CLEANFUEL USA

DEDICATED LIQUID PROPANE INJECTION

FUEL SYSTEM SUPPLEMENT FOR

8.0L ENGINE

LIQUID PROPANE INJECTION
This manual contains the latest information available at the time publication. CLEANFUEL USA reserves the right to make changes in the products or information contained in this manual without notice.
CleanFuel USA Liquid Propane Injection System

Introduction

Liquid Propane Injection LPI® is a fully integrated, factory installed propane fuel system installed in the OEM factory. LPI® is also EPA/CARB certified and has demonstrated compliant tail pipe emissions, evaporative emissions and onboard diagnostics as required.

This manual is to provide general information in the diagnosis and repair of an LPI equipped 8.0L Engine. Anyone who performs repairs to the LPI® system must be trained. Anyone who performs repairs must have knowledge of Liquefied Petroleum Gases and understand the safe handling and characteristics of propane. Some states may require a license to work on propane vehicles. Consult your state or local authorities or your state propane gas association. CleanFUEL USA is not responsible for your oversight to comply with federal, state or local laws regulating the installation or repair of propane gas systems.

The LPI 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 Powertrain Integration diagnostic scanner.

For information contact:

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Georgetown, Texas 78628
Technical call center 877-234-1722
www.cleanfuelusa.com
FUEL SYSTEM WARNINGS

CAUTION: Do not smoke, carry lit tobacco, or use an open flame of any type when working on or near any fuel related component. Flammable air-fuel mixtures may be present and can be ignited causing property damage, personal injury or death.

CAUTION: Do not allow liquid propane to contact the skin. Escaping propane can cause severe freeze burns to the skin on contact. Wear protective gloves anytime you are loosening a fuel line or fitting where liquid propane could be trapped. Propane is stored as a liquid and the fuel system lines transfer fuel in a liquid state to the injectors.

CAUTION: Propane is non-poisonous, non-toxic, has the lowest flammability range of any other alternative fuel, and dissipates quickly when released to the atmosphere. Propane is heavier than air and can settle at the lowest point. When the air to propane ratio is between 2.15% and 9.60% the propane can ignite in the presence of an ignition source of 940° F (504° C) and higher. Keep away from all sparks, flames, heat, static electricity or other sources of ignition. Property damage, personal injury or death may occur if this warning is ignored.

CAUTION: Do not make repairs to the liquid propane injection fuel system if you are not trained to service the liquid propane injection fuel system. Contact the OEM dealer who sold you the vehicle or the installer of the system to locate a repair facility with trained technicians to repair your fuel system.

CAUTION: When making repairs to the liquid propane injection system disconnect the battery ground to ensure that the vehicle has no system electrical current. Property damage, personal injury or death may occur if this warning is ignored.

WARNINGS, CAUTIONS: and NOTES

This manual contains several different warnings, cautions and notes that must be observed to prevent personal injury and or damage to the equipment, the fuel system or personal property.

A “WARNING” Label or statement is used when it has been determined that by performing a process or procedure defined in the manual improperly; it could result in serious bodily injury, death, property or vehicle damage.

Typical Warning Label

WARNING

Failure to heed could result in death, injury or property damage.

Typical Warning Label

CAUTION

Less severe than WARNING, but potential to cause injury or damage. Also used to notify of situations that could lead to eventual failure, injury or damage.

This caution label may also appear in areas of this manual which apply to service and repair procedures which could render the fuel and emissions control system non-compliant. In addition, it may also be used to indicate a failure to observe which may influence the terms of the warranty.

An “IMPORTANT” statement generally denotes a situation which requires strict adherence to the assembly, tightening, or service procedure. Failure to observe this
procedure could result in an unsafe condition or improper performance of the vehicle or a component.

A “NOTE” statement applies to a specific item or procedure which is to be followed during the servicing of the vehicle or its components.

PROPER USE OF THIS SERVICE MANUAL, TOOLS AND EQUIPMENT

To reduce the potential for injury or damage to the vehicle during service repairs the technician should observe the following steps:

- The service procedures defined in this manual, when followed, have been found to be a safe and efficient process to repair the fuel system. In some cases, special tools may be required to perform the necessary procedures in order to safely remove and replace a failed component.

