condition/leaking fuel injector, see basic diagnostic procedures

**Symptom Diagnosis, cont'd**

**Stalls but restarts (hot or cold)**

- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check IAC/ETC wiring harness connector
- Confirm IAC/ETC controls idle speed
- Check for vacuum leaks
- Check PCV
- Check for restricted air cleaner or incoming air ducts
- Check MAF
- Check exhaust for restriction, see basic diagnostic procedures
- Check EGR valve
- Check engine mechanical condition, compression test
- Verify there are no leaking fuel injectors, see basic diagnostic procedures
- Check for lean fuel injectors, verify long term fuel trims
- Check fuel pressure
- Check wiring & wiring harness connectors for intermittent failure/disconnect at electronic tank control box and all *LPEFI®* wiring connections & OEM connections

**Stalls but does not restart**

- Check fuel pressure and confirm the *LPEFI®* system refrigeration cycle is working, i.e. inner liquid supply line not sealing, fuel pressure is too low, fuel return valve malfunction; see basic diagnostic procedures
- Verify ignition voltage is not dropping out, primary or secondary ignition
- Check the *LPEFI®* system 30-amp fuse
- Verify engine is not overheating
- Verify engine oil level
- Check all wiring connectors for intermittent failure/disconnect
- Check for flooded condition/leaking fuel injector, see basic diagnostic procedures

**Stalls during acceleration**

- Check all wiring connections
- Check ignition voltage & ignition switch
- Check primary & secondary ignition voltage
- Check for vacuum leaks
- Check for excessive lean or rich conditions, leaking injector
- Check exhaust back pressure, see basic diagnostic procedures
- Check for intermittent fuel pump or fuel supply valve or return valve malfunction

**Stalls during deceleration**

- Check fuel level
- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check IAC/ETC wiring harness connector
- Confirm IAC/ETC controls idle speed
- Check for vacuum leaks
- Check PCV
- Check for restricted air cleaner or incoming air ducts
- Check MAF
- Check exhaust for restriction, see basic diagnostic procedures
- Check EGR valve
- Check engine mechanical condition, compression test
- Verify there are no leaking fuel injectors, see basic diagnostic procedures
- Check for lean fuel injectors, verify long term fuel trims
- Check fuel pressure
- Check wiring & wiring harness connectors for intermittent failure/disconnect at electronic tank control box and all *LPEFI®* wiring connections & OEM connections

**Stalls during steady speed driving**

- Check all wiring connections
- Check ignition voltage & ignition switch
- Check primary & secondary ignition voltage
- Check for vacuum leaks
- Check for excessive lean or rich conditions, leaking injector
- Check exhaust back pressure, see basic diagnostic procedures
- Check for intermittent fuel pump or fuel supply valve malfunction

**Stalls after vehicle stops**

- Check fuel level
- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check IAC/ETC wiring harness connector
- Confirm IAC/ETC controls idle speed
- If equipped with electronic throttle control check accelerator pedal and throttle plate control
- Check for vacuum leaks
- Check PCB

### Symptom Diagnosis, cont'd

#### Stalls after vehicle stops, cont'd

- Check for restricted air cleaner or incoming air ducts
- Check MAF
- Check exhaust for restriction, see basic diagnostic procedures
- Check EGR valve
- Check engine mechanical condition, compression test
- Verify there are no leaking fuel injectors, see basic diagnostic procedures
- Check for lean fuel injectors, verify long term fuel trims
- Check fuel pressure
- Check wiring & wiring harness connectors for intermittent failure/disconnect at electronic tank control box and all *LPEFI®* wiring connections & OEM connections

#### Stalls when put in gear

- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check IAC/ETC wiring harness connector
- Confirm IAC/ETC controls idle speed
- Check for vacuum leaks
- Check PCV
- Check for restricted air cleaner or incoming air ducts
- Check MAF
- Check exhaust for restriction, see basic diagnostic procedures
- Check EGR valve
- Check engine mechanical condition, compression test
- Verify there are no leaking fuel injectors, see basic diagnostic procedures
- Check for lean fuel injectors, verify long term fuel trims
- Check fuel pressure
- Check wiring & wiring harness connectors for intermittent failure/disconnect at electronic tank control box and all *LPEFI®* wiring connections & OEM connections

#### Stalls while idling

- Check fuel level, insure the fuel pump baffle area is not running out of fuel
- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check IAC/ETC wiring harness connector
- Confirm IAC/ETC controls idle speed
- If equipped with electronic throttle control check accelerator pedal and throttle plate control
- Check for vacuum leaks
- Check PCV
- Check for restricted air cleaner or incoming air ducts
- Check for interruption in ignition circuit voltage, primary & secondary; intermittent voltage drop
- Check MAF
- Check exhaust for restriction, see basic diagnostic procedures
- Check EGR valve
- Check engine mechanical condition, compression test
- Verify there are no leaking fuel injectors, see basic diagnostic procedures
- Check for lean fuel injectors, verify long term fuel trims
- Check fuel pressure
- Check wiring & wiring harness connectors for intermittent failure/disconnect at electronic tank control box and all *LPEFI®* wiring connections & OEM connections

#### Starts but stumbles and stalls

- Check fuel level
- Complete the purge cycle, repeat the purge cycle, try purging twice
- Verify fuel pressures; pump, fuel supply valve operation
- Check and/or adjust minimum idle speed per the OEM repair manual specification
- Check primary ignition voltage, ignition switch
- If equipped, check electronic throttle control, (accelerator pedal assembly or throttle plate actuator)
- Confirm injectors are sealing (no leaking injectors)
- Confirm injectors are not leaking a vacuum (check injector insulator housing seals and holds a vacuum)

## **Symptom Diagnosis, cont'd**

### **Hesitates**

- Check fuel level
- Verify fuel pressures; pump, fuel supply valve operation
- If equipped with electronic throttle control, check accelerator pedal and throttle plate control actuator
- Verify no leaking injectors (injectors leak fuel when there's no demand)
- Verify no vacuum leaks
- Check ignition system, primary & secondary
- Perform a hot restart – hot soak for 20 minutes and confirm restart is fast & smooth; if not, check fuel lines, specifically inner fuel line sealing or crimped; see hot soak

### **Surges**

- Check fuel level
- Verify fuel pressures
- Check injectors (fuel leaking/tip leaks or vacuum leaks)
- Check for vacuum leaks
- Check ignition system, primary and secondary
- Check EGR valve
- Check ignition timing
- If equipped, check electronic throttle control
- Check PCM control and sensors, MAF, MAP, O2 sensors, etc; some sensors can malfunction and not set a trouble code; refer to OEM guidelines to verify sensor condition

### **Backfires, misfires or cuts out during acceleration**

- Check fuel level
- Verify fuel pressures
- Check ignition timing, on distributor-less ignition systems camshaft sensor or crankshaft sensor could be faulty
- Check for vacuum leaks
- Check for leaking injectors or vacuum leaks on injector housings
- Check hot restart after 20-minute hot soak
- Check ignition system, primary and secondary
- Check O2 sensors, visually monitor scan tool during failure

### **Backfires, misfires or cuts out during deceleration**

- Check fuel level
- Verify fuel pressures
- Check ignition timing
- Check for vacuum leaks
- Check for leaking injectors (leaking fuel between pulses causes rich condition)
- Check long term fuel trim for rich condition
- Check ignition system, primary and secondary
- Check injectors, long term fuel trims injector fuel leaks or vacuum leaks at injector housings
- Check hot restart after 20-minute hot soak
- Check O2 sensors, visually monitor scan tool during failure

### **Buck & jerks**

- Check fuel level
- Verify fuel pressures
- Visually inspect fuel supply inner nylon line
- Check ignition system, primary and secondary
- Check EGR valve
- If equipped, check ETC (accelerator pedal and throttle plate actuator)
- Check for vacuum leaks
- Check O2 sensors, monitor scan tool during failure
- Check hot restart after 20-minute hot soak

### **Engine knocks or rattles, spark knocks**

- Check oil level
- Check cooling system
- Check engine condition
- Check ignition timing
- Check camshaft and crankshaft position sensors
- Check knock sensor circuit
- Check MAF and/or MAP sensors

**Symptom Diagnosis, cont'd**

**Loss of power during cruise or all the time**

- Check engine compression
- Check fuel pressures
- Check hot restart after 20-minute hot soak
- Check long term fuel trims for very lean injectors
- Check for vacuum leaks
- Check MAF and/or MAP sensors
- Check ignition system, primary & secondary
- Check ignition timing

**Loss of power during heavy load condition, wide open throttle**

- Check exhaust system, back pressure
- Check fuel pressures
- Check injectors, long term fuel trims, injector fuel leaks or vacuum leaks at injector housings
- Check hot restart after 20-minute hot soak
- Check ignition system, primary and secondary
- Check incoming air flow, air filter, fresh air hose to filter

**Poor fuel economy**

- Check incoming air flow, air filter, fresh air hose to filter
- Check fuel injectors, long term fuel trim, injector fuel leaks
- Check for vacuum leaks – vacuum leaks can cause a lean condition, which causes a rich fuel demand
- Check PCV

**Failed Emissions**

- Slow O2 sensor - Fluid leaks, wrong RTV
- Check spark plugs
- Check catalytic converter
- Leaking injector

**Runs rough all the time**

- Check ignition system, primary and secondary
- Check for vacuum leaks
- Check injectors, resistance values for open circuit
- Check engine condition, compression

**High oil consumption**

- Check engine condition, compression
- Check PCV
- Check exhaust back pressure
- Check oil change interval, use recommended oil grade

**Engine runs hot**

- Check cooling level and for leaks

- Check water pump
- Check thermostat
- Check temperature gauge
- Check exhaust back pressure
- Check engine condition, blown head gasket?

