Compressed Natural Gas

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INTRODUCTION

Compressed Natural Gas (CNG) vehicles are being introduced more and more to combat pollution. The use of natural gas requires modifications to the fuel and exhaust systems and some other components to operate. The market for CNG continues to be fleet type vans and trucks.

STUDENT LEARNING OBJECTIVES

Upon completion of this course, you should be able to:

- Identify characteristics of CNG as a vehicle fuel
- Identify components of CNG fuel systems
- Describe the function of CNG components
- Identify key safety issues
- Diagnose mechanical malfunctions in CNG fuel systems
- Diagnose electrical malfunctions of CNG fuel systems
- Use the DRB III to diagnose electrical malfunctions

Note: *Some states, counties and other municipalities now require that technicians be certified in CNG service to perform work on CNG fuel systems. Check with your local automotive regulations bureau for the requirements in your area.*

VEHICLE APPLICATIONS

The following vehicles can be equipped with the CNG fuel system option package:

- Dodge Grand Caravan/Plymouth Grand Voyager (3.3L V6, FWD)
- Dodge Ram Van/Wagon (5.2L V8, RWD)
- Dodge Ram Truck (5.2L V8, RWD)

Note: *Do not extend the intervals for servicing and required maintenance on CNG vehicles. Follow the same maintenance schedules as found in the Owner's and Service Manuals.*

Note: *Operate manual valves (fuel control and manual shut-off) to prevent seizing.*

ACRONYMS

In this publication there are several abbreviations that are referred to frequently. These acronyms are as follows:

- ASD Automatic Shutdown (as in ASD Relay)
- BTU British Thermal Unit
- CCD Chrysler Collision Detection (as in CCD Bus)
- CKP Crankshaft Position Sensor
- CMP Camshaft Position Sensor
- CNG Compressed Natural Gas
- DRB Diagnostic Readout Box
- DVOM Digit Volt Ohm Meter
- ECT Engine Coolant Temperature
- EGR Exhaust Gas Recirculation
- FWD Front Wheel Drive
- IAC Idle Air Control
- IAT Intake Air Temperature
- MAP Manifold Absolute Pressure (as in MAP Sensor)
- PCM Powertrain Control Module
- PDC Power Distribution Center
- PSI Pounds per Square Inch
- RWD Rear Wheel Drive
- TPS Throttle Position Sensor
- VSS Vehicle Speed Sensor
- WOT Wide Open Throttle

Compressed Natural Gas

INTRODUCTION TO COMPRESSED NATURAL GAS

CNG offers several advantages over gasoline and other alternative fuels. Some of these advantages include the following:

- Lower Carbon Monoxide (CO) emissions
- Lower Hydrocarbon (HC) emissions
- Lower Oxides of Nitrogen (NOX) emissions
- Cleaner burning with fewer deposits
- Higher octane eliminating engine knock

Natural gas is composed mainly of methane and carries a rating of 105 to 130 octane. Natural gas remains a gas, even when compressed to 3,000 to 3,600 PSI, and is not the same as propane. Propane is liquid petroleum gas (LPG). Natural gas is lighter than air and when released rises and dissipates into the atmosphere. Propane is heavier than air and when released collects at ground level.

CNG also offers the advantage of abundance. It is a plentiful resource, and distribution networks are already in place making it more economical than other alternative fuels.

CNG has a lower British Thermal Unit (BTU) rating per cubic inch than liquid fuels. Therefore, larger storage tanks are required to carry the fuel. As a result, traveling distance per tank full is somewhat lowered. The main target market for CNG is larger fleet vehicles, usually used in inner city delivery, service and public transportation.

IDENTIFICATION

It is very important to identify the CNG vehicle before performing any service or diagnostic procedures. There are safety precautions that must be observed when servicing a CNG vehicle. CNG vehicles are identified by decals located on the rear of the vehicle and on the driver's door (fig. 1). Vehicles intended to be sold in California have a different decal on the driver's door. This decal states that the vehicle is a "Clean Air Vehicle." An additional decal is affixed to the cargo door or liftgate above the lamp bar that says "Clean Air Vehicle" and directly below that, "Inherently Low Emission Vehicle." Always check local regulations to ensure compliance.

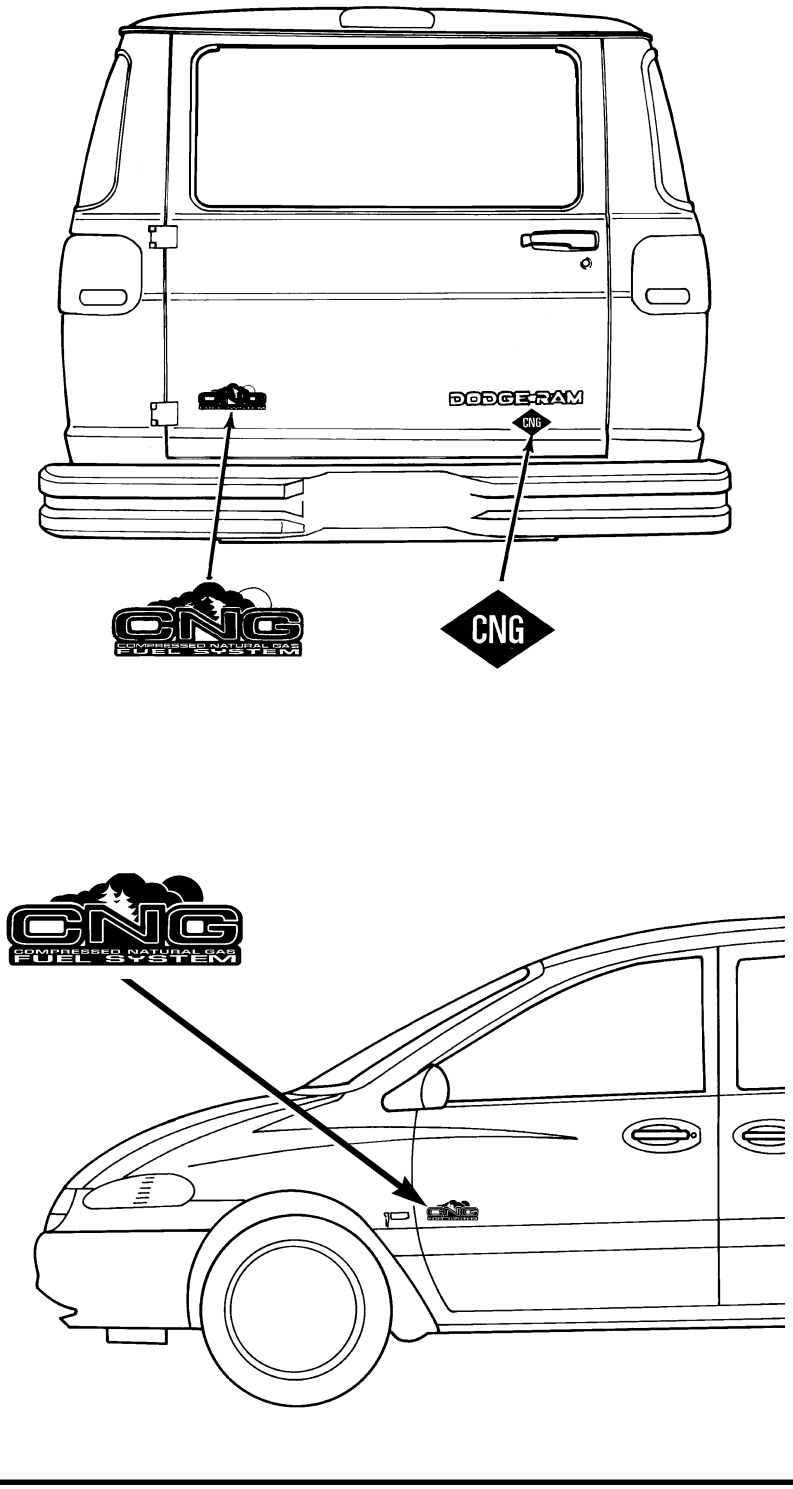


Figure 1 CNG Vehicle Decals

ENGINE MODIFICATIONS

Converting a vehicle to a CNG fuel system requires some minor engine modifications. The main changes required for CNG use include:

- Special valve seat inserts on intake and exhaust valves
- Chrome–plated valve stems
- Oversized valve stem seals

On both engine applications, the intake and exhaust valves require special seats because, in the CNG system, the valves are not lubricated by liquid fuel and its additives. Oversized valve stem seals are used on intake valve stems on all vehicles.

Warning:	*Before any part of the CNG fuel system is opened for repair, engine repair or removal, the fuel system must be purged of all natural gas. Failure to do so releases the gas into the atmosphere and may cause it to collect in the ceilings of work areas.*

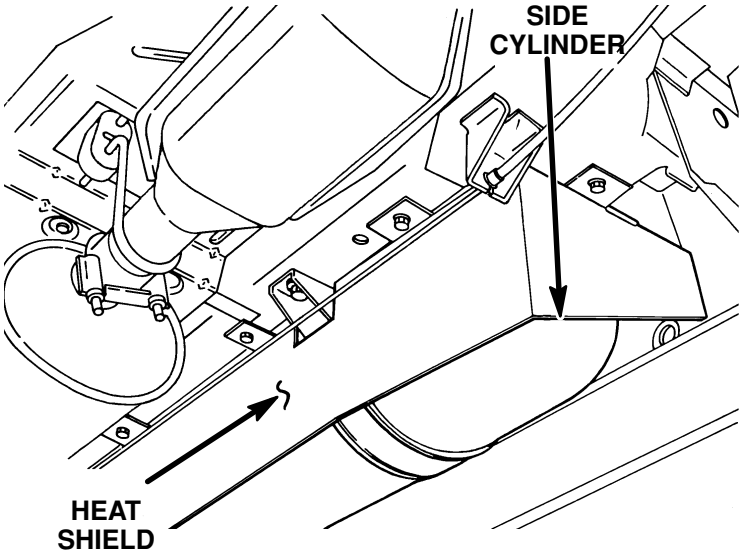
EXHAUST SYSTEMS

One of the most significant aspects of the CNG exhaust system is that there is no Exhaust Gas Recirculation (EGR) System (except for early Ram/Van Wagon 5.2L models).

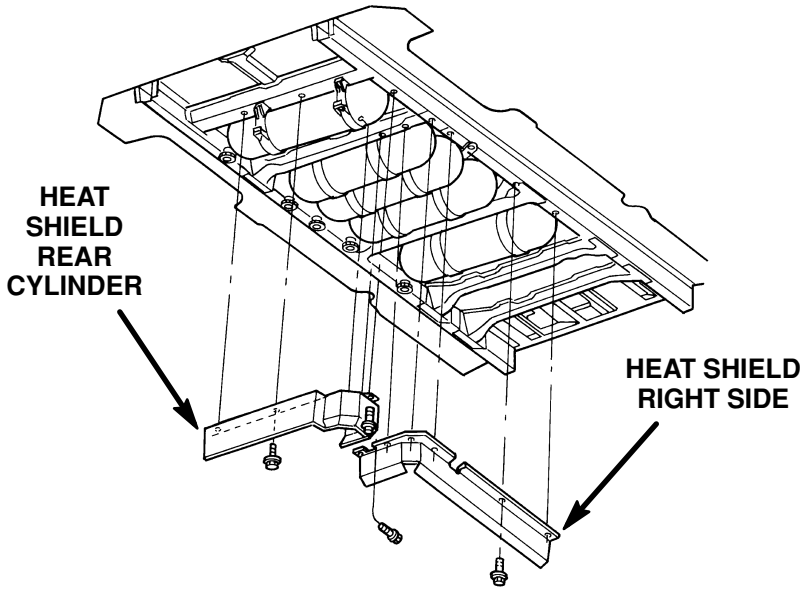
Some exhaust systems require additional heat shields to protect the CNG fuel storage tanks (fig. 2). Installation and removal procedures can be found in the appropriate Service Manual Supplement. The following vehicles have the additional exhaust shields:

- Dodge Grand Caravan/Plymouth Grand Voyager (3.3L V6, FWD)
- Dodge Ram Van/Wagon (5.2L V8, RWD)

The mini–vans have unique exhaust systems that is positioned lower than the standard system so the exhaust pipes clear the fuel cylinders.



RAM VAN



MINIVAN

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Figure 2 Heat Shields for Minivan and Ram Van

FUEL DELIVERY SYSTEM

The Fuel Storage and Delivery System is the major modification on a CNG vehicle (fig. 3). CNG is stored in large cylinders and is transferred through high pressure, stainless steel, seamless fuel tubes.

The fuel rail and injectors are unique to the CNG fuel system, but their functions remain the same as in a gasoline engine.

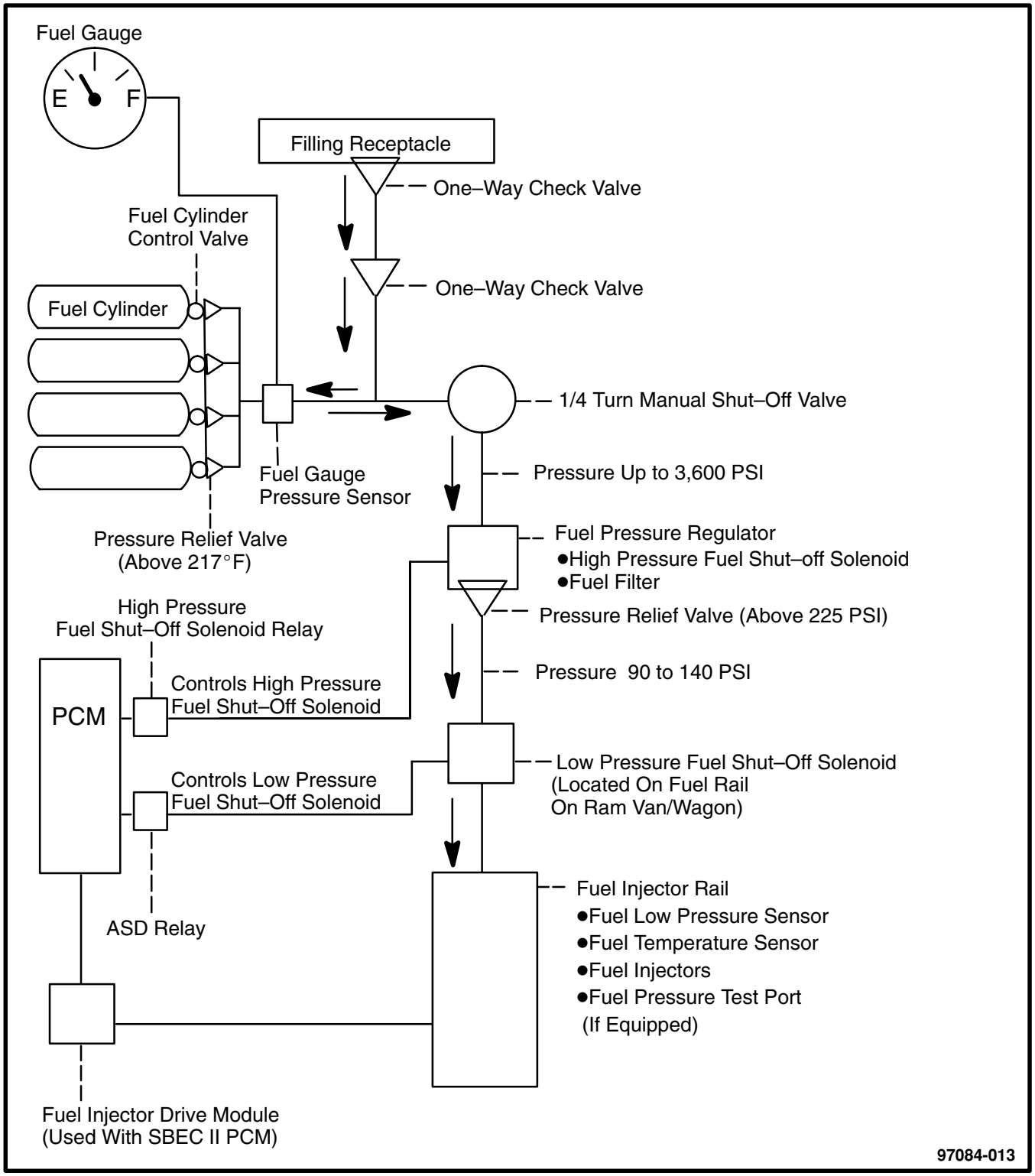


Figure 3 CNG Fuel Flow Diagram

FUEL CYLINDERS

CNG is stored in specially approved cylinders at pressures up to 3,600 PSI. The cylinders are composed of aluminum liners wrapped in fiberglass. This unique construction provides for such desirable characteristics as lighter weight, higher internal volume, increased safety and heat resistance.