- The liquid propane injection system installed on the 8.0L engine has been listed with the California Air Resource Board (CARB) as a certified system and complies with all model year emissions regulations. When servicing the fuel and emission control system, you should follow all the recommended service and repair procedures to ensure the fuel and emissions system are operational as designed and certified. Do not disable, defeat or tamper with any part of the fuel or emission systems which would leave the fuel and emissions control system in a non-compliant state.

- Tools identified in this manual can be obtained from Cleanfuel USA and/or a Cleanfuel USA distributor.

IMPORTANT:

It is important to remember that there may be a combination of metric and SAE fasteners used in the installation of the liquid propane injection fuel system. Check to ensure proper fit when using a socket or wrench on any fastener to prevent damage to the component being removed/installed or injury from “slipping off” the fastener.

IMPORTANT:

The liquid propane injection system utilizes fuel line hoses with swivel connections that attach to fixed mating connectors. You should always use a wrench of the proper size on both the swivel and the fixed fitting to prevent turning of the fixed fitting. Turning of the fixed fitting may cause a “twisting” or “kinking” of the hose or fuel line and may result in a restriction of the fuel line or a leak.

WARNING

ALWAYS LEAK CHECK ANY FUEL SYSTEM CONNECTION AFTER SERVICING! USE AN LIQUID LEAK DETECTION SOLUTION OR A ELECTRONIC LEAK DETECTOR OR BOTH. FAILURE TO LEAK CHECK COULD RESULT IN SERIOUS BODILY INJURY, DEATH OR SERIOUS PROPERTY DAMAGE

CAUTION

Do not use any other replacement o-rings other than those supplied by CleanFuel USA. These o-rings have been made with special material that is compatible with the liquid propane as well as the fuel system components. The use of o-rings other than supplied by CleanFuel USA can cause severe system damage and possible personal injury.

CAUTION

Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.
LPI® Service Tools

These kits are required for properly repairing 6.0L and 8.0L LPI® fuel systems

LPI® Service Tool Kit Part Number: SVK-0012-X-01

*Also Includes 40 Foot Evacuation Hose (Not Shown)

60 Gallon LPG recovery tank equipped with internal transfer pump (Part Number: FTX-0083-X-01)
Facts About Propane

**Approximate Properties of LP-Gases**
(Commercial Propane)

\[
C_3H_8
\]

Specific gravity of liquid (water = 1) at 60 degrees F......................... 0.504

Initial boiling point at 14.7 psia, (displayed in degrees F.)..................... -44.0

Weight per gallon of liquid at 60 degrees F. (displayed in pounds)......... 4.24

Cubic ft. of vapor per gallon at 60 degrees F.................................. 36.38

Specific gravity of vapor (air = 1) at 60 degrees F.............................. 1.50

Ignition temperature in air, degrees F............................................. 940 to 1120

Maximum flame temperature in air, 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 110

**Heating values:**

- BTU per cubic foot................................. 2,488
- BTU per pound...................................... 21,548
- BTU per gallon................................. 91,500

**Approximate vapor pressure in psig at:**

- 70 degrees F.............................................. 109.3
- 100 degrees F............................................ 172.3
- 110 degrees F............................................ 197.3

Rate of expansion by volume; 1 part liquid expands 270 times to vapor .......... 1:270

**CAUTION:** When servicing a propane fuel tank be aware of your surroundings and caution everyone nearby of the possibility of flammable vapors. Work with a high awareness for safety and respect for other people and property. Make SAFETY a priority by practicing proper handling of propane at all times.

**CAUTION:** It is your responsibility to know the law. NFPA, National Fire Protection Association, has manuals for your reference in understanding safe handling of many products. We recommend that you obtain and read NFPA #58, Standard for the Storage and Handling of Liquefied Petroleum Gases.
Facts Continued

Propane is stored as a liquid therefore providing as much storage capacity as gasoline however the operating range for the same storage capacity is about 90% that of gasoline due to the energy content of a given volume of fuel. Propane has less energy content than gasoline but is more efficient due to its ability to vaporize almost completely.