**Engine runs cold**

- Check thermostat
- Check temperature gauge & sending unit

**Fire comes out of exhaust**

- Check injectors, leaking fuel between pulses
- Check for vacuum leaks
- Check exhaust back pressure
- Check O2 sensors
- Check ignition timing per OEM recommended inspection procedure

**LPEFI® system specific symptoms**

**Smell of propane**

- Inspect entire system for fuel leaks using bubble test method with approved leak detection fluid or electronic leak detector (all tank valves, hose fittings, system components i.e. LPDM, hoses, injector rail end and injectors)
- Inspect injector for leaks, leaking through tip without an electrical command
- Inspect injector insulator housings for damaged or leaking o-rings
- Inspect injector housing screws for leaks when system is charged with fuel
- Check exhaust mixtures using an exhaust gas analyzer or monitor scan tool data stream for out of specified range long term fuel trims

**Slow fuel filling or no fill**

- Replace fuel fill filter, special Bi-Phase OEM part (5 micron)
- Check fuel level – if fuel liquid level is at 80% the automatic stop fill valve will stop the filling process, possibly will allow very slow filling after shut down
- NO FILL – check automatic stop orientation
- Compare vehicle tank pressure with filling station tank pressure; if it is < 70 p.s.i. difference, there may be a problem with the dispensing station pump or pump bypass adjustment; it also may be required to safely lower the pressure in the vehicle's fuel tank
- Check fuel level in propane station fuel storage tank
- Check the remote fill valve for obstruction or faulty check valve



**Unable to evacuate fuel in fuel lines through Schrader Valve**

- Confirm pressure gauge hose connecting fitting is penetrating the Schrader Valve
- Confirm there is fuel in the line by manually opening the Schrader Valve using a Schrader Valve service tool; note: wear gloves when opening Schrader Valve and do not release propane indoors or in a restricted space area
- If fuel pressure does not decrease or does not decrease completely from the fuel lines when attempting to evacuate the fuel line, replace the LPDM

**No fuel transfer from optional (secondary) transfer tank to main (primary) tank**

- Check power +12 volts and ground (-) to the Control module and relay
- Confirm the resistance value of the fuel level gauge sending unit matches the fuel control module; **refer to page 55 for correct resistance value.**
- Using the Bi-Phase 3-switch box, manually run pump on transfer tank to confirm it runs
- With transfer tank LPDM disconnected, bleed the fuel out of the transfer hose, disconnect the hose from the LPDM and install a tee with a gauge, reconnect to LPDM; run the pump manually; after the transfer line is refilled with fuel, turn the pump off and note the line pressure; Turn the pump back on, if the fuel pump boosts pressure increases by 10 to 20 psi the pump is good  
(Note: the primary tank should be at less than 50% liquid level)
- If the pump does not run, the amperage exceeds 15 amps or is less than 6 amps, replace the fuel pump
- Check the automatic stop fill device in the primary tank (the stop fill valve that the transfer tank pumps to) for correct operation.
- Try to initiate a fuel transfer; to simulate a level difference, remove each fuel level gauge sending unit from the tank; note: only remove the two very small Phillips head screws on the sending unit and lift the sending unit out of the float assembly head
  - Leave the sending units connected electrically

- Using a magnet, position each sending unit to an equal fuel level
- Start the engine
- Move the primary tank's sending unit the transfer tank pump should come on; if it does not, turn off the key/engine
- Synchronize the sending units to equal fuel levels; start the engine; move the primary tank's sending unit and listen for transfer tank pump to start running
- If the fuel transfer works by following the previous simulation, but fails to work when the vehicle is on the road you may need to simulate the over the road conditions
- Install pressure gauges on both tanks, a 0 to 250/350 on the vapor service valve or the fixed liquid level gauge; also install a gauge, in a prepared tee, in the transfer hose between the secondary and primary tank
- The vehicle should be driven for an hour or the time it takes to create heat and a fuel level differential of 15% to 20%
- Note the tank pressure in each tank
- If the tank pressure in the primary tank is 50 to 80 psi. more than the secondary (transfer) tank, a fuel transfer may not be accomplished
- Diagnose the reason there is such a pressure difference in the tanks – does the primary tank need a heat shield to protect it from the heat of the exhaust?
- All that is needed to complete a fuel transfer is a pump pressure from the secondary tank that exceeds the primary tank internal pressure

**Noisy fuel pump or noise in tank**

- The fuel pump is audible – the fuel pump makes more noise than a gasoline fuel pump, although it should not be distracting or annoying in the cab of the truck
- If the pump is more noisy than it should be, perform a few tests:
  - Install the 3-switch tester & fuel pressure gauge and confirm operating pressures are within specification
  - Has the pump boost dropped since it was last checked
  - Does the pump make more/less noise when checking operating pressure with the engine not running?
  - With the pump & supply valve on, does the pump make more/less noise?
  - Turn on the return valve – if the noise reduces, replace the LPDM.
- If the above tests do not reduce the noise and it is determined that the pump itself is making more noise than normal, replace the pump
- Early LPDMs did have a tendency to squeal; there was not a large volume of noisy LPDMs, but a few have been found and a rolling change has resolved the squeal or chatter
- A pressure equalization noise, after the engine is turned off, is normal and may be more prominent on one vehicle than another

**Fuel pump does not shut off**

- If the engine has been running longer than 30 seconds and the fuel pump does not shut off after the engine is turned off, the key is removed from the vehicle and door is closed, replace the tank control box
- The control box internal fuel pump control is shorted
- A fuel pump relay could cause the pump to run all of the time.

**No purge cycle**

- After driver-side door has been closed for 10 minutes, open door; if the purge cycle does not initiate, check the wiring from the door signal wire to the tank control box, refer to wiring diagrams
- Turn on the ignition key without starting the engine and after 2 seconds a purge should initiate, follow purge logic chart in this manual
- Start the engine and turn it off before 30 seconds and purge cycle should initiate

**Injector leaks with no electrical command**

- If the engine is off and the fuel system is pressurized an injector should not deliver any fuel
- Confirm there is not a ground (-) signal at the injector (unplug the electrical connector); if the fuel flow stops, diagnose the wiring per the OEM wiring diagram and/or service manual
- If a leaking injector is suspected, make sure the system is pressurized; open the throttle plate manually; listen, smell and look for fuel vapors inside the throttle plate; this would indicate a leaking injector
- Remove the injector rail to identify which injector is leaking and replace the injector per the procedures in this manual
- A leaking injector will cause misfire, overheating the catalytic converter, and could cause catalytic converter damage, which could cause excessive exhaust back pressure
- Always check exhaust back pressure after experiencing a leaking injector

**Injector insulator housing cracked or not sealing (vacuum leak)**

- Visually inspect each injector for visible cracks in the insulator housing
- Visually inspect each injector for ice build up on the insulator housing. (upper o-ring pushed out of the housing)

## Hot Soak Test

A hot soak test is a test conducted before and/or after a repair. It is the “soak” time after the engine has been turned off. As previously discussed in the manual, a purge cycle is required before attempting to start the vehicle, *see page 8 Theory & Operation*.

A hot soak test will reveal a number of things about the system.

1. If the vehicle starts in less than 3 seconds of cranking time
  - The concentric hoses inner liquid supply line is sealed at all points
  - The return valve is working properly
  - There are no injectors leaking fuel into the cylinder port
2. If the vehicle does not start with more than 3 seconds of cranking time
  - A pressure test may or may not indicate a problem with a non sealing inner liquid supply line
  - An inner liquid supply line may not be sealed in the port of the LPDM, or injector rail(s);
  - The return valve could be malfunctioning, closed and will not open, restricted, obstructed
  - An injector is not closed completely leaking fuel into the cylinder port and causing a rich condition
  - Weak fuel pump could cause hard starting, verify fuel pressures

Anytime this manual asks to perform a hot soak, the procedure for doing so is discussed below.

1. Drive the vehicle or run the vehicle with the hood closed until engine temperature is at full operating temperature, 194° F or greater; the longer the better because the more heat under the hood the more valid the hot soak is
2. Park the vehicle and close the doors, leaving the hood closed
3. Allow the vehicle to sit for 20 minutes; if the vehicle sits for hours the temperatures cool down and the vapor lock created during the hot soak is minimized; the first 10 to 30 minutes of the hot soak is most critical because the vapor lock is a higher pressure thus harder to push back to the tank
4. Return to the vehicle within 20 minutes, open the door or turn on the ignition key to initiate a purge cycle and wait for the purge cycle to complete, 12 to 15 seconds.
5. If the vehicle starts fast, less than 3 seconds cranking time, and idles smooth chances are there is no problem with inner liquid supply line, the fuel return valve or a leaking injector flooding the port with fuel

**NOTE:** Always perform a hot soak after a repair has been made to confirm a fast and smooth hot restart.

## Injectors

### R & R Injectors or Injector Rail Complete



**Warning:** Evacuate/drain/release the fuel pressure from the LPEFI® fuel lines before you work on it. The system contains cold liquid propane under pressure. Wear gloves and goggles to avoid freeze burns. If space is confined, arrange to burn the fuel release to prevent accumulation of flammable propane vapors.

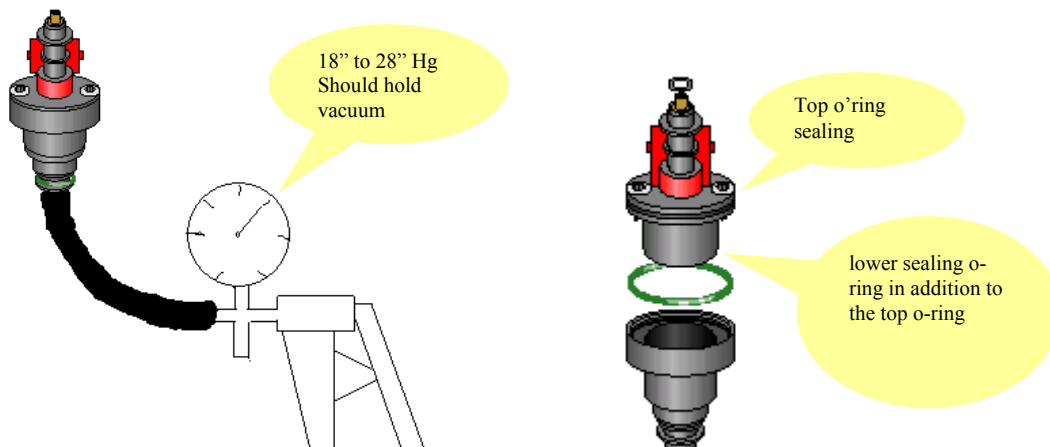
Before removing an injector from the rail or the fuel rail from the fuel line you must first safely evacuate/drain the fuel from the fuel lines and rails. This will not evacuate the fuel from the tank. Follow the steps below.

1. Disconnect the vehicle's battery (always disconnect the negative terminal first)
2. Disconnect the LPEFI® system electronic tank control box; this will prevent spillage of fuel from the tank in the case the door is opened or the ignition key is cycled
3. Install the gauge set to one of the system Schrader Valves
4. Bleed the pressurized fuel lines off to a torch or a safe area where flammable propane vapors will not accumulate
5. Leave the gauge set valve open to atmosphere and when the pressure gauge reads zero you may remove an injector or the entire fuel rail without further release of pressure

NOTE: If the fuel pressure does not stop flowing and the electronic tank control box is disconnected, the LPDM must be replaced (this will require evacuating all the fuel in the fuel tank).

### Injector insulator housing service

The injectors are internally unserviceable; however the insulator housing covers the injector and could require replacement. The injector insulator housing should be leak free of vacuum leaks or should hold a vacuum. Before installing the injector rail on an engine, check each injector for vacuum leaks. This is done by using a hand held (Mighty Vac) vacuum pump. Push the vacuum hose on the injector insulator housing tip and pump the vacuum pump to 18"Hg to 28"Hg. If it holds a vacuum, it is sealed and does not need any service. If it does not hold a vacuum, repair/replace the insulator housing and/or o-ring or o-rings.



### Injectors, cont'd

If freezing occurs on the insulator housing this is an indication the insulator housing is leaking or has a vacuum leak. Check the insulator housing for cracks and replace as necessary. Always check injectors for a vacuum tight seal before installing.

### Injector electrical

The injector is designed to mimic a gasoline injector. Therefore the injector coil resistance is similar to a gasoline injector. The nominal resistance across the electrical connectors should be 12.6 to 13Ω ohms. An acceptable range is 12Ω to 15Ω, but not to exceed 2Ω between the lowest reading injector to the highest reading injector. If there is greater than 2Ω difference, choose and replace the highest or lowest resistance injector, whichever corresponds, to achieve a range inside 2Ω. If the resistance test proves an open circuit, the injector must be replaced.

