

# **Service Manual**

**Liquefied Petroleum Gas (LPG)  
Fuel System  
for  
1994-1998 GM Medium Duty Chassis  
(C-60/C-70)  
with  
6.0L and 7.0L V8**



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## VEHICLE APPLICATION

This IMPCO® propane system was designed to be installed on 1994 to 1998 GM Medium Duty Chassis (>14,000 GVWR) with 6.0L and 7.0L V8. **For non-California vehicles**, the installation instructions and system content are based on the conversion of a stock gasoline powered vehicle. Installation of this system on a previously altered and/or converted gasoline powered vehicle may require repair or replacement of any previously altered base vehicle components.

## PROPANE FUEL SYSTEM WARNING

**CAUTION:** Do not smoke, carry lighted tobacco, or use a lighted flame of any type when working on or near any fuel related component. Highly flammable air-fuel mixtures may be present and can be ignited causing personal injury.

**CAUTION:** Do not allow propane to contact the skin. Propane is stored in the fuel tank as a liquid. When propane contacts the

atmosphere, it immediately expands into a gas, resulting in refrigeration which can cause severe burns.

**CAUTION:** Do not allow propane to accumulate in areas below ground level such as in a service pit or under an alignment rack. Propane is heavier than air and can displace oxygen, creating a dangerous condition.

## GENERAL DESCRIPTION

### PROPANE FUEL SYSTEM

The primary components of the propane fuel system are the converter, mixer, electric lock-off solenoids and electronic control unit. The system operates at pressures up to 312 psi.

Propane is delivered from the tank to the electric lock-off solenoid. This solenoid is activated by the fuel pump control circuit. The lock-off, which is normally closed, opens only when the engine is cranking or running. Fuel passes through the lock-off solenoid to the fuel inlet on the converter.

Propane enters the primary chamber of the converter through the primary jet where the pressure is reduced to 1-2 psi. This fuel is then vaporized as it passes through the heat exchanger located in the center of the regulator.

During normal engine operation, the fuel is drawn from the secondary chamber of the regulator by the vacuum created as the air passes through the mixer. This pressure drop is most commonly referred to as air valve vacuum. As the air valve vacuum increases or decreases, the amount of fuel drawn from the secondary chamber will increase or decrease. In the mixer, the propane vapor is combined with air to form a combustible air/fuel mixture.

The fuel system is controlled by the Adaptive Digital Processor (ADP). The ADP receives input from various engine sensors to determine the amount of fuel necessary to maintain a precise air/propane fuel mixture across the entire engine operational range. The ADP then sends a command to the fuel control valve (FCV) to meter the appropriate quantity of fuel. The FCV meters the fuel flow by changing the pressure on the regulator diaphragm from atmosphere to vacuum. The system will also automatically sense and compensate for changes in altitude.

## CONVERTER

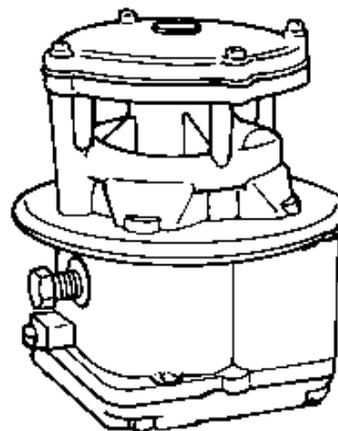
The IMPCO® Model E converter is a combined pressure regulator and vaporizer. The regulator is a negative pressure two-stage configuration which is closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line to the regulator. This opens the regulator, permitting fuel to flow to the mixer.

The regulator receives liquid fuel at tank pressure. The pressure is reduced in two stages to slightly less than atmospheric. In the first stage, the pressure is reduced to 1-2 psi. Also during this stage, the liquid fuel is vaporized by heating the base of the converter with engine coolant. A sponge located in the primary chamber absorbs any liquid fuel and prevents it from entering the secondary chamber. In the second stage, the vaporized fuel is drawn into the secondary chamber where the pressure is reduced to negative 1.5-1.8" of water column.

## MIXER

The IMPCO® Model 425 mixer is an air-fuel metering device and is completely self contained. It requires no linkage or idle vacuum line to the intake manifold. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load.

The vacuum applied to the air valve, working against a spring located on top of the valve, correctly positions the air valve to meter the proper amount of fuel for any given engine speed and load. The pressure drop which is controlled by the air valve spring provides the force to draw fuel into the air stream. The upward movement of the diaphragm controls the fuel flow in the venturi air valve.



A pressure drop under the air valve of approximately 0.2 PSI (6" water column) of pressure is required to lift the air valve off its seat. Approximately 0.5 PSI (13.8" water column) lifts the valve to the top of its travel in full open position. Lowered pressure communicated to the top of the diaphragm varies with engine speed and position of throttle valve opening. The air valve assembly measures the air flow into the engine by moving precisely in response to the demands of the engine and throttle valve position.

The controlled pressure drop of 0.2 to 0.5 PSI (6" to 13.8" water column) set up by the metering spring provides the signal or force necessary to draw fuel into the air stream within the carburetor. The gas metering valve is attached to the air valve assembly and is shaped to admit the correct amount of fuel from the gas jet to mix with incoming air at any opening of the air valve.

## ADAPTIVE DIGITAL PROCESSOR (ADP)

The IMPCO® Adaptive Digital Processor (ADP) is an electronic control module designed and manufactured as a closed-loop fuel controller for use with gaseous fuel systems. It receives input from various engine sensors to compute the required fuel flow rate required to maintain a precise air/propane fuel mixture across the entire engine operational range. The ADP controller does not require any service or scheduled maintenance.

The ADP incorporates an engine MAP (Manifold Absolute Pressure) sensor and engine RPM input. Feedback information from the oxygen sensor is used to update the digital block learn memory. By

storing this information, the ADP can instantly correct for proper air/fuel ratios under different operating conditions.

When the oxygen sensor sends a voltage above 450 mV, the ADP interprets that the fuel mixture is rich. The ADP will increase the duty cycle of the fuel control valve (FCV), increasing the vacuum signal on the top of the regulator secondary diaphragm. This closes the secondary valve slightly which reduces fuel flow. An oxygen sensor voltage of less than 450 mV is interpreted as a lean condition and vacuum is decreased. This increases fuel flow.

The ADP block learn memory is non-volatile. If the battery is disconnected, the memory will not be lost. The memory can be erased at any time by removing the ADP jumper connector as described in "ADP Initialization."

On the first start-up after the memory has been erased, the set-up procedure allows the ADP to enter a fast learn stage to update the internal memory cells within a very short period of time. After the ADP passes this fast learn stage, corrections slow down to provide stable performance for the rest of the vehicle fuel system's service life.

### **IMPCO® PROGRAMMABLE READ-ONLY MEMORY (PROM)**

The IMPCO® DSM incorporates most base vehicle diagnostic and control functions while optimizing spark advance specifically for propane to provide reduced emissions.

The DSM is available as a replacement part only and cannot be re-programmed in field.

The following base vehicle calibrations are modified by the IMPCO® DSM:

- Timing curve
- EGR diagnostics
- O2 Sensor diagnostics

The following base vehicle calibrations are disabled by the IMPCO® DSM:

- Injector circuit
- Evaporative Emission Control Diagnostics

### **ELECTRIC LOCK-OFF SOLENOID**

The electric lock-off solenoid provides electronic fuel shut-off for pressures up to 312 psi. It is a closed solenoid operated lock-off with a 1/4"

diameter fuel orifice. If the lock-off module fails, it is designed to fail in the closed position. The solenoid has a high temperature coil and is both UL and CGA approved.

## **FUEL AND IDLE CONTROL VALVES**

### **FUEL CONTROL VALVE (FCV)**

An electrically actuated control valve used to trim off idle fuel mixtures by controlling the pressure on top of the regulators secondary diaphragm. Controlled by the ADP, the valve is used to translate a duty cycle into a regulated vacuum signal. The fuel control valve will either meter air valve vacuum to the regulator to lean fuel mixtures, or reference atmospheric pressure to richen fuel mixtures.