With a boiling point of –44 degrees Fahrenheit propane is stored as a liquid and requires only moderate pressure to keep it a liquid in the tank. The liquid propane injection system takes advantage of this characteristic by injecting the fuel as a liquid;

- The liquid fuel exiting the injector absorbs heat to vaporize therefore cools the incoming air charge. This makes the incoming air a higher density which increases the amount of air charge entering the combustion chamber which results in improved power.
- The liquid charge will also provide some cooling of internal engine components, intake valve and valve seat.
- The liquid also contains heavy ends such as oils or paraffins which separate at the point of vaporization providing some lubrication benefits.

Propane in general is widely used but people are not as familiar with it as they are with gasoline. We carry gasoline around in an open container, it can sit open without concern other than evaporation. We pour it from a can into a lawn mower and because it has been the most widely used engine fuel, we don’t think about the dangers of it. Because propane is not so commonly used, people are not as familiar and therefore not as comfortable with handling propane. Propane is in a sealed container and cannot be simply poured from a can into a fuel tank. By understanding the properties and safe handling of propane, you can have a safe and successful experience with it. This is why you will find warnings in this manual that caution you about the characteristics of propane and/or dangers that you could be faced with handling the product improperly.

Propane is heavier than air in a vapor state; 1.5 times heavier than air. A good comparison that many people don’t know is that gasoline is heavier than air in a vapor state too; 4.5 times heavier.

Actually propane is not much different than gasoline. Generally it is considered to be the fuel closest to gasoline in combustion characteristics than any other alternative fuel. Butane is yet closer due to its higher boiling point.

IMPORTANT: We recommend that you obtain and read NFPA #58, Standard for the Storage and Handling of Liquid Petroleum Gases.

Propane is a colorless, odorless, non-toxic gas. An odorant called Ethyl Mercaptan is added at the producers terminal. All propane is odorized for the purpose of leak detection. Anytime the odor is detected an investigation for a leak must be performed.

Initially
- Eliminate all sources of ignition
- Verify that all tank manual valves are closed (Refer to fuel shut off in owners manual)
- If indoors, in a garage, all doors and windows should be opened
- Inspect the fuel system completely for leaks using approved leak detection solution or an electronic leak detection device
- Repair the source of the leak

CAUTION: Liquid propane vaporizes at a ratio of 270:1. This means it is 270 times more dense than vapor.

As previously mentioned, the boiling point of liquid propane is – 44° F. Above this temperature it changes to a vapor. Below this temperature is where the fuel changes to a liquid. In the propane tank the fuel is in a liquid state and the vapor pressure created by the boiling liquid sustain the fuel in a liquid state. As the temperature increases the pressure required to sustain the fuel in a liquid state increases. One other effect temperature has on the fuel is the space it occupies. As temperature & pressure increases, so does the liquid level inside of the tank. The liquid amount will remain the same however it expands and occupies more space. (refer to figure 1 in this section)
Facts Continued

This is why a propane tank is never filled more than 80% with liquid. There must be room for expansion of the liquid in case of increased temperature. For example, the tank is filled to 80% in the morning at the ambient temperature of 60 degrees. In the afternoon the temperature is at 80 degrees and the space requirement may increase by 3%.

CAUTION: Never overfill a propane tank.

<table>
<thead>
<tr>
<th>Temperature Degrees F</th>
<th>Approximate Pressure (PSIG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>1.3</td>
</tr>
<tr>
<td>-30</td>
<td>5.5</td>
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<td>-20</td>
<td>10.7</td>
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<td>100</td>
<td>172.3</td>
</tr>
<tr>
<td>110</td>
<td>197.3</td>
</tr>
</tbody>
</table>
Maintenance of the Liquid propane LPI® system

This section of the service manual supplement covers the components of the LPI® dedicated fuel system, which require regularly scheduled maintenance. For maintenance of the base engine, refer to the OEM engine service manual or for chassis refer to the OEM chassis manual.