The exterior of the cylinders is coated with an epoxy paint and clear polyurethane to provide additional environmental protection.

The cylinders are located differently depending on vehicle and option availability. Specific cylinder locations are covered in the next section.

U.S. and Canadian Government Requirements

Government regulations have standardized the testing and use of CNG fuel tanks throughout the automotive industry. US and Canadian regulations may vary, but the following are requirements of both countries:

- Tanks must be tested every three years
- Retest dates must be stamped on the cylinder neck or marked on a label securely affixed to the cylinder and overcoated with epoxy near the original test date
- Cylinders must be replaced after 15 years from original manufacture date

Although test dates must be on the cylinder themselves, they may also be listed on the fuel filler door for convenience.

Ram Van/Wagon Fuel Cylinders

Three or four high pressure fuel cylinders are used to store natural gas at pressures up to approximately 3,000 PSI. Two of the cylinders are mounted transversely behind the rear axle. The third cylinder is mounted longitudinally along the left side of the vehicle frame rail. A fourth cylinder (optional on some models) is mounted longitudinally along the right side of the vehicle frame rail (fig. 4).

The capacity of the three standard cylinders at 3,000 PSI is equivalent to 11.1 gallons of gas. The optional fourth cylinder increases the fuel capacity to an equivalent of 14.5 gallons of gasoline.

Each fuel cylinder is equipped with its own manually–operated fuel control valve. Each of these valves is equipped with a pressure relief safety device.

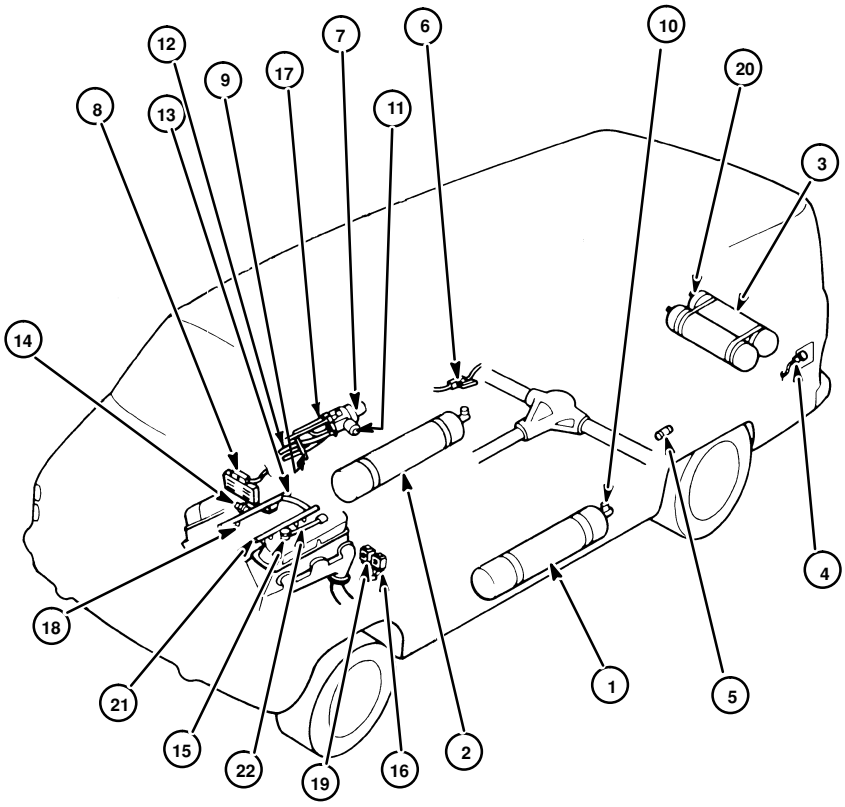
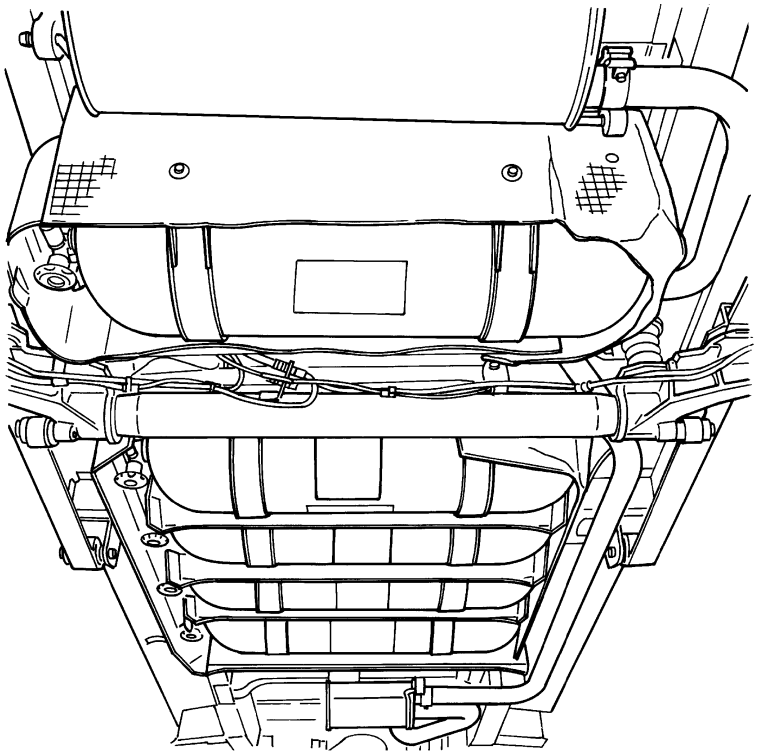


Figure 4 Ram Van/Wagon Fuel Cylinder Locations

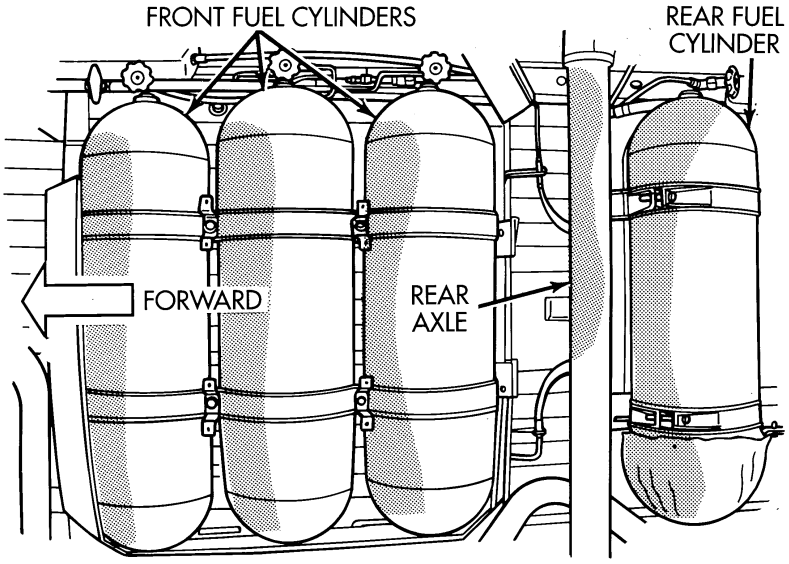
NS Grand Caravan/AS Grand Voyager Fuel Cylinders

Four or five separate fuel cylinders are used to store the CNG on 3.3L minivans (fig. 5). On the NS Grand Caravan, five cylinders are mounted transversely underneath the floor pan. One is mounted behind the rear axle and the other four are mounted in front of the rear axle. On the AS Grand Voyager, three cylinders are mounted to a common carrier in front of the rear axle. The fourth cylinder is separately mounted behind the rear axle.

Each cylinder stores CNG at pressures up to 3,600 PSI. The five cylinders on the NS Grand Caravan have a combined capacity equivalent to 10.1 gallons of gasoline at 3,000 PSI and 11.6 gallons at 3,600 PSI. The four cylinders on the AS Grand Voyager have a combined capacity equivalent to 8.2 gallons at 3,000 PSI and 9.4 gallons at 3,600 PSI. Each of the cylinders contain a manually–operated fuel control valve with pressure relief for safety.



NS GRAND CARAVAN



AS GRAND VOYAGER

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Figure 5 Minivan Fuel Cylinders

Ram Truck Fuel Cylinders

Ram Pickup Truck models use a single tank mounted in the truck bed near the cab (fig. 6). The cylinder is secured to the vehicle bed and a cover protects the cylinder from contact with cargo. The capacity of the cylinder is equivalent to 16.3 gallons of gasoline at 3,000 PSI. The single cylinder is equipped with a manually-operated fuel control valve with pressure relief for safety.

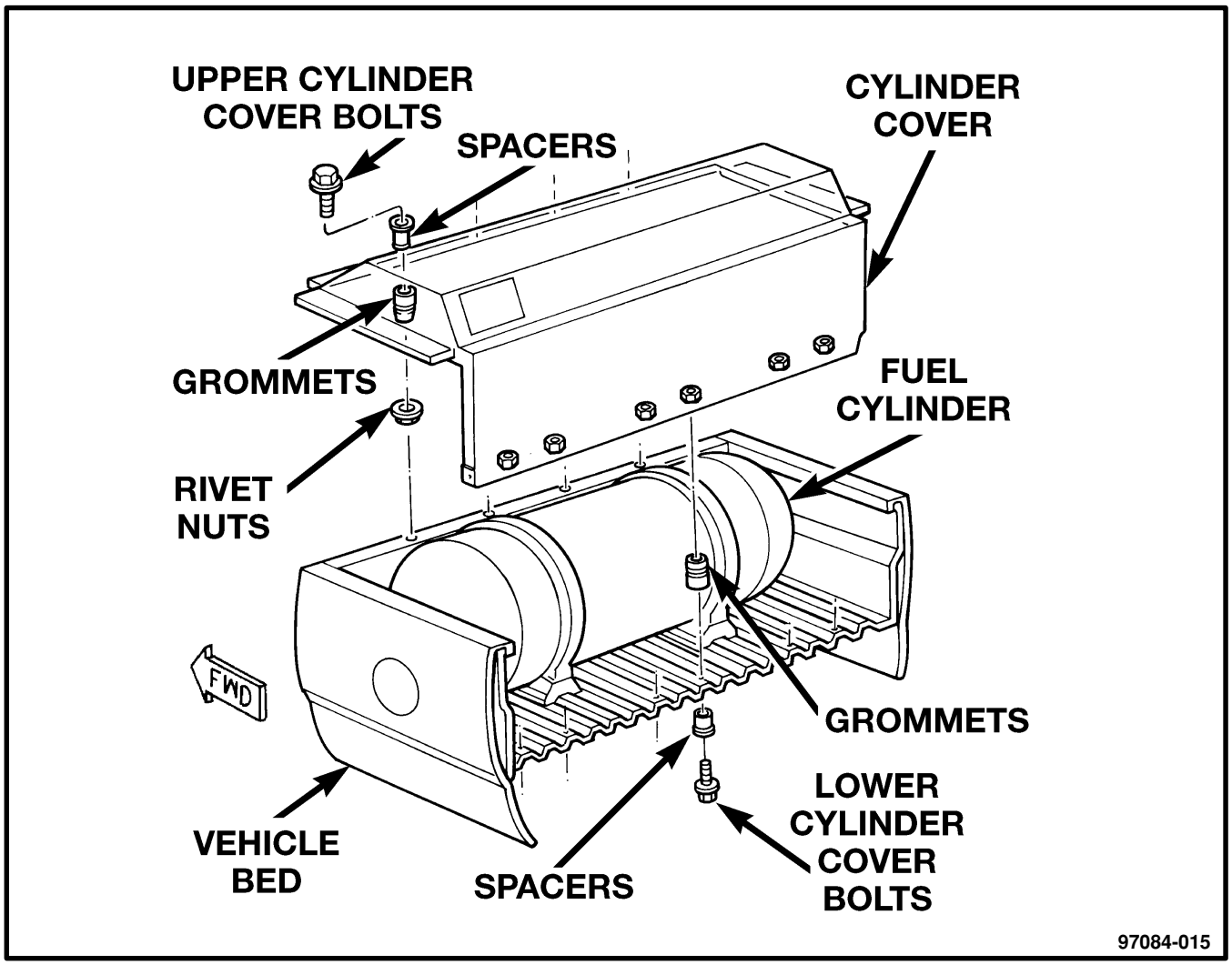


Figure 6 Ram Pickup Fuel Cylinder

FUEL CONTROL VALVES WITH PRESSURE RELIEF

Each tank on the CNG vehicles is equipped with its own manually–operated Fuel Control Valve, though locations vary from model to model (fig. 7). Turn the valve handle fully clockwise to stop gas flow (closed). Turn the valve handle fully counter–clockwise to provide gas flow (open).

Each control valve is equipped with a pressure relief device for safety. The device releases excess cylinder pressure to the atmosphere if the temperature rises above approximately 217° F. When a relief device opens, the CNG from the entire system (all cylinders) is released into the atmosphere. The relief device is not reusable.

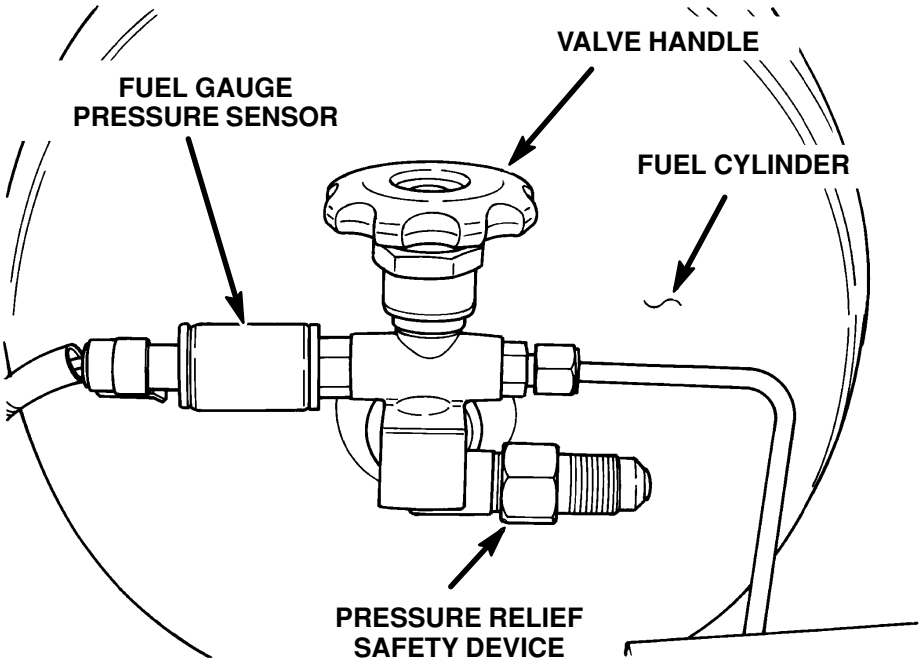


Figure 7 Fuel Control Valve (Typical)

1/4 TURN MANUAL SHUT–OFF VALVE

A Manual Shut–Off Valve is provided on each fuel system (fig. 8). Operated by hand, the valve stops fuel flow from all cylinders, preventing fuel from reaching the delivery system. A “Manual Shut–Off Valve” label is affixed to the exterior body panel, directly outboard from where the valve is located.