### **IDLE CONTROL VALVE (ICV)**

Two electrically actuated control valves are used to introduce either fuel or air into the mixer bore. Controlled by the ADP, the idle control valves will allow either fuel, air or a mixture of both into the mixer below the air valve. The idle control valves will go to a fixed position after the fuel control valve becomes active.

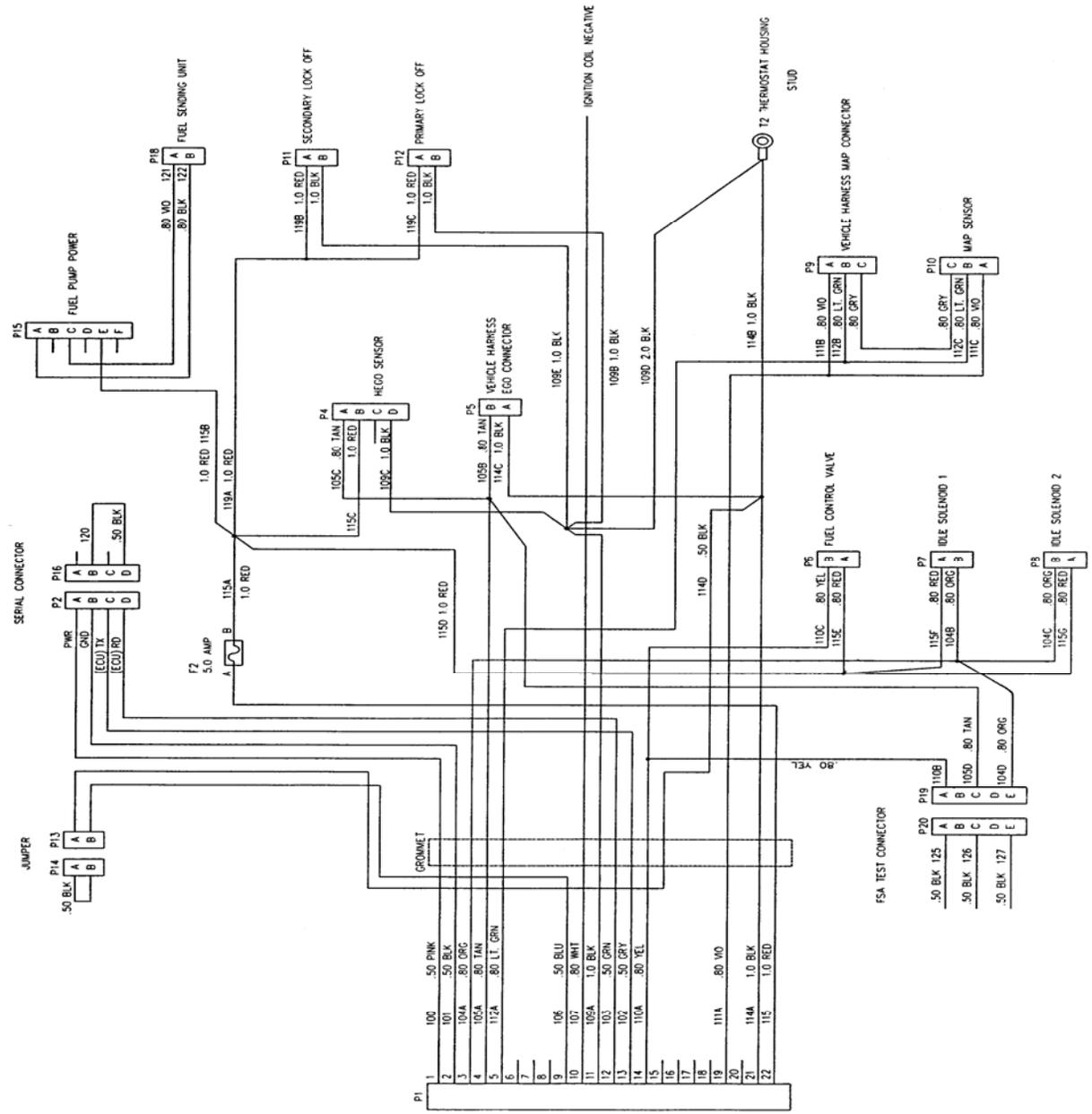
### **REGULATOR CONTROL VALVE (RCV)**

The regulator control valve (RCV) is mounted on the regulator cover. The RCV is a one way check valve that opens at 8-10" of water column and permits quick response of the secondary diaphragm during wide open throttle operation.



# DIAGNOSIS

## ELECTRICAL SCHEMATIC



ADP

**SYMPTOM DIAGNOSIS**

**Important Preliminary Checks**

| <b>Checks</b>              | <b>Action</b>  |
|----------------------------|--|
| Before Using This Section  | <p>Before using this section, you should have performed the Powertrain On-Board Diagnostic System Check and determined that:</p> <ol style="list-style-type: none"> <li>1. The Engine Control Module and MIL (Malfunction Indicator Lamp) are operating correctly.</li> <li>1. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.</li> </ol> <p>Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks which may save valuable time.</p>   |
| Visual and Physical Checks | <ul style="list-style-type: none"> <li>• Check the Engine Control Module grounds for being clean, tight and in their proper location.</li> <li>• Check the vacuum hoses for splits, kinks and proper connections, as shown on the Supplemental Vacuum Hose Routing Label.</li> <li>• Check for any type of leak or restriction.</li> <li>• Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.</li> <li>• Check for proper installation of the propane mixer and adapter</li> <li>• Check for air leaks at the propane mixer and adapter</li> <li>• Check the ignition wires for the following conditions:             <ul style="list-style-type: none"> <li>– Cracking</li> <li>– Hardness</li> <li>– Proper routing</li> <li>– Carbon tracking</li> </ul> </li> <li>• Check the wiring for the following items:             <ul style="list-style-type: none"> <li>– Proper connections</li> <li>– Pinches</li> <li>– Cuts</li> </ul> </li> <li>• The following symptom tables contain groups of possible causes for each symptom and cover several engines. The following symptom tables cover several engines. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to the appropriate OEM Service Manual.</li> </ul> |
| Symptom                    | <ol style="list-style-type: none"> <li>1. Verify the customer complaint.</li> <li>2. Locate the correct symptom table.</li> <li>3. Check the items indicated under that symptom.</li> </ol>  |

**Hard Start**

| Checks  | Action   |
|---|--|
| <p>DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.</p> |  |
| <p>Preliminary Checks</p>   | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> <li>• Make sure the vehicle's operator is using the correct starting procedure.</li> </ul>   |
| <p>Sensor Checks</p>  | <ul style="list-style-type: none"> <li>• Check the Engine Coolant Temperature (ECT) sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit.</li> <li>• Check the Throttle Position (TP) sensor. If a sticking throttle shaft or binding linkage causes a high TP sensor voltage (open throttle indication), the Control Module will not control the idle.</li> </ul>  |
| <p>Fuel System Checks</p>   | <p><b>Important:</b> A partially closed propane manual shut-off valve may create an extended crank condition</p> <ul style="list-style-type: none"> <li>• Check the fuel system pressures. Refer to the <i>Fuel System Pressure Test</i>.</li> <li>• Check mixer and adapter assembly for proper installation and leakage</li> <li>• Check fuel control and idle control valve operation</li> </ul>  |
| <p>Ignition System Checks</p>   | <p>Note: Propane, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. Peak ignition voltages are experienced during crank conditions. A thorough ignition system inspection should be performed.</p> <ul style="list-style-type: none"> <li>• Check for the proper ignition voltage output with <i>J 26792</i> or the equivalent.</li> <li>• Check the spark plugs for the following conditions: <ul style="list-style-type: none"> <li>– Wet plugs</li> <li>– Cracks</li> <li>– Wear</li> <li>– Improper gap</li> <li>– Burned electrodes</li> <li>– Heavy deposits</li> </ul> </li> <li>• Check for bare or shorted ignition wires.</li> <li>• Check for moisture in the distributor cap if applicable.</li> <li>• Check for loose ignition coil connections.</li> <li>• Check for loose Control Module or ignition system grounds.</li> <li>• Check the Ignition Control (IC) circuit for an open or short to ground.</li> </ul> |