Fuel Fill Valve
On the LPI® system, prior to each fill; the fill valve coupling for the following:

- Check coupling for damaged, cracked or stripped threads to prevent a “cross threaded” connection that may cause leaking or possible “blow-off” during fueling.
- Check the filler valve o-ring or gasket for any damage to prevent leakage during fueling. Replace if necessary. A new o-ring can be obtained from CLEANFUEL USA or a CLEANFUEL USA distributor. Part number: VAX-0503-S
- Check for debris in the fill valve and clean if necessary
- Check to ensure there is no debris in the fill nozzle, clean if necessary.
- Check to ensure the fill cap is in place to prevent fuel contamination. Replacement filler valve caps can be obtained from CLEANFUEL USA or a CLEANFUEL USA distributor. Part number: VAX-0502-S

Annual Overfill Protection Device (OPD) Function Verification
The OPD (Overfill Protection Device) must be annually inspected to verify proper function. The date of the test must be logged and maintained.

To test the function of the valve, park the vehicle on level ground. The tank fuel level should be less than 1/8 of a tank registering on the fuel gauge. The tank must then be filled while the 80% liquid level gauge (bleeder or outage valve) located on the tank is open. (This valve is not normally utilized for fueling, so it should be capped.) Remove the cap to perform this procedure, re-installing when completed. (Refer to Tank Section for valve location.)

With the tank fuel level below 1/8, fill the tank while monitoring the station pump meter and bleeder valve. The automatic stop fill valve (OPD) should close just before or after liquid appears in a steady stream from the bleeder valve. The metered volume of the tank should not exceed the published volume by more than 5%, with a temperature compensated meter. If the volume exceeds this amount, or the OPD does not stop the filling process within 2-3 gallons of the correct volume, then stop the filling process immediately. The tank OPD fill valve will need to be replaced. Refer to the Tank Service section of this manual.

Propane Fuel System Leak Inspection
The propane fuel system should be inspected for leaks at least once per year, or anytime the system is serviced, or anytime the distinctive odor of propane is detected. Use an approved liquid leak detection solution or an electronic leak detector. Inspection should be performed by a trained LPG service technician. If a leak is found repair or replace the component as required.

FUEL TANK MAINTENANCE
The LPI® fuel tank should be checked annually for the following:

- Check for any damage to the exterior of the tank.
- Inspect all fasteners and brackets to make sure the tank is securely fastened to the chassis.
- Check to ensure all service valves and or shut-off valves are functioning and the manual shut-off valve fully closes the valve.

- Check to ensure the pressure relief valve vent is clear of any obstructions (some might include a dust cap ensure the cap is securely in place) A new dust cap can be obtained from CLEANFUEL USA or a CLEANFUEL USA distributor. Part number: PRX-1000-S

- Check that all solenoid wiring and connectors are securely attached, connected and locked.

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**WARNING**

NEVER CUT OR WELD ON THE PROPANE FUEL TANK. REPAIRS TO FUEL TANK SHOULD BE MADE BY TRAINED TECHNICIANS ONLY

**INJECTORS AND FUEL RAILS**

The propane injectors and fuel rails require no adjustments. You should annually inspect the following items on the fuel rails and injectors.

- Check to ensure that all the injector electrical connectors are securely connected and locked.

- Check to make sure the fuel rail is securely attached to the engine.

- Check all injectors, rails and fittings for leaks using liquid leak detection solution or a electronic leak detector.

**FILL FILTER / INLINE FILTER**

Check the fill filter and inline filters annually for the following

- Check that the brackets are securely attached to the chassis

- Check all connections for leaks using a liquid leak detection solution or a electronic leak detector.

- Filters must be replaced every 30,000 miles.

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**CAUTION**

KNOWINGLY OR PURPOSELY DISABLING OR MODIFYING AN EVAPORATIVE EMISSIONS CONTROL DEVICE IS STRICTLY PROHIBITED

**FUEL LINES**

Check the fuel lines and fittings annually for the following:

- Check to ensure all mounting points are intact and securely mounted.