When the manual shut–off knob is turned parallel to the fuel line, the valve is open. When the valve is turned perpendicular to the fuel line, the valve is closed and fuel cannot reach the delivery system.

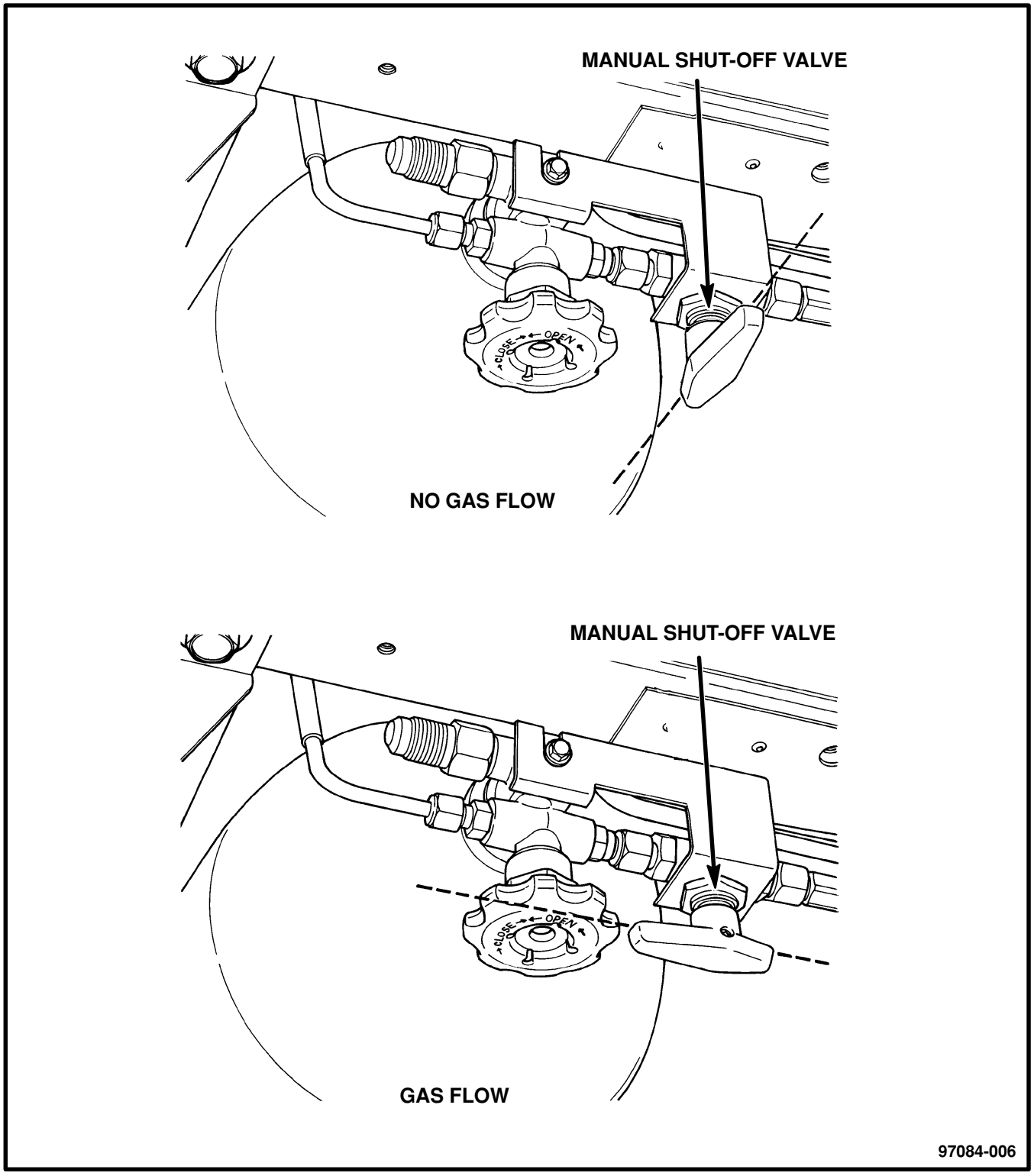


Figure 8 Typical Manual Shut–Off Valve (NS Shown)

FUEL PRESSURE REGULATOR

The Fuel Pressure Regulator reduces the fuel cylinder pressure to approximately 90–140 PSI and is located downstream from the Manual Shut–Off Valve (fig. 9). The regulator contains a built–in pressure relief device and fuel filter. This pressure relief device is a safety item that vents CNG to the atmosphere. It is on the regulator's low pressure side, and vents excess pressure above approximately 225 PSI.

Expanding the fuel to a lower pressure has a thermodynamic cooling effect. To counteract this effect, engine coolant is routed to the regulator to prevent freeze up. Routing of coolant hoses varies between vehicles (See section titled "Engine Cooling Systems" for more information).

High Pressure Fuel Shut–Off Solenoid

The High Pressure Fuel Shut–Off Solenoid is an ON/OFF valve that electronically controls high pressure gas flowing through the Fuel Pressure Regulator. This solenoid is an integral part of the Fuel Pressure Regulator and is controlled by the Powertrain Control Module (PCM) through the High Pressure Fuel Shut–Off Solenoid Relay.

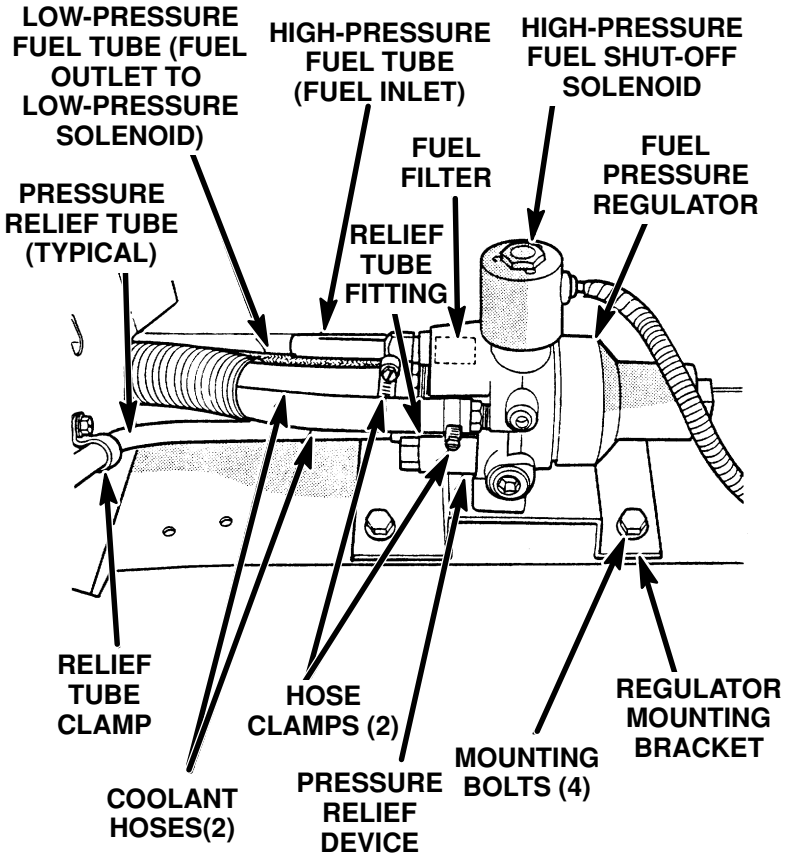
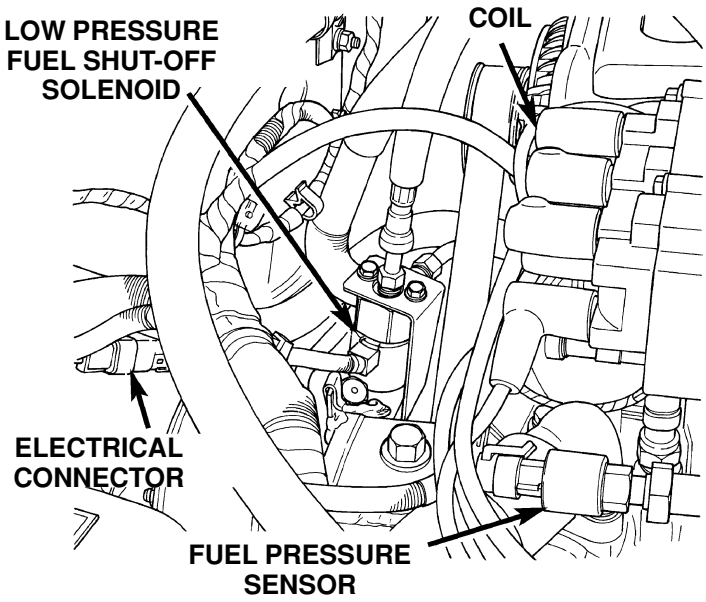


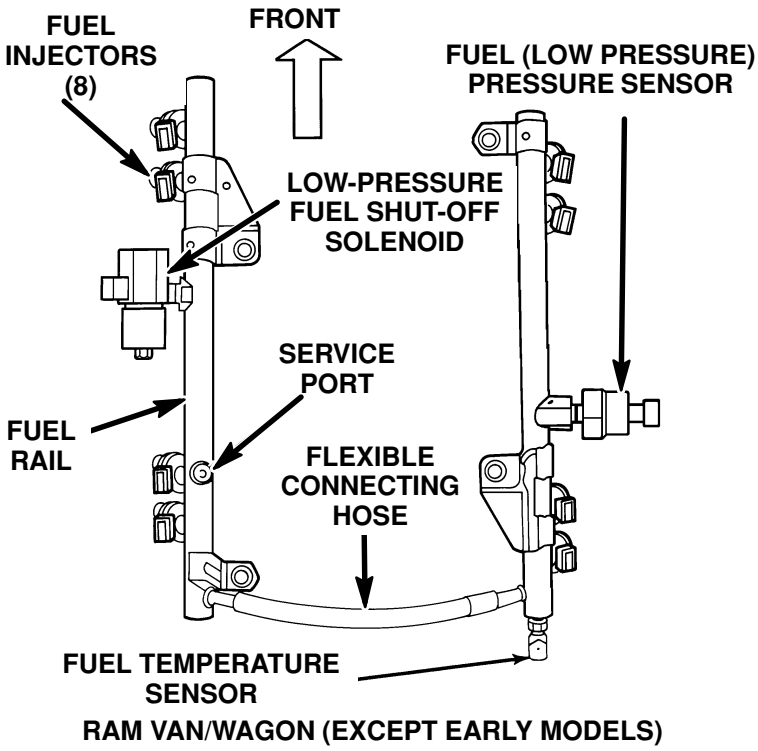
Figure 9 Typical Fuel Pressure Regulator (Ram Van/Wagon Shown)

LOW PRESSURE FUEL SHUT–OFF SOLENOID

The Low Pressure Fuel Shut–Off Solenoid is used to close off the fuel supply to the fuel injector rail (fig. 10). The PCM controls this device through the Automatic Shutdown (ASD) Relay. When the Ignition Switch is turned OFF, the PCM de–energizes the ASD Relay thus turning the solenoid OFF. When the solenoid is OFF, the fuel line is closed and CNG cannot enter the fuel rail. The solenoid on the minivan is located near the power steering pump. On the Van/Wagon, the solenoid is attached to the fuel rail.



MINIVAN



RAM VAN/WAGON (EXCEPT EARLY MODELS)

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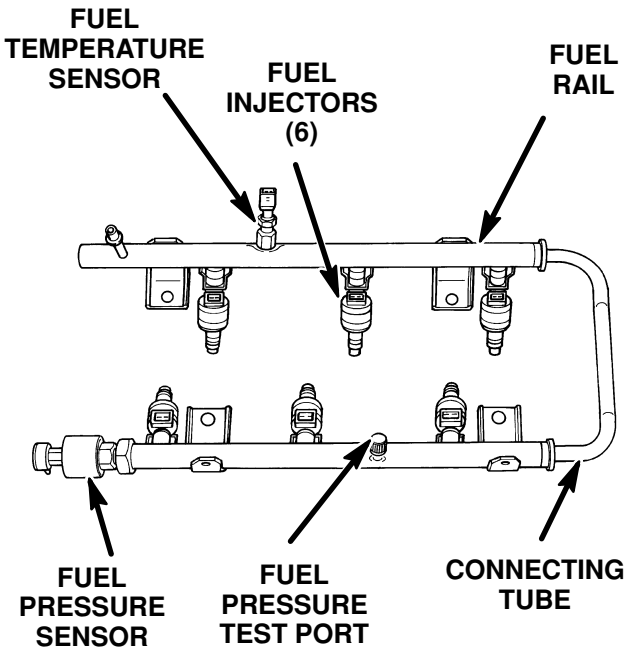
Figure 10 Low Pressure Fuel Shut–Off Solenoid

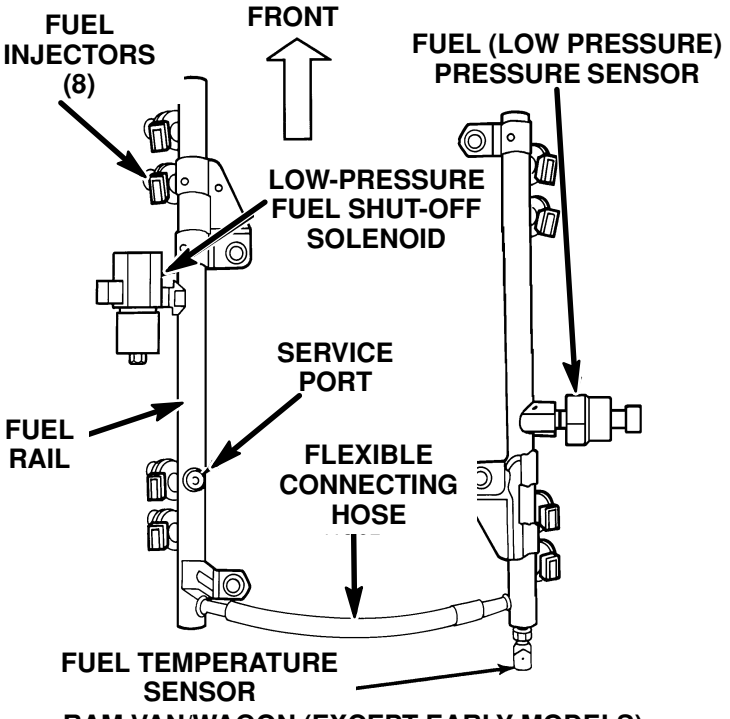
FUEL INJECTOR RAIL

A unique Fuel Injector Rail is required for the CNG fuel system (fig. 11). This rail is mounted to the intake manifold and supplies the necessary fuel to the individual injectors.