## IMPCO® PROPANE FUEL SYSTEM

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|                          |  |
|--------------------------|--|
| Engine Mechanical Checks | <p><b>Important:</b> The propane fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> <ul style="list-style-type: none"><li>• Check for the following ( Refer to Engine Mechanical in the OEM Service Manual):<ul style="list-style-type: none"><li>– Vacuum leaks</li><li>– Improper valve timing</li><li>– Low compression</li><li>– Bent pushrods</li><li>– Worn rocker arms</li><li>– Broken or weak valve springs</li><li>– Worn camshaft lobes.</li></ul></li><li>• Check the intake and exhaust manifolds for casting flash. Refer to Engine Mechanical in the OEM Service Manual.</li></ul> |
| Additional Check         | Check the Idle Air Control (IAC) operation.  |

**Surges/Chuggles**

| Checks  | Action   |
|---|--|
| <p>DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.</p> |  |
| <p>Preliminary Checks</p>   | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> <li>• Be sure the driver understands the Torque Converter Clutch operation.</li> <li>• Be sure the driver understands the A/C Compressor operation.</li> <li>• Use the scan tool to make sure the reading of the Vehicle Speed Sensor (VSS) matches the vehicle speedometer. This excludes vehicles with electronic transmissions where some variation between the VSS and the speedometer is normal.</li> </ul>   |
| <p>Sensor Checks</p>  | <ul style="list-style-type: none"> <li>• Check the (Heated) Oxygen Sensor (HO2S) performance.</li> </ul>   |
| <p>Fuel System Checks</p>   | <ul style="list-style-type: none"> <li>• Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem.</li> <li>• Check the fuel pressure while the condition exists. Refer to <i>Fuel System Pressure Check</i>.</li> <li>• Verify that the propane manual shut-off valve is open.</li> <li>• Verify that the excess flow valve has not closed.</li> <li>• Check for proper operation of the fuel control and idle control valves.</li> <li>• Check the fuel filter and lines for restrictions.</li> </ul> |
| <p>Ignition System Checks</p>   | <ul style="list-style-type: none"> <li>• Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. Refer to Ignition System.</li> <li>• Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>– Wet plugs</li> <li>– Cracks</li> <li>– Wear</li> <li>– Improper gap</li> <li>– Burned electrodes</li> <li>– Heavy deposits</li> </ul> </li> </ul>  |
| <p>Additional Check</p>   | <ul style="list-style-type: none"> <li>• Check the Control Module grounds for being clean, tight, and in their proper locations.</li> <li>• Check the generator output voltage.</li> <li>• Check the vacuum hoses for kinks or leaks. Refer to the Vehicle Emission Control Information label.</li> <li>• Check for an Intermittent EGR problem.</li> <li>• Check for Torque Converter Clutch (TCC) operation. Refer to Transmissions.</li> </ul>  |

## Lack of Power, Sluggishness, or Sponginess

| Checks   | Action   |
|--|--|
| DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal. |  |
| Preliminary Checks   | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> <li>• Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. <i>Do not compare the power output of the vehicle operating on propane to a vehicle operating on gasoline. The fuels have different drive feel characteristics</i></li> <li>• Remove the air filter and check for dirt or restriction.</li> <li>• Check the transmission shift pattern and the downshift operation. Refer to Transmission Controls section.</li> </ul> |
| Fuel System Checks   | <ul style="list-style-type: none"> <li>• Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to <i>Fuel System Pressure Test</i>.</li> </ul>   |
| Sensor Checks  | <ul style="list-style-type: none"> <li>• Check the Manifold Absolute Pressure (MAP) sensor</li> <li>• Check the Exhaust Gas Oxygen (EGO) sensor</li> </ul>   |
| Ignition System Checks   | <ul style="list-style-type: none"> <li>• Check for the proper ignition output voltage with the spark tester <i>J 26792</i> or the equivalent.</li> <li>• Check the Knock Sensor (KS) system</li> </ul>   |
| Exhaust System Checks  | <ul style="list-style-type: none"> <li>• Check the exhaust system for a possible restriction. Refer to Engine Exhaust.</li> <li>• Inspect the exhaust system for damaged or collapsed pipes. Inspect the muffler for heat distress or a possible internal failure.</li> </ul>  |
| Engine Mechanical Check  | <p>Check the engine for the proper operation of the following items:</p> <ul style="list-style-type: none"> <li>• Engine compression</li> <li>• Valve timing</li> <li>• Improper or worn camshaft. Refer to Engine Mechanical.</li> </ul>  |
| Additional Check   | <ul style="list-style-type: none"> <li>• Check the Control Module grounds for being clean, tight, and in their proper locations.</li> <li>• Check the EGR Valve for being open or partially open all the time. Refer to EGR System Check.</li> <li>• Check the A/C operation.</li> <li>• Check for Torque Converter Clutch (TCC) operation. Refer to the Torque Converter Clutch Solenoid in Automatic Transmission.</li> <li>• Check the generator output voltage. Refer to Engine Electrical.</li> <li>• Check for a stretched throttle cable.</li> </ul>                |

**Hesitation, Sag, Stumble**

| Checks   | Action   |
|--|--|
| <p>DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when accelerating after a complete stop. The condition may cause the engine to stall if severe enough.</p> |  |
| Preliminary Checks   | Refer to <i>Important Preliminary Checks</i> .   |
| Fuel System Checks   | <ul style="list-style-type: none"> <li>• Check the fuel pressure. Refer to <i>Fuel System Pressure Test</i>.</li> <li>• Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system.</li> <li>• Check the Throttle Position (TP) Sensor for binding or sticking. Voltage should increase at a steady rate as the throttle moves toward Wide Open Throttle (WOT).</li> <li>• Check the Manifold Absolute Pressure (MAP) sensor response and accuracy.</li> <li>• Check the mixer and adapter assembly for proper installation and leakage.</li> <li>• Check the mixer for proper operation. (sticking, wear etc.)</li> <li>• Check for sticking fuel control or idle control valve.</li> </ul> |
| Ignition System Checks   | <ul style="list-style-type: none"> <li>• Note: LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. Peak ignition voltages are experienced during crank. A thorough ignition system inspection should be performed.</li> <li>• Check for the proper ignition voltage output with <i>J 26792</i> or the equivalent.</li> <li>• Check ignition timing</li> <li>• Check for faulty spark plug wires</li> <li>• Check for fouled spark plugs.</li> <li>• Check for an open ignition system ground. Refer to Ignition System.</li> </ul>   |
| Additional Check   | <ul style="list-style-type: none"> <li>• Check the Service Bulletins for PROM updates.</li> <li>• Check for manifold vacuum or air induction system leaks</li> <li>• Check the generator output voltage. Refer to Engine Electrical.</li> <li>• Check the EGR valve operation.</li> </ul>  |