- Leak check all lines and fittings to ensure a leak free system.

**VAPORATIVE EMISSIONS SYSTEM**

Check the evaporative emissions system annually for the following:

- Check that all brackets are securely attached to the chassis

- Check all connections a securely connected to their mating ends

- Check that the pump cover has no damage.

- Check the electrical connection on the evap pump making sure it is securely connected and locked.
### CFUSA LPI® FUEL SYSTEM

#### RECOMMENDED MAINTENANCE SCHEDULE

<table>
<thead>
<tr>
<th>DESCRIPTION OF MAINTENANCE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annually</td>
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<tr>
<td>Fuel Tank Inspection</td>
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</tr>
<tr>
<td>Check for damage</td>
<td>X</td>
</tr>
<tr>
<td>Leak check all tank fittings and connections</td>
<td>X</td>
</tr>
<tr>
<td>Check all tank mounting hardware</td>
<td>X</td>
</tr>
<tr>
<td>Fuel Lines</td>
<td>X</td>
</tr>
<tr>
<td>Inspect lines for damage</td>
<td>X</td>
</tr>
<tr>
<td>Leak check all line fittings</td>
<td>X</td>
</tr>
<tr>
<td>Fuel Injector Rail and Injectors</td>
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</tr>
<tr>
<td>Leak check rail fittings and injectors</td>
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<tr>
<td>Injectors electrical connectors</td>
<td>X</td>
</tr>
<tr>
<td>Evaporative Emissions System</td>
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<tr>
<td>Check all connections are fully connected</td>
<td>X</td>
</tr>
<tr>
<td>Check pump cover has no damage</td>
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<tr>
<td>Check electrical connector on pump</td>
<td>X</td>
</tr>
<tr>
<td>Fill Filter and Inline Filters</td>
<td></td>
</tr>
<tr>
<td>Replace filters</td>
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</tr>
</tbody>
</table>

This maintenance schedule represents CleanFUEL USA recommended maintenance intervals to ensure safe & reliable operation of the CleanFUEL USA LPI® System. Vehicles which operate in harsh environments may require more comprehensive or frequent inspections. If you have any questions regarding the maintenance procedures and or question regarding the system please contact CleanFUEL USA (877-234-1722, service@cleanfuelusa.com) or a CleanFUEL USA distributor.
Liquid Propane Injection System Description and Operation

This LPI® fuel system is the most technological advanced propane engine fuel system ever developed, LPI® works much like a typical gasoline fuel injection system. It 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 is the same and controls the LPI® system just as it would a gasoline injection system. Engine control diagnostics remain unchanged so the diagnostic approach is the same as a gasoline running engine.

The LPI® system consists of four main components: the tank assembly, the fuel lines, the injectors/regulation and the evaporative emission system. The fuel tank contains the most complicated components of the LPI® system. It includes an internal electric fuel pump, fuel supply, return, and a baffle that keeps the pump submerged in liquid propane. It also has a fuel level float assembly, pressure relief valve, overfill prevention device, and both liquid and vapor service valves. The LPI® fuel pump increases or boosts the tank pressure by 50–60 psi. The fuel is supplied to the injectors then loops back to the return valve on the tank. The tank is located on the vehicle frame and the lines are routed forward to the engine compartment injector rail assemblies. They are mounted in the same location as a set of gasoline injector rails would be installed. The regulator is also mounted on the intake which is located on the rear. The regulator maintains the fuel pump boost pressure between 50 to 60 PSI. This allows there to be a pocket of liquid supplying the injectors at all times. Regardless of the propane tank internal pressure, the pump boost pressure remains constant. This is how the fuel remains liquid throughout the supply section of the system. When the engine is turned off heat soak increases the pressure inside the rails causing the liquid to vaporize and rapidly flow back to the tank. To help with hot restarts, the system goes through a purge cycle for 1 to 20 seconds, depending on temperature and pressure in the LPI® rails. With every start up the system activates a bypass solenoid valve (Also a part of the regulator assembly) which opens a larger return passage allowing the fuel rails to be purged rapidly with liquid propane. This time varies with the pressure and temperature of the LPI® fuel rails. This strategy is built in to the system’s LPG control module. During the purge cycle the “Wait to Start” indicator will be illuminated.
CFUSA LPI® 8.0L DEDICATED LIQUID PROPANE INJECTION FUEL SYSTEM