Caution: *The left and right halves of the Fuel Injector Rail are connected by a non–serviceable connecting hose. DO NOT attempt to separate the rails at this hose. When removing the fuel rail, take care not to bend or kink the hose.*



MINIVAN



RAM VAN/WAGON (EXCEPT EARLY MODELS)

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Figure 11 CNG Fuel Rails

FUEL LINES AND FITTINGS

High pressure stainless steel, seamless fuel tubes are used in the CNG system. Special stainless steel, **double–ferrule**, compression–type fittings are used on the high pressure side of the system (fig. 12). All component and fuel tube connections from the inlet side of the pressure regulator to the fuel cylinders must use this type of fitting. Certain components on the high pressure side require O–rings. Fittings on the low pressure side of the system (outlet side of the pressure regulator and all downstream connections) use NPT pipe threads and 45–degree flared fittings.

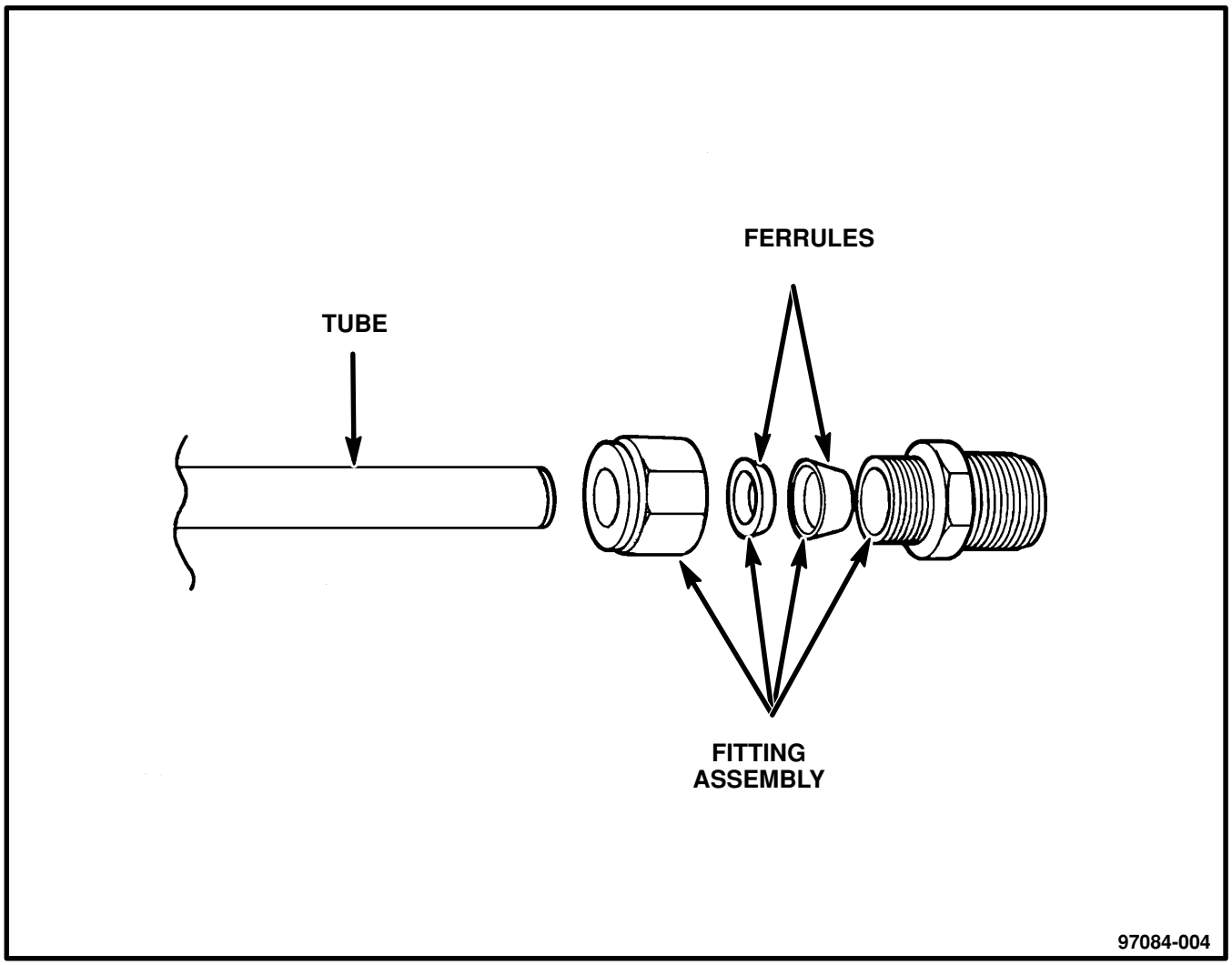


Figure 12 Typical CNG Fuel Line Fitting

FILLING RECEPTACLE AND CHECK VALVES

The fuel receptacle is mounted behind the fuel filler door (fig. 13). The receptacle contains an integral one–way check valve. An additional one–way check valve is installed in the fuel fill line between the Fuel Pressure Regulator and the fuel fill receptacle. Both the receptacle check valve and the in–line check valve prevent fuel from escaping through the filling receptacle.

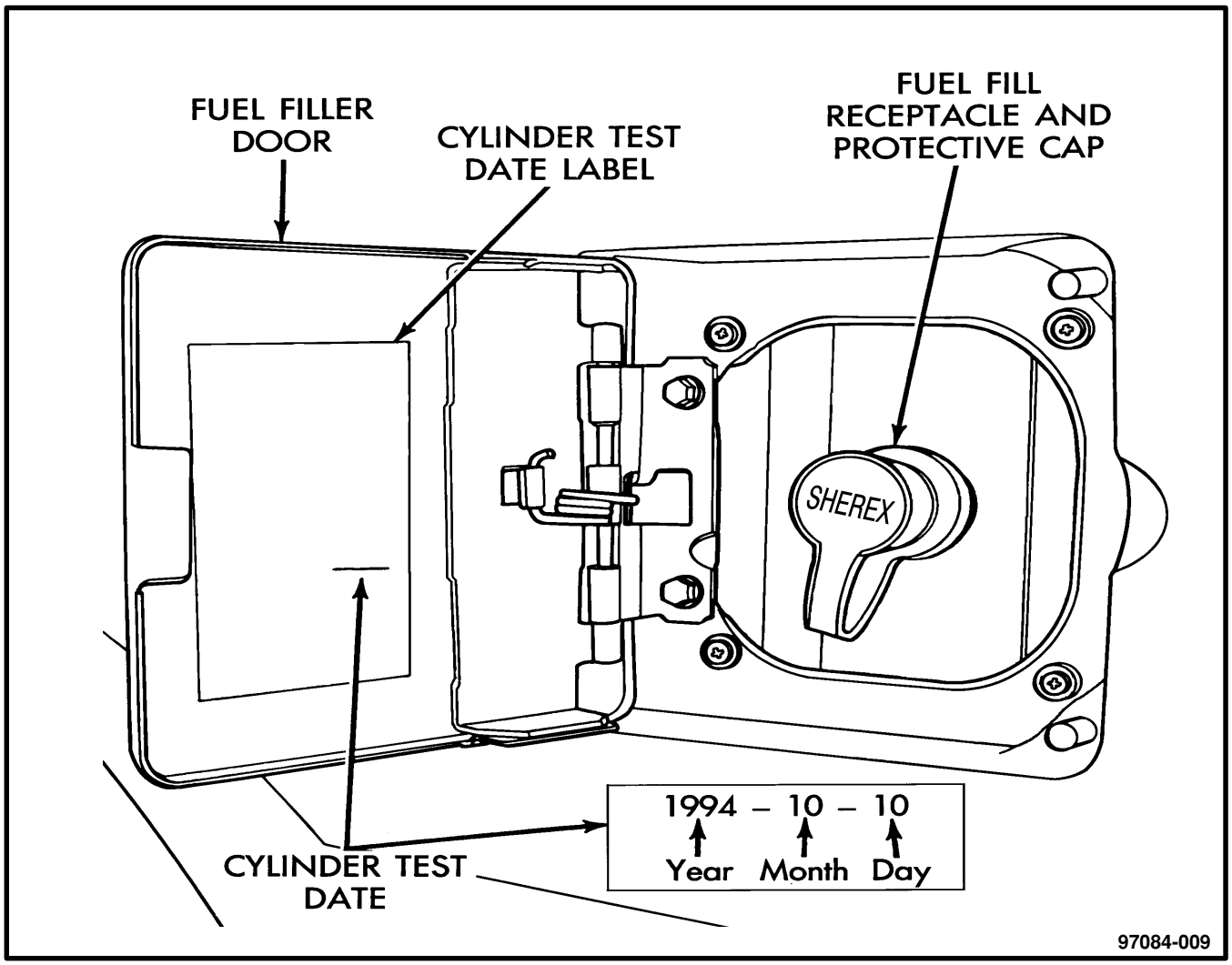


Figure 13 Typical Fuel Filling Receptacle (Ram Van Shown)

ACTIVITY ONE

CNG IDENTIFICATION

For this activity the Instructor will conduct a component location overview of the classroom CNG vehicle. Have the students complete the chart on the following page by completing the statements in the "Function" column and writing the location of the components for each vehicle line in the "Location" column.

Compressed Natural Gas

Component	Function	Location
Fuel Cylinders	Stores_____ _____ fuel.	*List number of cylinders also.* Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
Fuel Control Valve	Turns _____ to close the fuel line. Turns _____ to open the fuel line.	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
Fuel Control Valve Pressure Relief Device	Releases fuel to the atmosphere when temperature exceeds approximately _____ _____	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
Manual Shut–Off Valve	Used to open and close the _____ to the delivery system.	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
Fuel Pressure Regulator	Reduces fuel cylinder pressure to between _____ PSI.	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
High Pressure Fuel Shut–Off Solenoid	Operated by the PCM as an ON/OFF device to control fuel flow through the _____ _____.	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –
Low Pressure Fuel Shut–Off Solenoid	Operated by the PCM as an ON/OFF device to control fuel flow to the_____.	Ram Van/Wagon – Caravan/Voyager – Grand Caravan/Voyager –

ENGINE COOLING SYSTEM

The engine cooling systems on Chrysler's 5.2L and 3.3L CNG–powered vehicles are the same as those used on their gasoline equivalents. The only difference is the additional routing of two heater hoses to the Fuel Pressure Regulator (fig. 14). The hoses are teed into the vehicle heater hoses in the engine compartment (fig. 15).

Note: *The auxiliary rear heating and A/C units are not available on the CNG Grand Caravan/Grand Voyager models. The heater lines to the rear auxiliary heater box are routed to the Fuel Pressure Regulator.*

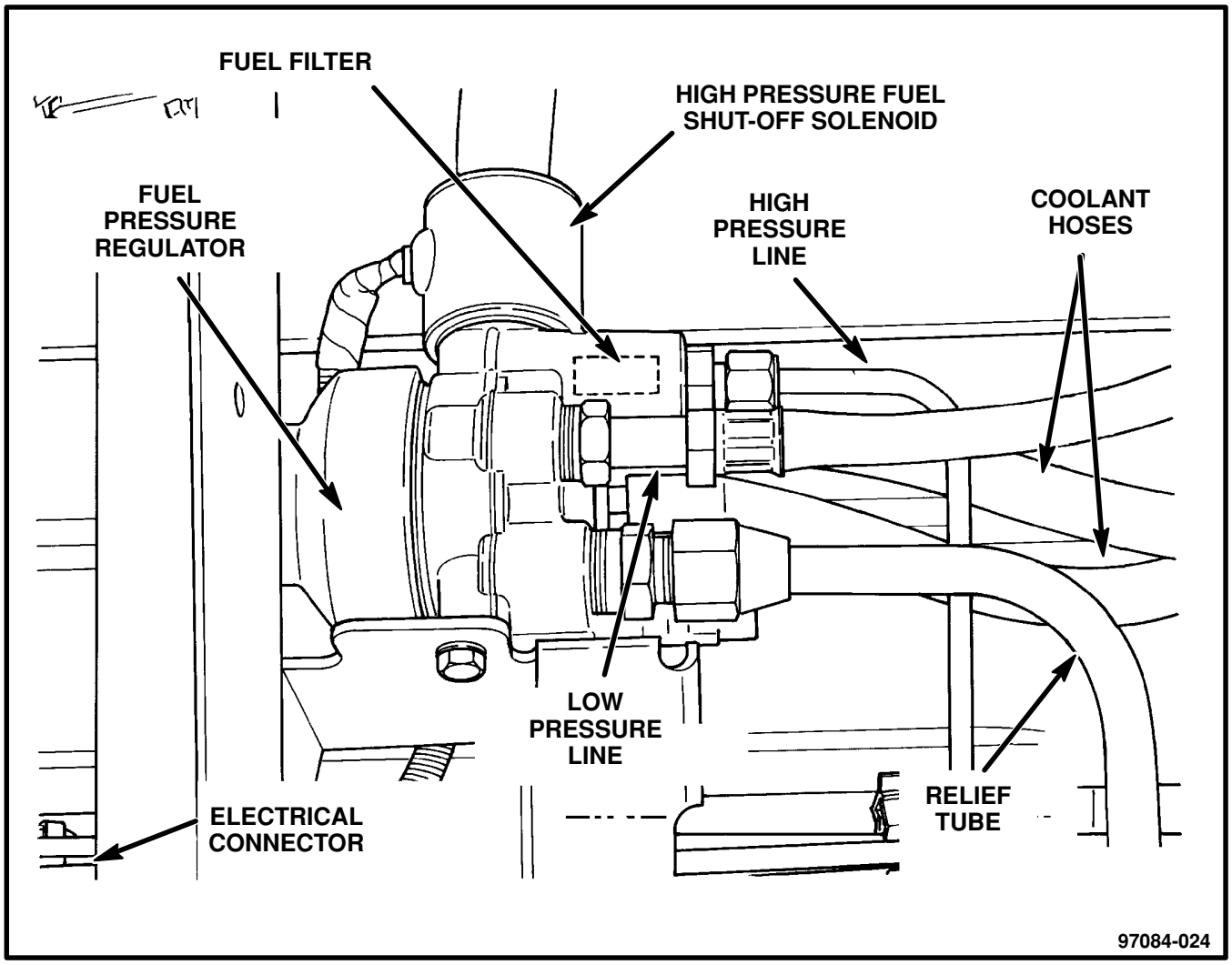


Figure 14 Fuel Pressure Regulator Coolant Hoses (NS Shown)