## Cuts Out, Misses

| Checks  | Action   |
|---|--|
| <p>DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.</p> |  |
| Preliminary Checks  | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> </ul>  |
| Ignition System Checks  | <ul style="list-style-type: none"> <li>• Check ignition timing</li> </ul> <p>Check for a cylinder misfire:</p> <ol style="list-style-type: none"> <li>1. Start the engine.</li> <li>1. Allow the engine to stabilize.</li> <li>1. Then disconnect the Idle Air Control (IAC) motor.</li> </ol> <p><b>Notice:</b> In order to prevent damaging the catalytic converter, do not perform this test for more than 2 minutes.</p> <ol style="list-style-type: none"> <li>2. Remove one spark plug wire at a time using insulated pliers.</li> <li>3. If there is a RPM drop on all cylinders (equal to within 50 RPM), go to <i>Rough, Unstable, or Incorrect Idle, Stalling</i>.</li> <li>4. Reconnect the IAC motor with the ignition OFF.</li> <li>5. If there is no RPM drop on one or more of the cylinders, or excessive variation in drop, check for spark on the suspected cylinders with a <i>J 26792</i> or the equivalent.</li> <li>6. If there is no spark, refer to <i>Ignition System</i> in the OEM Service Manual.</li> <li>7. If there is a spark, remove the spark plugs in these cylinders and check for the following conditions:             <ul style="list-style-type: none"> <li>• Insulation cracks</li> <li>• Wear</li> <li>• Improper gap</li> <li>• Burned electrodes</li> <li>• Heavy deposits                 <ul style="list-style-type: none"> <li>– Check the spark plug wire resistance (should not exceed 30,000 <math>\Omega</math>).</li> <li>– Check the distributor rotor and the distributor cap.</li> <li>– If the previous check did not find the problem, visually check the following items:                     <ul style="list-style-type: none"> <li>• The ignition system for moisture, dust, cracks, burns, etc.</li> <li>• With the engine running, spray the plug wires with a fine water mist to check for shorts.</li> </ul> </li> </ul> </li> </ul> </li> </ol> |
| Engine Mechanical Checks  | <ul style="list-style-type: none"> <li>• Perform a cylinder compression check. Refer to Engine Mechanical.</li> <li>• Check the engine for the following:             <ul style="list-style-type: none"> <li>– Improper valve timing</li> <li>– Bent pushrods</li> <li>– Worn rocker arms</li> <li>– Worn camshaft lobes.</li> <li>– Broken or weak valve springs. Refer to Engine Mechanical.</li> </ul> </li> <li>• Check the intake and exhaust manifold passages for casting flash. Refer to Engine Mechanical.</li> </ul>   |

|                    |  |
|--------------------|--|
| Fuel System Checks | <ul style="list-style-type: none"><li>• Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to <i>Fuel System Pressure Check</i>.</li><li>• Check for a sticking fuel control or idle control valve.</li><li>• Check the condition of the wiring to the primary and secondary lock off valves.</li></ul>  |
| Additional Check   | <p>Check for Electromagnetic Interference (EMI).</p> <ul style="list-style-type: none"><li>• EMI on the reference circuit can cause a missing condition.</li><li>• Monitoring the engine RPM with a scan tool can detect an EMI.</li><li>• A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present.</li><li>• If the problem exists, check the routing of the secondary wires and the ground circuit.</li></ul> |

## Poor Fuel Economy

| Checks   | Action   |
|--|--|
| <p>DEFINITION: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.</p> |  |
| <p>Preliminary Checks</p>  | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> <li>• Check the air cleaner element (filter) for dirt or being plugged.</li> <li>• Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections as shown on the Vehicle Emission Control Label.</li> <li>• Check the owner's driving habits for the following items:               <ul style="list-style-type: none"> <li>– The A/C ON full time (Defroster mode ON)?</li> <li>– Excessive idling or stop and go driving?</li> <li>– Tires at correct air pressure?</li> <li>– Low LPG refill quantity (check gauge accuracy and fill valve operation)?</li> <li>– Excessively heavy loads being carried?</li> <li>– Heavy acceleration too much, too often?</li> </ul> </li> <li>• Suggest to the owner to fill the fuel tank and to recheck the fuel economy.</li> <li>• Suggest to the driver to refer to Important Facts on Fuel Economy in the owner's manual.</li> </ul> |
| <p>Fuel System Checks</p>  | <ul style="list-style-type: none"> <li>• Check the fuel pressure. Refer to <i>Fuel System Pressure Check</i>.</li> <li>• Check the fuel system for leakage</li> </ul>  |
| <p>Sensor Checks</p>   | <ul style="list-style-type: none"> <li>• Check the Engine Coolant Temperature (ECT) sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit.</li> <li>• Check the Manifold Absolute Pressure (MAP) sensor</li> <li>• Check the Heated Exhaust Gas Oxygen (HEGO) sensor</li> </ul>  |
| <p>Ignition System Checks</p>  | <ul style="list-style-type: none"> <li>• Check the spark plugs. Remove the plugs and inspect them for the following conditions:               <ul style="list-style-type: none"> <li>– Wet plugs</li> <li>– Cracks</li> <li>– Wear</li> <li>– Improper gap</li> <li>– Burned electrodes</li> <li>– Heavy deposits</li> </ul> </li> <li>• Check for an open Ignition Control (IC) circuit.</li> <li>• Check the ignition wires for the following items:               <ul style="list-style-type: none"> <li>– Cracking</li> <li>– Hardness</li> <li>– Proper connections</li> </ul> </li> <li>• Check the Knock Sensor (KS) system.</li> </ul>   |

|                       |   |
|-----------------------|---|
| Cooling System Checks | <ul style="list-style-type: none"><li>• Check the engine coolant level.</li><li>• Check the engine thermostat for always being open or for the wrong heat range. Refer to Diagnosis of the Thermostat in Engine Cooling.</li></ul>  |
| Additional Check      | <ul style="list-style-type: none"><li>• Check the transmission shift pattern. Refer to the Transmission Controls section.</li><li>• Check for Torque Converter Clutch (TCC) operation. Refer to Torque Converter Clutch Solenoid in Automatic Transmission.</li><li>• Check for proper calibration of the speedometer.</li><li>• Check for dragging brakes. Refer to Section 5 of the appropriate service manual.</li></ul> |

## Rough, Unstable, or Incorrect Idle, Stalling

| Checks  | Action   |
|---|--|
| <p>DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.</p> |  |
| Preliminary Check   | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> </ul>  |
| Sensor Checks   | <ul style="list-style-type: none"> <li>• Check the (Heated) Oxygen Sensor (HO2S) performance.</li> <li>• Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The control Module will reduce the amount of fuel delivered to the engine causing a severe driveability problem.</li> <li>• Check the Engine Coolant Temperature (ECT) sensor using the scan tool to compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 5° greater than or less than the ambient air temperature on a cold engine, check for a high resistance in the coolant sensor circuit or the sensor itself.</li> <li>• Check the Manifold Absolute Pressure (MAP) sensor response and accuracy.</li> </ul> |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem.</li> <li>• Check the fuel pressure. Refer to the <i>Fuel System Pressure Test</i>.</li> <li>• Check LPG mixer for proper installation and connection.</li> <li>• Check for proper operation of fuel control and idle control valves</li> </ul>   |
| Ignition System Checks  | <ul style="list-style-type: none"> <li>• Check for the proper ignition output voltage using the spark tester <i>J26792</i> or the equivalent. Refer to <i>Ignition System</i>.</li> <li>• Check the spark plugs. Remove the plugs and inspect them for the following conditions:               <ul style="list-style-type: none"> <li>– Wet plugs</li> <li>– Cracks</li> <li>– Wear</li> <li>– Improper gap</li> <li>– Burned electrodes</li> <li>– Blistered insulators</li> <li>– Heavy deposits</li> </ul> </li> <li>• Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.</li> </ul>  |

|                                |   |
|--------------------------------|---|
| <p>Engine Mechanical Check</p> | <ul style="list-style-type: none"> <li>• Perform a cylinder compression test. Refer to Engine Mechanical.</li> <li>• Check the engine for the following:             <ul style="list-style-type: none"> <li>– Broken motor mounts</li> <li>– Improper valve timing</li> <li>– Low compression</li> <li>– Bent pushrods</li> <li>– Worn rocker arms</li> <li>– Broken or weak valve springs</li> <li>– Worn camshaft lobes</li> <li>– Refer to Engine Mechanical in the OEM Service Manual.</li> </ul> </li> </ul>   |
| <p>Additional Checks</p>       | <p><b>Important:</b> The LPG system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> <ul style="list-style-type: none"> <li>• Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low Idle Air Control (IAC) counts.</li> <li>• Check the IAC operation.</li> <li>• Check the Control Module grounds for being clean, tight, and in their proper locations.</li> <li>• Check the scan tool to determine if the Control Module is receiving an A/C signal. If a problem exists with the A/C ON, check the A/C system operation. Refer to the OEM Service Manual.</li> <li>• Check for EGR being ON while idling which will cause roughness, stalling, and hard starting.</li> <li>• Check the battery cables and ground straps. They should be clean and secure. Erratic voltage will cause the IAC to change its position resulting in poor idle quality.</li> <li>• Check the IAC valve. The IAC will not move if the system voltage is not within 9 to 16 volts.</li> <li>• Check the A/C refrigerant pressure for being too high or for a faulty high pressure switch.</li> <li>• Check the Crankcase Ventilation Valve for proper operation by placing a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace the valve.</li> </ul> |