Description and Operations

LPI® FUEL SYSTEM MECHANIZATION/HYDRAULIC DIAGRAM

CLEANFUEL USA Inc.  REV A  16  LIQUID PROPANE INJECTION
LPI® FUEL SYSTEM OVERVIEW.

External Fuel Tank (Figures 1 - 4)

The fuel tanks meet American Society of Mechanical Engineers (ASME) design for a working pressure of 312.5 psi and a burst pressure of 1250 psi. Baffles are built into the tank to keep the fuel pump submerged in liquid propane.

Overfilling Prevention Device (OPD)

The overfilling prevention device is a mechanical float-actuated valve that stops the tank from being filled more than 80% capacity. By code, tanks must not be filled more than 80% full. This is to allow room for the liquid propane to expand. (Pages 9-10)

Fixed Liquid Level Gauge (80% Bleeder)

The fixed liquid level gauge is a mechanical means of verifying when the propane tank reaches 80% capacity which is the maximum liquid capacity of any propane tank. This gauge is a bleeder opened by a small thumb wheel that can be for visual monitoring during filling. When a white mist appears exiting this bleeder the tank is at 80% liquid capacity and the fill process should be stopped and the bleeder closed. Because the tank is equipped with an OPD it is not required to be used each time the tank is filled. However, many fill station attendants prefer to utilize it during the fill process. There are also fill stations where bleeding fuel to the atmosphere is prohibited. CAUTION: If this bleeder is utilized propane exits the valve and when mixed with air, the area around the filling operation can become a flammable/combustible environment. Follow proper filling procedures when filling a propane tank.

Pressure Relief Valve

If the pressure in the fuel tank exceeds 312.5 psi, the pressure relief valve (PRV) will vent propane vapor to the atmosphere. The pressure will not get this high unless the tank has been overfilled, or unless the tank is hotter than 60°C (140°F) or both. When the PRV vents the sudden pressure drop significantly cools the remaining liquid, the boiling liquid propane absorbs heat, pressure drops and the valve closes.

Liquid Supply Valve

The liquid supply valve delivers liquid pressurized by the fuel pump thru the fuel lines to the injector rails. The valve is excess flow protected and is integrated with an external 12 volt operated solenoid. It is activated when the ignition key is cycled to the on position. It is controlled by the OEM fuel pump control strategy. The electric solenoid serves as a 100% fuel lock-off for safety.

Vapor Return Valve

The liquid fuel is circulated from the fuel pump through the liquid supply valve, fuel lines, injector rails and back to the tank via the return valve. This return valve is a manual valve and the fuel returns to the tank through a regulator and a balancing orifice internal to the vapor space of the tank. This valve is equipped with an internal hydrostatic line pressure relief device if the manual valve is closed.
Fuel Pump Wire Pass-Thru

These two wires provide 12V and ground to the fuel pump through this hi-pressure sealed plug. The wires are sealed and molded into the pipe fitting without any added connections or terminals to increase resistance.

Fuel Level Float / Sensor

Externally mounted, an arm and float extends to the inside of the tank. It raises or lowers with the liquid level of the fuel. A externally mounted sending unit reacts magnetically to the fuel level and provides a resistance value to the fuel level gauge on the dash. Resistance value is 250 ohms empty to 40 ohms full.

Liquid Evacuation Service Valve

This valve is used to evacuate the fuel from the tank before servicing any valve on the tank or the tank itself. The valve is capped with a brass cap which should always be reinstalled after any service procedure.

Fuel Pump Access Cover

This port is used to provide access to the fuel pump inside the tank. The fuel pump access cover utilizes an o-ring seal to seal to the flange. This o-ring should be replaced anytime it is removed.