### Injector harness

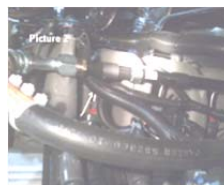
The injector electrical connectors should be facing outward to allow clearance between injector & intake plenum. The electrical connector could interfere with the installation of the rail or the installation of the rail could damage the injector if not pre-positioned outward.

**Note:** Always be aware of routing of the harness. Do not route over the top of the fuel rail.

#### INCORRECT ROUTING

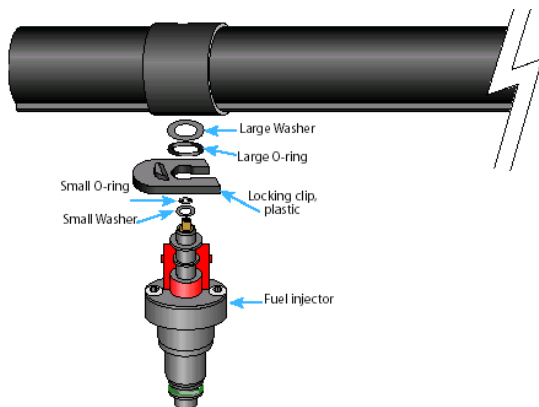


#### CORRECT ROUTING



### R & R Injector from Fuel Rail

When replacing an injector, it is very important to install it with the o-rings and washers correctly positioned. The stack up of the washers and o-rings not only prevents fuel leaks to the atmosphere, but permits fuel to return through the return passage to the tank. If the fuel fails to return, the refrigeration cycle will not be complete and poor performance will occur.

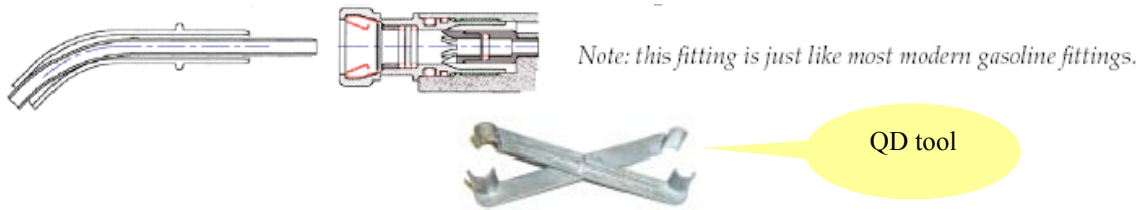


#### Direct mount into rail

1. Insert the upper large washer into rail
2. Insert the large o-ring into rail
3. Install the small washer on injector
4. Install the small o-ring on injector
5. Oil the o-rings with clean motor oil
6. Position the locking sleeve and insert injector into rail, push and rotate slowly through the large o-ring in the rail until the injector is seated
7. Slide the locking sleeve into place and install the plastic locking clip

**R & R Injector from Fuel Rail, cont'd****Remove the Fuel Rails, Disconnect the Fuel Lines**

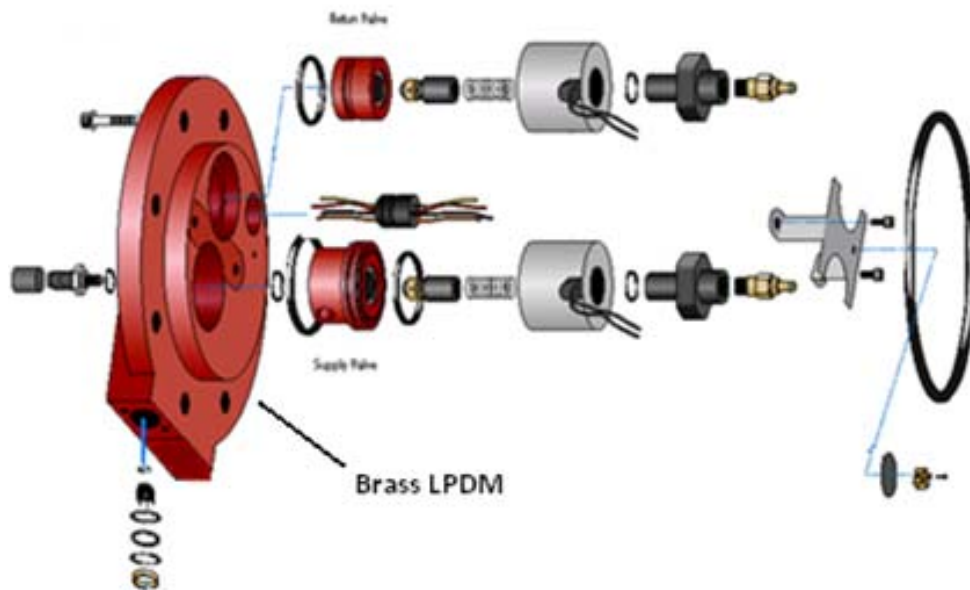
Removing the fuel rails is normally a simple procedure. Refer to our vehicle specific repair manuals for more detail on removing the fuel rail on a specific vehicle. After evacuating the fuel lines as described on page 53, you will need a 3/8" quick disconnect/QD tool commonly used on gasoline fuel lines. To disconnect the fuel line from the fuel rail, push the QD tool into the hose fitting to release the locking clip. Then pull the hose and the tool out together. See the drawing below.



## **LPDM (Liquid Propane Delivery Module)**

### **Servicing the LPDM (Liquid Propane Delivery Module)**

The LPDM is not serviceable. If a problem develops with the LPDM it should be replaced. The LPDM is a concentric design like the fuel lines and fuel rails. It provides 100% closure of fuel flow through the normally closed internal fuel supply valve and fuel return valve. When electrically energized the valves are two-stage opening allowing pressure to equalize to both sides of the valve before completely opening. This prevents higher amperage spikes in the 12-volt solenoid used to open the valve. Both valves are equipped with excess flow valves to prevent excessive flow of fuel in the case of fuel line/hose failure in an accident. As mentioned previously, the valves are normally closed and would close immediately upon engine failure, voltage failure or in an accident that disconnected the fuel line. Inside the tank, the condenser and the fuel pump connect to the LPDM.



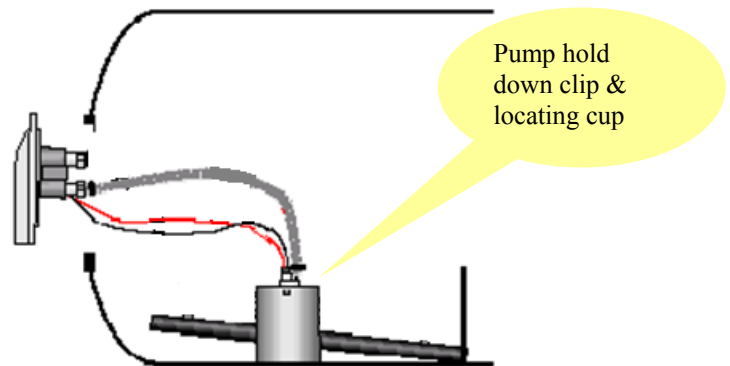
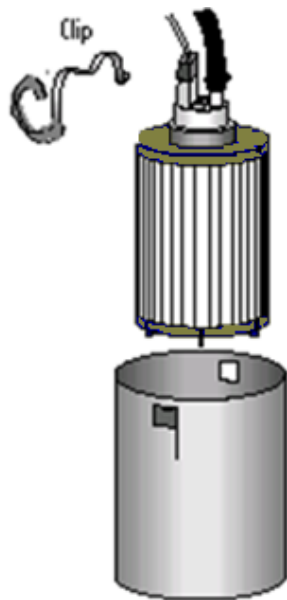
To remove the LPDM, the tank must be evacuated completely. Refer to the section in the manual for tank evacuation. The LPDM is secured to a tank flange by 8 bolts. The bolts are special aluminized bolts and should not be reused. Anytime the LPDM is removed for other tank service, a new o-ring and new bolts should be used.

### **Remove the LPDM**

1. Evacuate the fuel lines and tank completely, follow procedures on pages 49-53
2. You will need a 3/8" quick disconnect/QD tool commonly used on gasoline fuel lines.
3. To disconnect the fuel line from the fuel rail, push the QD tool into the hose fitting to release the locking clip. Then pull the hose and the tool out together.
4. Once the hose is out of the LPDM, protect the end of the hose and the LPDM hose port so that grease, dirt or contaminants do not enter the hose or the LPDM
5. Mark the orientation of the bulkhead with tape or chalk – this will help you orient the hose port correctly when reinstalling
6. Loosen the 8 LPDM flange bolts evenly in a crisscross pattern

**Remove the LPDM, cont'd**

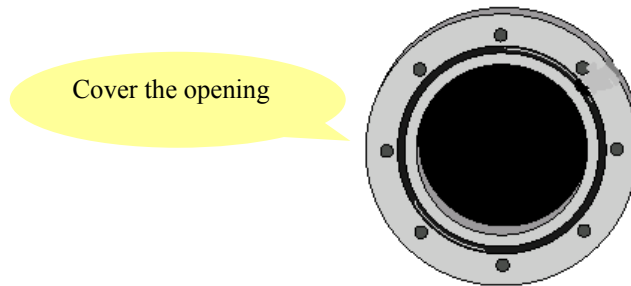
8. Remove all of the bolts completely
9. Pull the LPDM assembly away from the flange slightly
10. Reach into the tank to access the fuel pump and unclip the clip that holds the fuel pump and filter down inside the fuel pump locating cup; the clip fits through two holes in the fuel pump cup; simply unhook one side and swing the clip over to the opposite side of the pump locating cup; this helped to prevent dropping the clip inside the tank; it is not necessary to disconnect the electrical connector from the fuel pump to remove the hold down clip; however some may find this step makes it easier – remember, if you disconnect the connector, it must be reconnected when reinstalling the pump and LPDM
11. Once the fuel pump is unclipped you can remove the LPDM assembly by lifting out the fuel pump, and then whatever service is necessary can be performed





**Remove the LPDM, cont'd**

12. If the LPDM is going to be out of the tank for any length of time cover the opening/flange on the tank; use duct tape or a prepared cover that can be bolted into place utilizing the sealing o-ring; it is important to keep air, dirt and moisture out of the fuel tank


**Replace the Fuel Pump**


**Warning:** The supply hose attached to the pump contains propane under pressure. The pump bypass valve should have released any pressure in excess of 60 to 85 p.s.i. However, at cold temperatures the hose may contain liquid propane. Wear insulated PVC rubber gloves and goggles to prevent freeze burns or injuries.

1. Disconnect the electrical connector from the top of the pump
2. Remove the hose from the supply valve on the LPDM by loosening the clamp. Remove the hose carefully – propane pressure could spray out.
3. Remove the pump, and hose
4. Reinstall the fuel pump and connect the fuel supply hose from the fuel pump to the LPDM supply valve (the supply valve is always the valve closest to the hose port or directly inline/behind the Schrader Valve)
5. Connect the wiring harness to the fuel pump, confirm the wiring is in good condition
6. If you are not replacing the fuel pump, it is probably a good idea to install a new filter; however, we recommend that you replace the pump and the filter at the same time
7. Tighten all the hose clamps and prepare to reinstall the LPDM

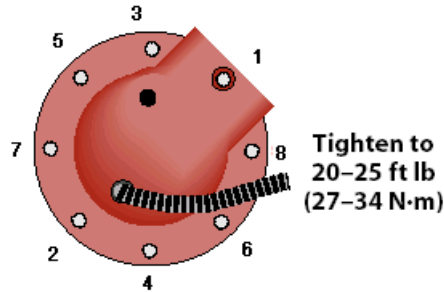
**Reinstall the LPDM**

**Clean inside of tank before reinstalling LPDM. Take a clean rag and wipe the inside of the tank within an arms reach. If tanks contains excess containments (i.e. sludge, metal flakes) tank should be removed and clean. Contact your local propane company for proper cleaning procedure.**

1. Inspect the wires, hoses, hose clamps to be certain everything is connected properly
2. Lift the LPDM with one hand, hold the fuel pump with the other hand
3. Guide the pump into the tank opening and place the fuel pump into its locating cup
4. Install the fuel pump hold down clip
5. Make sure all hoses and wiring is pushed inside the tank with no kinks or sharp bends, push the LPDM assembly over the opening in the tank and clock it the same way it was when it was removed; be careful with the o-ring, it must be in the o-ring groove or the LPDM will pinch it and cause a fuel leak when the tank is refilled with fuel

## Repair Procedures

6. Install the new aluminized coated bolts that came with the new o-ring and hand tighten (*note: anti-seize compound is not necessary with these aluminized coated bolts, but not prohibited*)
7. A deep well 3/8" 12-point socket is required to tighten the bolts
8. Tighten the bolts evenly, a little at a time
9. Finish tightening the bolts in the order shown below, or in a crisscross pattern; torque the bolts to 20-25 foot pounds



**Warning:** *Improperly attached fuel lines could cause the release of propane causing personal injury.*

10. Coat the steel hose end fitting and the nylon inner line with clean motor oil before inserting it; insert the fuel line fitting into the port on the LPDM (be careful not to damage or kink the inner line)
11. Center the inner line and carefully push it down until it is completely installed
12. **IMPORTANT:** After hearing the click of the line quick connecting, visually look and verify the 4 sides of the QD clip are over the locking ring.



**Warning:** Do not connect the LPDM wiring harness at this time. The tank must be purged and filled with fuel before the harness is connected. During service a combustible air/fuel mixture could have been created in the tank causing a dangerous condition if the fuel pump was energized before the tank is purged of this air/fuel mixture. Once the tank is purged and filled with a minimum of 5 gallons, there is no danger. Refer to evacuating and purging containers in this manual.

13. Purge the tank following the procedures on pages 47-48; once the tank is purged, pressurize the tank with propane – no more than a few tenths of a gallon
14. Leak check the LPDM sealing flange and the entire tank with an approved leak detection fluid or an electronic leak detector; also, submerge the end of the LPDM electrical harness in a cup of water to verify there are no leaks through the wiring, then dry the connector
15. Once the leak inspection is complete, finish filling the tank to the desired level

## **Auxiliary (secondary tank) LPDM (Liquid Propane Delivery Module)**

### **Servicing the auxiliary LPDM (Liquid Propane Delivery Module)**

The LPDM is not serviceable. If a problem develops with the LPDM it should be replaced. It provides 100% closure of fuel flow through the normally closed internal fuel supply valve. As mentioned previously, the valves are normally closed and would close immediately upon engine failure, voltage failure or in an accident that disconnected the fuel line. Inside the tank, the fuel pump connected to the LPDM.

To remove the LPDM, the tank must be evacuated completely. Refer to the section in the manual for tank evacuation. The LPDM is secured to a tank flange by 8 bolts. The bolts are special aluminized bolts and should not be reused. Anytime the LPDM is removed for other tank service, a new o-ring and new bolts should be used.

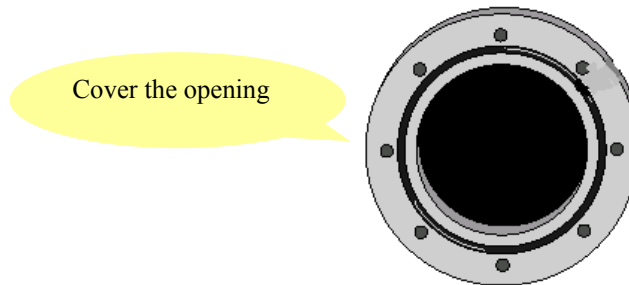
### **Remove the LPDM**

1. Evacuate the fuel lines and tank completely
2. Remove the line from the LPDM
3. Remove the line from the LPDM and install a 3/8" cap



4. Once the hose is out of the LPDM, protect the end of the hose and the LPDM hose port so that grease, dirt or contaminants do not enter the hose or the LPDM
5. Mark the orientation of the bulkhead with tape or chalk – this will help you orient the hose port correctly when reinstalling
6. Loosen the 8 LPDM flange bolts evenly in a crisscross pattern
7. Remove all of the bolts completely
8. Pull the LPDM assembly away from the flange and reach into the tank to access the fuel pump and unclip the clip that holds the fuel pump and filter down inside the fuel pump locating cup; the clip fits through two holes in the fuel pump cup (old clip designs did not attach permanently to the fuel pump locating cup so they were easy to drop inside the tank; a newer clip design allowed one side of the clip to stay attached to the fuel pump locating cup; simply unhook one side and swing the clip over to the opposite side of the pump locating cup; this helped to prevent dropping the clip inside the tank); it is not necessary to disconnect the electrical connector from the fuel pump to remove the hold down clip; however some may find this step makes it easier – remember, if you disconnect the connector, it must be reconnected when reinstalling the pump and LPDM
9. Once the fuel pump is unclipped you can remove the LPDM assembly by lifting out the fuel pump, and then whatever service is necessary can be performed

10. If the LPDM is going to be out of the tank for any length of time cover the opening/flange on the tank; use duct tape or a prepared cover that can be bolted into place utilizing the sealing o-ring; it is important to keep air, dirt and moisture out of the fuel tank

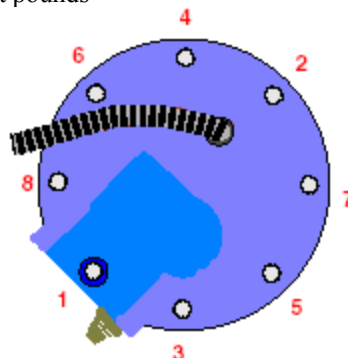


**Warning:** The supply hose attached to the pump contains propane under pressure. The pump bypass valve should have released any pressure in excess of 60 to 85 p.s.i. However, at cold temperatures the hose may contain liquid propane. Wear insulated PVC rubber gloves and goggles to prevent freeze burns or injuries.

#### Reinstalling the Auxiliary LPDM

**Clean inside of tank before reinstalling LPDM.** Take a clean rag and wipe the inside of the tank within an arms reach. If tanks contains excess containments (i.e. sludge, metal flakes) tank should be removed and clean. Contact your local propane company for proper cleaning procedure.

1. Inspect the wires, hoses, hose clamps to be certain everything is connected properly
2. Lift the LPDM with one hand, hold the fuel pump with the other hand
3. Guide the pump into the tank opening and place the fuel pump into its locating cup
4. Install the fuel pump hold down clip
5. Make sure all hoses and wiring is pushed inside the tank with no kinks or sharp bends, push the LPDM assembly over the opening in the tank and clock it the same way it was when it was removed; be careful with the o-ring, it must be in the o-ring groove or the LPDM will pinch it and cause a fuel leak when the tank is refilled with fuel
6. Install the new aluminized coated bolts that came with the new o-ring and hand tighten (*note: anti-seize compound is not necessary with these aluminized coated bolts, but not prohibited*)
7. A deep well 3/8" 12-point socket is required to tighten the bolts
8. Tighten the bolts evenly, a little at a time
9. Finish tightening the bolts in the order shown below, or in a crisscross pattern; torque the bolts to 20-25 foot pounds



**Tighten to  
20-25 ft lb  
(27-34 N·m)**



**Warning:** *Improperly attached fuel lines could cause the release of propane causing personal injury.*

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11. Install the line to LPDM fitting, first removing the 3/8" cap
10. Close all the valves on the tank and do not connect the LPDM wiring harness at this time



**Warning:** Do not connect the LPDM wiring harness at this time. The tank must be purged and filled with fuel before the harness is connected. During service a combustible air/fuel mixture could have been created in the tank causing a dangerous condition if the fuel pump was energized before the tank is purged of this air/fuel mixture. Once the tank is purged and filled with a minimum of 5 gallons, there is no danger. Refer to evacuating and purging containers in this manual.

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11. Purge the tank following the procedures; once the tank is purged, pressurize the tank with propane – no more than a few tenths of a gallon
12. Leak check the LPDM sealing flange and the entire tank with an approved leak detection fluid or an electronic leak detector; also, submerge the end of the LPDM electrical harness in a cup of water to verify there are no leaks through the wiring, then dry the connector
13. Once the leak inspection is complete, finish filling the tank to the desired level

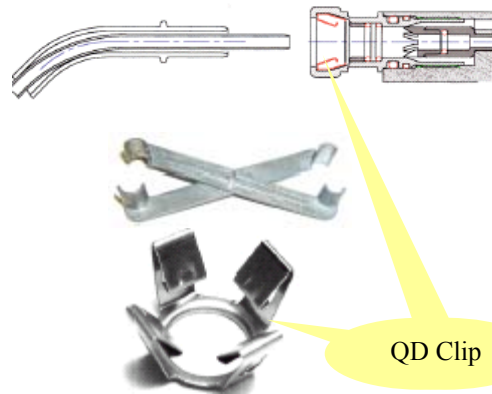
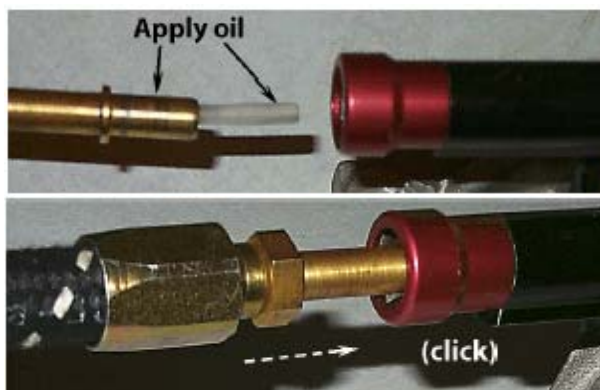
### Servicing Fuel Lines – Remove or Install

In the system there are a few different fuel line connections that should be considered. The three types you will see are discussed below.