# IMPCO® PROPANE FUEL SYSTEM

## Backfire

| Checks  | Action   |
|---|--|
| DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise. |  |
| Preliminary Check   | <ul style="list-style-type: none"> <li>• Refer to <i>Important Preliminary Checks</i>.</li> </ul>  |
| Ignition System Checks  | <p>Note: Propane, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. Peak ignition voltages are experienced during crank and transient conditions, a thorough ignition system inspection should be performed.</p> <ul style="list-style-type: none"> <li>• Check for the proper ignition coil output voltage using the spark tester <i>J26792</i> or the equivalent.</li> <li>• Check the spark plugs. Remove the plugs and inspect them for the following conditions:               <ul style="list-style-type: none"> <li>– Wet plugs</li> <li>– Cracks</li> <li>– Wear</li> <li>– Improper gap</li> <li>– Burned electrodes</li> </ul> </li> <li>– Heavy deposits</li> <li>• Check the ignition system. Refer to <i>Ignition System</i>.</li> <li>• Check for crossfire between spark plugs (distributor cap, spark plug wires, and proper routing of the plug wires).</li> </ul> |
| Engine Mechanical Check   | <p><b>Important:</b> The propane system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system.</p> <ul style="list-style-type: none"> <li>• Check the engine for the following (Refer to Engine Mechanical in the OEM Service Manual):               <ul style="list-style-type: none"> <li>– Improper valve timing</li> <li>– Engine compression</li> <li>– Manifold vacuum leaks</li> <li>– Intake manifold gaskets</li> <li>– Sticking or leaking valves</li> <li>– Exhaust system leakage</li> </ul> </li> <li>• Check for an EGR valve that is open all the time. Refer to the OEM Service Manual.</li> <li>• Check the intake and exhaust system for casting flash or other restrictions. Refer to Engine Mechanical in the OEM Service Manual.</li> </ul>  |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Perform a fuel system diagnosis. Refer to <i>Fuel System Pressure Check</i>.</li> <li>• Check operation of Idle control valves</li> <li>• Check mixer for proper operation (sticking, wear etc.)</li> <li>• Check FCV for proper operation</li> </ul>   |
| Additional Checks   | <ul style="list-style-type: none"> <li>• Proper E-Prom calibration</li> <li>• Check the EGR gasket for a faulty or loose fit.</li> <li>• Check for an EGR valve that is open all the time. Refer to the OEM Service Manual.</li> </ul>   |



# IMPCO® PROPANE FUEL SYSTEM

## FUEL SYSTEM PRESSURE CHECK

Special Tools: ITK-1 IMPCO® test kit.

| Step | Action  | Value(s)        | Yes                            | No           |
|------|---|-----------------|--------------------------------|--------------|
| 1    | <ol style="list-style-type: none"> <li>1. Close the propane manual shut-off valve.</li> <li>1. Remove regulator primary test port plug and install a gauge capable of reading 0-10 psi. Note: A small amount of fuel will be present behind the plug.</li> <li>1. Open the propane manual shut-off valve.</li> <li>1. Start the vehicle. Monitor the primary pressure gauge under various operating conditions.</li> </ol> <p>Is the pressure within the specified range?</p>                       | 1-2 psi         | Go To Step 2                   | Go To Step 3 |
| 2    | <ol style="list-style-type: none"> <li>1. Remove regulator secondary test port plug and install a gauge capable of reading negative inches of water column.</li> <li>1. Disconnect fuel control valve (FCV).</li> <li>1. Start vehicle. Monitor secondary pressure gauge under various operating conditions.</li> </ol> <p>Is the pressure within the specified range?</p>  | -1" to -2" w.c. | Go To Step 6                   | Go To Step 5 |
| 3    | <p>Observe regulator primary pressure gauge.</p> <p>Is pressure greater than specified value?</p>   | 2 psi           | Go to Step 5                   | Go to Step 4 |
| 4    | <ol style="list-style-type: none"> <li>1. Verify that liquid fuel is available from the tank.</li> <li>1. Verify that the propane manual shut-off valve is open and that the excess flow valve has not closed.</li> <li>1. Check the propane fuel filter and replace if necessary.</li> <li>1. Verify primary and secondary lock-off operation.</li> <li>1. Check fuel lines for kinks or restrictions (frost or condensation may be present if restricted).</li> </ol> <p>Was a problem found?</p> | —               | Repair As Necessary            | Go to Step 5 |
| 5    | <ol style="list-style-type: none"> <li>1. Regulator pressure is out of range. Repair or replace regulator.</li> <li>1. Repeat the regulator pressure test to verify repair.</li> </ol> <p>Is the action complete?</p>   | —               | Go to Step 6                   | —            |
| 6    | <p>Fuel supply system operating normally. If a driveability complaint persists, refer to diagnostic by symptom table.</p> <p>Are any DTCs or driveability symptoms present?</p>   | —               | Go to the Applicable DTC Table | System OK    |

**MECHANICAL DIAGNOSIS**

**CONVERTER TROUBLESHOOTING CHART**

| <b>CONDITION</b>   | <b>CAUSE</b>   | <b>CORRECTION</b>  |
|--|--|--|
| INSUFFICIENT FUEL FLOW                                     | Insufficient fuel supply or defective electric lock-off solenoid | Check fuel supply and electric lock-off solenoid. Repair as necessary.   |
|  | Incorrect secondary spring installed                             | Verify proper spring for application.                                    |
|  | Incorrect secondary lever height                                 | Adjust lever height using G2-2 gauge or appropriate repair instructions. |
|  | Secondary chamber full of oil or contaminants                    | Disassemble and inspect regulator.                                       |
|  | Primary pin sticking in bore                                     | Disassemble and inspect regulator.                                       |
|  | Secondary diaphragm damaged                                      | Replace regulator secondary diaphragm.                                   |
|  | Primary orifice or seat obstructed                               | Disassemble regulator and perform inspection.                            |
| EXCESSIVE FUEL FLOW  | Incorrect secondary spring installed                             | Check for proper spring application.                                     |
|  | Incorrect secondary lever height                                 | Adjust lever height using G2-2 gauge or appropriate repair instructions. |
|  | Defective, damaged or contaminated primary or secondary seat     | Disassemble, inspect and repair as necessary.                            |
|  | Defective or damaged primary or secondary diaphragm              | Inspect and repair regulator as necessary.                               |
|  | Primary pin sticking in bore                                     | Disassemble, inspect and repair as necessary.                            |
| REGULATOR/VAPORIZER ASSEMBLY FREEZING                      | Poor coolant flow or low on coolant                              | Check coolant level and condition of coolant.                            |
|  | Air trapped in converter   | Purge air from cooling system.   |
|  | Coolant passages blocked or restricted                           | Remove vaporizer and clean passages.                                     |
|  | Severe leakage of primary diaphragm or primary seat              | Verify converter operation.  |
| COOLANT FOUND IN PRIMARY OR SECONDARY CHAMBER OF REGULATOR | Porous or cracked heat exchanger                                 | Replace heat exchanger.  |
| EXTERNAL COOLANT LEAKAGE FROM HEAT EXCHANGER COVER         | Leaking heat exchanger gasket (G1-35)                            | Replace gasket.  |
|  | Porous or cracked heat exchanger                                 | Replace heat exchanger.  |

# IMPCO® PROPANE FUEL SYSTEM

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## ADP

### Idle Lean

| Checks  | Action  |
|---|---|
| DEFINITION: The ICV duty cycle readings on the FSA are above 80 and/or the oxygen sensor always indicates lean. |   |
| Sensor Checks   | <ul style="list-style-type: none"><li>• Check oxygen sensor operation</li></ul>   |
| Fuel System Checks  | <ul style="list-style-type: none"><li>• Check for proper secondary regulator pressure.</li><li>• Verify that the FCV is not leaking vacuum into the regulator diaphragm chamber when checking secondary pressure. If the FCV sticks open, it will cause lean fuel mixtures.</li><li>• Verify that the ICVs are functioning properly. Erratic driveability problems can be the result of malfunctioning ICVs.</li><li>• Verify FCV vacuum connections to air valve vacuum.</li><li>• Check mixer air valve for build-up (dirty).</li><li>• Verify correct air gas valve application.</li><li>• Check for engine vacuum leaks.</li><li>• Check for air leaks downstream of the mixer.</li></ul> |
| Additional Checks   | <ul style="list-style-type: none"><li>• Check oxygen sensor connection to ADP</li><li>• Check for proper ADP connections</li></ul>  |

### Idle Rich

| Checks  | Action  |
|---|---|
| DEFINITION: The ICV duty cycle readings on the FSA are below 20 and/or the oxygen sensor always indicates rich. |   |
| Sensor Checks   | <ul style="list-style-type: none"><li>• Check oxygen sensor operation</li></ul>   |
| Fuel System Checks  | <ul style="list-style-type: none"><li>• Check for proper secondary regulator pressure.</li><li>• Verify that the FCV is not stuck closed. If the FCV sticks open, it will cause lean rich mixtures.</li><li>• Verify that the ICVs are functioning properly. Erratic driveability problems can be the result of malfunctioning ICVs.</li><li>• Check mixer air valve for build-up (dirty).</li><li>• Check air gas valve and mixer for wear.</li><li>• Verify FCV vacuum connections to air valve vacuum.</li></ul> |
| Additional Checks   | <ul style="list-style-type: none"><li>• Check all vacuum hoses for proper connection or deterioration.</li><li>• Check for proper ADP connections.</li></ul>  |

**Wide Open Throttle Lean**

| Checks  | Action   |
|---|--|
| DEFINITION: Mixture duty cycle readings on the FSA are above 80 and/or the oxygen sensor always indicates lean when operating near full throttle. |  |
| Sensor Checks   | <ul style="list-style-type: none"> <li>• Check for proper oxygen sensor operation.</li> </ul>  |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Check propane fuel level.</li> <li>• Check for a plugged propane fuel filter.</li> <li>• Verify that the manual fuel shut-off valve is fully open.</li> <li>• Verify that the excess flow valve in the manual fuel shut off valve is not closing under high flow conditions.</li> <li>• Check for proper primary and secondary regulator pressure, validate steady pressure readings at wide open throttle. If pressure fluctuates, troubleshoot, and repair.</li> <li>• Verify that FCV is functioning properly. Erratic driveability problems can be the result of a malfunctioning FCV.</li> </ul> |
| Ignition System Checks  | <ul style="list-style-type: none"> <li>• Check ignition system operation.</li> </ul>   |
| Exhaust System Checks   | <ul style="list-style-type: none"> <li>• Check for exhaust leaks.</li> </ul>   |
| Engine Mechanical Check   | <ul style="list-style-type: none"> <li>• Verify condition of engine.</li> </ul>  |

**Wide Open Throttle Rich**

| Checks  | Action   |
|---|--|
| DEFINITION: Mixture duty cycle readings on the FSA are above 80 and/or the oxygen sensor always indicates rich when operating near full throttle. |  |
| Sensor Checks   | <ul style="list-style-type: none"> <li>• Check for proper oxygen sensor operation.</li> </ul>  |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Check for proper primary and secondary regulator pressure, validate steady pressure readings at wide open throttle. If pressure fluctuates, troubleshoot, and repair.</li> <li>• Verify that FCV is functioning properly. Erratic driveability problems can be the result of a malfunctioning FCV.</li> <li>• Check mixer air valve for build-up (dirty).</li> <li>• Check air gas valve and mixer for wear.</li> </ul> |
| Additional Checks   | <ul style="list-style-type: none"> <li>• Check for proper ADP connections.</li> <li>• Check air intake system for restrictions.</li> </ul>   |
| Exhaust System Checks   | <ul style="list-style-type: none"> <li>• Check for exhaust leaks.</li> </ul>   |
| Engine Mechanical Check   | <ul style="list-style-type: none"> <li>• Verify condition of engine.</li> </ul>  |

**Cruise Lean**

| Checks  | Action  |
|---|---|
| DEFINITION: Mixture duty cycle readings on the FSA are above 80 and/or the oxygen sensor always indicates lean when the engine is operating <b>off idle at low load</b> . |   |
| Sensor Checks   | <ul style="list-style-type: none"> <li>• Check for proper oxygen sensor operation.</li> </ul>   |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Verify that the ICVs are functioning properly. Erratic driveability problems can be the result of malfunctioning ICVs.</li> <li>• Validate proper FCV connection to air valve vacuum.</li> <li>• Check for proper primary and secondary regulator pressure.</li> <li>• Check for a plugged propane fuel filter.</li> </ul> |
| Additional Checks   | <ul style="list-style-type: none"> <li>• Check for air leaks downstream of the mixer.</li> </ul>  |

## Cruise Rich

| Checks  | Action  |
|---|---|
| DEFINITION: Mixture duty cycle readings on the FSA are below 20 and/or the oxygen sensor always indicates rich when the engine is operating <b>off idle at low load</b> . |   |
| Sensor Checks   | <ul style="list-style-type: none"> <li>• Check for proper oxygen sensor operation.</li> </ul>   |
| Fuel System Checks  | <ul style="list-style-type: none"> <li>• Check mixer air valve for build-up (dirty).</li> <li>• Check air gas valve and mixer for wear.</li> <li>• Check for proper primary and secondary regulator pressure, validate steady pressure readings at wide open throttle. If pressure fluctuates, troubleshoot and repair.</li> <li>• Verify that the ICVs are functioning properly. Erratic problems can be the result of a malfunctioning ICVs.</li> <li>• Verify FCV vacuum connections to air valve vacuum.</li> </ul> |
| Additional Checks   | <ul style="list-style-type: none"> <li>• Check air intake system for restrictions.</li> <li>• Check all vacuum hoses for proper connection or deterioration.</li> </ul>   |
| Exhaust System Checks   | <ul style="list-style-type: none"> <li>• Check for exhaust leaks.</li> </ul>  |

## ADP INITIALIZATION

### Tools Required

IMPCO Fuel System Analyzer (FSA)  
*or*  
 Dwell Meter (set to six cylinder scale)

### Important

- Initialization of the ADP is required after any major engine service or fuel system repair.
- If the engine and oxygen sensor are hot, voltage could be above 0.5 volts. The red LED on the ADP may remain off for several seconds.

1. Disconnect the two (2) pin connector jumper (P14) located in the passenger compartment near the HVAC blower motor.
2. A test connector (P19) is located in the engine compartment near the heater core and allows access to the oxygen sensor and fuel control valve (FCV) signals.

**Note:** Some models may not be equipped with a test connector. To initialize these vehicles, access the necessary signals directly.

If using a FSA, connect as follows:

- Black to ground.
- Red to power.
- Green clip to oxygen sensor signal (tan wire).
- Yellow clip to fuel control valve (FCV) signal (yellow wire).

If using a dwell meter, connect as follows:

- Black to ground
  - Red to power
  - Dwell lead to fuel control valve (FCV) signal (yellow wire).
3. Start the engine and allow it to reach normal operating temperature.
  4. During warm-up, monitor the following:
    - On a FSA, the reading should start at 0 and increase until the oxygen sensor output begins to switch from rich to lean. On a dwell meter, the reading should maintain an average 30° dwell.
    - Once the reading stabilizes on the FSA, the duty cycle should maintain a tight range and the rich and lean lights should cycle on and off.

### Important

- Do not turn the engine off before re-installing connector P14 or the ADP block learn memory will not be updated.
5. When the engine is at normal operating temperature and the FSA or the dwell meter shows continuous rich/lean cycling, re-connect connector P14 and disconnect the tool.
  6. To update block learn memory, the vehicle should be driven for approximately five minutes under the following conditions.
    - 1st: Steady state cruise
    - 2nd: Light throttle
    - 3rd: Medium throttle
    - 4th: Heavy throttle

When the drive cycle is completed, return the vehicle to service.

### IMPCO® PROM

Check the OEM data stream using a scan tool. If no data stream is available, refer to the OEM service manual for proper diagnostic procedures and repair instructions to restore the data stream before proceeding.

Check the vehicle ignition timing. Timing must be set to the manufacturer specifications shown on

the underhood label. If necessary, reset the timing to match those specifications.

### Important

- Installing the wrong PROM in the ECM will cause poor operation and possible damage to electric components. When removing a new IMPCO® PROM from its packaging, check the part number to verify that it is the correct part for your vehicle.

## ON-VEHICLE SERVICE

### PROPANE FUEL SYSTEM PRESSURE RELIEF

**CAUTION:** The propane fuel system operates at pressures up to 312 psi. To minimize the risk of fire and personal injury, relieve the propane fuel system pressure (where applicable) before servicing the propane fuel system components.

To relieve propane fuel system pressure:

1. Close the manual shut-off valve (MSV) on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF. Note: Residual vapor pressure will be present in the fuel system. Ensure the work area is well ventilated prior to removing any fuel lines.

### PROPANE FUEL SYSTEM LEAK TEST

**CAUTION:** Never use an open flame of any type to check for propane fuel system leaks.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.

### PROPANE FUEL FILTER

#### Removal

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Disconnect the fuel inlet line from the filter.
4. Remove the nut retaining the filter clamp.
5. Unscrew the filter from the electric lock-off .

#### Installation

1. Coat the male pipe threads with a liquid thread sealant compound.

2. Install and tighten the filter into the lock-off assembly.
3. Install and secure the filter clamp and nut.
4. Connect the fuel inlet line to the filter and tighten.
5. Open manual shut-off valve.
6. Reconnect battery and the start vehicle.
7. Leak check the fuel system using a liquid leak detector.

### ELECTRIC LOCK-OFF SOLENOIDS

#### Underbody

#### Removal

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Remove the propane fuel filter. Refer to "Propane Fuel Filter."
4. Disconnect the electric lock-off solenoid electrical connector.
5. Disconnect the fuel line.
6. Remove the two (2) electric lock-off solenoid mounting bolts.
7. Remove the lock-off from the bracket.
8. Remove the elbow fitting from the fuel outlet port.

#### Installation

#### Important

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.
1. Install in reverse order of removal.
  2. Tighten fuel fittings finger tight plus 1 to 2 turns.
  3. Tighten fuel line fittings to 16-20 lb-ft.
  4. Leak check the system using a liquid leak detector.

**Underhood****Removal**

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Disconnect the hot and cold air ducts.
4. Remove the air cleaner.
5. Disconnect the fuel supply hose.
6. Disconnect the coolant hoses. NOTE: be sure to relieve cooling system pressure prior to disconnecting the coolant lines.
7. Disconnect the FCV electrical connector.
8. Disconnect the fuel and idle control valve electrical connectors.
9. Remove the four (4) rear support brackets bolts.
10. Remove the two (2) bolts that retain the converter main bracket to the throttle body adapter.
11. Remove the four (4) bolts that retain the mixer plate to the throttle body adapter.
12. Remove the mixer / converter module from the engine.
13. Disconnect the hose from the RCV valve and remove the RCV valve.
14. Disconnect the vacuum hose from the converter that comes from the fuel control valve.
15. Unscrew converter from the mixer assembly.
16. Remove the bolts that retain the lock-off to the converter main bracket.
17. Remove the bolts that retain the converter to the converter main bracket.
18. Remove the lock-off from the converter.
19. Transfer fittings to new lock-off using a liquid thread sealing compound .

**Installation****Important**

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.
1. Install in reverse order of removal.
  2. Replace all gaskets during re-assembly.
  3. Tighten fuel fittings finger tight plus 1 to 2 turns.
  4. Tighten fuel line fittings to 16-20 lb-ft.
  5. Leak check the system using a liquid leak detector.

## FUEL CONTROL VALVE (FCV)

### Removal

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable
3. Remove the air cleaner.
4. Disconnect the FCV electrical connector.
5. Disconnect the three (3) hose from the FCV and remove the valve.

### Installation

1. Install in reverse order of removal.

## IDLE CONTROL VALVE (ICV)

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Remove the air cleaner.
4. Disconnect the ICV electrical connector.
5. Disconnect the three (3) hoses from the ICV and remove the valve.

### Installation

1. Install in reverse order of removal.

## REGULATOR CONTROL VALVE (RCV)

### Removal

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Remove the air cleaner.
4. Disconnect the vacuum hose from the regulator control valve (RCV).
5. Unscrew the RCV from the converter.

### Installation

#### Important

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.
1. Apply liquid pipe thread sealant to the RCV threads.
  2. Install in reverse order of removal.

## CONVERTER

### Removal

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable
3. Disconnect the hot and cold air ducts.
4. Remove the air cleaner.
5. Disconnect the fuel supply hose.
6. Disconnect the coolant hoses. NOTE: Relieve cooling system pressure before disconnecting the coolant lines.
7. Disconnect the electric lock-off solenoid electrical connector.
8. Disconnect the fuel and idle control valve electrical connectors.
9. Remove the four (4) bolts that attach the two rear support brackets to the main bracket.
10. Remove the two (2) bolts that retain the converter main bracket to the throttle body adapter.
11. Remove the four (4) bolts that retain the mixer plate to the throttle body adapter.
12. Remove the mixer / converter module from the engine.
13. Disconnect the RCV hose and remove the RCV.
14. Disconnect the fuel control valve vacuum hose from the converter.
15. Unscrew the converter from the mixer assembly.
16. Remove the two (2) lock-off solenoid mounting bolts.
17. Remove the two (2) converter to bracket mounting bolts.
18. Remove the lock-off solenoid from the converter.
19. Transfer all fittings to the new converter.

### Installation

#### Important

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.
1. Install in reverse order of removal.
  2. Replace all gaskets during re-assembly,
  3. Tighten fuel fittings finger tight plus 1 to 2 turns.
  4. Tighten fuel line fittings to 16-20 lb-ft.
  5. Leak check the system using a liquid leak detector.
  6. Start the vehicle. If the system does not perform properly, perform a fuel system pressure check to verify all system components are operating properly. If system pressure

check reveals no problems, reinitialize the ADP. Refer to ADP initialization procedure

## **MIXER**

### **Removal**

1. Relieve the propane fuel system pressure. Refer to "Propane Fuel System Pressure Relief."
2. Disconnect the negative battery cable.
3. Remove air filter assembly, cold and hot air ducts
4. Disconnect the fuel supply hose.
5. Disconnect the coolant hoses. NOTE: be sure to relieve cooling system pressure prior to disconnecting the coolant lines.
6. Disconnect the electric lock-off solenoid electrical connector.
7. Disconnect the fuel and idle control valve electrical connectors.
8. Remove the (4) bolts that attach the two rear support brackets to the main bracket.
9. Remove the (2) bolts that retain the converter main bracket to the throttle body adapter.
10. Remove the (4) bolts that retain the mixer plate to the throttle body adapter.
11. Remove the mixer / converter module from the engine.
12. Remove the three (3) screws that retain the air inlet adapter to the top of the mixer.
13. Remove the air inlet adapter spacer.
14. Disconnect and remove the fuel and idle control valves and hoses.
15. Remove the four (4) mixer plate screws.
16. Unscrew mixer from the converter.

### **Installation**

#### **Important**

- Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing fittings.
1. Install in reverse order of removal.
  2. Replace all gaskets during re-assembly.
  3. Tighten fuel fittings finger tight plus 1 to 2 turns.
  4. Tighten fuel line fittings to 16-20 lb-ft.
  5. Leak check the system using a liquid leak detector.
  6. Start vehicle, if system does not perform properly, perform a fuel system pressure check to verify all system components are operating properly. If system pressure check reveals no problems, reinitialize the ADP. Refer to "ADP Initialization" in Mechanical Diagnosis.

## **ADAPTIVE DIGITAL PROCESSOR (ADP)**

### **Removal**

1. Disconnect the negative battery cable.
2. Disconnect the ADP electrical connector.
3. Remove the mounting bolts and the ADP.

### **Installation**

1. Install in reverse order of removal.
2. Initialize the ADP. Refer to "ADP Initialization" in Mechanical Diagnosis.

## **IMPCO® PROM**

Refer to the OEM service manual for removal and installation instructions. Note: Install only a genuine IMPCO® replacement PROM assembly, installation of the OEM gasoline PROM will result in decreased engine performance and possible engine or exhaust system damage.

## REBUILD INSTRUCTIONS

### CONVERTER

Under normal conditions, installation of a complete rebuild kit should be necessary only at the time of a major engine overhaul or when the converter has been out of service for a long period of time. Gaskets and diaphragms may deteriorate if the converter is stored after being used.

1. Remove the diaphragm cover (AC1-22-1) by taking out the eight screws around the circumference of the cover.
2. Remove the secondary diaphragm assembly (AD1-23). This requires the assembly to be moved about one inch away from the gas outlet to disengage the two prongs of the diaphragm link from the lever.
3. The diaphragm and cover are removed, revealing the secondary lever with the valve and spring.
4. Remove the screw that retains the fulcrum pin.
5. Slide out the fulcrum pin (P1-7). Remove it completely from the assembly.
6. The removal of the secondary fulcrum pin releases the spring and lever assembly. Note the three retaining pins on the underside of the lever (above the index finger). These are used to locate the spring.
7. Remove the primary diaphragm cover (C1-20). This requires the removal of four Phillips head screws and two pan head screws.
8. The C1-20 cover removal releases two S2-13 primary springs and the primary diaphragm assembly.
9. Remove the primary diaphragm assembly (AD1-15) and the primary valve pin (P1-11). The primary valve is actuated by this pin through the body. This isolates the diaphragm from any contact with liquid propane.
10. Remove the last two S1-39 screws.
11. Remove the body (B1-20) from the heat exchanger (AB1-19).
12. After the B1-20 body is removed, remove the body gasket (G1-37) and sponge (F3-1). The purpose of the sponge is to absorb liquid propane on cold starts, then retain the liquid until it vaporizes.
13. Remove the primary valve seat (S4-7) and discard. The high pressure jet is case hardened steel and is pressed in place.
14. Remove the back cover (C1-21) of the heat exchanger. This requires the removal of six (S1-3) back cover screws.
15. Tap the side of the cover firmly with a plastic handle to break the cover loose from the gasket.
16. Remove the back cover gasket (G1-35). The ribs on the underside of the cover support the back gasket while providing air gaps for expansion in case of a water freeze up.
17. Thoroughly clean all parts to be reused. The RK-TPEV kit contains all of the necessary parts to replace the components that are subject to deterioration.
18. Re-assemble the back cover (C1-21) and gasket (G1-35) to the heat exchanger body (AB1-19). Replace the six S1-3 screws as necessary. Match the mounting bosses in the cover with those on the heat exchanger. Tighten the screws in a crossing pattern.
19. The AB1-19 has a recess that has been cast into the body to locate the sponge. The recess is approximately .040-inch deep, so the sponge must be located accurately.
20. Install the primary seat (S4-7).
21. Install the body (B1-20) and body gasket (G1-37). Mount the body gasket on the primary pin boss and the two locating pins on the underside of the body. Use two S1-39 screws to locate the body on to the heat exchanger body (AB1-19). Tighten the screws to hold the units in place.
22. Install the primary valve pin (P1-11).  
Install the primary diaphragm assembly (AD1-15) over the locating pins and screw bosses. This gives the proper alignment for the assembly of the springs and the cover.
23. Place the two primary valve springs (S2-13) upon the locating perches that are extruded from the back up plate on the primary valve diaphragm assembly (AD1-15).
24. Press the primary cover (C1-20) in place over the primary valve springs and the diaphragm assembly. Insert the S1-40 screws. The protruding cups in the cover house the primary springs.
25. Install all of the screws except for the one required for fulcrum pin installation.
26. Tighten the primary cover screws until they just make contact with the body. Then tighten the screws solidly in a diagonal pattern until all the screws are tight.
27. Replace the secondary lever and seat with the new assembly supplied in the kit.

28. Install the secondary lever and insert the fulcrum pin (P1-7).
29. Replace the final S1-39 screw at this time.
30. Tighten the final screw.
31. Using a straight edge or G2-2 gauge, check the lever height. The secondary lever link pin should be approximately 1/32-inch below the level of the body casting.
32. Replace the secondary spring. Slip the spring under the secondary lever, making sure it is retained by the two tabs at the sides and the single tab punched through the top of the lever.
33. Install the secondary diaphragm. Verify that the slotted diaphragm link is engaged with the link pin.
34. Replace the cover (AC1-22-1). Turn all eight of the S1-3 screws until they contact the cover. Tighten the screws in a diagonal pattern until they are all firmly seated.
35. The converter is now complete. Check the converter for leakage using soap suds or a compatible testing solution.

## MIXER

1. Remove the mixer from the engine and place it on a suitable work surface.
2. Remove the four S1-3 screws that secure the C1-30 diaphragm cover in place.
3. Remove the diaphragm cover and the S2-30 diaphragm spring.
4. Lift the air valve assembly out of the mixer body.
5. Remove the diaphragm from the air valve assembly by removing the 4 S1-22 retaining screws.
6. Clean and inspect all parts. Inspect the air-gas valve and the body assembly for evidence of wear. If scratches, damage, marring, or a wear ridge (or step) exist, *these parts must be replaced*.
7. Reassemble in the reverse order of disassembly. Torque the S1-40 and S1-19 screws to 15 lb-in.
8. Reinstall the mixer to the engine.

## PROPANE FUEL SYSTEM INSPECTION

Inspect the propane fuel system hoses and vacuum lines for cracks, wear or other damage. Replace if necessary. Inspect the propane fuel system brackets for cracks, deformation or other damage. Replace if necessary. Inspect all fasteners and service as necessary.

## SPECIAL TOOLS

Liquid Leak Detector  
 IMPCO® ITK-1  
 IMPCO® FSA-1 (Qty. 2)  
 GM PROM Removal Tool



Weight per gallon @ 60°F .....4.24# .....6.3#  
 BTU per gallon (vaporized) .....91,500 .....123,000  
 BTU per pound (vaporized) .....21,560 .....20,500

**PRESSURE CONVERSION CHART**

| <b>MULTIPLY<br/>→<br/>TO OBTAIN<br/>↓</b> | Inches of<br>Water<br>Column | Ounces Per<br>Square<br>Inch | Inches of<br>Mercury<br>Column | Pounds Per<br>Square<br>Inch |
|---|------------------------------|------------------------------|--------------------------------|------------------------------|
| Inches of<br>Water Column                 | By<br>↓                      | 1.731                        | 13.6                           | 27.7                         |
| Ounces Per<br>Square<br>Inch              | .578                         | ↑<br>By<br>↓                 | 7.85                           | 16                           |
| Inches of<br>Mercury<br>Column            | 0.0736                       | 0.128                        | ↑<br>By<br>↓                   | 2.04                         |
| Pounds Per<br>Square Inch                 | 0.0361                       | .0625                        | 0.491                          | ↑<br>By                      |