INTERNAL FUEL TANK

Fuel Pump

The LPI® system is equipped with a submerged fuel pump located in the bottom of the propane tank much like a submerged gasoline fuel pump. In order to maintain the fuel in a liquid state through out the fuel lines and injectors the fuel pump will boost pressure to approximately 50 - 60 PSI over tank pressure.

Baffle Check Valve

A one way check valve is used to allow fuel to flow into the baffled area freely, thus submerging the fuel pump in liquid propane. The baffle check valve will not allow fuel to escape out from outside the baffled area.

WARNING

Do not remove any valves or fittings from the tank unless the tank had been evacuated completely. The pressure inside a propane tank can push a valve or fitting out with enough force to cause death, injury or property damage.
FILTRATION AND FUEL LINES

Fill Filter / Supply Filters (Figures 5 - 7)

It is necessary as with any fuel to filter contaminants from entering the system. The liquid propane injection system incorporates a fill filter to catch contaminants from entering the tank during fueling. This alone will prevent most contamination from entering the fuel system however our filtration continues as with a gasoline system utilizing a “sock” type filter screen on the fuel pump and another inline fuel filter, located on the frame rail in the fuel supply line, to catch any contaminants before the fuel reaches the injectors. The fill filter and the inline fuel filter are replaceable and the recommended replacement interval is 30,000 miles. **Warning: When replacing filters the fuel line evacuation procedures must be followed.**

Fuel lines are Type III LPG approved hoses with minimum permeability in order to pass the evaporative shed test required by EPA/CARB. These hoses are very robust with rubber coated stainless steel braiding to protect against chaffing while built to a design working pressure of 350 PSI and burst pressure of 1,750 PSI. The lines are installed not to impinge on any sharp edges of the vehicle, engine or transmission components and are protectively routed the same as gasoline vehicles.

**FUEL RAILS AND FUEL DISTRIBUTION (Figure 9)**
LPI® Fuel Rails
The fuel rails are built of billet aluminum for minimum heat transfer and to accommodate the fuel distribution to each injector. The liquid fuel is delivered to each injector through a dedicated supply passage while a separate return passage allows for the fuel to flow back to the tank with minimum restriction. While the engine is running, the fuel flows through the rails and back to the tank generally in a liquid state. However, the absorption of heat from the engine and some restriction in the return passage can cause production of vapor bubbles which are returned to the tank and condense back to liquid depending on temperature and pressure. Once the engine has been turned off the absorption of heat into the rails will vaporize the liquid fuel increasing the pressure in the rail which pushes the fuel mixture back to the tank until temperature and pressure is equal to the tank. This leaves a void of vapor “a vapor lock” in the injector rails. Therefore the pump must prime the system for 3-30 seconds (depending on temperature) before the engine is started. The LPI® system utilizes a “wait to start light” that illuminates during the duration for the pump priming. If the engine was turned off it can be restarted immediately without waiting for the “wait to start light” to turn off. It is recommended to follow the “wait to start light” procedure to start the engine without the risk of a failed start. If started before the time a rough idle may be experienced until the injectors are full of liquid.

LPI® Fuel Injector
(Figures 12 - 14)
The injectors are high quality automotive injectors manufactured by Siemens VDO which is now Continental AG. The injectors are very reliable unless subjected to fuel contamination, such as water. When water is present in large amounts freezing could occur causing random misfires. Other contaminants such as rust particles, sulfur or brine (salt) could restrict the injector orifice.

The fuel injectors are a bottom feed design and the high impedance operating coil electrically match the resistance of most gasoline injector controllers at 12-14 Ω ohms. Flow calibrations are sized to meet the application. The spray pattern is commonly referred to as “pencil stream” and as liquid propane flows out of the injector orifice it immediately starts to vaporize.

WARNING
Do not remove an injector, injector rail fittings, or hoses unless the liquid supply/return valves have been closed and the fuel lines have been completely evacuated. The fuel pressure can push a valve or fitting out with enough force to cause death, injury or property damage.
Pressure/Temperature Sensor (Figure 16)

The combination LPG pressure and temperature sensor is located on the driver's side fuel rail. The LPG control module provides a reference voltage and ground to the sensor and receives the fuel pressure and temperature signals from the combination sensor. The values are used to calculate the amount of purge time required for start-up.