**Warning:** *Improperly attached fuel lines could cause the release of propane causing personal injury.*

1. The injector rail uses a QD (quick disconnect) to lock the fuel line in place in the rail; the internal sealing of the inner fuel liquid supply line is accomplished with an inner line guide bushing with o-ring behind it to seal the nylon inner fuel liquid supply line; a 3/8" QD tool is required to remove the fuel line from the rail once it is installed; special care should be taken when installing the fuel line into the rail due to the nylon inner line being easily crimped



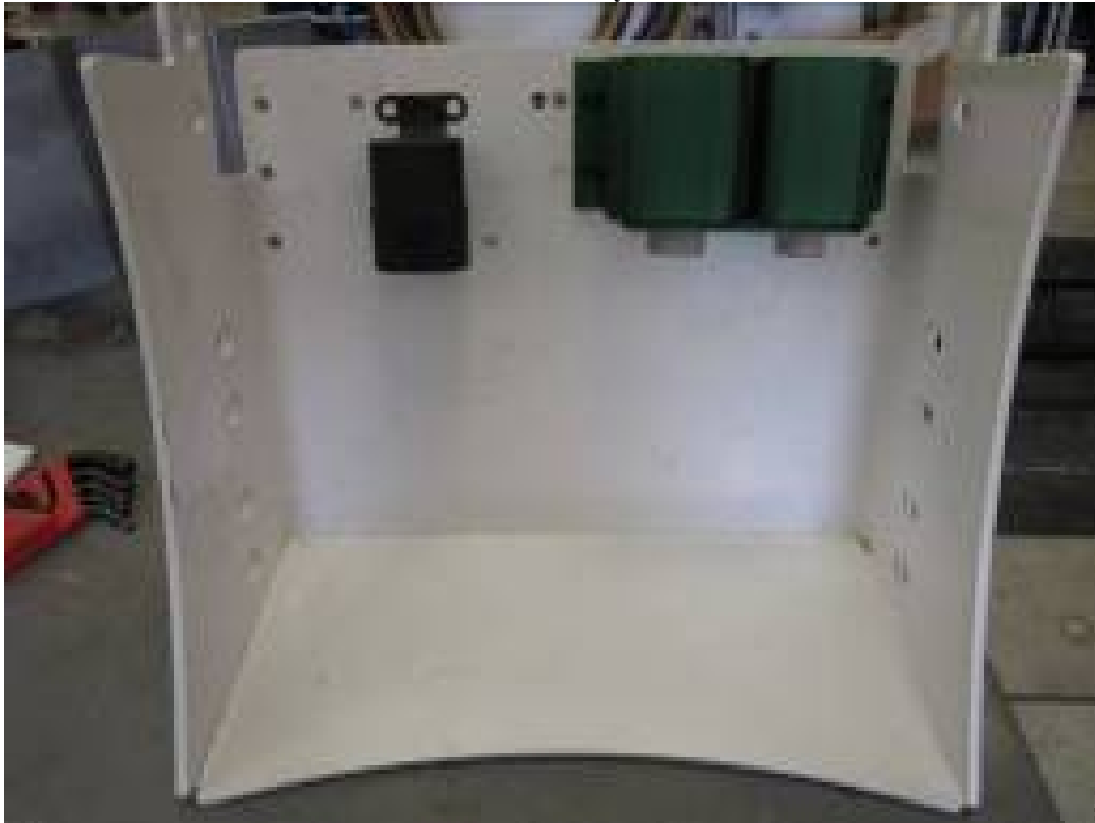
**IMPORTANT:** After hearing the click of the line quick connecting, visually look and verify the 4 sides of the QD clip are over the locking ring.

2. Gently pull on the on the hose ends to verify the fitting will not disconnect
3. The LPDM uses the same type of nylon inner liquid supply line sealing as the rail (guide bushing with o-ring sealing behind the guide bushing), however, the fuel line ports on the LPDM do not use a QD clip; the hose end fitting is of the same design with the locking flange or ring near the end of the metal fitting, but to lock it in place two red split collar (locking wedges) are used; it is very important that these split collar retainers are positioned so that the locking flange or locking ring at the end of the metal fitting is below the split collar retainers and locks it into the component without a doubt, see the illustrations below

**Tank Control Box (Electronic Tank Control Assembly)**

The tank control box is located near the LPDM. In most cases, it is located on a tank guard at the front of the primary (main) fuel tank. The latest version is a product of our continuous improvement efforts and has taken the fuel pump power supply out of the box and routed it through a relay. The tank control box operating strategy did not change, only the fuel pump relay was added.

For operating logic, see page 24-25 and for wiring schematics see pages 60.

**Control Box & Relay**

## Purge the Tank



**Warning:** Purge the tank outdoors in the open, away from buildings, other vehicles, electrical devices, gas appliances, and other sources of ignition. Disconnect the electrical connection from the tank control box and disconnect the battery to avoid ignition inside the tank. Any spark or flame can ignite a cloud of propane vapor in or near the tank which could cause severe burns, personal injury and/or property damage. Always disconnect the negative battery terminal first.

Purging the tank is different from the purge cycle in the LPEFI® system. Purging the tank means removing the air (oxygen) and moisture from inside the tank before putting the tank into service. This is a required procedure on all new tanks (tanks that have never been filled with propane) or tanks that have been evacuated and opened to the atmosphere for service or for any reason. *Note: Purging the tank is always required if the tank is evacuated and any valve or component is removed that causes the tank to be exposed to the atmosphere.*

### Why Purge a Tank?

Most tanks are steel and are prone to rust. To prevent rust, purging will remove air (oxygen) and moisture which causes rust. Also, by purging and removing the air (oxygen) from the tank there is no chance of air in the tank causing pressure fluctuations. This trapped air could also cause excess pressure in the tank and could cause a slow fill situation. New tanks come purged with an inert gas and this same situation could also occur if the inert gas is not purged from the tank. Always follow proper purge procedures.

The LPEFI® system uses an electric fuel pump mounted inside the tank. Propane must be mixed with air between 2.15% and 9.6% fuel to air mixture to be combustible or flammable. If not purged, a spark from the electric fuel pump could ignite such a mixture. Fortunately, this combustible mixture is seldom found inside a tank and by purging the tank prior to filling or refilling, the tank will prevent the air/fuel mixture from ever reaching a combustible mixture.

### How to Purge a Tank



**Warning:** You purge the tank in the open (outside), at least 25 feet from any building.

You can perform the purge with the tank installed on the vehicle. You should not connect any electrical connectors to the tank after service or before filling a new tank. If the tank is connected electrically, DISCONNECT it from the tank control box and disconnect the vehicle battery (always disconnect the negative terminal first). It is also recommended that the tank be grounded to earth ground with a cable (like a battery jumper cable) to prevent sparks due to static electricity.

At this point all replaced components should be installed and tightened to specification. The following procedures or method is approved by the United States National Propane Gas Association (NPGA). For more information you can go to their website at [www.npga.org](http://www.npga.org).

1. Remove the brass cap from the vapor service valve on the tank you want to purge – the tank should not have fuel at this time (it should be totally evacuated); some pressure may build up if the tank was closed up for a period of time due to the porosity of the steel; release this pressure build up before starting the purging process
2. Open the valve to release such pressure build up and allow it to equalize to atmospheric pressure
3. Connect the propane vapor source to the fill connection on the tank or if the tank is equipped with a vapor service valve, hook up to the vapor service valve

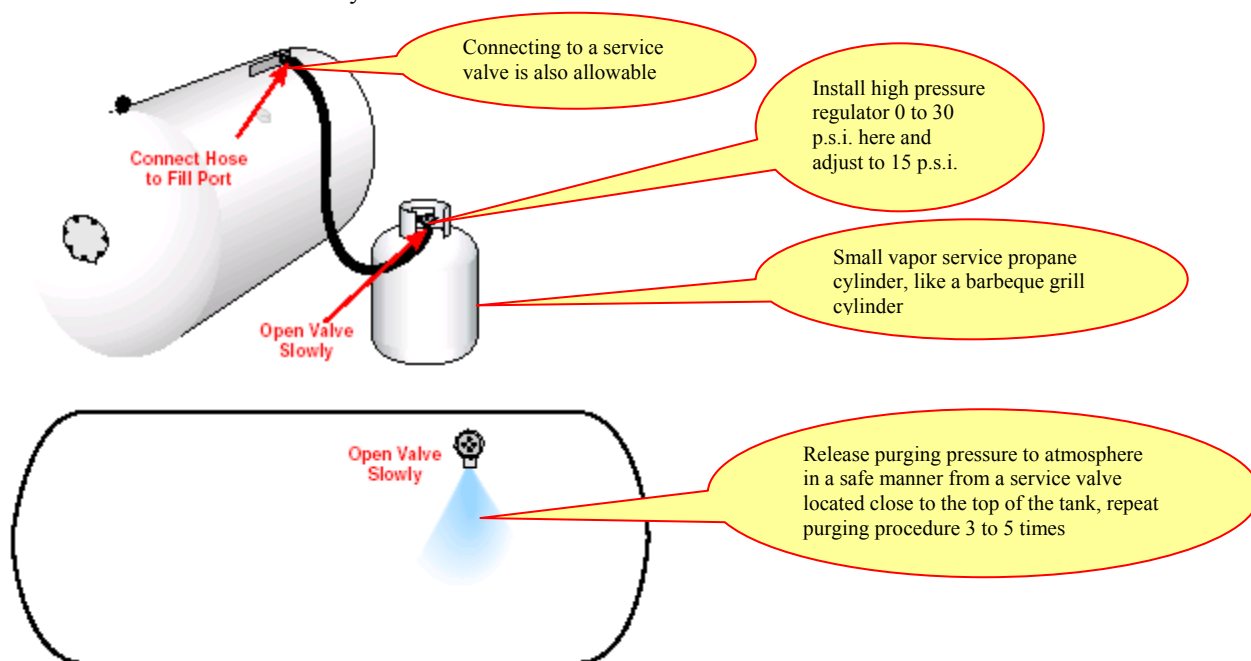


**How to Purge a Tank, cont'd**

4. The propane vapor used can be a small cylinder, such as a barbeque grill cylinder – these cylinders are vapor service only; attach an adjustable high pressure regulator to the cylinder and adjust the outlet pressure of the regulator to 15 p.s.i. (this is to be connected to vapor service only)
5. Slowly open the vapor service valve on the cylinder and allow vapor pressure to equalize into the tank being purged to 15 p.s.i. and turn off the valves
6. Release all the pressure in the tank being purged to atmosphere or to a flare stack and close the valve when all the vapor pressure is released
7. In order to ensure that at least 95% of the air is removed, the container must be pressurized and bled down or depressurized several times – usually 3 to 5 times is sufficient
8. The closer to the top of the tank the valve you are using to release the pressure or depressurize the tank, the better

*Note: If there is any indication of moisture or water in the tank and most of the liquid water was removed during service of the tank, there remains some moisture. In this case, it is a good idea to inject some methanol into the tank before filling the tank with fuel. On average, one pint of methanol per 100 gallons of propane or 1 gallon of methanol per 1,000 gallons of propane will resolve any moisture or water residue.*

9. On the last purge with vapor, leave the tank being purged pressurized and this is a good time to check the tank and valves for leaks; check for leaks with an approved leak detection fluid or electronic combustible gas detector
10. If no leaks are found and the purge process is complete, the tank is ready to be filled with propane liquid
11. Fill the tank with 5 gallons of fuel before any electrical components are reconnected. This will insure there is no or very little air in the tank.



**Drain/Evacuate the Tank for Service**

The safest way to empty a propane tank is to:

1. Use the fuel in the tank
2. Transfer the fuel to an empty tank
3. Burn the fuel through a flare stack

**NEVER** release propane to the atmosphere where conditions would not permit:

1. The volume required to be released is excessive (> 1 gallon of liquid )
2. Where there are buildings, structures in close quarters
3. When there is no wind to dilute the releasing fuel to a noncombustible limit of flammability

It is never recommended to release to the atmosphere. In all cases when it is necessary to release fuel to the atmosphere all sources of ignition, clearances and wind condition must be considered. It is recommended if you cannot transfer the fuel to an empty tank that you burn the fuel through a flare stack, as previously mentioned.



**Warning:** Never service a tank inside a building. Always perform the evacuation procedures outside with 25 feet of clearance from any combustibles, hazardous atmosphere, buildings, structure and source of ignition. Always remove any possible sources of ignition when performing the evacuation. If required to release fuel to the atmosphere, do so with the utmost of safety and give consideration to such factors as distance to buildings, terrain, wind direction and velocity, and use of a vent stack so that a flammable mixture will not reach a point of ignition. The person(s) or company performing any fuel transfer or service work on a propane system is liable for their actions and must be properly trained, insured and licensed if required by the authority having jurisdiction.

*The National Fire Protection Associations pamphlet No. 58 states in Chapter 1, "General Provisions 1-5 Qualification of Personnel: Persons who transfer liquid LP-Gas, who are employed to transport LP-Gas, or whose primary duties fall within the scope of this code shall be trained in proper handling procedures. Refresher training shall be provided at least every three years. The training shall be documented."*

For more information, contact your local, state or national propane gas association and ask about certified employee training programs. For more information on NFPA or to order the LP-Gas Code Handbook, call NFPA at 1-800-344-3555 or visit their website at [www.nfpa.org](http://www.nfpa.org).

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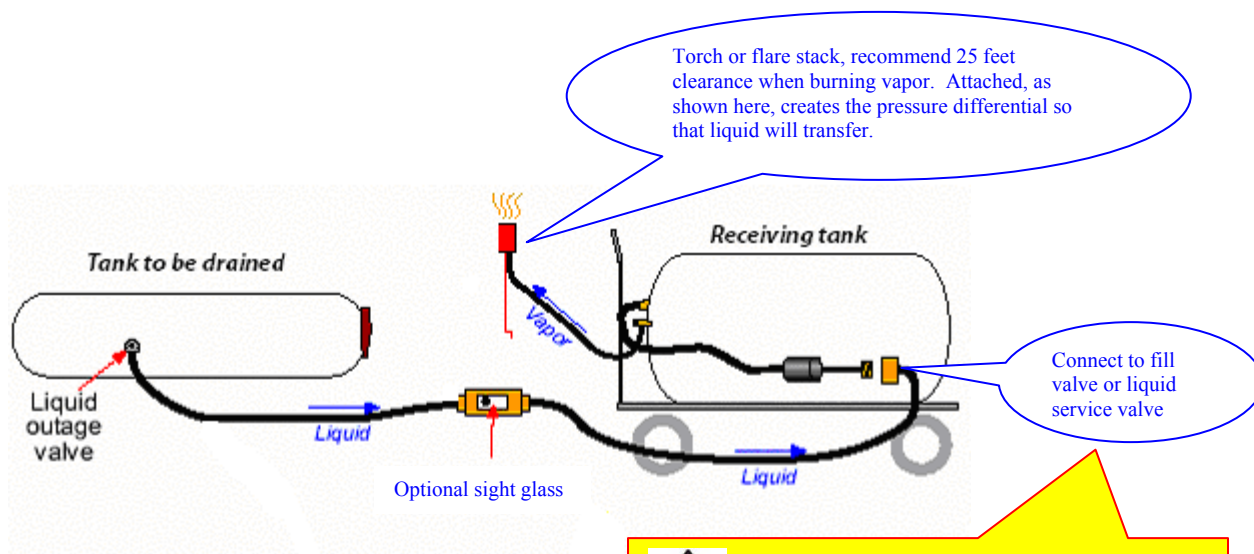
## Transferring Fuel from One Tank to Another



**Danger:** Do not remove any valves, bulkheads or fittings from a propane tank unless the tank has been properly drained (evacuated) completely. The pressure inside a propane tank can push a loosened bulkhead or valve out with enough force to cause injury. Release of propane in an uncontrolled situation will create a flammable/explosive mixture of air and propane, which could cause serious injury, death and property damage.

Propane is stored under pressure. When you remove a valve or bulkhead from a tank, all of the pressure is released at once, in a violent rush. Always drain the tank before you work on it. Failure to do this will result in damage to the tank or valves and can result in severe injury or death. You should drain the tank using a torch or flare stack in an approved safe manner. Your propane supplier can help you with this.

1. Disconnect the LPDM connector from the electronic tank control box and disconnect the vehicle battery – always disconnect the negative terminal first
2. Be sure the liquid and vapor service valves are closed and remove the brass cap – if a service valve hand wheel handle is missing, replace it for this service procedure
3. Connect an approved for LPG hose from the tank liquid service valve to a receiving tank liquid service valve – receiving tank is the tank that the fuel will be transferred to



If connecting service valve to service valve for fuel transfer, you must pay close attention and use the fixed liquid level outage gauge on the receiving tank. Do not overfill the tank. Propane tank maximum filling capacity is 80%.

**Transferring Fuel from One Tank to Another, cont'd**

4. Open the liquid service valves slowly on both tanks; if the receiving tank is empty and has no vapor pressure, the liquid service valve's excess flow protection will close and stop/decrease the flow; both the liquid and vapor service valves on the vehicle tank are equipped with excess flow protection and will only allow 1.7 g.p.m. (gallons per minute); if the flow exceeds this, the excess flow will close
5. Open the receiving tank vapor service valve and light the torch or flare stack, whichever is used; *do not release any vapor pressure from the tank being evacuated during transfer from the vehicle tank to the receiving tank as this would decrease the pressure differential between the two tanks or could cause a flammable environment while the torch is burning*
6. You can open the liquid service valve more for more flow, but be aware that if the flow rate is exceeded, the excess flow protection could close



**Warning: The person performing this procedure must be trained and familiar with the properties and characteristics of propane gas; this person must stand watch of this procedure until it is complete and cannot leave the process unattended; if the person must leave the evacuation process then all valves should be shut off and the process would require restarting upon return**

7. When the tank being evacuated is empty of liquid or the flow of liquid has stopped, turn off all valves and the torch/flare stack
8. Remove the torch/flare stack hose from the receiving tank and connect it to the liquid service valve of the tank being evacuated
9. Open the liquid service valve and light the torch/flare stack to burn the remaining fuel in the tank being evacuated
10. If frost is appearing on the bottom of the tank being evacuated, liquid propane is in that area of the tank; this could be in the area of the LPEFI® system tank baffle; you could spray the tank in that area with a water hose to help vaporize the fuel so that it will all be burned from the tank; if you open the tank (remove the LPDM or any valve) before this frost or ice (depending on the temperature) has dissipated you may find propane in a liquid state sitting in the bottom of the tank; finding liquid in the bottom of the tank could be dangerous



**Warning: Make sure that all the propane has been evacuated before removing any valves or the LPDM from the tank**

11. Reverse these steps to transfer the fuel back to the vehicle tank

*These procedures must be followed if any service valve, fuel level float gauge assembly, bleeder valve, filling valve, relief valve, LPDM or any component is removed from the tank.*

**Flaring Off a Tank (Burning Off a Tank)**


**Warning: Always disconnect the negative battery terminal first**

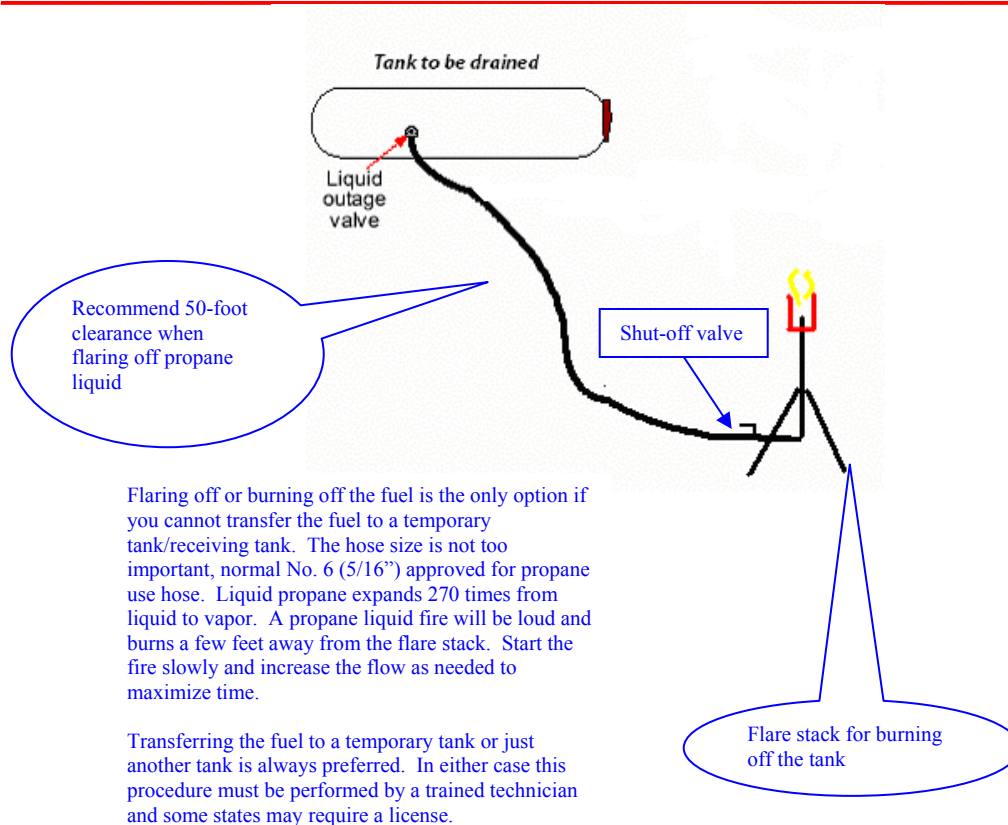
1. Disconnect the LPDM connector from the electronic tank control box and disconnect the vehicle battery
2. Be sure the liquid and vapor service valves are closed and remove the brass cap – if a service valve hand wheel handle is missing, replace it for this service procedure

**Flaring Off a Tank (Burning Off a Tank), cont'd**

3. Connect an approved LPG hose from the tank liquid service valve to a torch or prefabricated flare stack; if a torch is used, remember that the time required to burn all of the fuel from the tank is based on the BTU rating of the torch – for example, 1 gallon of propane supplies 91,500 BTUs per hour; if the torch is a 1,000,000 BTU torch it would only burn approximately 10 gallons per hour; if a prefabricated flare stack is built, there would not be an orifice to restrict flow and it would burn as fast as the liquid service valve is rated to flow – for example, if the liquid service valve is flow rated at 2 g.p.m. (gallons per minute), it could burn 120 gallon per hour
4. Slowly open the liquid service valve and light the torch or flare stack



**Warning:** We recommend 50 feet clearance from the vehicle and/or buildings or combustible materials if the tank is flared.



5. Open the liquid service valve or if the flare stack is equipped with a valve, open the valve a little more until the flow rate and the burn rate are maximized
6. If the flame goes out due to improper fuel mixture, wind or any reason, the tank service valve must be closed immediately; wait a few minutes for any accumulation of propane vapor to dilute into the atmosphere before attempting to restart or relight
7. A technician trained in this procedure must attend the process at all times and cannot leave the area without closing off all valves and discontinuing the evacuation process

### Flaring Off a Tank (Burning Off a Tank), cont'd

8. When the tank liquid service valve no longer accesses the liquid level in the tank, a frost or ice line on the tank indicates liquid propane is in the tank; the burning process is faster than the liquid in the tank can vaporize, therefore the liquid will freeze the tank and decrease the ability of the propane liquid to vaporize; spray the tank with a water hose to promote vaporization; you may also close all valves to see if pressure builds up indicating some liquid fuel remains in the tank
9. Do not remove any valve, gauge or LPDM from the tank until it is completely empty of propane liquid and vapor

### After Servicing the Tank

Purge the tank properly as described on pages 47-48, check the tank and all connections to the tank for leaks and fill the tank with a minimum of 5 gallons of fuel before reconnecting the battery and electrical connectors to the tank control box. Remember that the fuel level must be to an adequate level to transfer propane liquid through the transfer pipe to the fuel pump side of the baffle or the engine will lack fuel to start.

### How to Drain the Fuel Lines

1. Disconnect the electronic tank control box and the vehicle battery – always disconnect the negative battery terminal first
2. Connect the fuel gauge test kit to the Schrader Valve located at the LPDM on the tank or at the Wye, if equipped – not all systems are equipped with a Wye
3. Connecting to the Schrader Valve communicates with the liquid supply section of the system, but also accesses the fuel return section
4. Open the valve on the gauge set and allow the fuel lines to bleed out until the gauge reads zero (*note: bleed the fuel lines down in a safe place, not indoors unless you have enough drain hose to route the drain hose outside the shop and not near any source of ignition*)
5. Leave the gauge set hooked up and leave the valve open until the necessary service is complete



6. Once the fuel lines have drained completely leave the valve open and service the injectors, fuel lines or Wye – this does not drain the tank, so the tank cannot be serviced until the tank evacuation procedure has been completed as previously discussed

### **Recommended Preventative Maintenance**

*Note: Regardless of mileage, the propane fuel system should be inspected annually.*

1. Ask the driver of the vehicle for his comments about the drive ability of the vehicle
2. Visually inspect the injector rail(s) on the engine; confirm the mounting bolts are tight and visually inspect each injector housing for cracks or misaligned upper o-rings visually detectable at the top of the injectors insulator housing.
3. Inspect for any loose engine wire harnesses that have come in contact with injector rails or injector components.
4. Fuel hose routing from tank to injector rails – inspect all hoses for proper routing, protection from chaffing, hose clamps are tight, and if a hose does not have 8” clearance or more from the exhaust, it must be protected by a shield; correct any problems that are found
5. Inspect the tank for corrosion, rust, dents and confirm the identification plate is attached to the tank and it is legible; if the data plate is not legible, the tank must be replaced
6. Inspect all tank mounting bolts for proper torque, 52 foot pounds
7. Inspect mounting supports for cracks and replace tank if cracks are found; report any problems with structural integrity of the tank to Bi-Phase
8. Confirm the tank service valves are protected with a brass flare cap and if the valve does not have a cap on the service valve, install a brass 3/8” flare cap and tighten
9. **Verify the fill valve/hose is holding pressure. (Test procedure on pages 58-59)**
10. Follow the fuel pressure testing flow chart on pages 21-22 and confirm all fuel pressures are within specification
11. **Initiate a purge cycle and after the purge cycle is complete. Spray the injectors, injector connectors, injector rails and all hose connection with leak detecting solution. Check for leaks..**
12. **Leak test the entire propane system, all hose connections, tank valves and appurtenances with leak detecting solution.**
13. Install a scan tool and document
  - Check for diagnostic trouble codes and investigate
  - ECT, engine coolant temperature, must be operating temperature 194 F
  - STFT, short term fuel trim, Bank One & Bank Two
  - LTFT, long term fuel trim, Bank One & Bank Two; document this value at idle and 2000 RPMs
  - Injector pulse width, Bank One & Bank Two, at idle
14. Test drive the vehicle and document any abnormal driving characteristics
15. Perform a 20-minute hot soak as described on page 34
16. Document all these results, keep a copy and give the customer a copy
17. **Verify transfer system works.**
18. To simulate a level difference, remove each fuel level gauge sending unit from the tank; note: only remove the two very small Phillips head screws on the sending unit and lift the sending unit out of the float assembly head
19. Leave the sending units connected electrically



**Recommended Preventative Maintenance, cont'd**
**Fuel transfer**

20. Using a magnet, position each sending unit to an equal fuel level
21. Start the engine
22. Move the primary tank's sending unit; the transfer tank pump should come on; if it does not, turn off the key/engine
23. Synchronize the sending units to equal fuel levels; start the engine; move the primary tank's sending unit and listen for transfer tank pump to start running.

**Fuel Level Gauge- Resistance Values**
**Isuzu**

<b>Year</b>	<b>Gauges (Empty to Full)</b>	<b>Tanks</b>
<b>2012</b>	<b>40-250 ohms</b>	<b>1</b>



## Replace the Fill Valve, Fill Filter or Fill Hoses

*Note: You will need to drain the fuel from the fill hoses and filter, but not from the fuel tank(s). There is a back-check valve where the fill hose connects to each tank, so the contents of the tank(s) cannot escape through the fill hose or fittings. It does not matter how much fuel is in the tank(s).*

1. Park the vehicle outdoors at least 15 feet from other vehicles, buildings and sources of ignition
2. Locate the fill filter, fill valve or fill hoses
3. Slightly loosen the flare nut on the fill filter, fill valve or fill hoses – cold liquid propane will spray out until the hoses are empty (this should take less than a minute)
4. Wait until the propane stops venting from the flare nut, then loosen the nut a bit further – more propane may spray out
5. Loosen flare nut(s) completely
6. Remove clamps or ties
7. Install new fill filter (directional flow), fill valve or fill hoses
8. Reinstall clamps and ties and tighten
9. Tighten flare nut(s)
  - Fill filter – 10-15 foot pounds
  - Fill valve – 10-15 foot pounds (note: fill valve also has a mounting nut, tighten to 12-18 foot pounds)
  - Fill hoses – 10-15 foot pounds
10. Refuel the vehicle, check for leaks using a leak detecting probe or soapy water

## Recommended Filter Maintenance

Bi-Phase recommends that the fill filter 30,000 miles.

### Fill Filter

Each LPEFI® system is equipped with a fill filter to remove any particles that may flow from the dispensing system used for filling the tank. This filter is a proprietary filter and can only be purchased from Bi-Phase Technologies. If this filter is changed to an inferior filter or removed from the system, the warranty is void. Fuel only flows through this filter while you are refueling the vehicle.

### Change Fill Filter

1. Park the vehicle outdoors, at least 15 feet from other vehicles, building and sources of ignition
2. Locate the fill filter – it is installed between the remote fill valve receptacle (where you connect the refueling hose) and the overfill prevention device located on the tank, as well as inline with the hoses

*Note: You will need to drain the fuel from the fill hoses and filter, but not from the main fuel line or from the tank. There is a double back-check valve in the tank that prevents fuel from escaping through the fill hoses. It does not matter how much fuel is in the tank(s).*



**Warning:** Cold liquid propane will spray out as you drain the fill hoses. To prevent freeze burns, wear insulated PVC rubber gloves. Always be aware of your surroundings and do not allow any sources of ignition.

3. Slightly loosen one of the flare nuts on the fill filter; use a  $\frac{3}{4}$ " wrench to keep the filter from turning as you loosen the flare nut – cold liquid propane will spray out until the fill filter and fill hoses are empty (this should take less than a minute)
4. Wait until the propane stops venting from the flare nut, then loosen the flare nut a little more to confirm all pressure has been released from the fill hose and fill filter assembly
5. Loosen the remaining flare nut on the fill filter and remove both hoses from the fill filter
6. Remove the hold down clamp on the fill filter and remove the fill filter
7. Reinstall the new fill filter noting that it is directional and must be installed in the direction of flow; arrow pointing to the tank or inlet pointing to the remote fill valve receptacle
8. Install the hold down clamp and bolt it in place
9. Using a  $\frac{3}{4}$ " wrench to hold the filter in place, tighten the flare nuts of each fill hose; tighten both flare nuts to 10-15 foot pounds
10. Refuel the tank, check all the fittings for leaks and tighten the flare nuts more, if required
11. Use an approved leak detection fluid to check for leaks, or an electronic combustible gas detector

### Fill Filter Illustrations



## **Fuel Fill System and Fuel Transfer System Leak Test**

**Purpose:** To ensure that no leaks are present in the propane **Fuel Fill System and the Fuel Transfer System**.

**Frequency:** These steps must be performed at scheduled preventative maintenance intervals.

### **Test Instructions**



**Warning:** Follow all safety procedures.

**This test must be performed outdoors and away from any ignition sources.**

**Ensure vehicle was NOT fueled within the last 20 minutes prior to performing this test.**

## **Fuel Fill System Leak Test**

This test requires the use of fill system test tool (Bi-Phase Technologies p/n 271292)

1. Insure test tool valve is turned completely out (clockwise).
2. Remove truck fill valve cap and install test tool. Side discharge hole on test tool should point downward.
3. Turn test tool valve inward (counter clockwise) until resistance is felt.
4. Continue to turn valve inward until propane is released through the side discharge hole of the test tool. If propane is released, quickly turn valve outward (clockwise) to stop loss of propane.
5. If propane is released, Fuel Fill System passes the test. Proceed to **Fuel Transfer System Leak Test** if vehicle is equipped with dual tanks.
6. If propane was not released the fill system has a leak and lost its pressure. Close valve by turning it clockwise and proceed to step 7.
7. Pressurize vehicle fill system by connecting fill system test tool (p/n 274068) to a suitable hose. Use transfer hose p/n 271698 part of the vapor burner kit p/n 271157. Connect the other end of the hose to one of the service valves on the vehicle tank. Verify spitter valve on fill system test tool is closed. Slowly open service valve to prevent tripping the overflow protection device (OPD). Turn fill system test tool valve slowly inward (counter clockwise) until vehicle fill system is pressurized with propane from the tank.
8. Check each connection in the fill system using leak detection fluid (included in the PMI Leak Test Kit p/n 271292).
9. Repair all detected leaks.
10. Pressurize and recheck for leaks.

**Fuel Transfer System Leak Test** (perform only on dual tank trucks), **cont'd**

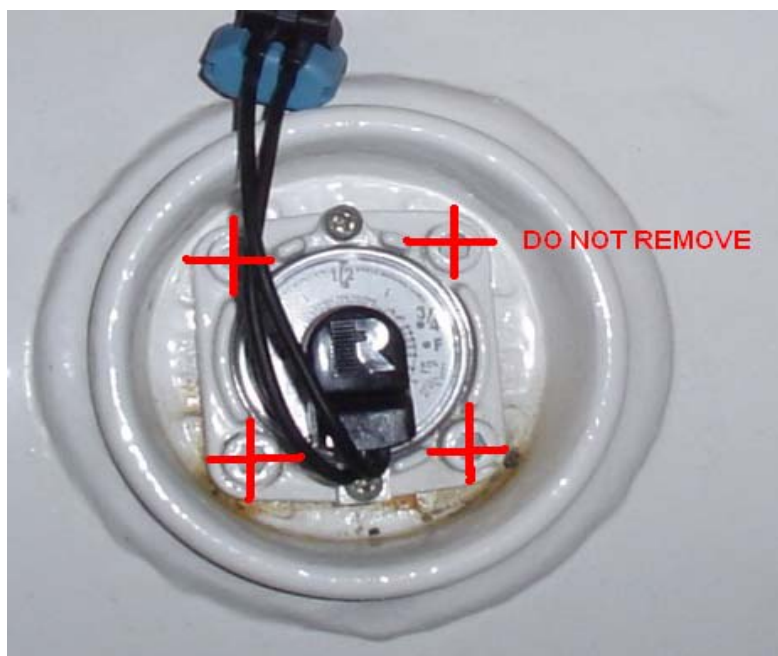
A transfer must be initiated to insure that pressure is present in the transfer system. Secondary tank must not be completely empty when performing this test

1. To initiate a transfer, inspect and verify that the secondary tank gauge reads  $\frac{1}{4}$  tank or more. If it does not, remove gauge and using a magnet position the gauge to read at least  $\frac{1}{4}$  tank. Note: only remove the two very small Phillips head screws on the sending unit and lift the sending unit out of the float assembly head.
2. Remove the primary tank gauge. Using a magnet, position the gauge to read empty. **Note: only remove the two very small Phillips head screws on the sending unit and lift the sending unit out of the float assembly head.**



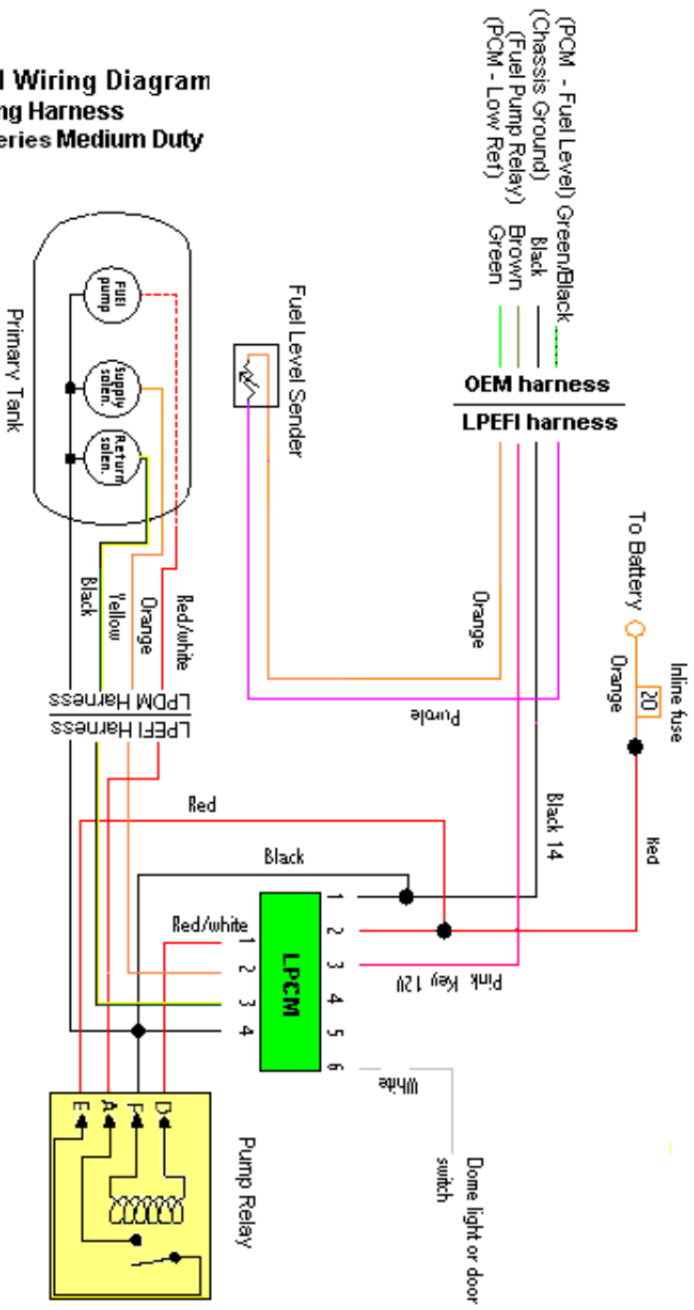
**Warnings DO NOT ATTEMPT TO REMOVE THE 4 SOCKET HEAD CAP SCREWS THAT HOLD THE FLOAT ASSEMBLY UNITS TO THE TANKS. THE PRESSURE INSIDE THE PROPANE TANK CAN PUSH THE FLOAT ASSEMBLY UNIT OUT WITH ENOUGH FORCE TO CAUSE SEVERE INJURY OR DEATH.**

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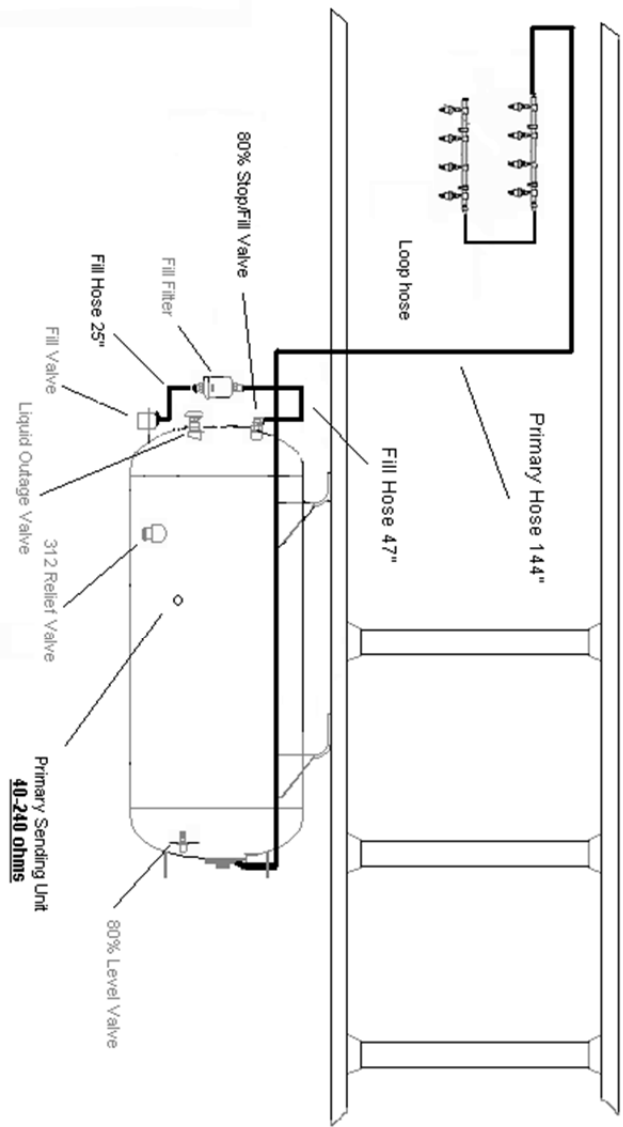


3. Leave the sending units connected electrically
4. Start the engine
5. Verify that the secondary pump has turned on. If it has not, perform diagnosis to determine transfer system problem. If the pump turned on, proceed to next step.
6. Using leak detection fluid, inspect all connections in the transfer system.
7. If any leaks are found, repair and retest.

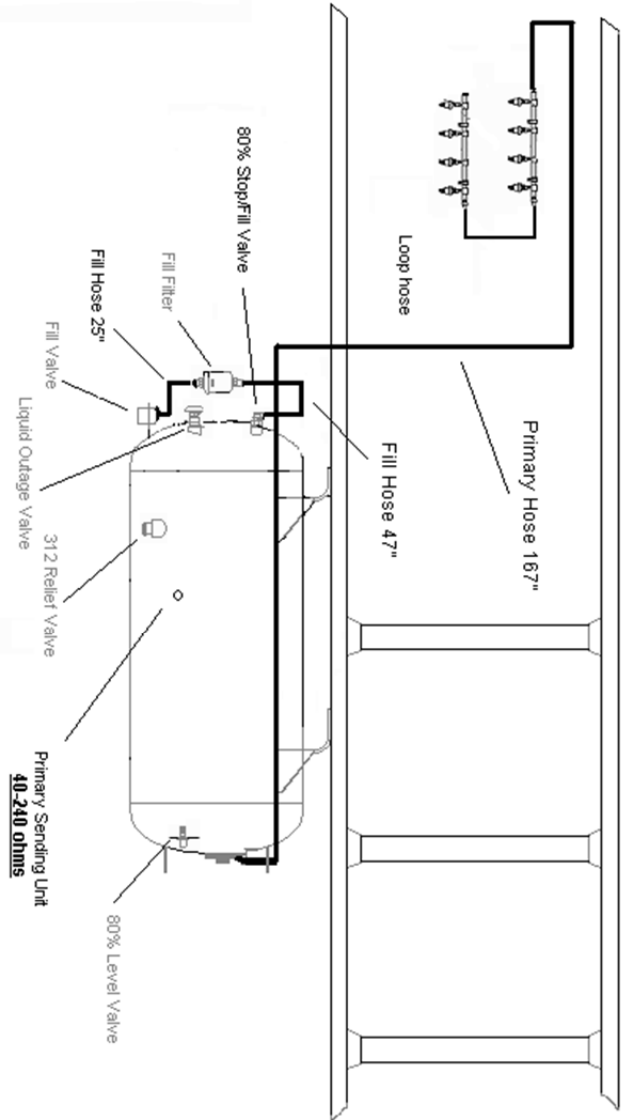
**LPEFI**  
**Electrical Wiring Diagram**  
**Main Wiring Harness**  
**Isuzu W series Medium Duty**



6.0L Tank & Hose Configuration



6.0L Tank & Hose Configuration  
Crew Cab



***Bi-Phase Technologies***  
***LPEFI®***

**Service Tools**

**“3-Switch” Test Box**

This tool available from Bi-Phase Technologies allows a technician to manually operate the tank fuel supply valve, fuel return valve and fuel pump. A built-in ammeter displays the total current consumed by the fuel pump and valves. It makes diagnosing easy and every technician servicing the Bi-Phase Technologies, *LPEFI* system should order one.



**Fuel Pressure Gauge Testing Kit**

This pressure gauge testing kit is equipped with a quick connect Schrader Valve connector which allows for easy connection and safe disconnect without releasing any fuel trapped in the hose. A valve on the gauge tee allows the technician to bleed the fuel from the hose outside in a safe location, instead of uncontrolled release in the service bay. The valve would also be used to evacuate the fuel lines on the vehicle when required. Every technician should have one.





***Bi-Phase Technologies***  
***LPEFI®***

## **Service Tools**

### **Torch Kit**

This tool is necessary to transfer fuel from one tank to another. The torch allows you to safely burn the vapor being released from the receiving tank (instead of releasing the vapor to atmosphere) so liquid transfer can be accomplished with the transfer hose. The transfer hose has a sight glass that allows you to see the direction of the fuel flow. An 80-gallon transfer operation can be completed in one hour with this kit and by following the instructions in this manual on pages 56-60. Every serious technician should have this kit.