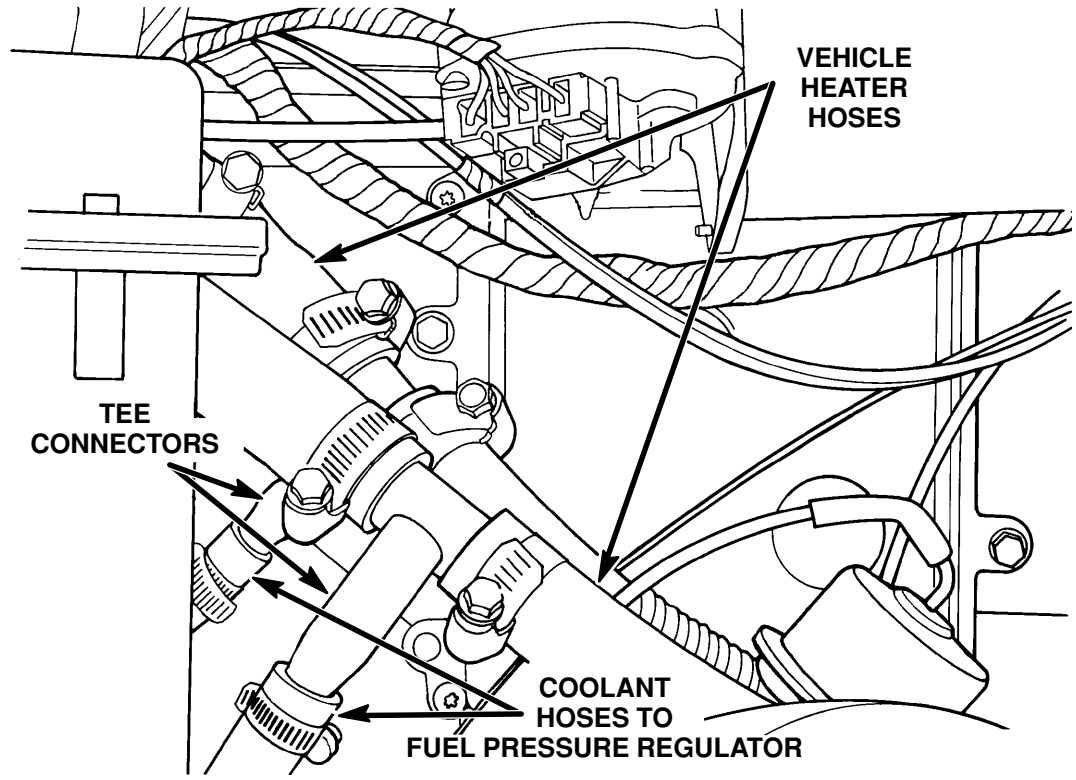


Figure 15 Coolant Hoses in Engine Compartment (Ram Van Shown)

FUEL DELIVERY SYSTEM SERVICE

The fuel system must be purged of natural gas before any of the following components are removed or repaired:

- High and low pressure fuel lines
- Fuel Injector Rail
- Fuel injectors
- Fuel Temperature Sensor
- Fuel Low Pressure Sensor
- Fuel Gauge Pressure Sensor
- Fuel fill receptacle
- Fuel cylinder
- Fuel Control Valve
- Manual Shut–Off Valve
- Fuel filter
- Low Pressure Fuel Shut–Off Solenoid
- High Pressure Fuel Shut–Off Solenoid
- Fuel Pressure Regulator
- One–way check valve

After performing any service procedures that open the fuel system, use a Go–No–Go gauge inspection tool to check fuel tube high pressure fittings. These fittings are located only on the high pressure side of the fuel system. Refer to the Service Manual section of “Fuel Tubes and Fittings” in the “Removal/Installation” section.

Warning:	*Before any part of the CNG fuel system is opened for repair or replacement, the system must be purged of all natural gas.*

VISUAL INSPECTION

Always perform a thorough visual inspection for loose, damaged, disconnected or incorrectly routed wires and fuel tubes. A visual check can reveal many faults and save unnecessary diagnostic time. Before conducting a visual inspection, verify that the Manual Shut–Off Valve is OPEN (by turning valve handle parallel to gas line) and the Fuel Control Valves are OPEN (by turning valve handle fully counter–clockwise). The following visual checks are particularly helpful for the CNG fuel system:

1. Check electrical connections at the following components:
   - Low Pressure Fuel Shut–Off Solenoid
   - High Pressure Fuel Shut–Off Solenoid
   - Fuel Temperature and Fuel Pressure Sensors
   - PCM connector
   - Battery cables
   - High Pressure Fuel Shut–Off Solenoid Relay and ASD Relay
   - Injector Driver Module (if equipped)

2. Inspect fuel tubes for damage or kinking.

3. Inspect fuel tubes' connections for leaks.

Further items can be visually inspected. Refer to the appropriate Service Manual for additional information on visual inspections under "Diagnosis and Testing" in the "Fuel System" section.

FUEL TUBE PURGING

Engine Able To Run

Use this procedure when purging the fuel tubes on a vehicle with an engine that can run:

Note: *If fuel tanks must be purged, refer to the following section on "Fuel Cylinder Purging."*

1. Close Fuel Control Valves (by turning valve handle fully clockwise) on all fuel cylinders.

2. Open Manual Shut–Off Valve (by turning valve handle parallel to gas line) to allow gas flow.

3. Start and operate the engine until it runs out of fuel.

4. Attempt three more starts.

If the engine does not operate, the fuel tube is purged. However, always slowly loosen the fuel tube fitting being serviced.

Warning:	*Although the fuel tubes are now purged of gas, the fuel cylinders are still under high pressure. Do not open the closed valves until all high pressure components have been resealed.*

Engine Not Able To Run

Use this procedure when purging the fuel tubes on a vehicle with an engine that is not able to run:

Note: *If fuel tanks must be purged, refer to the following section on "Fuel Cylinder Purging."*

Warning:	*If a fuel system component is being serviced on an engine that will not start, move the vehicle outdoors.*

1. Move vehicle outdoors.
2. Close Fuel Control Valves (by turning valve handle fully clockwise) on all fuel cylinders.
3. Open Manual Shut–Off Valve (by turning valve handle parallel to gas line) to allow gas flow.
4. Cycle the Ignition Switch to the RUN position a few times to activate the High Pressure Fuel Shut–Off Solenoid.

Note: *The DRBIII can also be used to activate the solenoid.*

5. Turn the Ignition Switch to the OFF position.
6. Slowly loosen the fuel line at the Low Pressure Fuel Shut–Off Solenoid. Pressure will be observed. Leave line loosened until all pressure is relieved.

Warning:	*Although the fuel tubes are now purged of gas, the fuel cylinders are still under high pressure. Do not open the closed valves until all high pressure components have been resealed.*

FUEL CYLINDER PURGING

The following procedures are to be used when purging a fuel cylinder.

Engine Able To Run

Use this procedure when servicing any of the CNG fuel cylinders on a vehicle with an engine that can run:

1. Open Manual Shut–Off Valve (by turning valve handle parallel to gas line) to allow gas flow.

2. Open Fuel Control Valves (by turning valve handle fully counter–clockwise) on the fuel cylinder(s) to be serviced.

3. Close Fuel Control Valves (by turning fully clockwise) on the fuel cylinder(s) not being serviced.

4. Start and operate the engine until it runs out of fuel.

5. Attempt three more starts.

If the engine does not operate, the applicable fuel cylinder and tubes are purged. However, always slowly loosen the fitting to the fuel cylinder being serviced.

Warning:	*Although the fuel tubes and opened fuel cylinders are now purged of gas, the fuel cylinders (with valves still closed) are still under high pressure. Do not open the closed valves until all high pressure components have been resealed.*

Engine Not Able To Run

Use this procedure when servicing any of the CNG fuel cylinders on a vehicle with an engine that is not able to run:

Warning:	*If a fuel system component is being serviced on an engine that will not start, move the vehicle outdoors.*

1. Move vehicle outdoors.

2. Open Manual Shut–Off Valve (by turning valve handle parallel to gas line) to allow gas flow.

3. Open Fuel Control Valves (by turning valve handle fully counter–clockwise) on the fuel cylinder(s) to be serviced.

4. Close Fuel Control Valves (by turning fully clockwise) on the fuel cylinder(s) not being serviced.

5. Very slowly loosen the fuel tube fitting at the Fuel Control Valve of the fuel cylinder being serviced. High pressure will be observed.

6. Leave line loosened until all pressure is relieved.

Warning:	*Although the fuel tubes and opened fuel cylinders are now purged of gas, the fuel cylinders (with valves still closed) are still under high pressure. Do not open the closed valves until all high pressure components have been resealed.*

FUEL SYSTEM PRESSURE TESTING

Check the fuel system pressure only when fuel cylinders are at least one–half full. Minimum fuel injector operating pressure is 90 PSI. Maximum operating pressure is 140 PSI. To test system pressure perform the following procedure:

Note: *The DRB III can be used on vehicle models that do not have a pressure service port.*

1. Remove the fuel pressure service port cap on fuel rail. (if equipped)

Caution: *Use the correct gauge to measure pressures between 90 and 140 PSI or damage to equipment may result.*

2. Attach a pressure test gauge to the service port.

3. Start the engine and bring to operating temperature.

4. Check pressure. Pressure reading at the fuel rail should be between 90 PSI and 140 PSI.

5. If pressure is above 140 PSI with fuel cylinders one–half full or more, replace the Fuel Pressure Regulator.

6. If pressure is lower than 90 PSI, check the following:
   - Verify fuel cylinder control valves are OPEN (by turning valve handle fully counter–clockwise)
   - Verify Manual Shut–Off Valve is OPEN (by turning valve handle parallel to gas line)
   - Verify fuel volume
   - Check for damaged fuel tubes
   - Perform Low Pressure Fuel Shut–Off Solenoid electrical tests
   - Perform High Pressure Fuel Shut–Off Solenoid electrical tests
   - Refer to fuel injector tests

7. After tests have been completed, remove pressure test gauge.

8. Check system for leaks.

U.S. AND CANADIAN REGULATIONS FOR FUEL CYLINDER TESTING

All testing of CNG fuel cylinders must be performed by a certified testing facility.

Warning:	*U.S. Department of Transportation (DOT) requires that each CNG fuel cylinder manufactured on or after March 27, 1995 must be removed and reinspected every three years in accordance with Federal Motor Vehicle Safety Standard 304. The inspection shall be performed by a qualified person in accordance with the cylinder manufacturers' established reinspection criteria and the appropriate Compressed Gas Association, Inc. guideline. Retest markings must be stamped on the cylinder neck or marked on a label securely affixed to the cylinder, and overcoated with epoxy near the original test date. Reheat treatment or repair of rejected cylinders is not authorized. The fuel cylinder expires and must be removed from service fifteen years from the date of manufacture. A label on the fuel filler door states the cylinder retest date and cylinder expiration date. A similar label is attached to each fuel cylinder. If there is a question about the proper inspection of the CNG cylinder, contact the manufacturer as identified on the cylinder label.*

Warning:	*Canadian Requirements: The cylinder must be reinspected and hydrostatically retested every three years in accordance with the Canadian Standards Association (CSA) CAN/CSA–B339, as prescribed for TC–3FCM containers. Retest dates must be stamped on the exposed metallic surface of the cylinder neck or marked on a label securely affixed to the cylinder, and overcoated with epoxy near the original test date. Reheat treatment or repair of rejected cylinders is not authorized. The fuel cylinder expires and must be removed from service fifteen years from the date of manufacture. A label on the fuel filler door states the first cylinder retest date and cylinder expiration date. It is recommended that the fuel system components be inspected periodically for leaks and/or excessive wear.*

FUEL TUBE FITTING REPLACEMENT

High pressure stainless steel, seamless fuel tubes are used in the CNG system. Special stainless steel, **double–ferrule**, compression–type fittings are used on the high pressure side of the system. All component and fuel tube connections from the inlet side of the pressure regulator to the fuel cylinders (high pressure) must use this type of fitting. Fittings on the low pressure side of the system (outlet side of the pressure regulator and all downstream connections) use NPT pipe threads and 45–degree flared fittings.

If any fuel tube, fitting or a component connected to a fuel tube must be removed, thoroughly clean fitting and tube before disassembly. This helps to prevent dirt or foreign material from entering into the fuel system.

New high pressure tube fittings are delivered completely assembled with two ferrules installed. Disassembly is not recommended because dirt or foreign material could get into the fitting and cause a leak. Connections of used fittings can be made several times. Refer to the appropriate Service Manual for procedures on reconnecting used fittings.

Certain components on the high pressure side require O–rings. Special precautions must be taken when removing and installing this type of fitting. Refer to the appropriate Service Manual for component identification and procedures.

Always use the correct size Go–No–Go gauge (fig. 16) to ensure the fitting has been sufficiently pulled up (tightened) on the fitting body. Different size gauges are available for one–quarter and three–eighth inch fuel tubes.

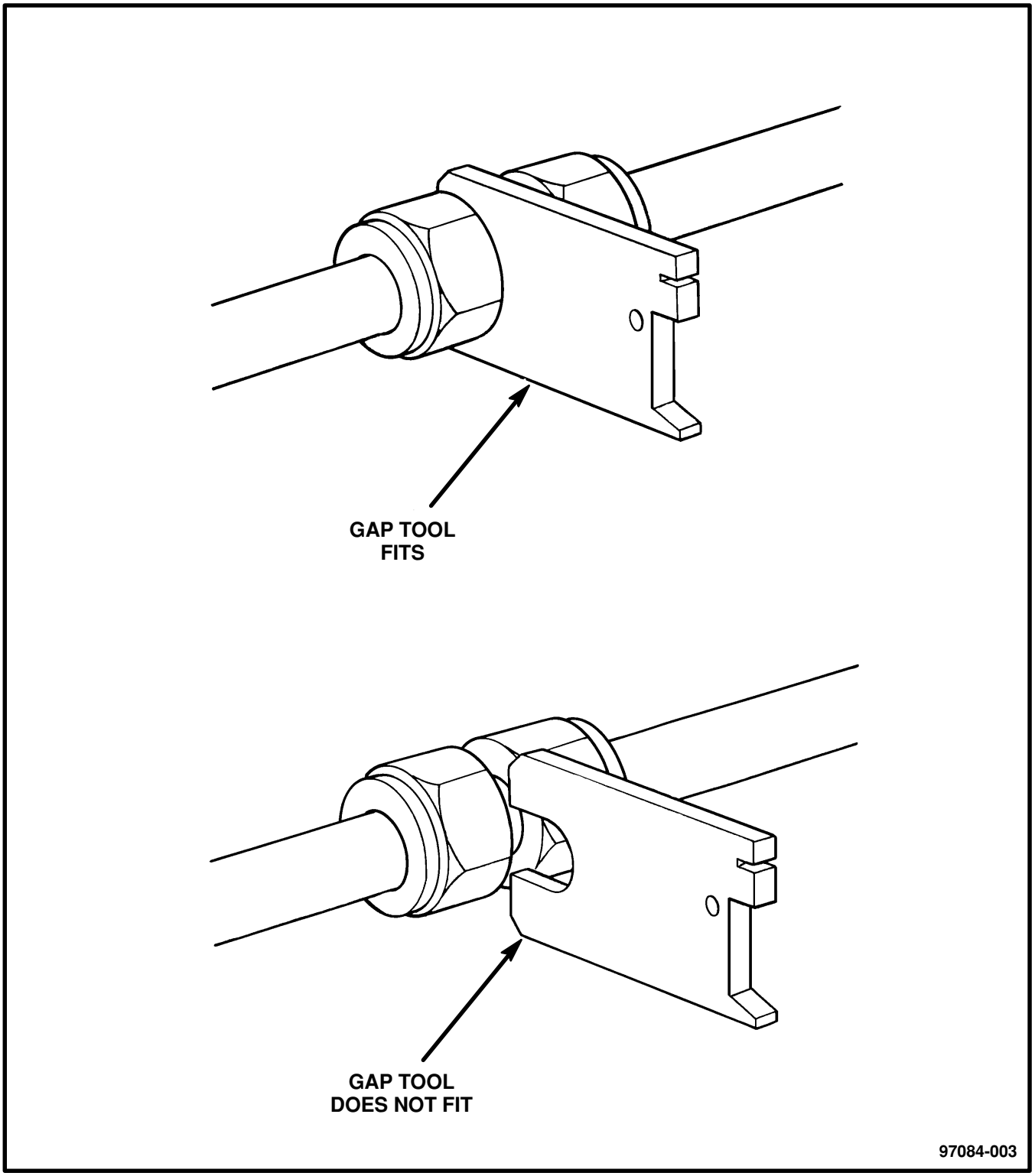


Figure 16 Go–No–Go Gauge

To install a new high pressure fuel tube fitting, perform the following:

1. Insert fuel tube into fitting. Be sure that fuel tube is completely through ferrules and resting firmly on shoulder of fitting body.

2. Tighten fitting finger tight.

3. Using a soft tip marker, place a reference mark on the fitting at the six o'clock position.

Caution: *To prevent damage to fitting and tool, do not install Go–No–Go gauge inspection tool to fitting while tightening. It is to be used only as a test gauge after fitting has been tightened.*

4. Attach a backup wrench to fitting body. With a second wrench, rotate fitting one and one–quarter turns. The reference mark should now be at the nine o'clock position. (fig. 17)

5. Inspect fitting with a Go–No–Go gauge. If gauge **DOES NOT FIT** between fitting and hex on fitting body, fitting has been properly tightened.

6. If gauge **FITS** between fitting and hex on fitting body, additional tightening is required. Remove Go–No–Go tool from fitting. Slowly continue to tighten fitting until gauge tool does not fit between fitting and fitting body. Do not over tighten fitting.

7. After installation and tightening, always leak test the component. Refer to "Testing For Gas Leaks" in the next section.

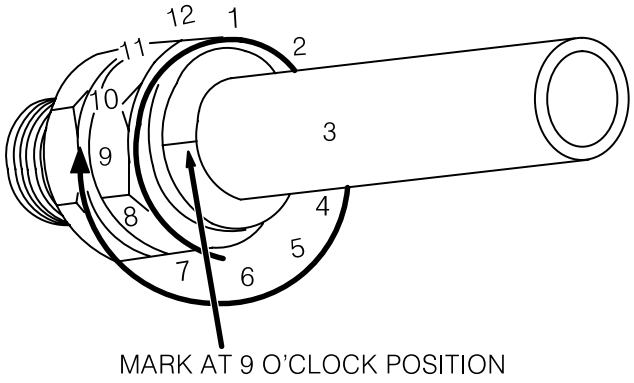


Figure 17 Fuel Tube Fitting Tightening

TESTING FOR GAS LEAKS

If a leak is suspected at a fuel tube, fuel tube fitting or fuel system component, obtain a commercially–available leak detector. A tube fitting supplier is a good source for this tool.

When inspecting for leaks, be sure the fuel is under operating pressure. Apply a generous amount of detecting fluid to the suspected leak area(s). Watch the area for about three to five minutes. In most cases, a leak will cause a steady flow of bubbles to appear at the leak source. Refer to the appropriate section of the Service Manual for repair procedures.

ACTIVITY TWO

CNG SERVICE PROCEDURES

For this activity you will purge a fuel line, replace a high pressure fuel tube fitting, test the fitting for leaks and perform a pressure test of the system. Answer all questions as the activity is being conducted.

TASK ONE

FUEL LINE PURGING – ENGINE ABLE TO RUN

1. What must be done with the Fuel Control Valves prior to purging the fuel system and how is it done?

   _____

   _____

2. What must be done with the Manual Shut–off Valve prior to purging the fuel system and how is it done?

   _____

   _____

3. Close control valves on all fuel cylinders.

4. Open Manual Shut–off Valve.

5. Start and operate the engine until it runs out of fuel.

6. How many times should you attempt to start the vehicle after it runs out of fuel?

   _____

7. Attempt to start the vehicle the required number of times.

TASK TWO

HIGH PRESSURE FUEL TUBE FITTING REPLACEMENT

1. Thoroughly clean the high pressure fuel tube fitting and fuel tube.

2. Attach a backup wrench to fitting body. With a second wrench, rotate fitting until loose.

3. Remove fitting.

4. Inspect the fuel tube and new fitting for damage.

5. Insert fuel tube into new fitting. Be sure that fuel tube is completely through ferrules and resting firmly on shoulder of fitting body.

6. Tighten fitting finger tight.

7. Why should you never scribe a mark on a fuel tube fitting?

_____

_____

8. Using a soft tip marker, place a reference mark on the fitting at the six o'clock position.

Caution: *To prevent damage to fitting and tool, do not install Go–No–Go gauge inspection tool to fitting while tightening. It is to be used only as a test gauge after fitting has been tightened.*

9. How many rotations should the fitting be turned before inspecting it with a Go–No–Go gauge?

_____

10. Attach a backup wrench to fitting body. With a second wrench, rotate fitting the correct number of turns.

11. At what position should the reference mark be at after tightening the fitting?

_____

12. Inspect fitting with a Go–No–Go gauge.

TASK THREE

TESTING FOR GAS LEAKS

1. Open control valves on all fuel cylinders.

2. Apply a generous amount of detecting fluid to the fitting and surrounding areas.

3. Start the engine.

4. How long should you inspect the fitting for leaks?

_____

5. If bubbles appear at the fitting, a leak is present. Purge the system and inspect the fitting and fuel tube for damage.

6. Shut down the engine.

TASK FOUR

FUEL SYSTEM PRESSURE TESTING

1. How full should the fuel cylinders be when testing fuel system pressure?

_____

2. Slowly loosen the fuel pressure service port cap on fuel rail and remove.

Caution: ***Use the correct gauge to measure pressures between 90 and 140 PSI or damage to equipment may result.***

3. Attach a pressure test gauge to the service port.

4. Start the engine and bring to operating temperature.

5 Check pressure. What is the observed pressure with the engine running?

_____

6. Remove pressure test gauge.

7. Check the fuel pressure service port for leaks.

ELECTRONIC FUEL CONTROL

MAJOR CHANGES

Several electronic control components have been added or deleted from the gasoline versions of the 3.3L and 5.2L engines to accommodate the CNG fuel delivery system. Items that have been **deleted** include:

- Exhaust Gas Recirculation (EGR) System (except for early Ram/Van Wagon 5.2L models)
- Fuel pump
- EVAP System

Because the CNG fuel cylinder is sealed to the atmosphere, the EVAP canister and purge solenoid are unnecessary. The fuel pump is not needed because, unlike gasoline, natural gas is under constant pressure, even when the engine is not running.

Components or systems that have been added or modified for CNG vehicles include:

- Powertrain Control Module (modified)
- Fuel Injector Driver Module used with the SBEC II PCM (added)
- Fuel Pressure Regulator (modified)
- Fuel injectors (modified)
- Fuel Low Pressure Sensor (added)
- Fuel Temperature Sensor (added)
- Low Pressure Fuel Shut–Off Solenoid (added)
- High Pressure Fuel Shut–Off Solenoid (added)

Compressed Natural Gas

The following components are the same in gasoline and CNG systems:

- Throttle body
- Throttle Position Sensor (TPS)
- Manifold Absolute Pressure (MAP) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Idle Air Control (IAC) motor
- Crankshaft Position (CKP) Sensor
- Automatic Shutdown (ASD) Relay
- Fuel Pump Relay (Renamed High Pressure Fuel Shut–Off Solenoid Relay)
- Oxygen Sensor
- Vehicle Speed Sensor (VSS)
- Ignition systems
- Air conditioning electrical inputs
- Generator
- Speed control components
- Park/Neutral Position Switch
- Brake Switch controls

POWERTRAIN CONTROL MODULE

The PCM performs many of the same functions as on any other Chrysler vehicle, however the internal programming for the ignition and fuel control systems is different. For example, there are some added Diagnostic Trouble Codes (DTCs) relating to fuel pressure monitoring. Open loop and closed loop fuel delivery is also slightly different, and is covered in greater detail later.

FUEL INJECTOR DRIVER MODULE

The Fuel Injector Driver Module used with the SBEC II PCM supplies power to operate the fuel injectors (fig. 18). The PCM calculates and supplies individual signals to the Fuel Injector Driver Module along a low–current path. The driver module then supplies the higher current ground circuit necessary to operate the injectors.

Note: *A defective Injector Driver module or faulty circuit can produce misleading symptoms. Test the entire system before replacing parts.*

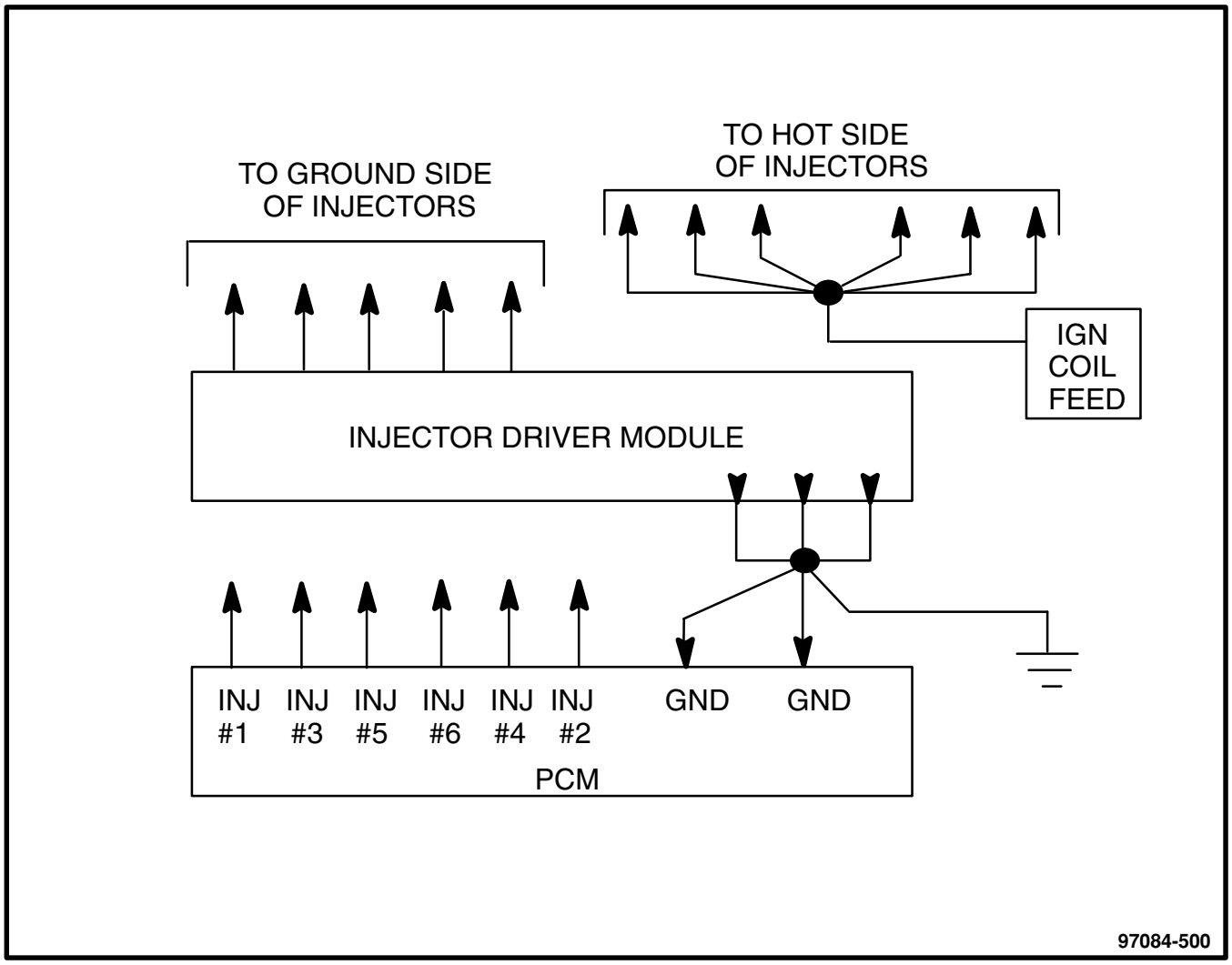


Figure 18 Fuel Injector Driver Module Circuit Diagram

FUEL LOW PRESSURE SENSOR

The Fuel Low Pressure Sensor provides an input to the PCM based on the pressure of the CNG fuel at the fuel rail (fig. 19). The PCM uses this input, along with various other sensors, to calculate fuel injector timing. The sensor is located in different places depending on engine application:

- On the right fuel rail, approximately in the middle (5.2L)
- On the forward end of the left fuel rail (3.3L)

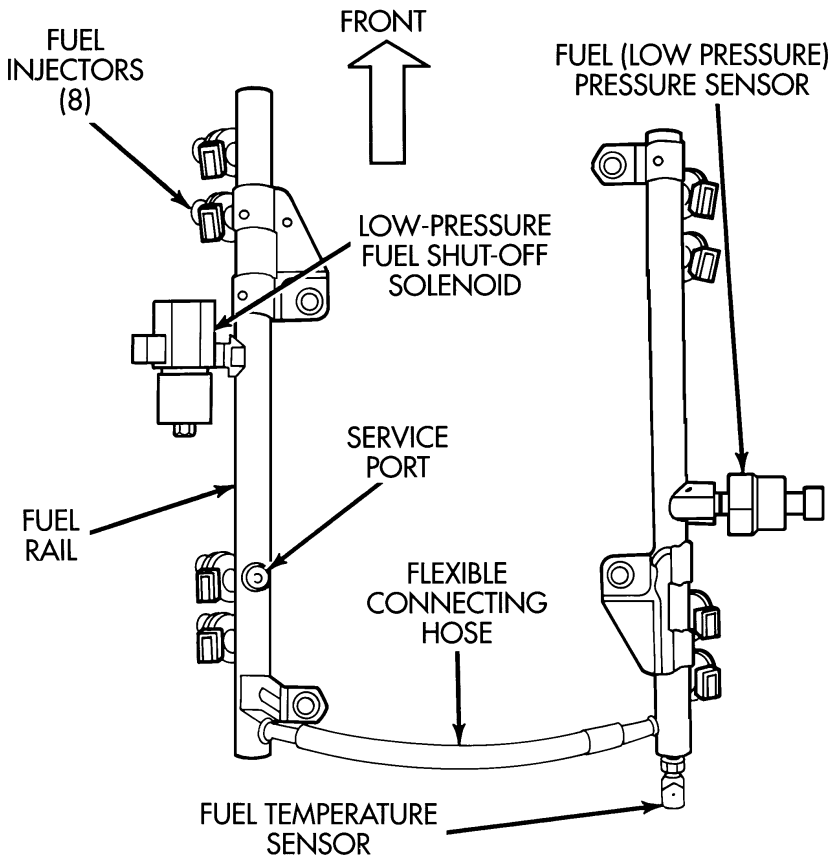


Figure 19 Fuel Low Pressure Sensor (5.2L)

FUEL TEMPERATURE SENSOR

The PCM uses input from the Fuel Temperature Sensor to help calculate fuel injector timing (fig. 20. The sensor is located in different places depending on engine application:

- On the rear right fuel rail (5.2L)
- Near the inlet side of the right fuel rail (3.3L)

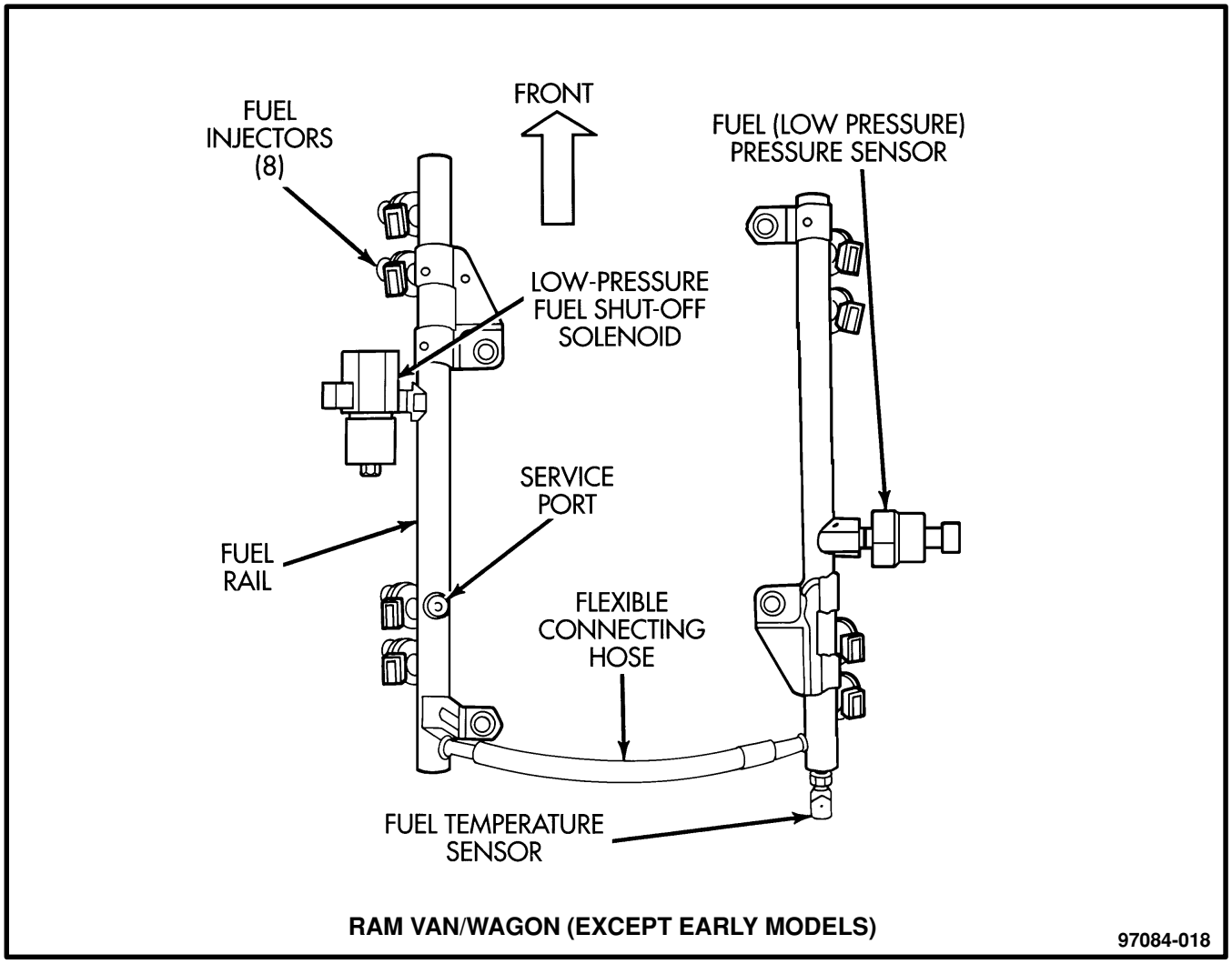


Figure 20 Fuel Temperature Sensor (5.2L)

Compressed Natural Gas

NOTES:

INSTRUMENT PANEL AND GAUGES

All Instrument Panel Gauges remain the same from gasoline models. The sensors for all gauges, except for fuel level, remain the same. Fuel level on CNG is transformed to a voltage based on pressure. CNG vehicles use a specially calibrated Fuel Gauge Pressure Sensor (transducer) as described earlier.

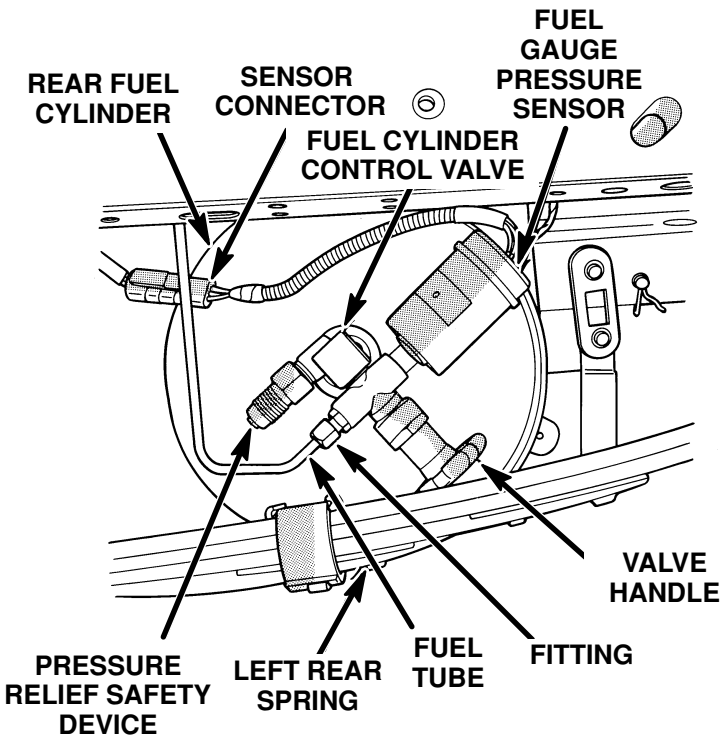
FUEL GAUGE PRESSURE SENSOR

CNG vehicles use a specially calibrated Fuel Gauge Pressure Sensor (transducer) (fig. 21). On the Ram/Van Wagon, the sensor converts the fuel cylinders' high pressure to an equivalent resistance between approximately 8 and 100 ohms. On the minivan, the sensor converts the high pressure of the CNG into a voltage signal of approximately 1 to 6 volts. When the fuel pressure is high, the voltage reading will be low or approximately 1 volt. Low fuel pressure produces a higher voltage reading of approximately 6 volts.

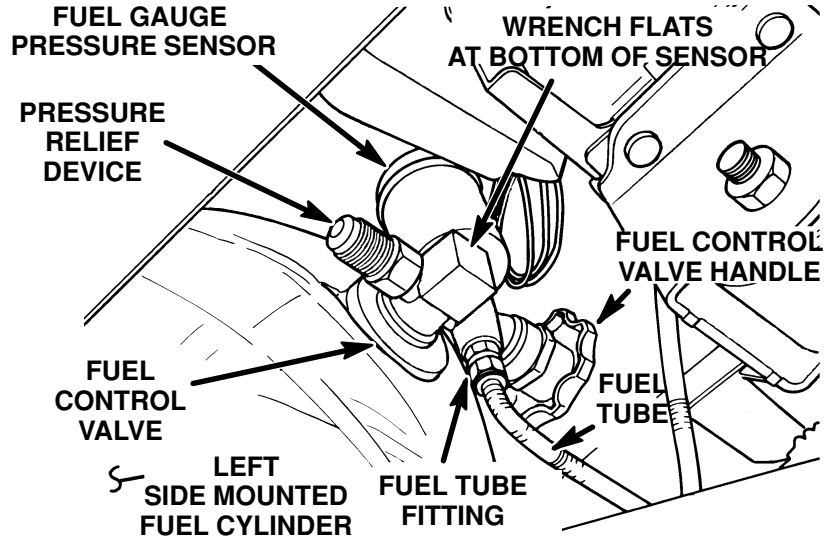
Because of active elements in the circuit board, the sensor output cannot be tested using conventional electrical test equipment. No multimeter reading can be taken at the signal wire. Refer to "Diagnosis and Testing" for the proper diagnostic procedures.

The sensor has three circuits: voltage, ground and a signal circuit to the Mechanical Instrument Cluster (MIC). On the Grand Caravan/Grand Voyager the signal circuit is connected to the Body Control Module (BCM). The BCM then broadcasts the percent fuel tank full message to the MIC over the CCD Bus.

The fuel gauge has the same calibration as the gasoline–powered models.



MINIVAN



RAM VAN/WAGON

97084-001

Figure 21 Fuel Gauge Pressure Sensor

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown (ASD) Relay performs the same functions as on any other Chrysler vehicle. In addition to the generator, fuel injectors, ignition coil and O2 Sensors, the ASD Relay on CNG vehicles provides voltage for the Low Pressure Fuel Shut–Off Solenoid. On 3.3L engines, this relay may be called the Low Pressure Shut–Off Relay.

The coil of the ASD Relay is connected to battery voltage from the Power Distribution Center (PDC) on all vehicles. The other side of the coil is connected to a switched ground at the PCM, which grounds the ASD coil to energize the relay.

The PCM energizes the relay when the Ignition Switch is in the RUN or START (CRANK) position. The PCM also monitors inputs from the Crankshaft Position Sensor and the Camshaft Sensor to determine engine speed. If the PCM does not receive the necessary information from the Crankshaft and Camshaft Position Sensors indicating that the engine is not running, it de–energizes the relay.

Refer to the “Wiring Diagram” section of the appropriate Service Manual for additional information.

HIGH PRESSURE FUEL SHUT–OFF SOLENOID RELAY (FUEL PUMP RELAY)

The High Pressure Fuel Shut–Off Relay is located in the PDC on most vehicles. This relay is used in place of the conventional fuel pump relay found on gasoline engines. It is used for control of the High Pressure Fuel Shut–Off Solenoid.

The PCM operates the relay in the same manner as the ASD Relay: by providing a switched path to ground. The PCM turns the ground path OFF when the Ignition Switch is in the OFF position. Both relays (ASD and High Pressure Fuel Shut–Off Solenoid) are then de–energized. The position of the relay in the PDC is labeled as "HIGH PRESSURE SHUT–OFF RELAY."

Refer to the "Wiring Diagram" section of the appropriate Service Manual for additional information.

FUEL INJECTORS

Unique low impedance (4.6 ohm) fuel injectors are used on the CNG engines. The fuel injectors are located on a specially–designed fuel rail. The injectors control fuel delivery into each cylinder through a separate intake port.

Because CNG is a gas at all times, there is no liquid passing through the injectors to dampen the sound. Therefore, CNG fuel injectors “click” louder than gasoline injectors during operation. This is a normal noise, and does not indicate a malfunction.

Control of the fuel injectors is similar to gasoline engines in that the PCM controls injector ON time by grounding the injector coil. Injector ON time, or pulse width, is determined by various sensor inputs specific to the CNG PCM software.

CNG ELECTRICAL COMPONENT DIAGNOSTICS

Use the following procedures to test the electrical components of the CNG fuel system. To perform a complete test of components and circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

FUEL LOW PRESSURE SENSOR TESTING

The Fuel Low Pressure Sensor is located on the fuel injector rail. The sensor has a three wire connector. For pin location, refer to the wiring diagrams of the appropriate Service Manual. The first circuit is a 5–volt reference signal from the PCM to the sensor. The second circuit is a ground from the sensor back to the PCM. The third circuit is the sense circuit to the PCM. The PCM monitors the pressure by measuring the voltage on this circuit.

By backprobing the sense circuit at either the sensor or the PCM connector, sensor pressure–versus–voltage operating ranges should be as follows:

- 0 PSI 0.5V
- 150 PSI 4.5V

To test only the sensor, perform the following:

Caution: *Use only approved testing probes to backprobe the connector or damage to equipment may result.*

1. With the engine running, backprobe the Fuel Low Pressure Sensor connector and measure the voltage of the sensor circuit.

2. The voltage reading should be approximately 3 to 4.5 volts.

3. Disconnect low pressure solenoid.

4. Measure the voltage of the sensor circuit after engine runs out of fuel.

5. The voltage reading should be approximately 0.5 volts.

When 0 volts is measured on this circuit, the sensor has a short circuit. When 5 volts is measured, the sensor has an open circuit.

FUEL TEMPERATURE SENSOR TESTING

The Fuel Temperature Sensor is located on the fuel injector rail. The sensor has a two wire connector. For pin location, refer to the wiring diagrams of the appropriate Service Manual. The first circuit provides the Fuel Temperature Sensor signal to the PCM. The second circuit is a ground from the PCM to the sensor. To test only the sensor, perform the following:

1. Run engine until operating temperature is reached.

2. Disconnect the Fuel Temperature Sensor wiring connector.

3. Using a DVOM check the internal resistance of the sensor. Resistance should be less than 4,000 ohms with the engine at operating temperature. Using Table 1, compare the resistance of the sensor to the fuel temperature (not engine temperature). Replace the sensor when the resistance reading is out of the given range.

4. Test resistance of wire harness between the PCM connector and Fuel Temperature Sensor connector. Refer to the “Wire Diagram” section for circuit identification. Repair wire harness as necessary if resistance is greater than 1 ohm.

Table 1 Fuel Temperature Sensor Resistance Values

FUEL TEMPERATURE		RESISTANCE (OHMS)	
C	**F**	**Minimum**	**Maximum**
–40°	–40°	291,490	381,710
–20°	–4°	85,850	108,390
–10°	14°	49,250	61,430
0°	32°	29,330	35,990
10°	50°	17,990	21,810
20°	68°	11,370	13,610
25°	77°	9,120	10,880
30°	86°	7,370	8,750
40°	104°	4,900	5,750
50°	122°	3,330	3,880
60°	140°	2,310	2,670
70°	158°	1,630	1,870
80°	176°	1,170	1,340
90°	194°	860	970
100°	212°	640	720
110°	230°	480	540
120°	248°	370	410

FUEL GAUGE PRESSURE SENSOR TESTING

The Fuel Gauge Pressure Sensor is mounted to the Fuel Control Valve of one of the fuel cylinders. The sensor has a three wire connector. For pin location, refer to the wiring diagrams of the appropriate Service Manual. The first circuit is a 12–volt battery supply. The second circuit is a ground return. The third circuit is the sense circuit to the fuel gauge. The PCM monitors the pressure by measuring the voltage on this circuit. Use the following procedure to test the Fuel Gauge Pressure Sensor:

1. Turn the Ignition Switch to RUN (early models may require the engine to be running).

2. Disconnect the electrical connector at the Fuel Gauge Pressure Sensor.

3. The fuel gauge should move to EMPTY. If OK, go to step 6.

4. If the fuel gauge did not move to EMPTY, check signal circuit between connector and gauge.

5. If signal circuit is OK, remove and replace fuel gauge.

6. Install jumper wire between the Fuel Gauge Pressure Sensor signal circuit and the ground circuit cavities in the body harness.

7. The fuel gauge should move to FULL. If OK, go to step 10.

8. If the fuel gauge did not move to FULL, turn Ignition Switch to OFF and check for continuity between the ground circuit cavity in the body harness and a good ground.

9. If ground circuit is OK, remove and replace fuel gauge.

10. Turn the Ignition Switch to RUN.

11. Check for battery voltage at the fused Ignition Switch output circuit cavity in the body harness connector.

12. If battery circuit is OK, remove and replace Fuel Gauge Pressure Sensor.

HIGH PRESSURE FUEL SHUT–OFF SOLENOID

Solenoid Electrical Test

The High Pressure Fuel Shut–Off Solenoid is located on the Fuel Pressure Regulator. It is used as an ON/OFF valve to electrically control high pressure gas, and is operated by the PCM through the High Pressure Fuel Shut–Off Solenoid Relay.

To perform a complete test of the solenoid and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

To test solenoid electrical operation perform the following steps:

1. Unplug two–way electrical connector from the Fuel Pressure Regulator (Refer to appropriate Service Manual for location).

2. Using a set of jumper wires (approximately 18 gauge), momentarily apply battery voltage across terminals.

3. Solenoid should cycle “click” after battery voltage is applied.

4. If the solenoid does not cycle “click,” replace Fuel Pressure Regulator assembly.

Note: *The solenoid is NOT serviceable separately.*

High Pressure Fuel Shut–Off Relay Test

To perform a complete test of relay operation and circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures Manual. Testing of the High Pressure Fuel Shut–Off Relay and ASD Relay are the same. Terminal numbers can be found on the bottom of each relay. The terminal numbers correspond to the following (fig. 22):

- Terminal 30 is connected to battery voltage, and is switched or B+ (hot) at all times.
- The center terminal, number 87A, is electrically connected to terminal number 30 in de-energized (normally OFF) position.
- Terminal number 87 is electrically connected to terminal 30 in energized (ON) position. Terminal number 87 then supplies battery voltage to the component being operated.
- Terminal number 86 is connected to a switched (+) power source.
- Terminal number 85 is grounded by the PCM.

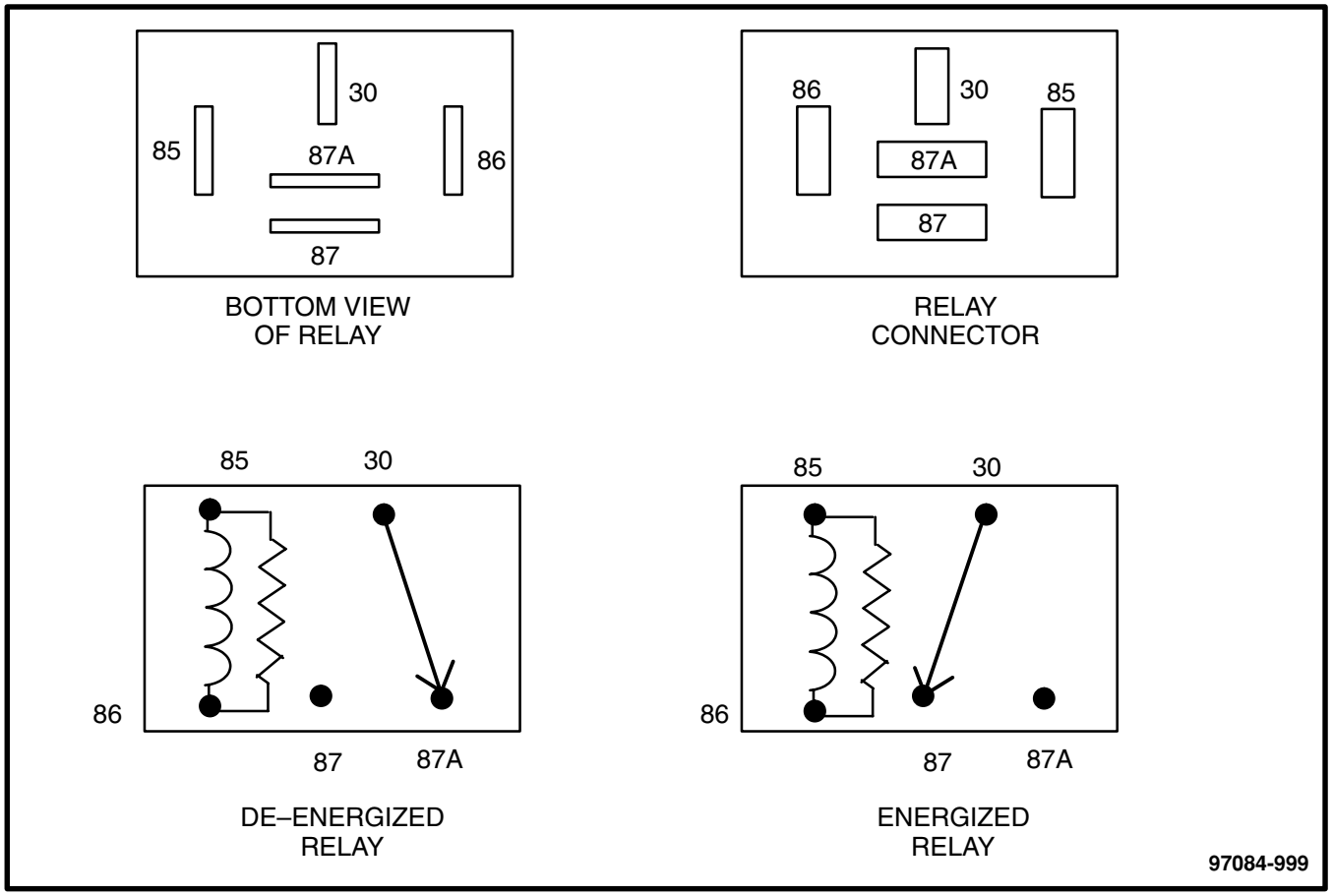


Figure 22 CNG Relay Terminal Numbers

To test the relay, use a DVOM to perform the following procedure:

1. Remove the relay.

2. Check relay coil resistance by measuring between terminals 85 and 86 – resistance should be 75 ohms (5 ohms) for resistor-equipped relays.

3. Check for continuity between terminals 87A and 30 – continuity should be present at this time.

4. Check for continuity between terminals 87 and 30 – continuity should not be present at this time.

5. Connect a jumper wire (approximately 18 gauge) between terminal 85 and the ground side (–) of a 12-volt power source.

6. Connect a second jumper wire between terminal 86 and the positive side (+) of a 12-volt power source to energize the relay.

Caution: *Do not allow ohmmeter to contact terminals 85 or 86 or damage to ohmmeter may result.*

7. Check for continuity between terminals 87 and 30 – continuity should be present at this time.

8. Check for continuity between terminals 87A and 30 – continuity should not be present at this time.

9. Disconnect jumper wires from relay and 12-volt power source. Replace relay if continuity or resistance tests did not pass.

LOW PRESSURE FUEL SHUT–OFF SOLENOID TESTING

Electrical Test

After cylinder pressure has been lowered by the Fuel Pressure Regulator, the Low Pressure Fuel Shut–Off Solenoid is used as an ON/OFF valve to electrically control CNG entering the fuel rail assembly. The solenoid is controlled by the PCM through the ASD relay. The solenoid on the minivan is located near the power steering pump. On the Van/Wagon, the solenoid is attached to the fuel rail.

To perform a complete test of the solenoid and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

To test solenoid electrical operation:

1. Unplug two–way electrical connector at solenoid.

2. Using a set of jumper wires (approximately 18 gauge), momentarily apply battery voltage across terminals (polarity not important).

3. Solenoid should cycle “click” after battery voltage is applied.

4. If the solenoid does not cycle “click,” replace the solenoid.

Low Pressure Fuel Shut–Off Solenoid (ASD) Relay Testing

The Low Pressure Fuel Shut–Off Solenoid is controlled by the PCM through the ASD Relay. Refer to the High Pressure Fuel Shut–Off Relay testing procedure.

FUEL INJECTOR TESTING

Pressure Testing

There are no tests for injector spray patterns since CNG is not a liquid fuel and not readily visible. Pressure testing of the fuel injectors consists of checking the pressure at the fuel rail. Refer to the "Fuel System Pressure Testing" section.

Fuel Injector Electrical Testing

Note: *The DRBIII can also be used to test the injectors.*

Because there is no liquid passing through the injector to help muffle sound, CNG injectors may seem to "click" louder than normal.

Warning:	*Before performing the following electrical test, be sure the Ignition Switch is in the OFF position. Disconnect the electrical connector at the Low Pressure Fuel Shut–Off Solenoid to prevent natural gas from entering the engine.*

To perform a complete test of the fuel injectors and fuel injection circuits, use the appropriate Powertrain Diagnostics Procedures Manual. To check the injectors only, perform the following:

1. Unplug the fuel injector electrical connector.

2. Using a set of jumper wires (approximately 18 gauge), momentarily apply battery voltage across terminals.

3. Injector should cycle "click" after battery voltage is applied.

4. With injector connector still disconnected, and using an ohmmeter, measure resistance value across terminals of fuel injector – resistance should be 4.5 ohms ± .5 ohm.

5. If injector does not click or if resistance values cannot be met, replace fuel injector.

FUEL SYSTEM OPERATION

The PCM controls all functions of the CNG system by using input signals and controlling the various output devices. Similar to gasoline systems, the PCM operates in open and closed loop modes depending on operating conditions.

The PCM monitors various inputs and recognizes the following modes of operation:

Open loop –

- Ignition Switch ON (engine not running)
- Engine Start–Up (crank)
- Engine Warm–Up
- Deceleration
- Ignition Switch OFF

Closed loop (with engine at operating temperature) –

- Idle
- Cruise
- Acceleration
- Wide Open Throttle (WOT)

All of the modes of operation are the same as the gasoline system except for:

WIDE OPEN THROTTLE (WOT) MODE

This is normally an open loop mode on gasoline powered vehicles. On CNG vehicles, WOT is a closed loop mode of operation. The PCM does not revert to open loop under WOT. During WOT on CNG vehicles, the PCM performs the following:

- Continues fuel injection
- Adjusts injector pulse width
- Adjusts spark advance

DECELERATION MODE

When the vehicle is under hard deceleration with proper rpm and closed throttle conditions, the PCM enters open loop, enters fuel cut–off until idle speed is approached and then adjusts the IAC motor.

When under light deceleration, the PCM continues fuel injection but adjusts injector pulse width accordingly. Based on all the inputs, the PCM adjusts engine idle speed through the IAC motor. This provides a smooth transition to Idle Mode.

ACTIVITY THREE

CNG ELECTRICAL COMPONENT TESTING

For this activity various electrical tests of CNG fuel system components are performed. Answer all questions as the activity is being conducted.

Note: *The following procedures are for 1996 model CNG vehicles. Refer to the specific Service Manual for other model years.*

TASK ONE

HIGH PRESSURE FUEL SHUT–OFF SOLENOID TEST

1. What major component of the CNG system is the High Pressure Fuel Shut–Off Solenoid part of?

   _____

2. Obtain a set of 18 AWG jumper wires.

3. Disconnect the two–way electrical connector for the solenoid.

4. Momentarily apply 12 volts across the connector terminals (component side).

5. Did the solenoid click? YES NO

6. Does this test indicate that the solenoid is functioning properly?

   YES NO

7. What can be verified by this test?

   _____

8. Reconnect the two–way electrical connector for the solenoid.

TASK TWO

FUEL GAUGE PRESSURE SENSOR TEST

1. Turn the Ignition Switch to RUN (early models may require the engine to be running).

2. Disconnect the electrical connector at the Fuel Gauge Pressure Sensor.

3. Did the fuel gauge move to EMPTY? YES NO

4. Check the signal circuit between connector and gauge.

5. Install jumper wire between the Fuel Gauge Pressure Sensor signal circuit and the ground circuit cavities in the body harness.

6. Did the fuel gauge move to FULL? YES NO

7. Turn the Ignition Switch to OFF and check for continuity between the ground circuit cavity in the body harness and a good ground.

8. Turn the Ignition Switch to RUN.

9. Check for battery voltage at the fused Ignition Switch output circuit cavity in the body harness connector.

TASK THREE

FUEL LOW PRESSURE SENSOR TESTING

1. What is the purpose of the Fuel Low Pressure Sensor?

_____

Caution: *Use only approved testing probes to backprobe the connector or damage to equipment may result.*

2. With the engine running, backprobe the Fuel Low Pressure Sensor connector and measure the voltage of the sensor circuit. Refer to the "Wiring Diagrams" of the appropriate Service Manual for pin locations.

3. How much voltage is measured?

_____

4. Shut down the engine.

5. With the Ignition Switch in the RUN position, measure the voltage of the sensor circuit again.

6. How much voltage is measured?

_____

7. Complete the following statement by filling in the blanks:

"If the Fuel Low Pressure Sensor circuit is an open circuit, ____ volts will be observed. If the circuit is a short circuit, ___ volts will be observed."

TASK FOUR

FUEL TEMPERATURE SENSOR TEST

1. Connect the DRB III to the Data Link Connector.
2. Start the engine and let it warm–up to normal operating temperature.
3. Access the “Sensors” menu under “Engine Systems.”
4. What is the Engine Coolant Temperature after letting the engine warm–up?

_____

5. Disconnect wire harness connector from the Fuel Temperature Sensor.
6. Measure the resistance of the Fuel Temperature Sensor (component side).
7. What is the observed resistance reading?

_____

8. Is this reading within specification? YES NO
9. Disconnect the DRB III from the Data Link Connector.
10. Connect wire harness connector to the Fuel Temperature Sensor.

TASK FIVE

LOW PRESSURE FUEL SHUT–OFF SOLENOID TEST

1. What is the purpose of the Low Pressure Fuel Shut–Off Solenoid?

_____

_____

2. Disconnect the two–way electrical connector at the solenoid.

3. Using a set of 18 AWG jumper wire, momentarily apply 12 volts across the terminals of the solenoid.

4. Did the solenoid click? YES NO

5. Should it have clicked? YES NO

6. Reconnect the two–way electrical connector at the solenoid.

TASK SIX

FUEL INJECTOR TEST

Warning:	*Before performing the following electrical test, be sure the Ignition Switch is in the OFF position. Also disconnect the electrical connector at the Low Pressure Fuel Shut–off Solenoid. This prevents natural gas from entering the engine.*

1. Disconnect the electrical connector from a selected fuel injector.

2. Obtain a set of 18 AWG size jumper wires.

3. Momentarily apply 12 volts across the fuel injector terminals (component side).

4. Did the injector click when voltage was applied? YES NO

5. Does this indicate proper operation of the fuel injector solenoid?

   YES NO

6. Obtain a DVOM and, with the connector still disconnected, measure the resistance across the terminals of the injector.

7. What is the measured resistance of the injector (obtain resistance specification from the correct Service Manual)?

   _____

8. Is the resistance of the fuel injector within specification?

   YES NO

9. “The fuel injector of a CNG vehicle is a repairable component.”

   YES NO

10. Reconnect the electrical connector to the fuel injector.

ACTIVITY FOUR

CNG TECHNICAL SERVICE BULLETINS

In this activity you will be required to research Technical Service Bulletins (TSB's) using the Mopar Diagnostic System (MDS) relating to CNG vehicles.

1. A customer brings in their 1996 CNG Ram Van/Wagon 5.2L with the concern of a lack of power during acceleration when the ambient temperature is less than 30 degrees Fahrenheit. Using the MDS, look–up the TSB concerning this condition. What is the TSB number and corrective action to repair the vehicle?

   _____

   _____

2. Using the MDS, look–up the TSB that contains revised diagnostic manual pages for a 1993–1994 Ram/Wagon 5.2L CNG vehicle.

   _____