Fuel Distribution / By-pass Regulator Blocks (Figure 17)

The LPI® system fuel distribution/regulator blocks are located behind the intake manifold. There is a supply block and regulated return block. The fuel passes into the supply block from the tank and distributes fuel equally to each rail, then once the fuel exits the other side of both rails it is then returned to the regulated return block where the fuel is regulated allowing the fuel rails to keep 50—60 PSI boost over tank pressure and the unregulated fuel then flows back to the tank.

By-pass Solenoid (Figure 17 and 18)

This normally closed valve opens when the LPG control module energizes the LPG bypass relay. When energized, the fuel bypasses the fuel pressure regulator and flows directly into the return fuel line which is then returned straight into the LPI® fuel tank. This reduces the time required to purge all vapor from the system during start-up.

Stainless Steel Fuel Lines (Figure 19)

The fuel lines going from the distribution block to the rails are made out of 1/4” OD 316 stainless steel. Each connection incorporate a double flare for added leak protection. The max rated working pressure is 4300 PSI which is well over the 350 Max PSI needed for running the LPI® System.

Evaporative Emissions System

For many years gaseous fueled vehicles were exempt from evaporative emissions however after re-visiting the facts and conducting some testing; the requirements of EPA/CARB have identified that propane vehicles do need
to pass evaporative emissions tests. There are difficulties in the doing this, especially with “vapor style” propane systems due to the fact that hoses are permeable, diaphragms are permeable and injectors do leak. Actually gasoline injectors leak and additional “EVAP” considerations are made on some gasoline vehicles instead of the usual handling of the vapors in the gasoline storage tank. With a propane vehicle the fuel storage tank is a closed system containing a pressurized fuel where control of fuel vapors is not necessary although any small leak from a fitting, a hose or an injector can cause failed test results over a 72 hour “shed test.” The LPI® system has been designed to minimize any possibilities of leaks by using TYPE III hoses, stainless steel fuel supply tubes, reducing the amount of openings in the tank, utilizing environmental friendly thread sealing compounds and using no external regulator or vaporizer. The injectors however have a specified minimum leak rate, after mileage accumulation the leak rate may increase. This does not effect the performance of fuel control. Therefore a proprietary designed EVAP fuel handling system was implemented to ensure compliance with regulations. The LPI® system utilizes the OEM carbon canister and canister purge solenoid as well as the addition of a vacuum pump, to take care of any injector leakage while the engine is not running. This accomplishes two goals, it eliminates the possibility of fuel vapor leaking to the atmosphere and eliminates the chance of a richer fuel mixture during start up; both of which could cause non-compliance of tailpipe emissions or evaporative emissions.

When the engine is shut-off, a low amperage vacuum pump evacuates the manifold on command by the LPG Control Module. The pump may be heard while the vehicle is parked as it comes on at specific intervals for about a minute. Once the vehicle is re-started, the OEM canister purge strategy is utilized to purge the carbon canisters. The process starts over again when the vehicle is turned off.

The LPG Control Module also controls the “wait to start” light function and utilizes the pressure/temperature sensor to achieve this.
Vacuum Pump

Controlled by the LPG control module which supplies a ground signal to turn the pump on. The pump operates with a nominal current draw of .055 - 0.60 Amps.

LPI® EVAPORATIVE EMISSIONS SYSTEM DIAGRAM

Driver Side Valve Cover

8.0L Intake Assembly

Passenger Side Valve Cover

Vehicle 12V Battery

Sleep/Wake Signal

Chassis Ground

EVAP Pump Signal

EVAP Pump

Purge Solenoid

Canister Assembly

Evap 12V Positive Battery

Chassis Ground

Control Module

Sleep/Wake +12V Signal Under Hood

Fuse Block

PCV Line

Makeup Air

Figure 23

Figure 24

Figure 25
NOTES: