SECTION 26

84/85

Diesel Diagnostics—2.4L Engine

Contents

Preliminary Checkout

This Section covers the adjustments, diagnosis, and testing procedures for the 2.4L diesel engine Glow Plug System and Fuel Injection System.

Checkout

- Visually inspect the engine compartment to ensure all wiring harnesses and fuel lines are properly routed and securely connected.
- Examine all wiring harnesses and connectors for insulation damage, burned, overheated, loose or broken conditions.
- Be certain the battery is fully charged.
- All accessories should be Off during testing and diagnosis.

Test Equipment

The following test equipment, (Figs. 1 through 5) is required for adjusting idle speed, injection pump linkage and injection timing.

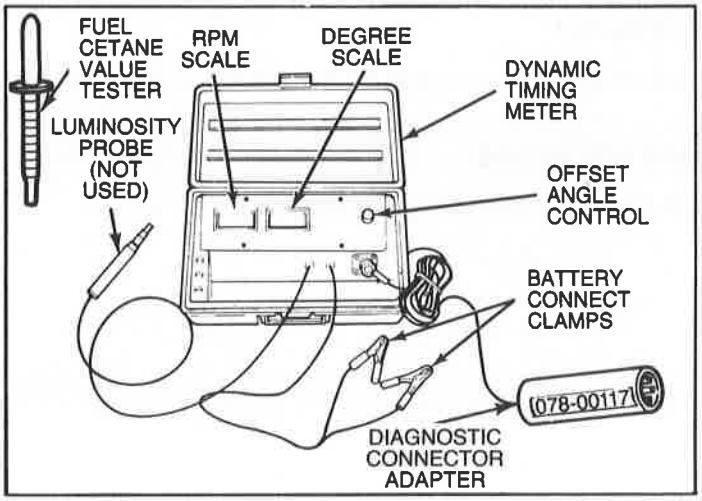


Figure 1 Rotunda 078-00116 Dynamic Timing Meter

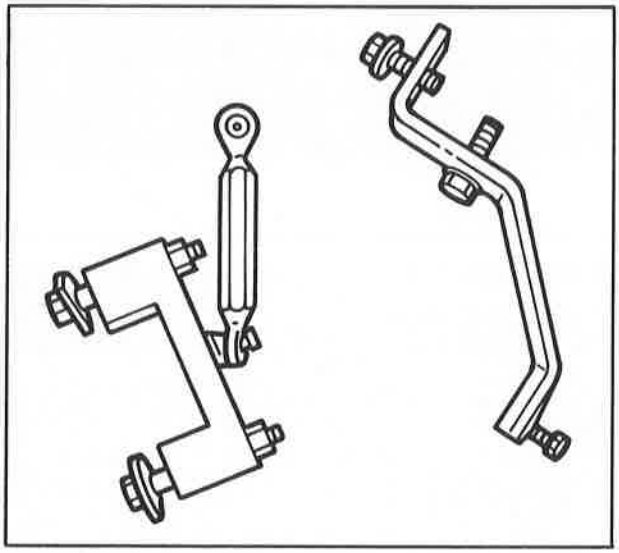


Figure 2 T84P-9000-B Injection Pump Rotating Tool

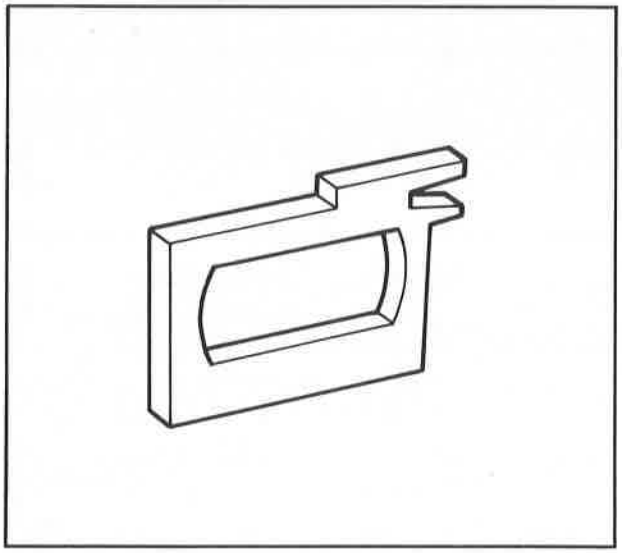


Figure 3 T84P-7B200-A EGR Vacuum Regulator Adjustment Key

Test Equipment

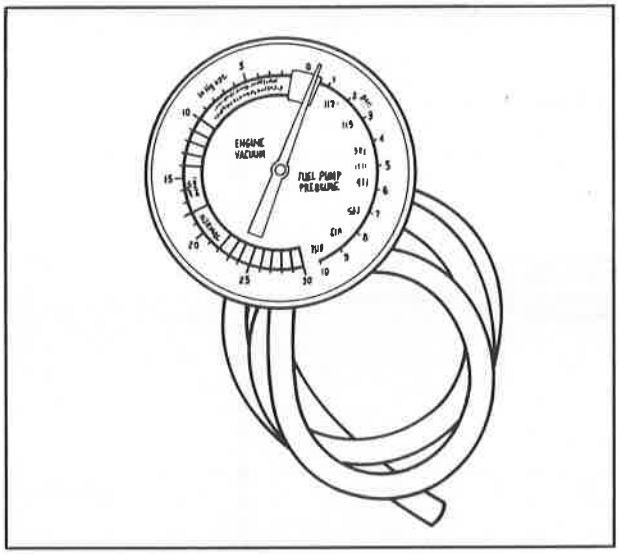


Figure 4 Rotunda 059-00008 Vacuum Gauge

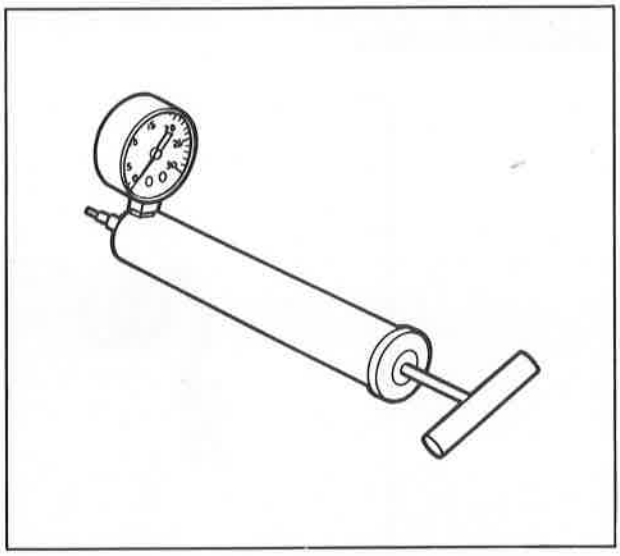


Figure 5 Rotunda 021-00014 Vacuum Tester

The following test equipment (Fig. 6) is required for performing the Engine Performance Diagnostic procedure.

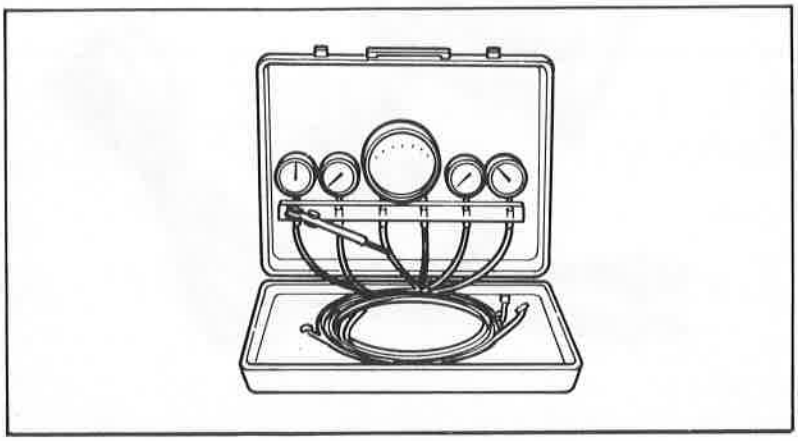


Figure 6 Rotunda 019-00002 Pressure Test Kit

Test Equipment

The following test equipment (Figs. 7 and 8) is required for performing the Glow Plug system diagnostic procedure.

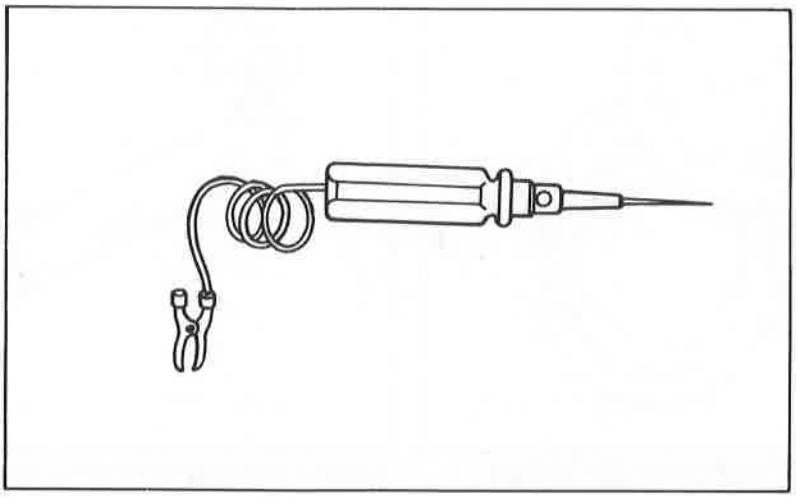


Figure 7 12-Volt Test Lamp

Figure 8 Rotunda 007-00001 Digital Multimeter

Test Equipment

The following test equipment (Figs. 9 and 10) is required for Injection Nozzle testing and cleaning.

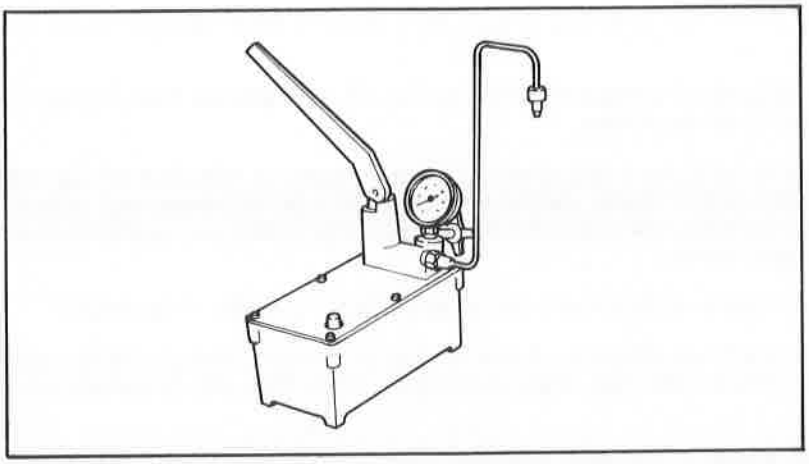


Figure 9 Rotunda 014-00300 Injector Nozzle Tester

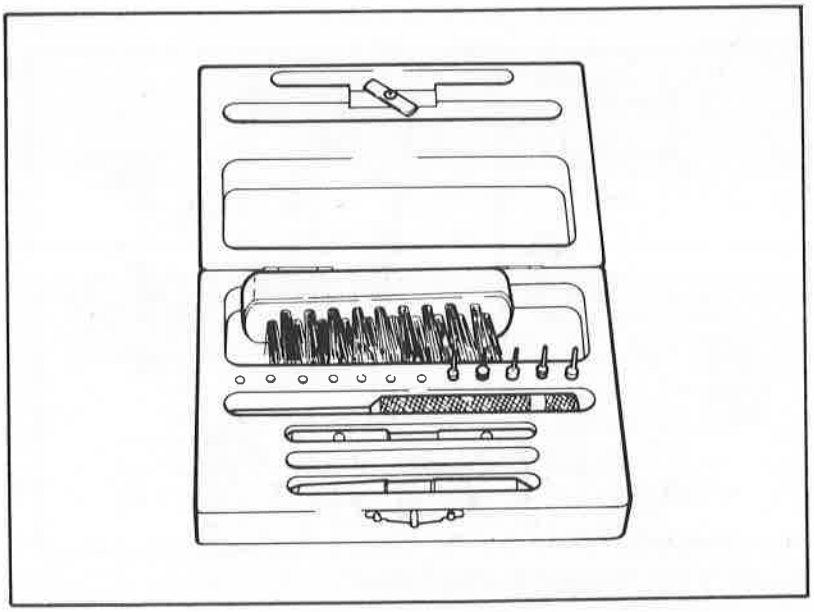


Figure 10 Rotunda 014-00301 Injector Nozzle Cleaning Kit

Idle Speed Setting Procedures

Curb Idle Speed Adjustment

1. Place transmission in Park.
2. Bring engine up to normal operating temperature (throttle lever against idle stop bolt) (Fig. 11). Stop engine.
3. Open cover on diagnostic connector (Fig. 12) and connect adapter from Dynamic Timing Meter, Rotunda 078-00116, or equivalent.
4. Start engine and observe curb idle speed. Curb idle speed is specified on the Vehicle Emission Control Information (VECI) decal. Adjust to specification by loosening lock nut on idle speed screw. Turn idle speed screw clockwise to increase idle speed, or counterclockwise to decrease idle speed. Tighten locknut.
5. Momentarily rev engine and recheck idle speed, adjusting again, if necessary.
6. After idle speed has been adjusted, check for gap of 0.3 to 0.7mm (0.012 to 0.028 inch) between knurled knob on throttle advance cable and throttle lever (Fig. 13). Adjust knurled knob to obtain this gap.

   NOTE: After idle speed is adjusted, injection pump linkage and EGR vacuum regulator linkage must be checked and adjusted, if necessary. Refer to Injection Pump Linkage and EGR Vacuum Regulator Linkage adjustments.

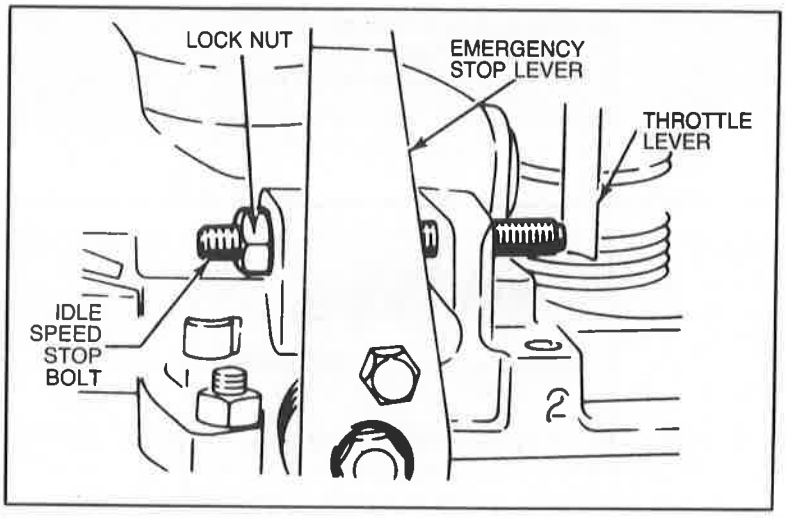


Figure 11 Idle Speed Adjusting Screw

Idle Speed Setting Procedures

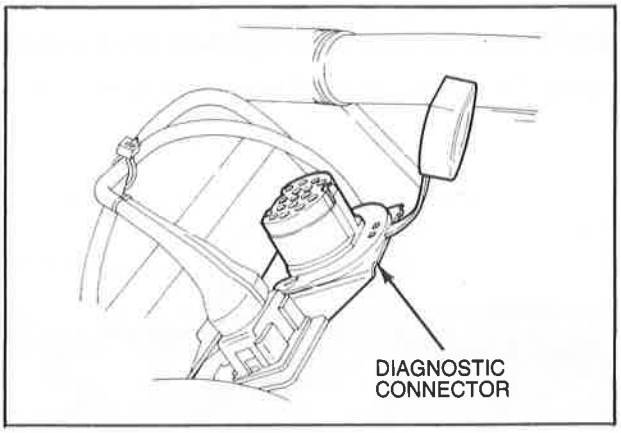


Figure 12 Diagnostic Connector

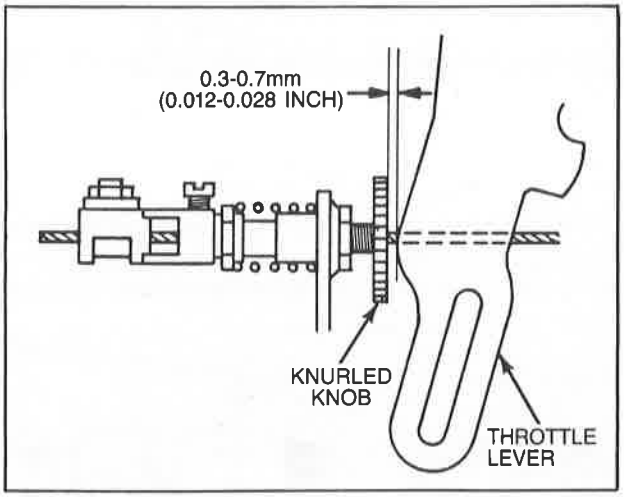


Figure 13 Throttle Advance Cable Gap

Fast Idle Adjustment

1. Place transmission in Park.
2. Bring engine up to normal operating temperature (throttle lever against idle stop screw) (Fig. 11). Stop engine.
3. Measure and record distance between bracket and knurled knob (Fig. 14, Dimension A).
4. Loosen thermostat housing bolts evenly until thermostat spring tension is released.

   CAUTION: Be careful that pin in thermostat housing does not fall out.
5. Again, measure and record distance between bracket and knurled knob (Fig. 15, Dimension B).
6. Subtract Dimension A from Dimension B. Difference should be 5.5mm (0.217 inch).

Idle Speed Setting Procedures

7. If difference is not to specification, rotate knurled knob until correct distance is obtained.
8. Tighten thermostat housing bolts evenly to 15-20 N•m (11-14 lb-ft).

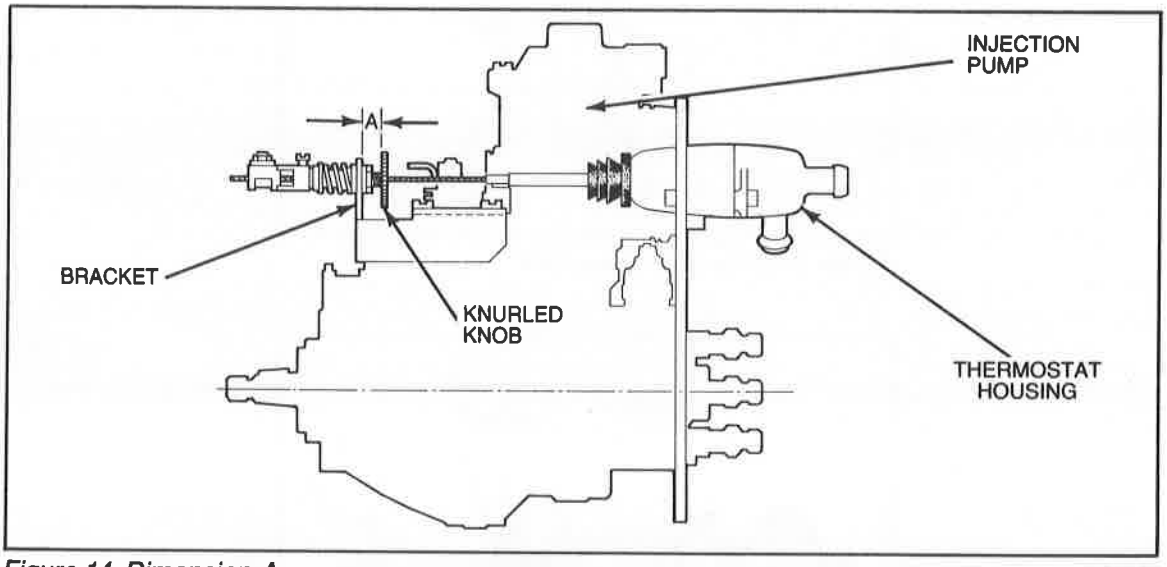


Figure 14 Dimension A

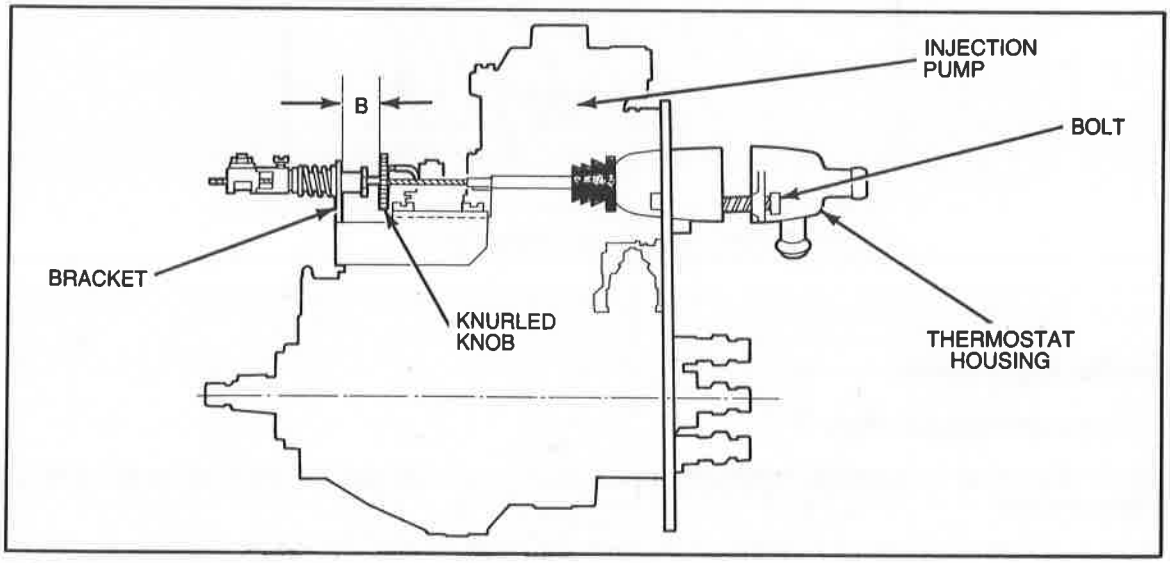


Figure 15 Dimension B

Injection Pump Linkage Adjustments

NOTE: Whenever curb idle speed is adjusted, the injection pump linkage and the EGR vacuum regulator linkage must be adjusted.

1. Bring engine up to normal operating temperature (throttle lever against curb idle stop screw) (Fig. 11). Stop engine.
2. Measure and record distance between pump lever and pump rear bracket (Fig. 16, Dimension A).
3. Move lever against high speed stop screw. Measure and record distance between pump lever and pump rear bracket (Fig. 17, Dimension B).
4. Subtract Dimension B from Dimension A. Record the difference, (Dimension Y).
5. Using the adjusting chart in Fig. 18, determine Dimension C.
6. Remove the linkage between the throttle lever and the transmission kickdown lever. Measure the distance between the ball joint and the lever pivot locknut on the throttle lever (Fig. 19). This dimension should equal Dimension C in the chart.
7. If the distance between the ball joint and pivot nut does not equal Dimension C, loosen nut on bottom of ball joint (Fig. 19), and slide ball joint in or out to obtain a distance equal to Dimension C. Tighten ball joint locknut.

CAUTION: Do not loosen lever pivot nut (Fig. 19). Loosening pivot nut can affect injection pump internal adjustments.

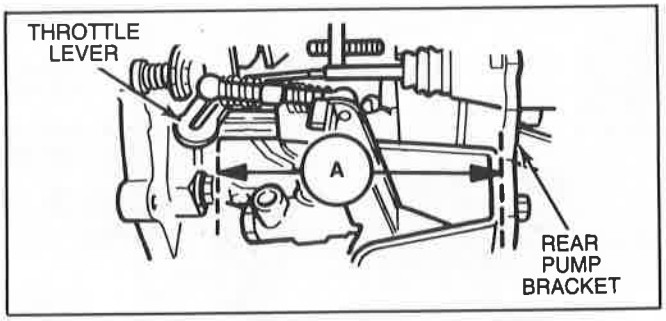


Figure 16 Dimension A

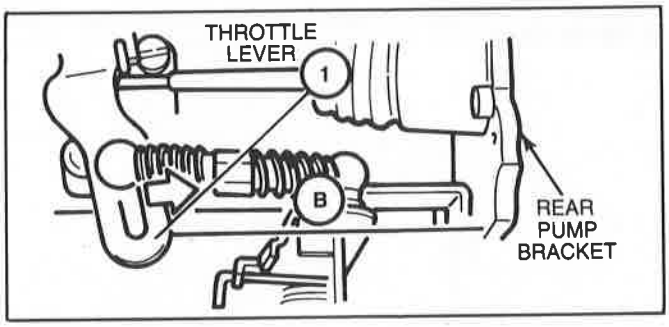


Figure 17 Dimension B

Injection Pump Linkage Adjustments

DIMENSION C mm (INCHES)					
If Y is:	C is:	If Y is:	C is:	If Y is:	C is:
41 (1.61)	78.1 (3.08)	46 (1.81)	68.6 (2.70)	51 (2.01)	61.6 (2.43)
41.5 (1.63)	77.0 (3.03)	46.5 (1.83)	67.8 (2.67)	51.5 (2.03)	61.0 (2.40)
42 (1.65)	76.0 (2.99)	47 (1.85)	67.0 (2.64)	52 (2.05)	60.5 (2.38)
42.5 (1.67)	74.9 (2.95)	47.5 (1.87)	66.3 (2.61)	52.5 (2.07)	59.9 (2.36)
43 (1.69)	73.9 (2.91)	48 (1.89)	65.6 (2.58)	53 (2.09)	59.4 (2.34)
43.5 (1.71)	73.0 (2.87)	48.5 (1.91)	64.9 (2.56)	53.5 (2.11)	58.8 (2.32)
44 (1.73)	72.0 (2.84)	49 (1.93)	64.2 (2.53)	54 (2.13)	58.3 (2.30)
44.5 (1.75)	71.1 (2.80)	49.5 (1.95)	63.5 (2.50)	54.5 (2.15)	57.8 (2.28)
45 (1.77)	70.3 (2.77)	50 (1.97)	62.9 (2.48)	55 (2.17)	57.3 (2.26)
45.5 (1.79)	69.4 (2.73)	50.5 (1.99)	62.3 (2.45)	55.5 (2.19)	56.8 (2.24)
—	—	—	—	56 (2.21)	56.4 (2.22)

Figure 18 Adjusting Chart

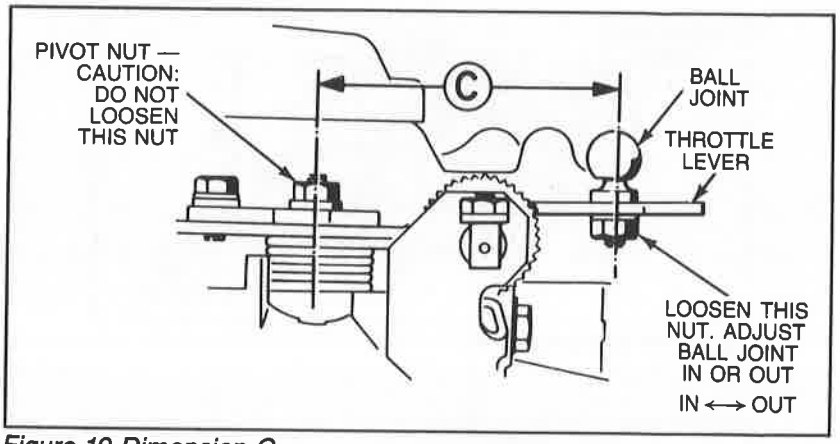


Figure 19 Dimension C

Injection Pump Linkage Adjustments

8. Reconnect linkage between throttle lever and transmission kickdown lever. Measure distance between end of link and pump rear bracket (Fig. 20, Dimension X). Dimension X must be 68mm (2.677 inches). Adjust linkage rod as necessary to obtain correct Dimension X.
9. Move lever against high speed stop and measure distance from end of linkage to pump rear bracket (Fig. 21, Dimension Z). Dimension Z must be 28.5 to 29.5mm (1.122 to 1.161 inches). If Dimension Z is not to specification, repeat Steps 2 through 8.

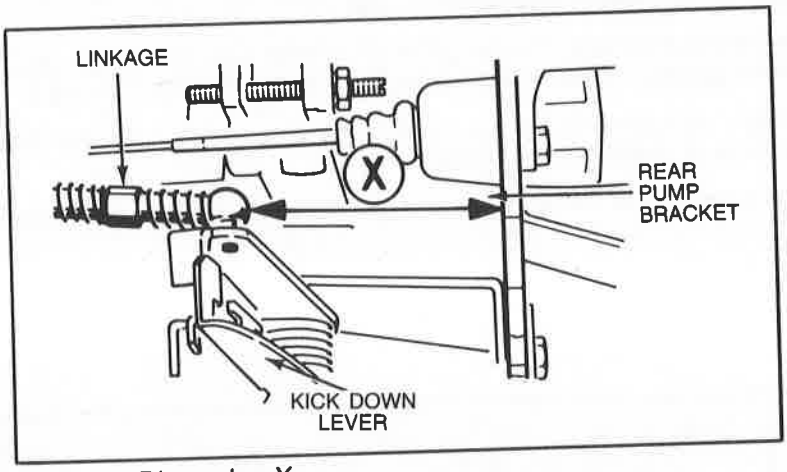


Figure 20 Dimension X

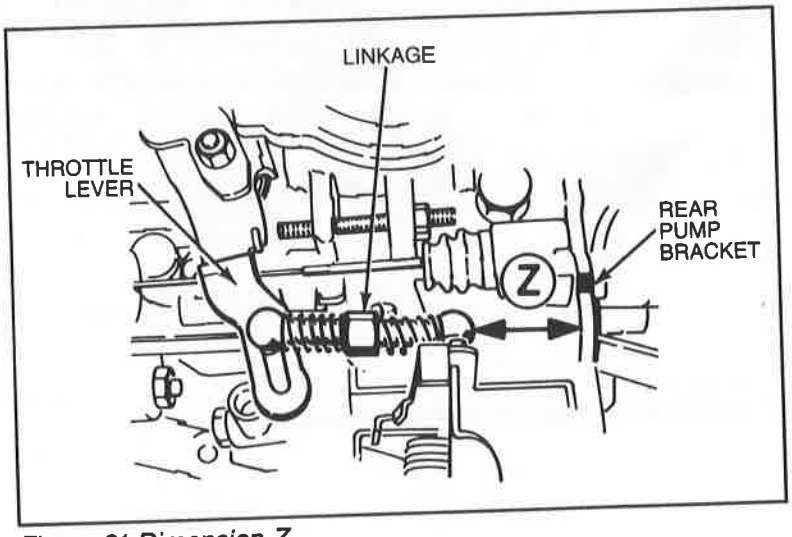


Figure 21 Dimension Z

EGR Vacuum Regulator Adjustment — Engine Off

NOTE: Curb idle speed and injection pump linkage adjustments must be set to specifications before EGR vacuum regulator linkage adjustment can be performed.

1. Install Vacuum Regulator Adjustment Key, T84P-7B200-A or equivalent, on throttle linkage, making sure slot in key fits over boss on injection pump (Fig. 22).
2. Disconnect vacuum hose (red) from vacuum pump at vacuum regulator port (Fig. 23). Connect Vacuum Tester, Rotunda 021-00014 or equivalent, to port.
3. Remove vacuum hose (blue) from vacuum regulator to EGR valve (Fig. 23). Connect Vacuum Gauge, Rotunda 059-00008 or equivalent, to port.
4. Apply and maintain a minimum vacuum of 54 kPa (16 in. Hg.) at vacuum regulator inlet port. Observe vacuum gauge. Vacuum gauge should read 38.7 kPa (11.5 in. Hg.).
5. If vacuum is not to specification, loosen locknuts on vacuum regulator link (Fig. 24) and adjust link until vacuum is at specification. Tighten locknuts.
6. Remove vacuum tester and vacuum gauge. Connect vacuum hoses to vacuum regulator (Fig. 24).

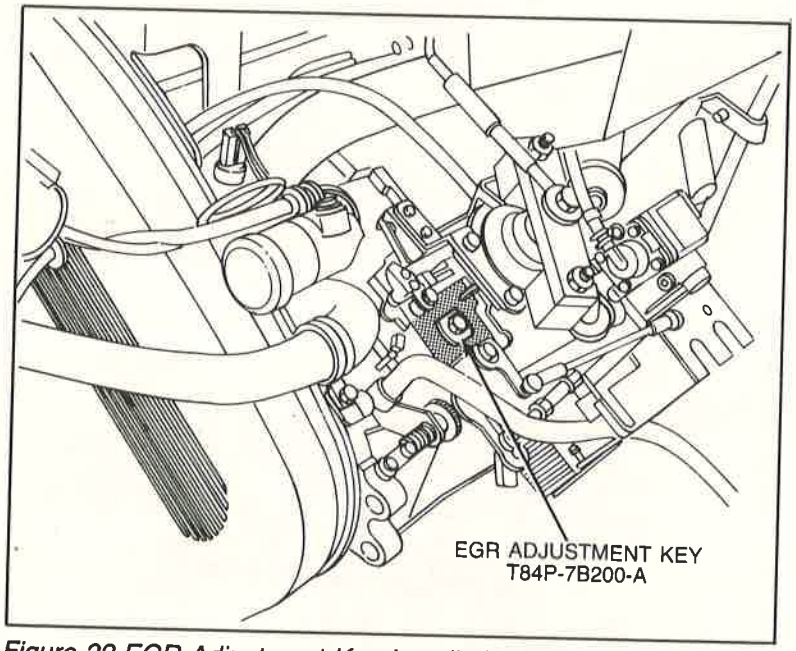


Figure 22 EGR Adjustment Key Installation

EGR Vacuum Regulator Adjustment — Engine Off

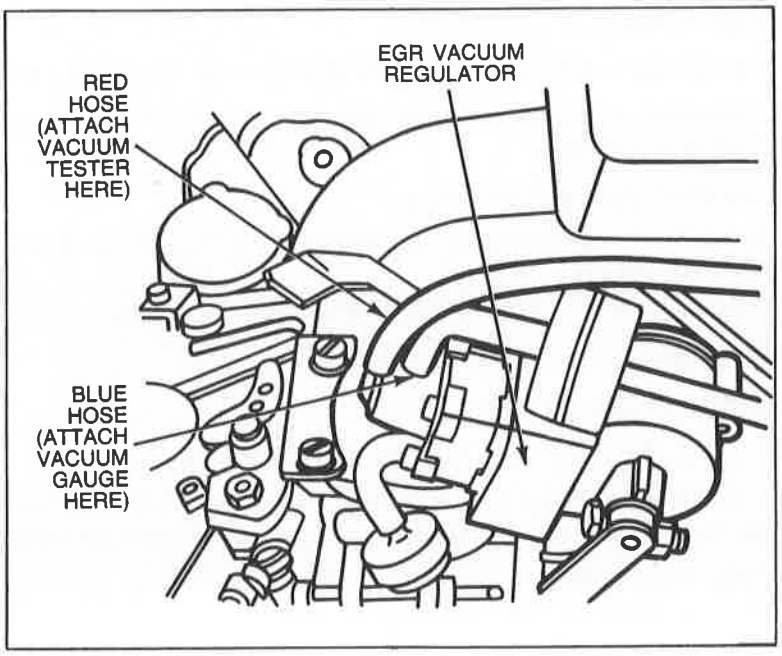


Figure 23 EGR Vacuum Regulator Hose Installation

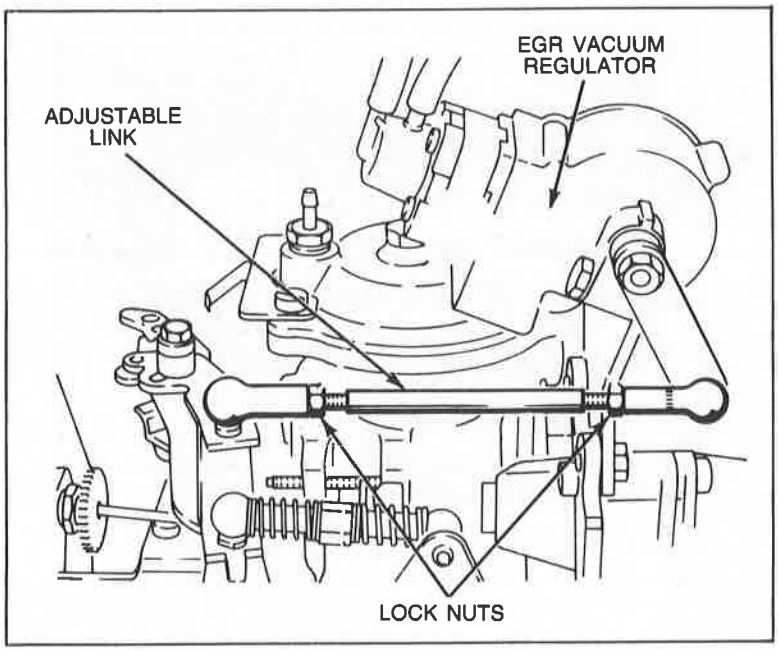


Figure 24 EGR Vacuum Regulator Link

Injection Pump Timing

1. Place transmission in Park.
2. Bring engine up to normal operating temperature (throttle lever against idle stop screw).
3. Open cover on diagnostic connector (Fig. 12), and connect adapter from Dynamic Timing Meter, Rotunda 078-00116 or equivalent.
4. Observe meter for RPM and Injection Timing.

   RPM is listed on the Vehicle Emission Control Information (VECI) decal. If rpm is not to specification, adjust as outlined.

   Injection timing should be 5° ± 1.5° BTDC at 1500 RPM.
5. If injection timing is not to specification, stop engine.
6. Rotate engine until No. 1 cylinder is on TDC.
7. Remove injector pump distributor head plug bolt and sealing washer.
8. Install adapter D84P-9000-D, Rotunda 014-00420 or equivalent, into injection pump. The plunger portion of adapter must project into pump so it contacts the fuel injection pump plunger.
9. Mount dial indicator, D84L-4201-A or equivalent, into adapter making sure there is at least 0.25mm (0.100 inch) preload on dial indicator (Fig. 25).

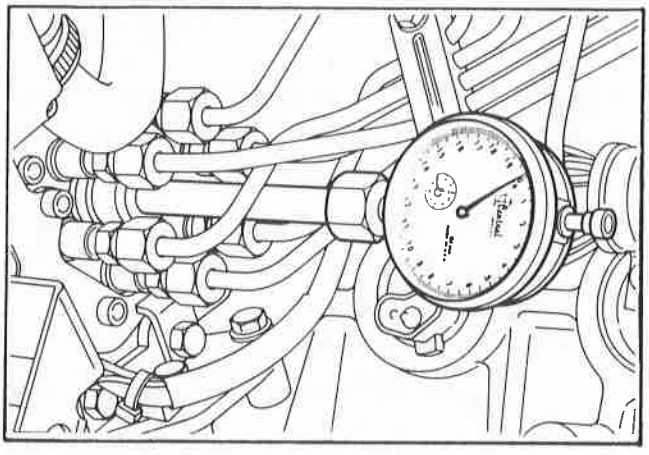


Figure 25 Adapter and Dial Indicator Installation

Injection Pump Timing

10. Rotate crankshaft clockwise until dial indicator displays the lowest value. Set dial indicator to zero.
11. Continue rotating the crankshaft clockwise until No. 1 piston is again at TDC on its compression stroke. Install crankshaft holding tool T84P-6400-A or equivalent, to hold crankshaft in place.
12. Dial indicator should read as follows:

    Timing belt less than 10,000 miles use: 0.65 ± 0.04mm (0.0256 ± 0.0015 inch).

    Timing belt more than 10,000 miles use: 0.63 ± 0.04mm (0.0248 ± 0.0015 inch).
13. If timing is out of specification, install timing adapter T84P-9000-B or equivalent, on injection pump (Fig. 26).

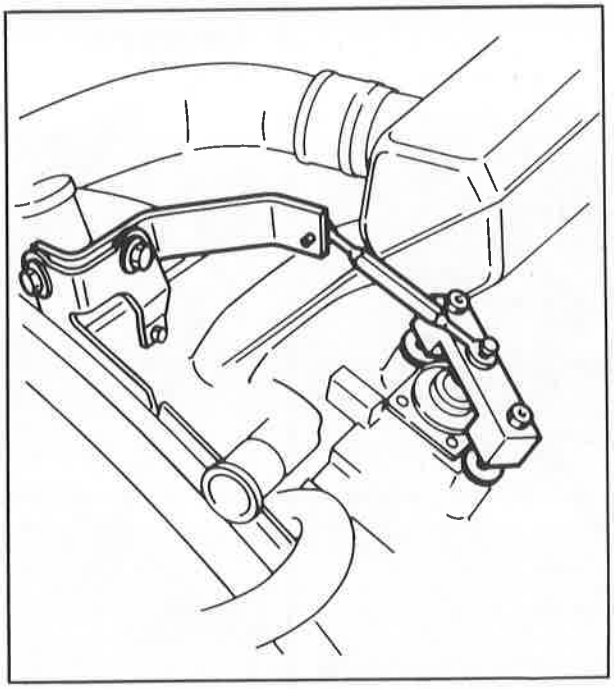


Figure 26 Injection Pump Timing Adapter

Injection Pump Timing

14. Loosen injection pump mounting bolts and rotate tool clockwise to increase the reading or counterclockwise to decrease the reading.
15. Tighten injection pump mounting bolts to specification in the order shown in Fig. 27.
16. Remove injection pump timing adapter and flywheel holding tool. Rotate engine two complete revolutions until No. 1 cylinder is on TDC again. Check reading on dial indicator. if reading is correct, remove dial indicator and adapter and install distributor head plug and sealing washer. Tighten bolt to 8-10 N•m (6-7 lb-ft). If reading is still incorrect, repeat Steps 3 through 8.
17. Repeat Steps 1 through 4 to check dynamic timing.

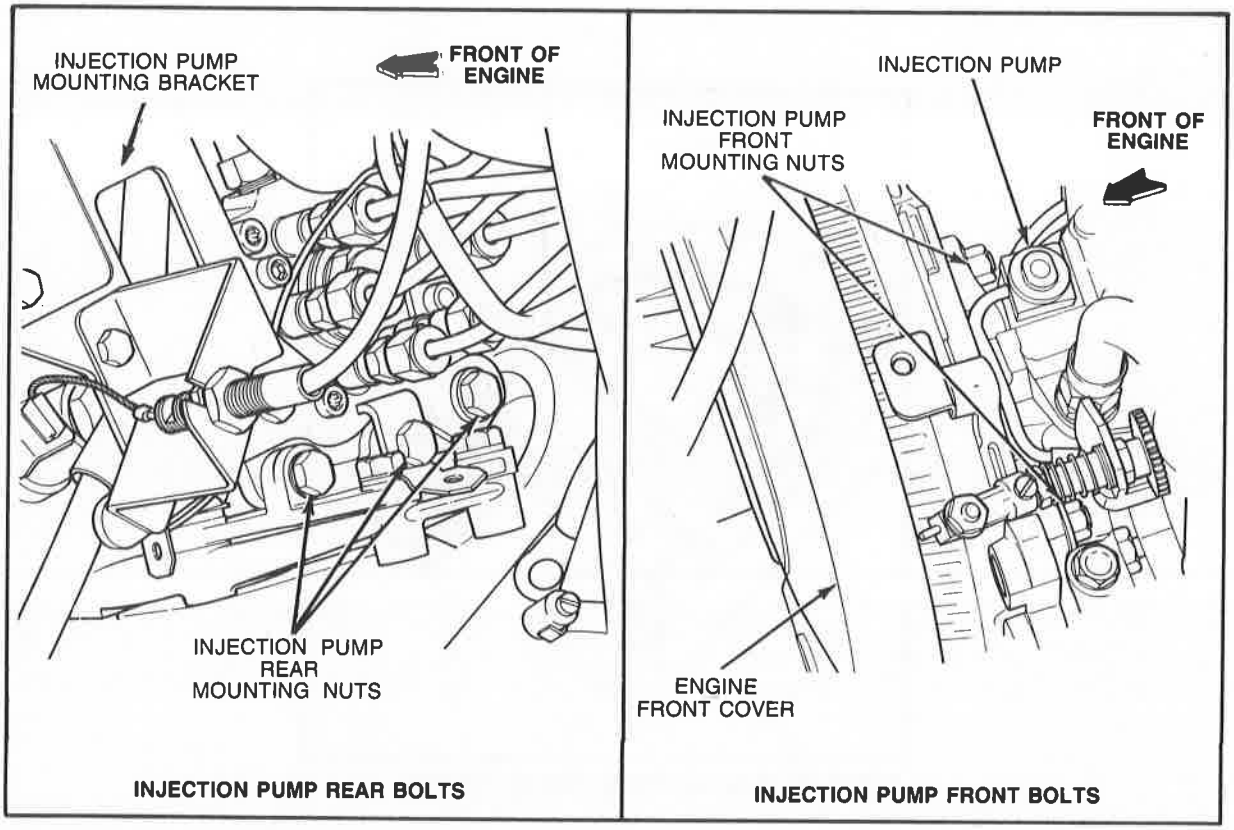


Figure 27 Injection Pump Bolt Tightening Sequence

System Description and Diagnosis

This portion of this Section contains a brief description of the 2.4L diesel engine Glow Plug System and Fuel Injection System. It also contains detailed diagnostic procedures for these systems.

The diagnostic procedures are broken into two parts. The first part is Symptom Analysis. This section should be consulted first, as it will direct you to perform a specific repair or it will direct you to a specific diagnostic procedure.

The second part contains the Wait-to-Start Lamp, Glow Plug System and Engine Performance diagnostic procedures. At the beginning of each of these procedures, there is an explanation of how to use that procedure. Read this explanation before performing the tests.

Glow Plug System

DESCRIPTION

This system (Fig. 28), is used to enable the engine to start more quickly when the engine is cold. It consists of the six glow plugs, the control module, the coolant temperature switch, the Wait-to-Start lamp and connecting wiring. The control module is protected by a 10A fuse in the fuse panel, and the glow plugs are protected by an 80A fuse in the control module.

When the ignition switch is in Start or Run power flows to the control module. When the engine coolant temperature is below 70°C (158°F), the Wait-to-Start lamp turns on and the glow plugs start heating. After 2 to 10 seconds, depending on engine temperature, the Wait-to-Start lamp will turn Off, and the engine can be started.

The glow plugs continue to heat up during engine start and for a short time after the engine starts, depending on coolant temperature.

If the engine is started before the Wait-to-Start lamp turns Off, the glow plugs will continue to heat up after the engine is started.

The glow plug control module has a built-in timer circuit which will turn off the glow plugs 8 to 13 seconds after the Wait-to-Start lamp turns Off, if the engine is not started. If the engine is started after this time period, without turning the ignition switch to Off, the glow plugs will heat up while the engine is being started.

The glow plugs also heat up whenever the ignition switch is in the Start position, regardless of engine temperature.

Glow Plug System

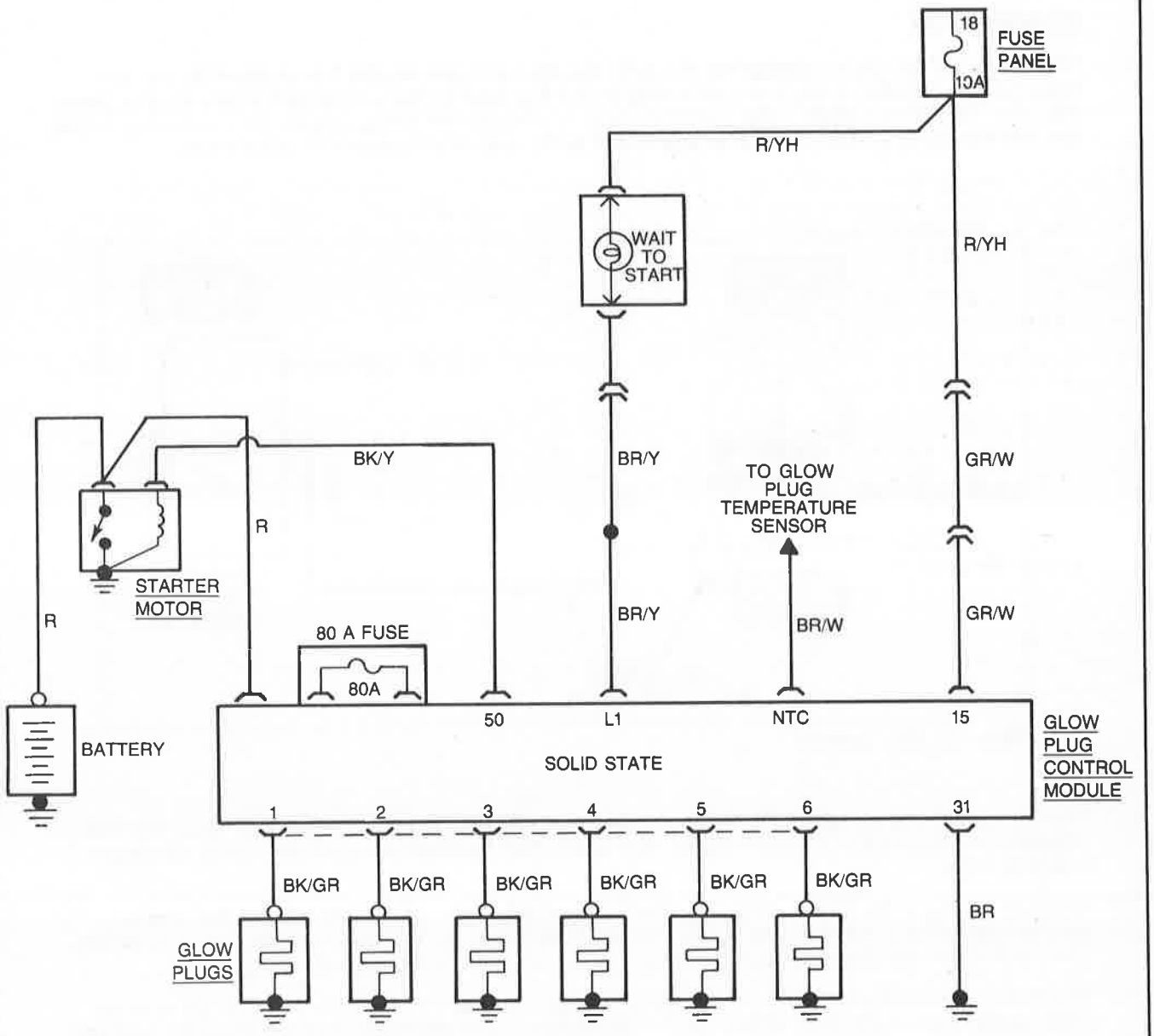


Figure 28 Glow Plug System Schematic

Fuel System

DESCRIPTION

The fuel in the fuel tank is pulled into the fuel lines by the in-line electric fuel pump. The fuel is filtered and any water in the fuel is extracted by the fuel filter before it reaches the electric fuel pump (Fig. 29). The fuel supplied to the injection pump is sent into the plunger by the control sleeve, linked with the accelerator, in an amount proportionate to the degree of accelerator depression.

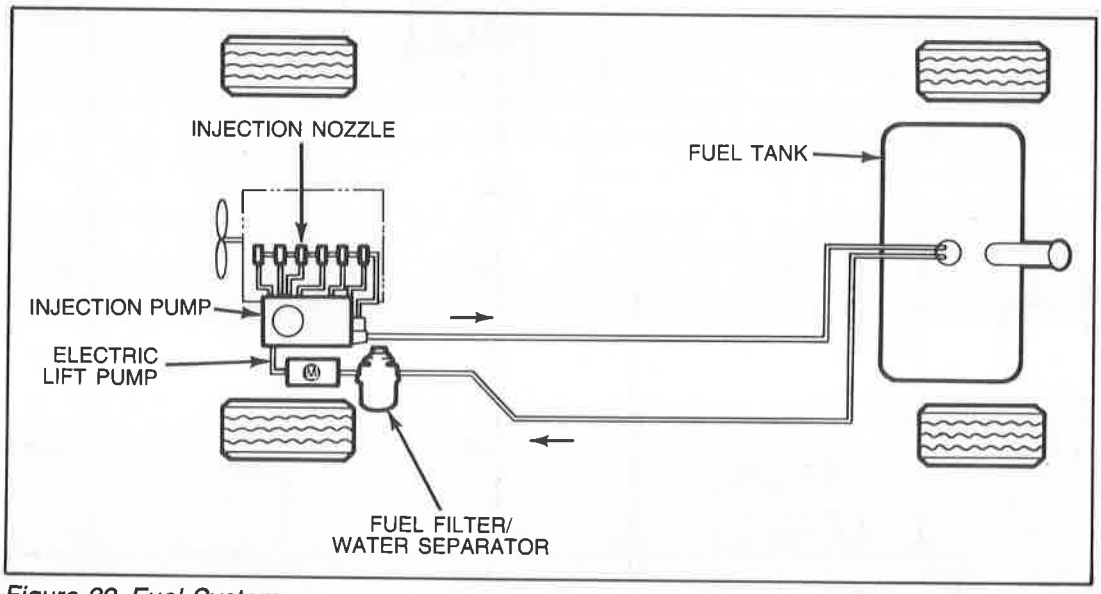


Figure 29 Fuel System

The fuel sent to the plunger is highly pressurized and is forced through the delivery valve, into the injection line, then to the injection nozzle. The fuel is then injected into each cylinder in the proper injection order.

Any fuel leaking at the sliding section of the nozzle needle valve at the time of injection, and any surplus fuel in the injection pump housing will be returned to the fuel tank through the overflow line. The surplus fuel circulates through to injection pump to cool and lubricate the pump.

The fuel cutoff solenoid, located on the pump and activated with the ignition switch in the Run or Start position, interrupts the fuel flow on the distributor side of the injection pump when the ignition switch is turned to the OFF position. This closes the intake port of the plunger and stops the engine.

The injection nozzle injects the fuel directly into the precombustion chamber. When high pressure fuel from the injection pump reaches a certain pressure 14,696 kPa (2133 psi) or more, the fuel overcomes the needle pressure spring, lifts the needle valve off its seat and allows the fuel to enter the cylinder. When the fuel pressure drops below nozzle opening pressure, the needle valve closes, stopping the fuel injection into the cylinder. During this process some fuel lubricates the nozzle between the needle valve and nozzle body, then returns to the fuel tank through the return line.

Fuel System

The VP-20 fuel injection pump used on 2.4L diesel engines is controlled by an electronic control assembly mounted in the luggage compartment (Fig. 30).

The control assembly processes information from the engine coolant temperature sensor (Fig. 31), the position sensor (Fig. 32) and the lift sensor located in the No. 4 injector (Fig. 33) and varies the injection timing according to this information. To change the injection timing, the control assembly controls the cycling of the fuel control solenoid in the injection pump (Fig. 34). The solenoid varies the fuel pressure available to the advance piston by providing an additional pressure bleed, whenever it is open. By cycling the solenoid, the control assembly can precisely control the fuel pressure at the advance piston and therefore control injection timing. The amount of fuel injected into the cylinders is not affected by the solenoid.

The system has a built-in diagnostic capability which will light the "Check Turbo" warning indicator when there is a problem in the system.

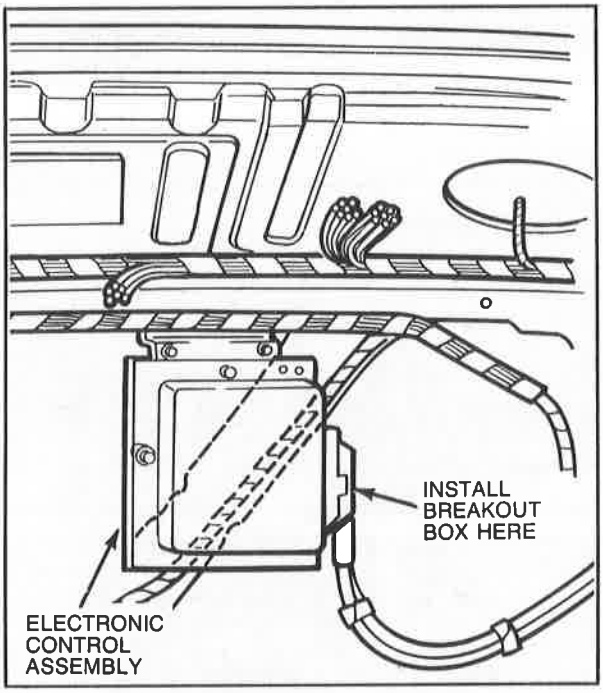


Figure 30 Electronic Control Assembly

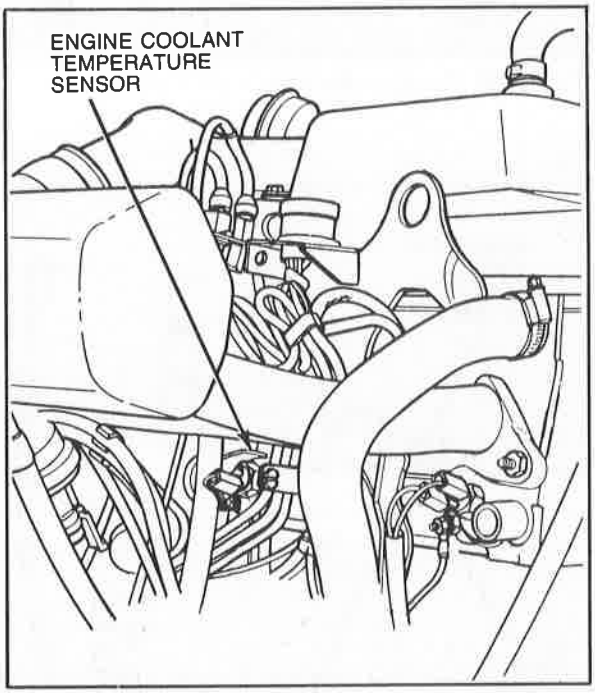


Figure 31 Engine Coolant Temperature Sensor

Fuel System

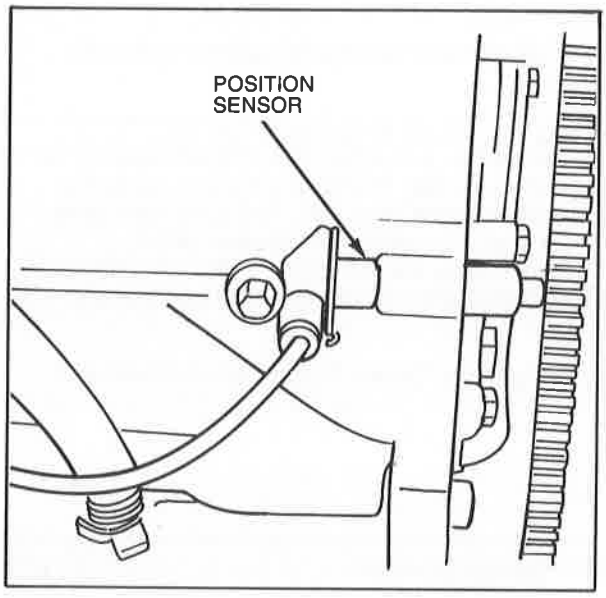


Figure 32 Position Sensor

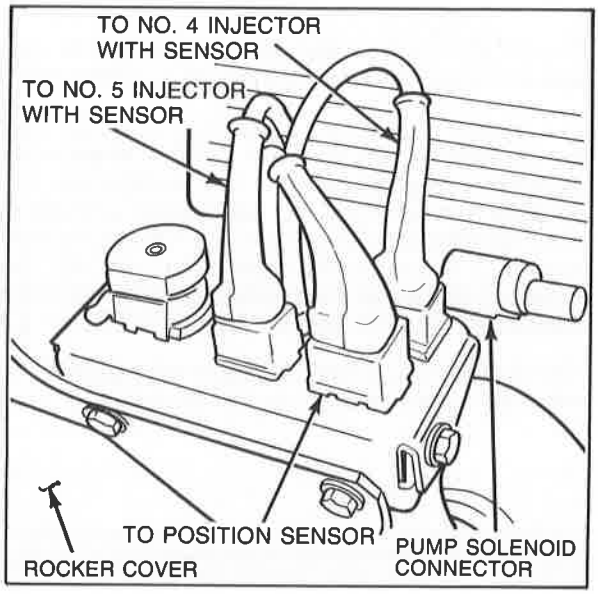


Figure 33 Lift Sensor Connector, No. 4 Injector

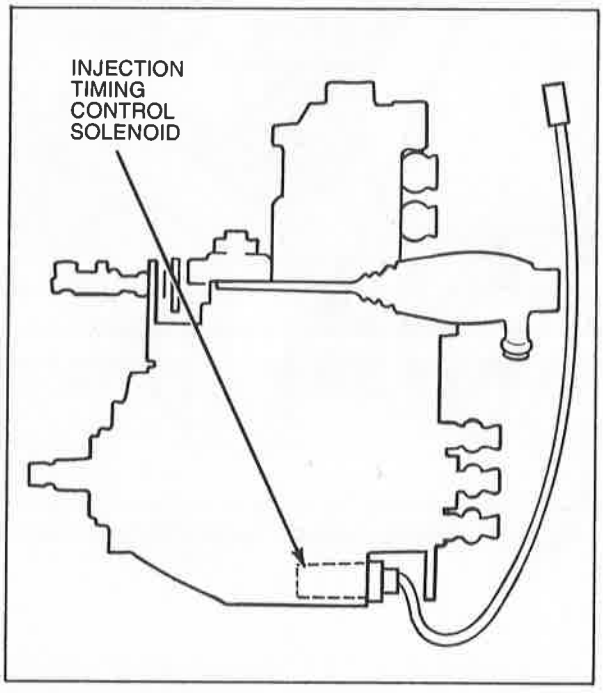


Figure 34 Fuel Control Solenoid

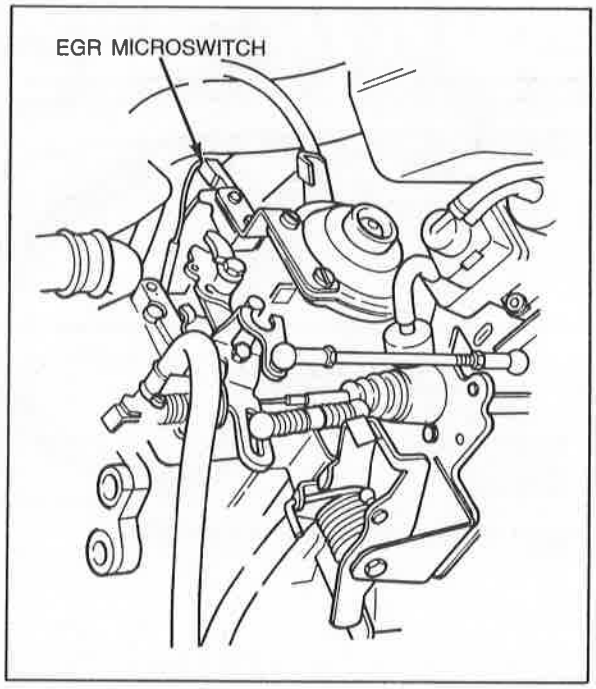


Figure 35 EGR Microswitch

EGR System

DESCRIPTION

Refer to Figs. 36, 37 and 38.

The EGR system is controlled by the electronic control assembly mounted in the luggage compartment.

The system consists of a temperature sensor mounted on the cylinder head (Fig. 31), a microswitch mounted on the injection pump (Fig. 35), a speed sensor mounted on the engine block (Fig. 40), a vacuum regulator mounted on the injection pump (Fig. 41), a solenoid and an altitude switch mounted on the RH side of the dash panel (Fig. 42), an EGR valve (Fig. 43), and a vent valve for ALDA ventilation.

With the ignition switch in Start or Run, power flows to the EGR solenoid. When the engine coolant temperature reaches 78°C (172°F) the temperature switch closes. With the engine at idle, the EGR microswitch is closed providing a ground for the EGR solenoid and the EGR valve is opened.

When the throttle is depressed, the EGR microswitch opens and the EGR valve closes. The speed sensor senses engine speed and sends this information to the electronic control assembly. With the engine speed between 1000 RPM and 2800 RPM, the electronic control assembly provides a ground for the EGR solenoid and the EGR valve is opened.

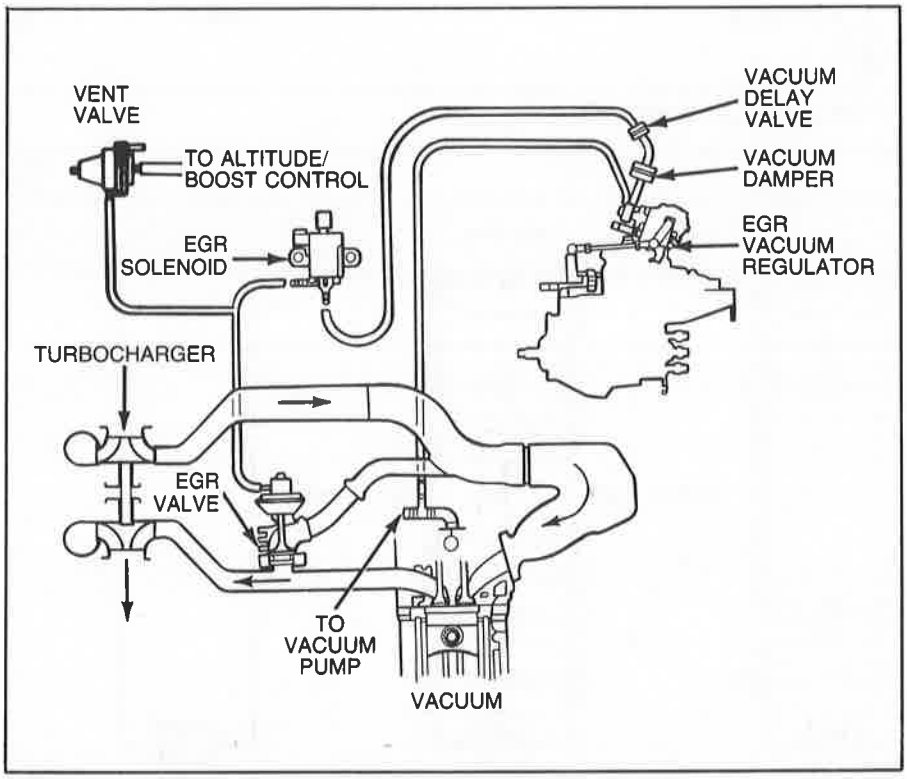


Figure 36 EGR Vacuum Schematic

EGR System

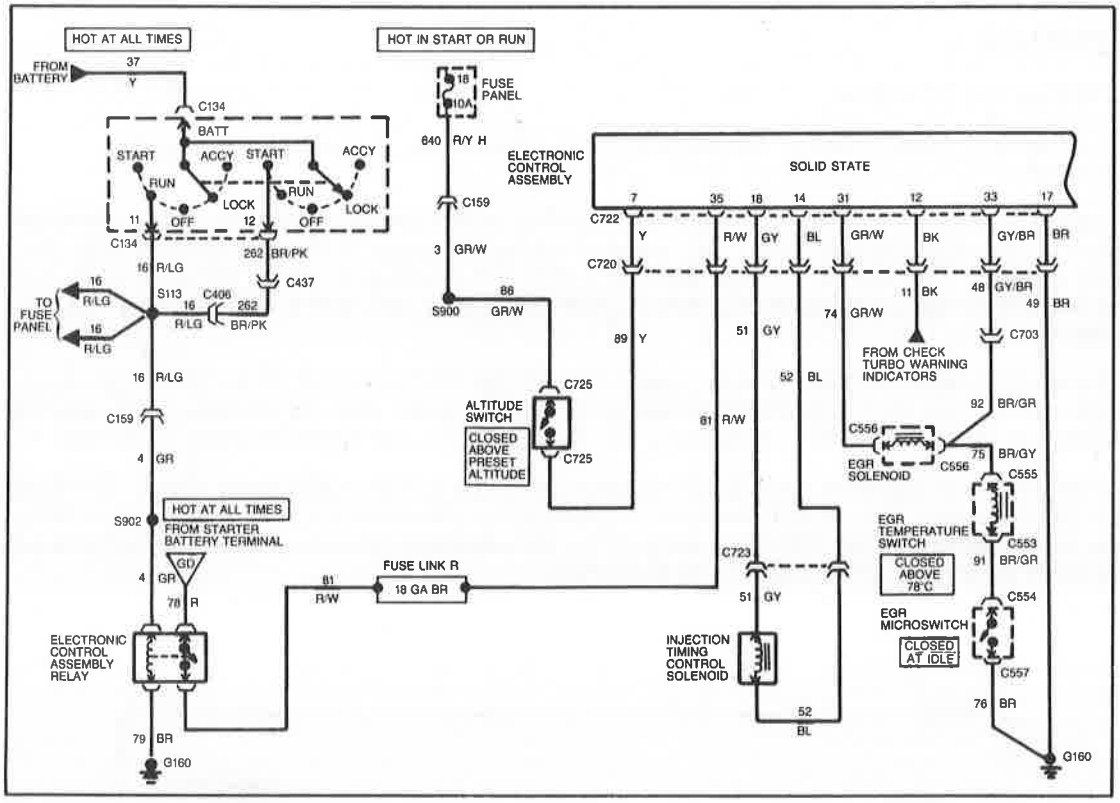


Figure 37 EGR Electrical Schematic

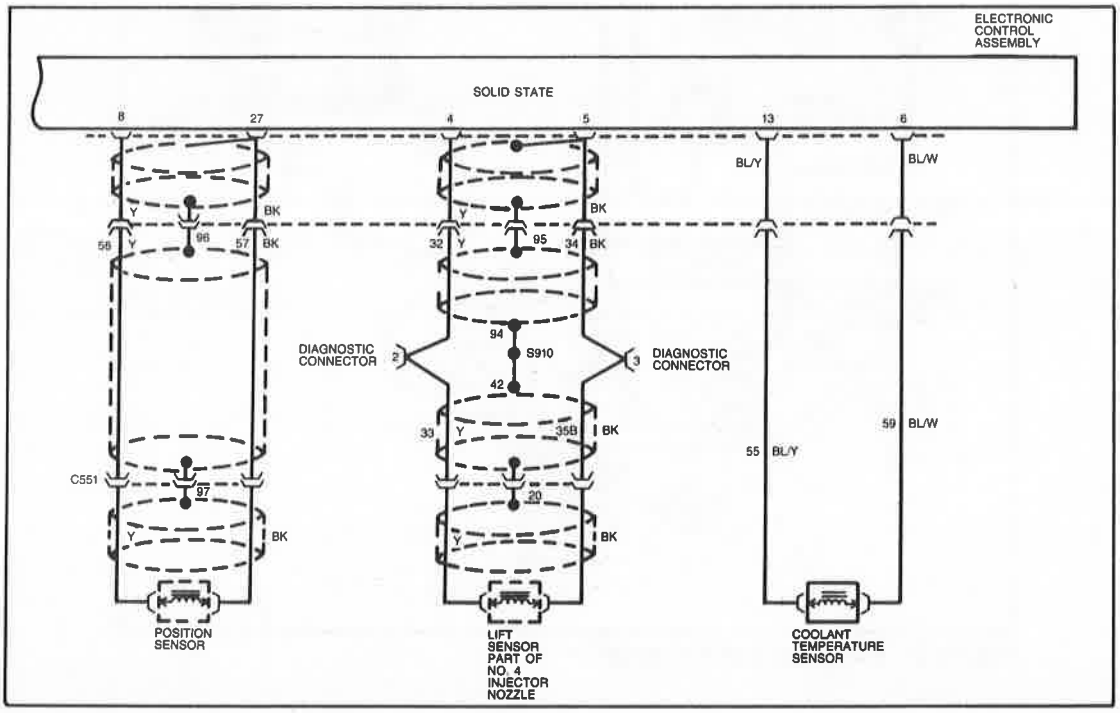


Figure 38 EGR Electrical Schematic — Cont'd.

EGR System

The amount the EGR valve is opened is controlled by the EGR vacuum regulator. As the throttle is depressed, the vacuum regulator bleeds off vacuum to the atmosphere, reducing the amount the EGR valve is opened.

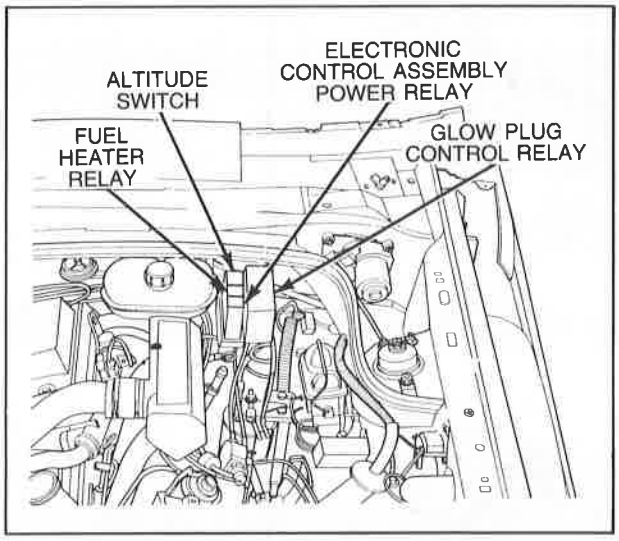


Figure 39 EGR Control Module

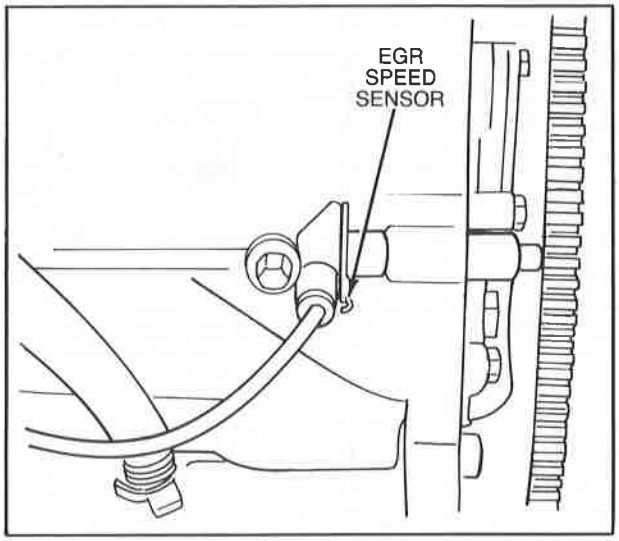


Figure 40 Speed Sensor

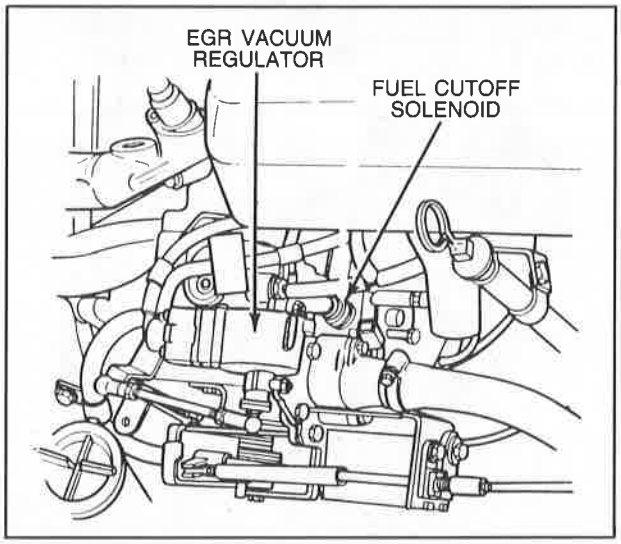


Figure 41 EGR Vacuum Regulator

EGR System

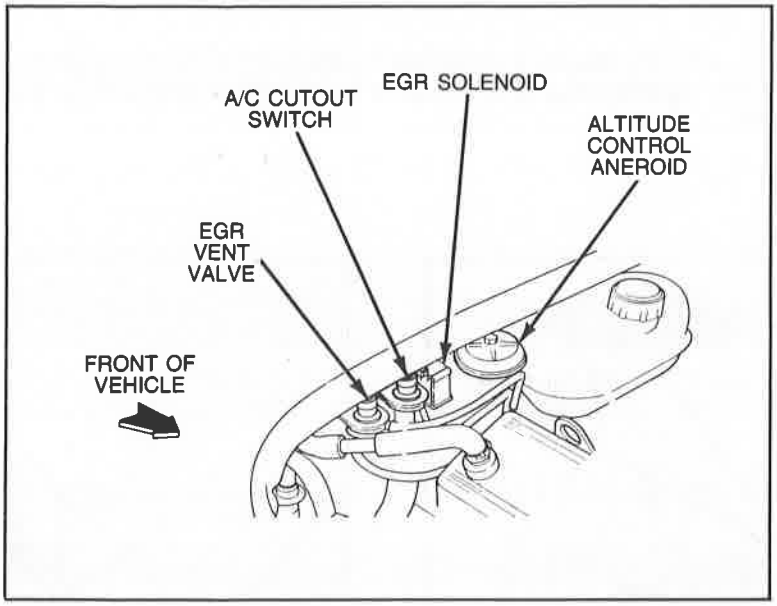


Figure 42 EGR Solenoid

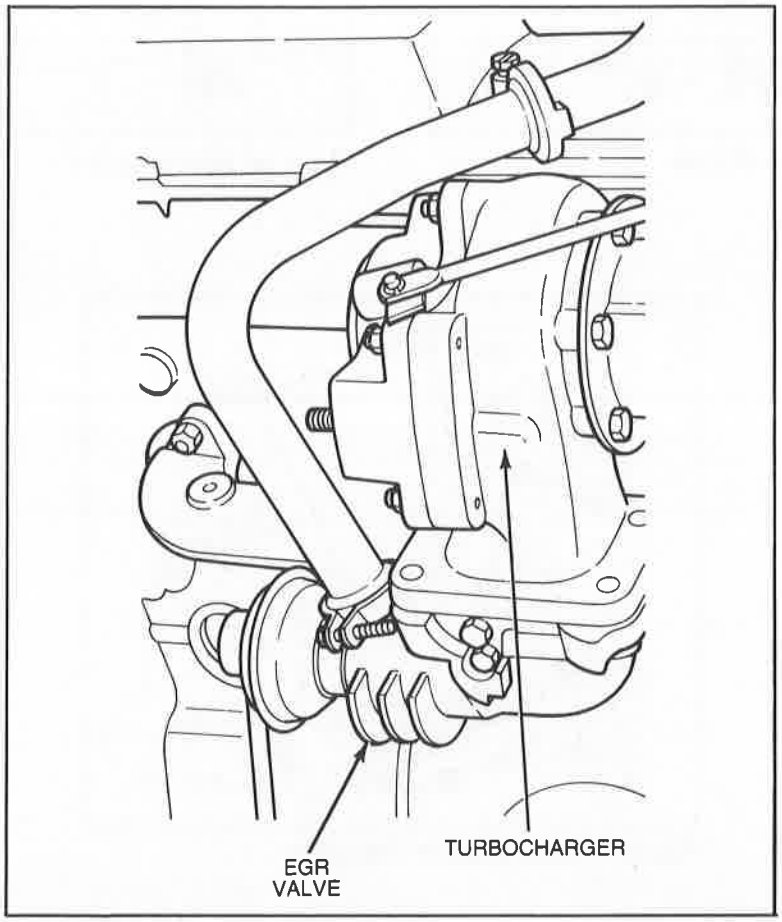


Figure 43 EGR Valve

Altitude Control System

DESCRIPTION

The altitude control system consists of a diaphragm spring installed horizontally in the housing. On the bottom of the housing is a reference pressure, which replaces atmospheric pressure and is modulated by a barometer box.

The difference between charge pressure and reference pressure determines the position of the diaphragm spring.

The diaphragm spring lifts with decreasing air pressure. The spring-loaded adjusting rod moves vertically against the spring force; and the guide pin moves horizontally because of the control taper. This causes the stop lever to swing around its pivoting point and forces the tensioning lever in the direction of the full load stop screw, against the governor spring force.

This moves the control valve in the "stop" direction and reduces the fuel delivery rate to conform with the air flow rate.

The altitude switch (Fig. 39) closes above a preset altitude. When the switch closes, a signal is sent to the electronic control assembly. The electronic control assembly processes this signal and charges injection timing to improve efficiency.

The EGR vent valve (Fig. 42) senses when the EGR system is working. The vent valve then vents atmospheric pressure to the altitude/boost compensator (Fig. 44). The altitude/boost compensator then adjusts fuel pressure to improve efficiency.

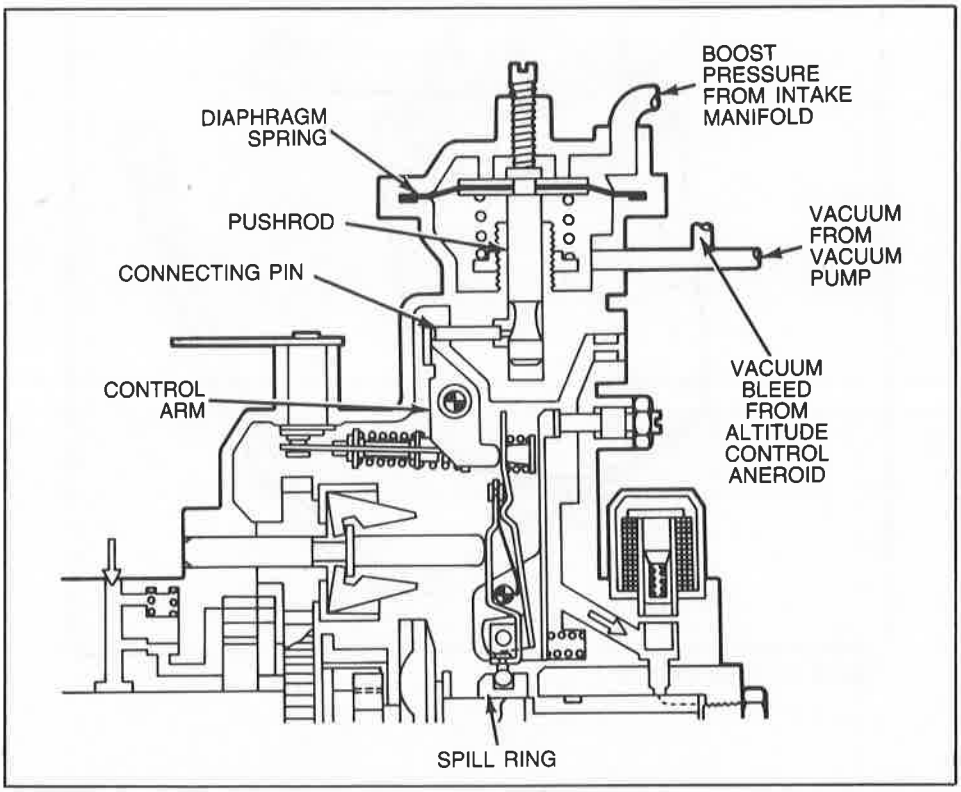


Figure 44 Altitude/Boost Compensator

Fuel Heater

DESCRIPTION

The fuel heater is part of the fuel filter/water separator (Fig. 45). When the fuel temperature is below 5.5°C (42°F), and the ignition switch is in the Run position, power flows through the temperature switch (Fig. 45) to the fuel heater relay (Fig. 39). The relay closes and power from the battery flows to the fuel heater. When the fuel temperature is above 5.5°C (42°F), the temperature switch opens, the fuel heater relay opens, and the fuel heater turns off.

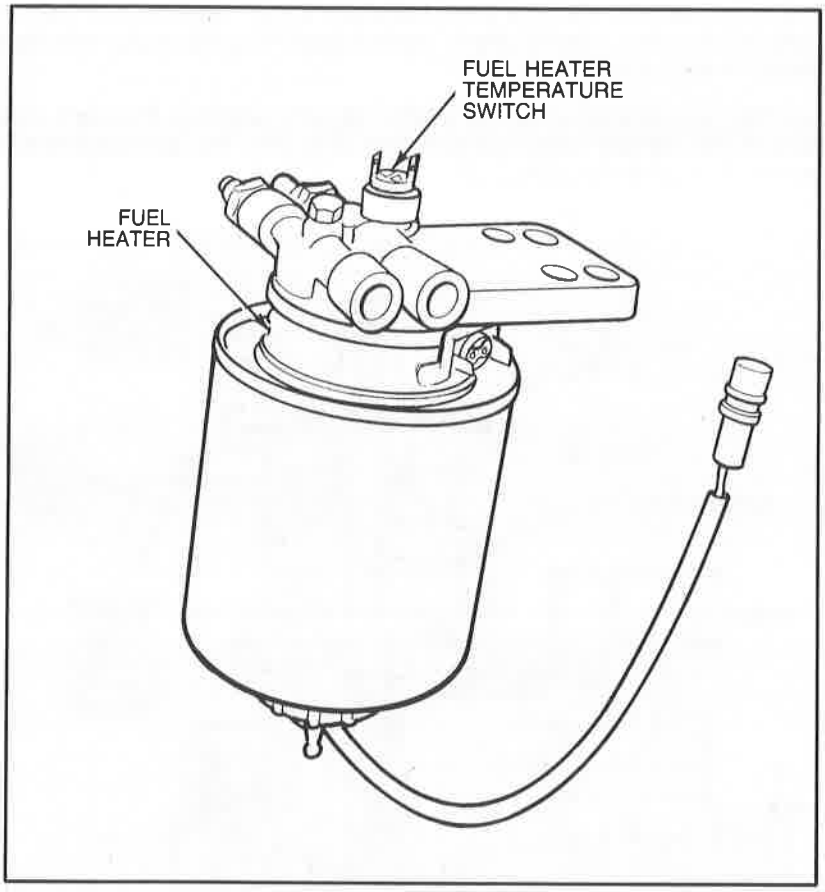


Figure 45 Fuel Heater

Engine Cranks But Will Not Start — Pinpoint Test A

TEST STEP	RESULT ▶	ACTION TO TAKE
A0 STARTING PROCEDURE		
• Check and follow correct starting procedure.	(OK) ▶	RETURN vehicle to customer.
	(OK) ▶	GO to **A1**.
A1 CURRENT TO FUEL SHUT OFF SOLENOID		
• Turn ignition switch to Run position. Using a 12-volt test lamp, check to see that voltage is available at solenoid.	(OK) ▶	GO to **A2**.
	(OK) ▶	REPAIR or REPLACE circuit as necessary. REPEAT Step **A1**.
A2 FUEL SHUT OFF SOLENOID		
• With ignition switch in Run position, disconnect and connect connector at fuel shutoff solenoid.	Solenoid clicks ▶	GO to **A3**.
	Solenoid does not click ▶	REPLACE fuel shut off solenoid and REPEAT Step **A2**.
A3 FUEL FLOW CHECK		
• Loosen one injector nozzle line nut and crank engine.	Fuel discharges ▶	GO to Glow Plug Control System Diagnosis.
	Fuel does not discharge ▶	GO to Engine Performance Diagnosis.

Engine Knocks	Pinpoint Test	B

TEST STEP	RESULT ▶	ACTION TO TAKE
B0 BELT DRIVEN ACCESSORIES		
• Check belt driven accessories for looseness.	(OK) ▶	GO to **B1**.
	(OK) ▶	REPAIR or REPLACE as necessary. REFER to Shop Manual, Section 27-02.
B1 FUEL SYSTEM CHECK		
• Perform fuel system diagnostic procedures.	(OK) ▶	PERFORM engine bearing inspection. REFER to Shop Manual, Section 22-07.
	(OK) ▶	MAKE necessary repairs and adjustments. If engine still knocks, PERFORM engine bearing inspection. REFER to Shop Manual, Section 22-07.

Engine Misses	Pinpoint Test	C

TEST STEP	RESULT ▶	ACTION TO TAKE
C1 DETERMINE WHEN MISS OCCURS		
• Engine will miss when cold if: a. One or more glow plugs are not heating. b. Cold Idle Advance is not operating. • Engine will miss at operating temperature if: — EGR system is not operating correctly. — Fuel has air bubbles. — Fuel injection system is not operating properly (including turbocharger).	Engine misses only when cold ▶	CHECK and ADJUST cold idle advance as described in this Section. If miss still exists, GO to Glow Plug System Diagnosis.
	Engine misses at operating temperature ▶	CHECK for air bubbles in fuel line. REPAIR fuel line leak as necessary. If miss still occurs, GO to EGR System Diagnosis. If miss still occurs, GO to Engine Performance Diagnosis.

Excessive Smoke	Pinpoint Test	D

TEST STEP		RESULT ▶	ACTION TO TAKE
D1	DETERMINE WHEN EXCESSIVE SMOKE OCCURS		
• Engine will smoke when cold if one or more glow plugs are not heating. • Engine will smoke at operating temperatures if: a. EGR system is not operating correctly. b. Fuel injection system is not operating correctly (including turbocharger). c. Altitude control system not working. d. Vent valve not working.		Engine smokes only when cold ▶ Engine smokes at operating temperatures ▶	GO to Glow Plug System Diagnostics. GO to EGR System Diagnosis. If smoke still occurs, GO to Altitude Control System Diagnosis. If smoke still occurs, GO to Engine Performance Diagnosis.

Engine Performance Diagnostic Procedure

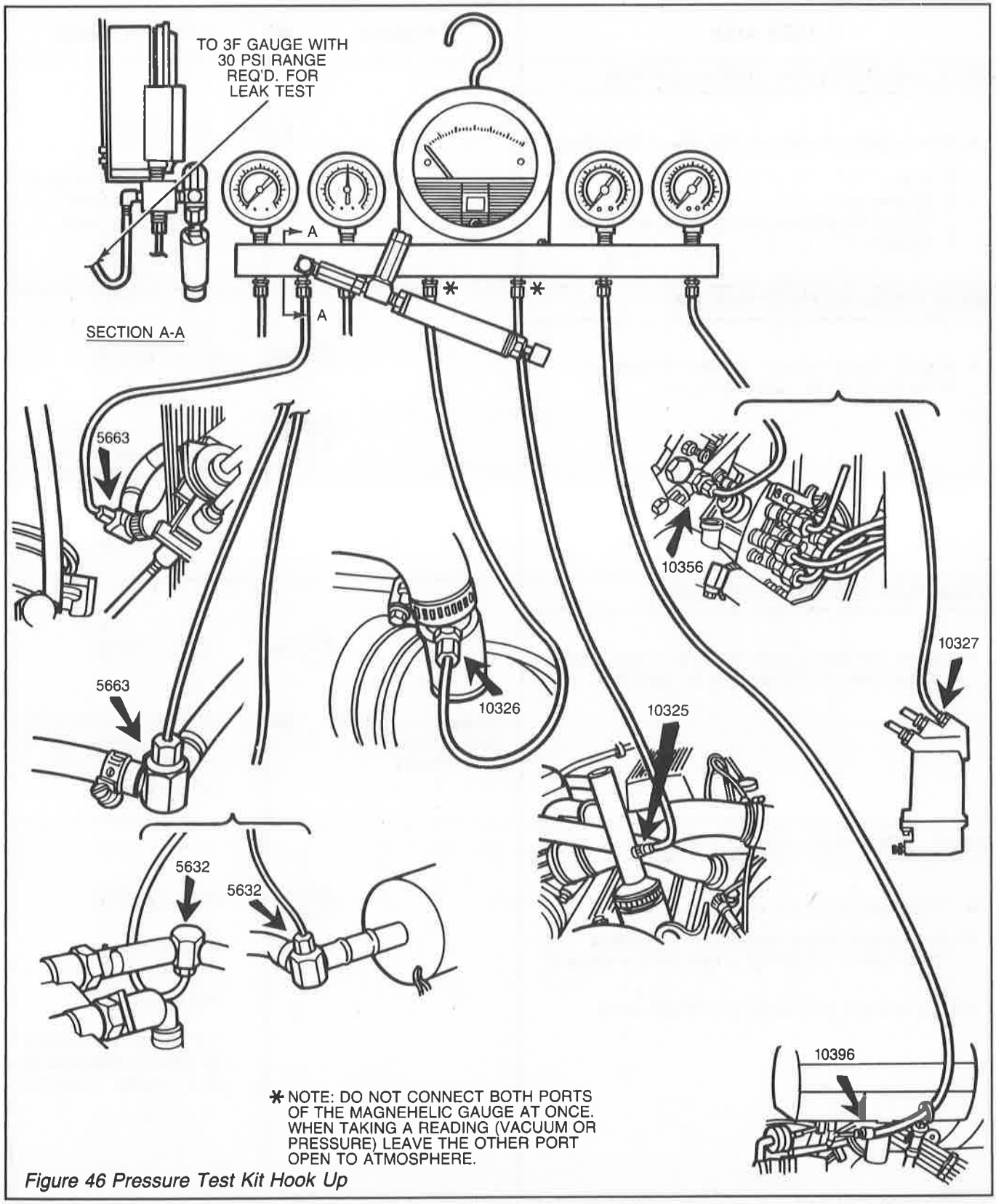


Figure 46 Pressure Test Kit Hook Up

Engine Performance Diagnosis	Pinpoint Test	EPC

TEST STEP	RESULT ▶	ACTION TO TAKE
EPC.1 CHECK FOR EXTERNAL LEAKAGE • With engine running, visually check for leakage of: 1. Fuel 2. Engine oil 3. Proper installation and dirt past air cleaner 4. Coolant	No leakage ▶ Leakage detected ▶	GO to **EPC.2**. REPAIR or REPLACE faulty component(s). If problem still exists, GO to **EPC.2**.
EPC.2 CHECK EXHAUST SYSTEM • Visually check exhaust system for dents or kinks which could cause restriction.	(OK) ▶ (OK) ▶	GO to **EPC.3**. REPAIR or REPLACE exhaust system as required. (Refer to Shop Manual, Section 26-30) GO to **EPC.3**.
EPC.3 FUEL SYSTEM CONDITION • Inspect fuel supply and return lines and hoses for kinks and all connections for tightness.	(OK) ▶ Kinked lines/hoses, and/or loose connections ▶	GO to **EPC.4**. REPAIR or REPLACE faulty component(s). If problem still exists, GO to **EPC.4**.
EPC.4 CHECK FUEL FOR CETANE VALUE • Obtain fuel sample in clean container. • Using cetane tester included with Dynamic Timing Meter 078-00116, check cetane value of fuel. • Cetane value should be a minimum of 40.	(OK) ▶ (OK) ▶	GO to **EPC.5**. INFORM owner to change fuel source. GO to **EPC.5**. **NOTE: Do not replace fuel pump because of low cetane problem.**

Engine Performance Diagnosis | Pinpoint Test | EPC

TEST STEP	RESULT ▶	ACTION TO TAKE
EPC.5 CHECK IGNITION PUMP TIMING • Install Dynamic Timing Meter Rotunda Model 078-00116 and check injection pump timing. • Measure timing. **NOTE: Refer to VECI decal for timing specifications.** **NOTE: Warranty claims for the injection pump will not be accepted unless all tamper resistant seals are intact.** • Leave Dynamic Timing Meter installed.	(OK) ▶ (OK) ▶	GO to **EPC.6** and DO NOT RECHECK timing in test **EPC.6**. DO NOT RESET engine timing at this time. GO to **EPC.6**. RECHECK timing in test **EPC.6**.
EPC.6 CHECK THROTTLE LINKAGE • Verify that injection pump top lever contacts high speed stop in WOT. • Verify that injection pump top lever contacts idle speed stop bolt. • Verify that adjustment bead on T.V. cable is 0.2-1.2mm (0.008-0.047 inch) from threaded barrel at idle.	(OK) ▶ (OK) ▶	GO to **EPC.7A**. CHECK and ADJUST throttle linkage as outlined in this section. GO to **EPC.7A**.
EPC.7A CHECK LIFT PUMP PRESSURE • Disconnect fuel outlet hose from electric lift pump. • Install adapter 5632 and Pressure Test Kit 019-00002 or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at idle. • Pressure should be 7-39 kPa (1-5.6 psi).	(OK) ▶ (OK) ▶	DISCONNECT adapter 5632 and connect fuel hose. GO to **EPC.7B**. GO to Electric Lift Pump Diagnosis in this Section. Complete diagnosis of electric lift pump system. REPEAT Test Step **EPC.7A**.

Engine Performance Diagnosis | Pinpoint Test | EPC

TEST STEP	RESULT ▶	ACTION TO TAKE
EPC.7B CHECK FUEL FILTER OUTLET • Disconnect fuel outlet hose from fuel filter. • Install adapter 5632 and Pressure Test Kit 019-00002, or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at idle. • Vacuum should be a maximum of 19.25 kPa (5.7 in. Hg.). • Record reading.	(OK) ▶ (OK) ▶	GO to **EPC.8**. GO to **EPC.7C**.
EPC.7C CHECK FUEL FILTER INLET • Disconnect fuel inlet hose at fuel filter. • Install adapter 5663 and Pressure Test Kit 019-00002, or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at idle. • Vacuum should be a maximum of 19.25 kPa (5.7 in. Hg.). • Record reading.	If vacuum is lower than vacuum recorded in **EPC.7B**. ▶ If vacuum is the same or higher than vacuum recorded in **EPC.7B**. ▶	REPLACE fuel filter. REPEAT Test Steps **EPC.7B** and **EPC.7C**. GO to **EPC.8**. Restriction is in fuel line from fuel tank or in fuel sender. SERVICE as necessary. REPEAT Test Step **EPC.7C**. GO to **EPC.8**.
EPC.8 CHECK CRANKCASE PRESSURE • Remove oil filler cap. • Install adapter 10325 and Pressure Test Kit 019-00002, or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Disconnect and plug crankcase ventilation hose at air cleaner. • Disconnect vacuum pump hose, and cap vacuum pump fitting. • Run engine at 3300 RPM. • Pressure should be a maximum of 30 in. H_2O at normal engine operating temperature.	(OK) ▶ (OK) ▶	GO to **EPC.9**. Problem is internal to the engine. REFER to Shop Manual, Section 22-07.

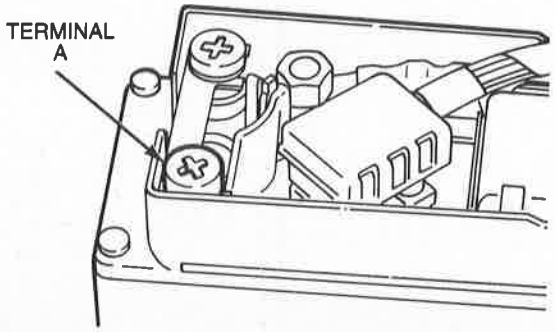
Engine Performance Diagnosis | Pinpoint Test | EPC

TEST STEP	RESULT ▶	ACTION TO TAKE
EPC.9 CHECK AIR INTAKE RESTRICTION • Disconnect crankcase ventilation hose on turbocharger inlet duct. • Install adapter 10326 and Pressure Test Kit 019-00002, or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at 3300 RPM. • Pressure should not exceed 4.8 in. H_2O. **NOTE: This reading also indicates turbocharger inlet pressure.**	(OK) ▶ (OK) ▶	GO to **EPC.10**. REPLACE air filter element. REPEAT Test Step **EPC.9**. If new element does not solve problem, CHECK for restriction inside fender area or air cleaner opening.
EPC.10 CHECK TURBO BOOST PRESSURE • Disconnect Boost Compensator hose at base of intake plenum chamber. • Install adapter 10396 and Pressure Test Kit 019-00002, or equivalent (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46). **NOTE: Be sure hose to Altitude/Boost Compensator is reconnected to adapter 10396.** • Raise rear wheels off ground. • With transmission in Drive and brakes applied, run engine at W.O.T. (minimum of 2500 RPM). **CAUTION: Do not run engine under full load with brakes applied for longer than 30 seconds. Longer periods under full load could cause transmission damage.** • Pressure should be a maximum of 80 ± 5 kPa (11.6 ± 1 PSI). • **NOTE: After running engine under full load, place transmission in Neutral and run engine at 1000 RPM for one minute to allow transmission to cool down.**	(OK) ▶ Below 75 kPa (10.6 PSI) ▶ Over 85 kPa (12.6 PSI) ▶	GO to **EPC.12**. GO to **EPC.11**. REPLACE turbocharger. Refer to Shop Manual, Section 25-45. REPEAT Test Step **EPC.10**.
EPC.11 CHECK FOR INTAKE LEAKS • Run engine at idle. Check for air leaks in intake manifold in the following areas: a. Crossover pipe between turbo and intake plenum. b. Intake manifold at cylinder head. c. Pressure relief valve at base of intake plenum.	(OK) ▶ (OK) ▶	REPLACE turbocharger. Refer to Shop Manual, Section 25-45. REPEAT Test Step **EPC.10**. SERVICE or REPLACE component(s) as necessary. REPEAT Test Step **EPC.10**.

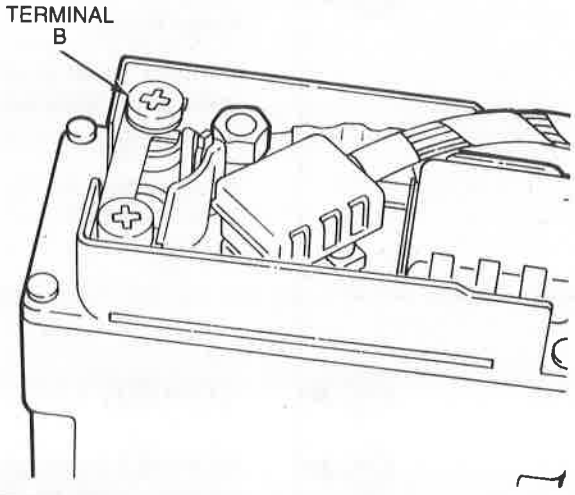
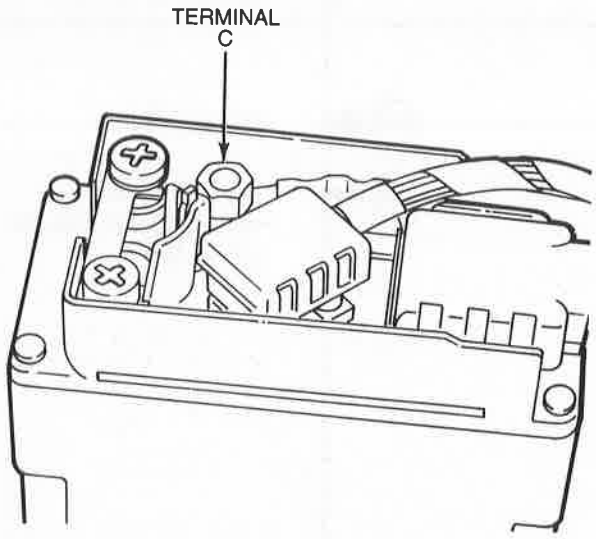
Engine Performance Diagnosis | Pinpoint Test | EPC

TEST STEP	RESULT ▶	ACTION TO TAKE
EPC.12 CHECK FUEL RETURN PRESSURE • Disconnect fuel return line at connection to chassis fuel line at base of LH fender apron. • Install adapter 5663 and Pressure Test Kit 019-00002, or equivalent (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at idle. • Pressure should be a maximum of 14 kPa (2 PSI).	(OK) ▶ (OK) ▶	GO to **EPC.13**. CHECK fuel return line and fuel sender for kinks or restrictions. SERVICE as necessary. REPEAT Test Step **EPC.12**.
EPC.13 CHECK INJECTION PUMP INTERNAL PRESSURE • Remove banjo bolt (marked OUT) from fuel return line on injection pump. • Install adapter 10356 and Pressure Test Kit 019-00002, or equivalent. (Refer to Pressure Test Kit Hook-up Illustration, Fig. 46.) • Run engine at the following RPM's and observe pressure readings. Readings should be: a. 800 RPM with engine at normal operating temperature — 400 ± 55 kPa (58 ± 8 PSI). b. 4500 RPM — 800 ± 8 kPa (116 ± 8 PSI).	(OK) ▶ (OK) ▶	GO to **EPC.14**. REPLACE injection pump. REFER to Shop Manual, Section 22-07. ADJUST injection timing as outlined in this Section. If performance problem still exists, GO to **EPC.14**.
EPC.14 CHECK INJECTION PUMP TIMING • With Dynamic Timing Meter installed, and engine at normal operating temperature, check injection timing. • Measure timing. **NOTE: Refer to VECI decal for timing specifications.**	(OK) ▶ (OK) ▶	GO to **EPC.15**. ADJUST timing as outlined in this Section. If performance problem still exists, GO to **EPC.15**.
EPC.15 CHECK INJECTION NOZZLES AND INLET LINES • Check injection nozzle inlet lines for kinks or restrictions. • Remove injection nozzles. Refer to Shop Manual, Section 22-07. • Test injection nozzles as described in this Section.	(OK) ▶ (OK) ▶	System OK. REPLACE injection nozzle(s) and/or injection nozzle inlet line(s) as necessary. REFER to Shop Manual, Section 22-07.

Glow Plug System Diagnosis — Pinpoint Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F1 CHECK VOLTAGE TO GLOW PLUGS • Connect positive lead of voltmeter to glow plug. Connect negative lead to ground. • With engine coolant temperature below 70°C (158°F) have an assistant turn ignition switch to Run position. • Voltmeter should indicate battery voltage.	(OK) ▶ (OK) ▶	GO to **F2**. REPEAT Test Step **F1** on another glow plug. If voltage is indicated, GO to **F2**. If no voltage is indicated, GO to **F3**.
F2 CHECK GLOW PLUGS • Remove cover from glow plug module. • Remove large connector from glow plug control module. • Connect one lead of ohmmeter to ground. • Probe each terminal of connector with other lead of ohmmeter. • Ohmmeter should indicate 0.3 to 0.6 ohms for each terminal.	(OK) ▶ (OK) ▶	GO to **F3**. REPLACE faulty glow plug(s). REPEAT Test Step **F2**. If ohmmeter readings are still out of specification, REPLACE faulty wire(s). CHECK system operation.
F3 CHECK GLOW PLUG FUSE TERMINAL A • Remove cover from glow plug control module. • Connect negative lead of voltmeter to ground. • Connect positive lead to terminal A. • Voltmeter should indicate battery voltage.  	(OK) ▶ (OK) ▶	GO to **F6**. LEAVE voltmeter connected to ground. GO to **F4**.

Glow Plug System Diagnosis — Pinpoint Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F4 CHECK GLOW PLUG FUSE TERMINAL B		
• Connect voltmeter positive lead to terminal B. • Voltmeter should indicate battery voltage. 	(OK) ▶	REPLACE 80A fuse. CHECK system operation.
	(OK) ▶	LEAVE voltmeter connected to ground. GO to **F5**.
F5 CHECK GLOW PLUG FUSE TERMINAL C		
• Connect voltmeter positive lead to terminal C. • Voltmeter should indicate battery voltage. 	(OK) ▶	REPLACE glow plug control module. CHECK system operation.
	(OK) ▶	SERVICE open circuit in R wire between glow plug control module and starter motor. CHECK system operation.

Glow Plug System Diagnosis — Pinpoint Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F6 CHECK MODULE GROUND CIRCUIT • Remove small connector from glow plug control module. • Connect an ohmmeter between terminal 31 (BR) and ground. • Ohmmeter should indicate zero ohms.	(OK) ▶ (OK) ▶	GO to F7. SERVICE BR wire between control module and ground. CHECK system operation.
F7 CHECK GLOW PLUG TEMPERATURE SENSOR • Remove small connector from glow plug control module. • Connect ohmmeter negative lead to ground. • Connect positive lead to the N.T.C. terminal in the connector. • Compare ohmmeter indication to chart below. Resistance should be within specifications depending on coolant temperature. °C / °F / Ohms −20 / −4 / 6446 ± 980 0 / 32 / 2447 ± 300 20 / 68 / 1040 ± 110 40 / 104 / 488 ± 40 60 / 140 / 247 ± 18.5 90 / 194 / 102 ± 6 120 / 248 / 48 ± 3	(OK) ▶ (OK) ▶	GO to F8. CHECK wire then REPLACE temperature sensor. CHECK system operation.
F8 CHECK VOLTAGE TO GLOW PLUG CONTROL MODULE • Remove small connector from glow plug control module. • Connect negative lead of voltmeter to ground. • Connect positive lead of voltmeter to terminal 15 in connector. • Turn ignition switch to Run position. • Voltmeter should indicate battery voltage.	(OK) ▶ (OK) ▶	LEAVE voltmeter connected to ground. GO to F9. SERVICE open circuit in GR/W wire between glow plug control module.

Glow Plug System Diagnosis — Pinpoint Test F

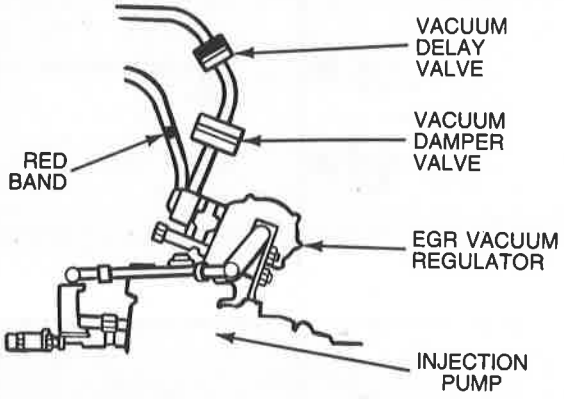
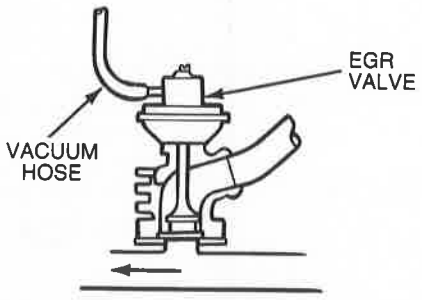
TEST STEP		RESULT ▶	ACTION TO TAKE
F9	CHECK VOLTAGE TO GLOW PLUG CONTROL MODULE		
• Connect voltmeter to terminal 50 in connector. • Have assistant turn ignition switch to Run position. • Voltmeter should indicate voltage.		(OK) ▶	REPLACE glow plug control module. CHECK system operation.
		(OK) ▶	SERVICE open circuit in BK/Y wire between glow plug control module and starter motor. CHECK system operation.

Glow Plug Wait Lamp System Diagnosis

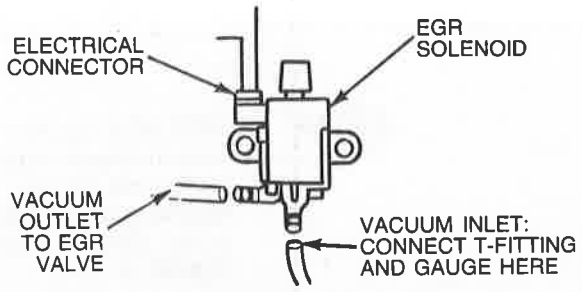
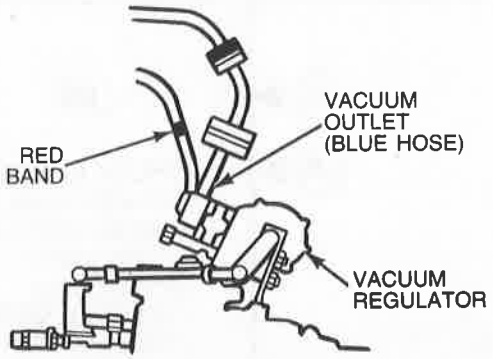
Pinpoint Test G

TEST STEP	RESULT ▶	ACTION TO TAKE
G1 CHECK WAIT LAMP WITH ENGINE COLD • With engine coolant temperature below 66°C (150°F), turn ignition key to Run position. • The WAIT lamp should light. The length of time the WAIT lamp is lit will depend on engine coolant temperature.	(OK) ▶ (OK) ▶	Wait lamp and wiring OK. GO to **G2**.
G2 CHECK WAIT LAMP WITH WARM ENGINE • With engine coolant temperature above 66°C (150°F), bypass the control function (for diagnostic purposes) by disconnecting the two temperature sensor wire connectors located in the top water outlet connection. • Turn ignition key to the Run position. • The WAIT lamp should light for up to 10 seconds.	(OK) ▶ (OK) ▶	Wait lamp and wiring OK. GO to **G3**.
G3 CHECK BULB AND WIRING HARNESS • Remove plastic cover from glow plug control module. • Disconnect small connector from glow plug control module. • Connect a jumper wire from a suitable ground to pin LA1 **in the connector.** • Turn ignition key to the Run position. • WAIT lamp should light.	(OK) ▶ (OK) ▶	PERFORM Glow Plug System Diagnosis as outlined in this Section. REPAIR or REPLACE bulb or wiring harness as necessary.

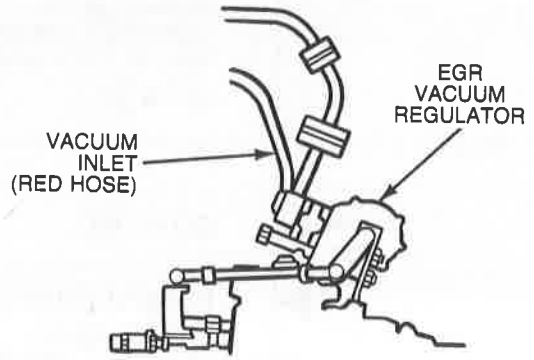
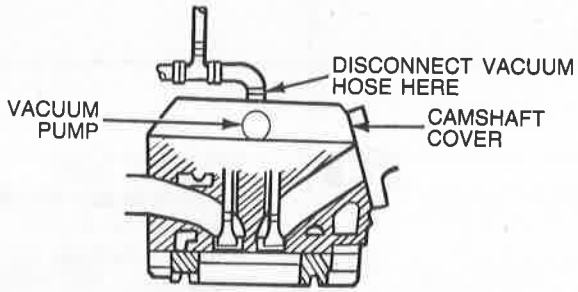
EGR System Diagnosis — Pinpoint Test H

TEST STEP	RESULT ▶	ACTION TO TAKE
H1 CHECK VACUUM HOSES		
• Verify that EGR vacuum hoses are connected to correct fittings. Refer to VECI decal for vacuum hose routing. • Verify that vacuum delay valve is installed in the correct direction. (Black side toward EGR solenoid).  **NOTE: VACUUM DELAY VALVE IS LOCATED NEAR EGR SOLENOID.**	(OK) ▶ (OK) ▶	GO to H2. INSTALL vacuum hoses and/or vacuum delay valve correctly. RUN engine and CHECK for smoke. If smoke is still excessive, GO to H2.
H2 CHECK EGR VALVE		
• Disconnect vacuum hose at EGR valve. • Connect a hand-held vacuum pump to EGR valve and apply 3.54 kPa (12 in Hg.). • Observe gauge for loss of vacuum. • Release vacuum from EGR valve and listen for click of valve hitting seat.  	(OK) ▶ (OK) ▶	GO to H3. REPLACE EGR valve. CHECK system operations.

EGR System Diagnosis — Pinpoint Test H

TEST STEP	RESULT ▶	ACTION TO TAKE
H3 CHECK VACUUM AT EGR VALVE • Install T-fitting at EGR valve and connect vacuum gauge. • With engine running at idle and engine coolant temperature above 78°C (172°F) vacuum should be present.	(OK) ▶	CHECK and ADJUST EGR linkage as necessary, as outlined in this Section.
	(OK) ▶	REMOVE T-fitting and vacuum gauge. CONNECT vacuum hose to EGR valve. GO to **H4**.
H4 CHECK VACUUM AT EGR SOLENOID • Disconnect vacuum inlet hose at EGR solenoid and install T-fitting and vacuum gauge. • Run engine at idle and check for vacuum.  	(OK) ▶	GO to **H8**.
	(OK) ▶	REMOVE T-fitting and vacuum gauge. CONNECT vacuum hose to EGR solenoid. GO to **H5**.
H5 CHECK VACUUM AT EGR VACUUM REGULATOR • Disconnect vacuum outlet hose (blue) from vacuum regulator and install T-fitting and vacuum gauge. • Run engine at idle and check for vacuum.  	(OK) ▶	REPLACE faulty vacuum hoses and/or delay valve and/or vacuum damper as necessary. RECHECK system operation.
	(OK) ▶	REMOVE T-fitting and vacuum gauge. CONNECT vacuum hose (blue) to EGR vacuum regulator. GO to **H6**.

EGR System Diagnosis — Pinpoint Test H

TEST STEP	RESULT ▶	ACTION TO TAKE
H6 CHECK VACUUM AT EGR VACUUM REGULATOR • Disconnect vacuum inlet hose (red) from vacuum regulator and install T-fitting and vacuum gauge. • Run engine at idle and check for vacuum. 	(OK) ▶ (OK) ▶	REPLACE vacuum regulator. CHECK system operation. REMOVE T-fitting and vacuum gauge. CONNECT vacuum inlet hose (red). GO to H7.
H7 CHECK VACUUM PUMP • Disconnect vacuum hose at vacuum pump outlet on camshaft cover. Connect vacuum gauge to vacuum pump outlet. • Run engine at idle and check for vacuum. 	(OK) ▶ (OK) ▶	REPLACE vacuum hose between vacuum pump and vacuum regulator on injection pump. CHECK system operation. REPLACE vacuum pump. CHECK system operation.
H8 CHECK VOLTAGE AT EGR SOLENOID • With ignition switch in Run position, check for voltage on GR/W wire at EGR solenoid.	(OK) ▶ (OK) ▶	GO to H9. CHECK for open circuit between EGR solenoid and Fuse 18 in fuse panel. SERVICE as necessary. CHECK system operation.

EGR System Diagnosis — Pinpoint Test H

TEST STEP	RESULT ▶	ACTION TO TAKE
H9 CHECK EGR SOLENOID OPERATION • Disconnect vacuum outlet hose at EGR solenoid and install a T-fitting and vacuum gauge. • Disconnect BR/GR wire at EGR temperature switch and jumper wire to ground. • Start engine and check for vacuum.	(OK) ▶ (OK) ▶	GO to **H11**. GO to **H10**.
H10 CHECK WIRING • Disconnect EGR solenoid and check continuity of BR/GR wire between EGR solenoid and EGR temperature switch.	(OK) ▶ (OK) ▶	REPLACE EGR solenoid. CHECK system operation. SERVICE open circuit in BR/GR wire. CHECK system operation. GO to **H11.**.
H11 CHECK CONTINUITY OF EGR TEMPERATURE SWITCH • Disconnect leads from EGR temperature switch. • Check continuity of EGR temperature switch. [Engine coolant temperature above 78°C (172°F).]	(OK) ▶ (OK) ▶	LEAVE wires disconnected. GO to **H12**. REPLACE EGR temperature switch. CHECK system operation.
H12 CHECK EGR MICROSWITCH • Verify that injection pump top lever is against idle stop bolt (warm idle). • Connect one lead of ohmmeter ground. • Connect the other lead to the BR/BK wire at EGR temperature switch. • Ohmmeter should read zero ohms.	(OK) ▶ (OK) ▶	GO to Engine Performance Diagnosis — Pinpoint Test N. GO to **H13**.

EGR System Diagnosis — Pinpoint Test H

TEST STEP	RESULT ▶	ACTION TO TAKE
H13 CHECK MICROSWITCH • Check microswitch adjustment as outlined in this Section.	(OK) ▶	GO to **H14**.
	(OK) ▶	ADJUST microswitch as outlined in this section. CHECK system operation.
H14 CHECK CONTINUITY OF WIRING • Check continuity of BR/BK wire between EGR temperature switch and EGR microswitch. • Check continuity of BR wire between EGR microswitch and ground.	(OK) ▶	REPLACE microswitch. CONNECT wires. CHECK system operation.
	(OK) ▶	SERVICE open circuits in BR/BK and/or BR wire. CHECK system operation.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test N

TEST STEP	RESULT ▶	ACTION TO TAKE
N1 CHECK TIMING **NOTE: If "Check Turbo" warning indicator is On, GO to N3.** **NOTE: Under certain conditions, a delay of up to 15 seconds may occur before "Check Turbo" warning indicator turns On.** • Install Dynamic Timing Meter, Rotunda 078-00116, or equivalent. • With engine running at normal operating temperature, measure timing. **NOTE: Refer to VECI decal for timing specifications.** **NOTE: Warranty claims for injection pump will not be accepted unless all tamper-resistant seals are intact.** • Leave dynamic timing meter connected.	(OK) ▶ (OK) ▶	GO to N2. GO to N3.
N2 CHECK EGR • Install a T-fitting between EGR valve and EGR solenoid and connect vacuum gauge. • With engine running and engine coolant temperature at normal operating temperature, vacuum should be present at idle and between 1,000 and 2,800 rpm ± 100 rpm.	(OK) ▶ (OK) ▶	GO to N3. CONNECT breakout box as outlined in Test Step N3. GO to N17.
N3 INSTALL BREAKOUT BOX • Disconnect electrical connector at electronic control assembly in luggage compartment. • Install Breakout Box, T83L-50-EEC-IV, Rotunda 014-00322, and Adapter T84P-50-D2.4, or equivalent, between harness connector and control assembly. • With engine running and at normal operating temperature, depress and release button on Adapter T84P-50-D2.4 or equivalent, and count and record number of flashes of indicator lamp. • Leave breakout box and adapter installed.	No indicator lamp ▶ 2 flashes ▶ 4 flashes ▶ 6 flashes ▶ 8 flashes ▶ More than 8 flashes ▶	GO to N4. GO to N9. GO to N14. GO to N21. GO to N12. GO to N4.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test N

TEST STEP	RESULT ▶	ACTION TO TAKE
N4 CHECK POWER TO CONTROL ASSEMBLY • With ignition switch in Run position, connect voltmeter positive lead to pin 35 and negative lead to pin 17. • Voltmeter should indicate a minimum of 10.5 volts.	(OK) ▶ (OK) ▶	GO to **N9**. GO to **N5**.
N5 CHECK POWER TO POWER RELAY • Remove power relay and bracket assembly from glow plug module bracket. • Connect negative lead from voltmeter to ground. • With ignition switch in Run position, connect voltmeter positive lead to circuit 30 (R wire) at relay connector. • Voltmeter should indicate battery voltage.	(OK) ▶ (OK) ▶	LEAVE negative lead connected to ground. GO to **N6**. SERVICE open circuit 30 (R wire) between relay and starter solenoid and/or battery. REPEAT Step **N1**.
N6 CHECK CIRCUIT 81 • With ignition switch in Run position, connect positive lead of voltmeter to circuit 81 (R/W wire) at relay. • Voltmeter should indicate battery voltage.	(OK) ▶ (OK) ▶	SERVICE open circuit 81 (R/W wire) between relay and control assembly including fuse link. REPEAT Step **N1**. LEAVE negative lead connected to ground. GO to **N7**.
N7 CHECK IGNITION CIRCUIT • With ignition switch in Run position, connect positive lead of voltmeter to circuit 86 (GR) at relay. • Voltmeter should indicate battery voltage.	(OK) ▶ (OK) ▶	LEAVE negative lead connected to ground. GO to **N8**. SERVICE open circuit 86 (GR wire) between relay and ignition switch including fuse. REPEAT Step **N1**.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test **N**

TEST STEP	RESULT ▶	ACTION TO TAKE
N8 CHECK GROUND CIRCUIT • With ignition switch in Off position, connect ohmmeter positive lead to circuit 85 (BR wire) at relay. • Ohmmeter should indicate continuity.	(OK) ▶	REPLACE power relay. REPEAT Step **N4**.
	(OK) ▶	SERVICE open circuit 85 (BR wire) between relay and ground. REPEAT Step **N1**.
N9 CHECK LIFT SENSOR WIRING • Disconnect Electronic Control Assembly. • With ignition switch in Off position, connect positive lead of ohmmeter to pin 4 of breakout box and negative lead to pin 5 of breakout box. • Ohmmeter should indicate 100-160 ohms.	(OK) ▶	GO to **N12**.
	Ohmmeter indicates less than specification ▶	LEAVE probes connected to breakout box. GO to **N10**.
	Ohmmeter indicates more than specification ▶	GO to **N11**.
N10 CHECK FOR SHORT TO GROUND • With ignition switch in Off position, and positive lead connected to pin 4 of breakout box, connect negative lead to pin 17, and observe ohmmeter. • Ohmmeter should not indicate continuity.	(OK) ▶	Go to **N11**.
	(OK) ▶	SERVICE short to ground in circuit 32 Y and/or 34 BK. REPEAT Step **N9**.
N11 CHECK LIFT SENSOR • Disconnect electrical connector at **No. 4 Injector.** • Connect ohmmeter across leads of injector connector. • Ohmmeter should indicate 100-160 ohms.	(OK) ▶	SERVICE open in circuit 32 Y and/or 34 BK, between No. 4 Injector and control assembly. CONNECT Electronic Control Assembly and REPEAT Step **N1**.
	(OK) ▶	REPLACE **No. 4** injector. REPEAT Step **N1**.

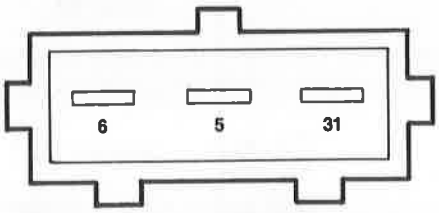
Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test N

TEST STEP	RESULT ▶	ACTION TO TAKE
N12 CHECK COOLANT TEMPERATURE SENSOR • Disconnect Electronic Control Assembly. • With ignition switch in Off position, connect positive lead of ohmmeter to pin 6 of breakout box. Connect negative lead to pin 13. • Ohmmeter should indicate 0.38-0.24 K ohms.	(OK) ▶ (OK) ▶	GO to N14. GO to N13.
N13 CHECK COOLANT TEMPERATURE SENSOR • Disconnect electrical connector (Black) at temperature sensor located on LH side of cylinder head between cylinders No. 5 and No. 6. • Connect ohmmeter across terminals of switch. • Ohmmeter should indicate same values as shown in Step N12.	(OK) ▶ (OK) ▶	SERVICE open in circuit 55 BL/Y and/or 59 BL/W between temperature sensor and control assembly. CONNECT Electronic Control Assembly and REPEAT Step N1. REPLACE temperature sensor. CONNECT Electronic Control Assembly and REPEAT Step N1.
N14 CHECK SPEED SENSOR • With Electronic Control Assembly disconnected, connect voltmeter positive lead to breakout box, pin 27 and negative lead to pin 8. Set meter on A/C mode. • Run engine at idle and observe voltmeter. • Voltmeter should indicate between 1.0 and 2.0 volts **AC.** • Connect Electronic Control Assembly after this test.	(OK) ▶ No voltage indicated ▶ Voltage indicated, but out of specification ▶	GO to N17. GO to N15. GO to N16.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test **N**

TEST STEP	RESULT ▶	ACTION TO TAKE
N15 CHECK SPEED SENSOR • Disconnect harness connector from speed sensor connector, located on diagnostic connector bracket. • Connect voltmeter probes to terminals No. 5 and No. 6 of sensor connector. • With engine running, voltmeter should indicate between 1.0 and 2.0 volts **AC.**  SENSOR CONNECTOR	(OK) ▶ (OK) ▶	SERVICE open in circuit 56 Y and/or 57 BK, between sensor harness connector and control assembly. REPEAT Step **N1**. TURN engine Off. LEAVE connector disconnected. GO to **N16**.
N16 CHECK SPEED SENSOR • Connect ohmmeter leads across terminals No. 5 and No. 6 of speed sensor connector. • Ohmmeter should indicate 800-2000 ohms.	(OK) ▶ (OK) ▶	CHECK and ADJUST clearance between speed sensor in cylinder block and pins on flywheel. Clearance should be 1.3 mm (0.051 inches). REPEAT Step **N14**. REPLACE and ADJUST speed sensor. CONNECT Electronic Control Assembly. REPEAT Step **N1**.
N17 CHECK EGR SYSTEM • With ignition switch in Off position, connect positive lead of ohmmeter to breakout box pin 31 and negative lead to pin 33. • Ohmmeter should indicate 10-40 ohms.	(OK) ▶ (OK) ▶	GO to **N19**. GO to **N18**.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test N

TEST STEP	RESULT ▶	ACTION TO TAKE
N18 CHECK EGR SOLENOID • Disconnect electrical connector from EGR solenoid on dash panel. • Connect positive lead of ohmmeter to positive terminal of solenoid and negative lead to negative terminal. • Ohmmeter should indicate 10-40 ohms.	(OK) ▶	SERVICE open in circuit 71 GR/W and/or 57 BR/GR between EGR solenoid and control assembly. REPEAT Step **N1**.
	(OK) ▶	REPLACE EGR solenoid. REPEAT Step **N1**.
N19 CHECK INJECTION TIMING • With dynamic timing meter and breakout box connected and engine running at warm idle, observe engine rpm and timing. • Disconnect electrical connector for injection pump timing control solenoid (round connector attached to bracket above No. 5 injector). • Injection timing should advance to 9°-14° BTDC. • Reconnect injection timing control solenoid. • Injection timing should return to original value. Then, check timing. Refer to VECI decal for specifications.	(OK) ▶	System OK.
	(OK) ▶	GO to **N20**.
N20 CHECK STATIC TIMING • Check injection pump static timing as outlined.	(OK) ▶	GO to **N21**.
	(OK) ▶	ADJUST static timing as outlined. REPEAT Step **N19**.

Engine Performance Diagnosis — Electronic Control Assembly

Pinpoint Test N

TEST STEP	RESULT ▶	ACTION TO TAKE
N21 CHECK INJECTION TIMING SOLENOID • With ignition switch in Off position, connect positive lead of ohmmeter to breakout box pin 14 and negative lead to pin 18. • Ohmmeter should indicate 5-25 ohms.	(OK) ▶	GO to Engine Performance Diagnosis — Fuel System **EPC1**. If, after performing Fuel System Diagnosis, problem still exists, REPLACE electronic control assembly. REPEAT Step **N1**.
	(OK) ▶	GO to **N22**.
N22 CHECK INJECTION TIMING SOLENOID • Disconnect electrical connector from injection pump timing solenoid. • Connect ohmmeter probes across solenoid connector terminals. • Ohmmeter should indicate 5-25 ohms.	(OK) ▶	SERVICE open in circuit 51 GY and/or 52 BL, between solenoid and control assembly. REPEAT Step **N1**.
	(OK) ▶	Injection timing solenoid is faulty. PERFORM Engine Performance Diagnosis — Fuel System. RECORD fuel system pressures to submit with warranty claim. REPLACE injection pump. Refer to Shop Manual, Section 22-07. ADJUST injection pump timing and injection pump linkages as outlined in this Section.

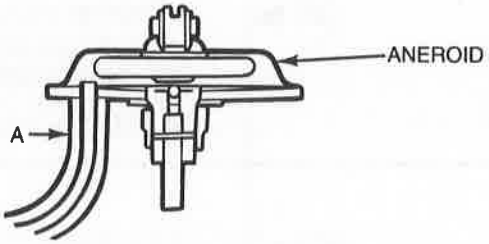
Fuel Heater Diagnosis — Pinpoint Test K

TEST STEP	RESULT ▶	ACTION TO TAKE
K1 CHECK FOR POWER TO FUEL HEATER • With ignition switch in Run position, and fuel temperature below 5.5°C (42°F), check for power on BK wire at fuel heater. **NOTE: For these test procedures, if fuel temperature is above 5.5°C (42°F), disconnect leads at fuel heater temperature switch and connect a jumper wire between them.**	(OK) ▶ (OK) ▶	GO to K5. GO to K2.
K2 CHECK FOR POWER OUT OF FUEL HEATER RELAY • With ignition switch in Run position, check for power at fuel heater relay terminal with BK wire.	(OK) ▶ (OK) ▶	SERVICE open circuit in BK wire between fuel heater and fuel heater relay. REPEAT Test Step K1. GO to K3.
K3 CHECK FOR POWER TO FUEL HEATER RELAY • Remove connector from fuel heater relay. • Check for power on R wire. • With ignition switch in Run position, check for power on GY wire.	(OK) ▶ No power on R wire ▶ No power on GY wire ▶	LEAVE connector removed. GO to K4. REPAIR open circuit in R wire between relay and battery. CHECK system operation. REPAIR open circuit in GY wire between relay and ignition switch. CHECK system operation.

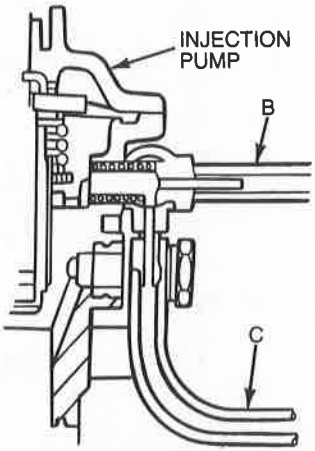
Fuel Heater Diagnosis — Pinpoint Test K

TEST STEP	RESULT ▶	ACTION TO TAKE
K4 CHECK RELAY GROUND CIRCUIT • Connect an ohmmeter between BK/Y wire and ground. Ohmmeter should indicate continuity.	OK ▶	REPLACE fuel heater relay. CHECK system operation.
	~~OK~~ ▶	SERVICE open circuit in BK/Y wire between fuel heater relay and starter motor. CHECK system operation.
K5 CHECK FUEL HEATER GROUND • Connect an ohmmeter between BR wire of fuel heater connector and ground, and check for continuity.	OK ▶	GO to **K6**.
	~~OK~~ ▶	SERVICE open circuit in BR wire between fuel heater and ground. CHECK system operation.
K6 CHECK CONTINUITY OF FUEL HEATER • Connect an ohmmeter to two terminals of fuel heater. Ohmmeter should indicate continuity.	OK ▶	If temperature switch was not jumpered in Test Step K1, system OK. If temperature switch was jumpered, GO to **K7**.
	~~OK~~ ▶	REPLACE fuel heater. CHECK system operation.
K7 CHECK CONTINUITY OF FUEL HEATER TEMPERATURE SWITCH • With temperature of fuel heater temperature switch below 5.5°C (42°F), check continuity of switch.	OK ▶	System OK.
	~~OK~~ ▶	REPLACE fuel heater temperature switch. CHECK system operation.

Altitude Control System Diagnosis — Pinpoint Test L

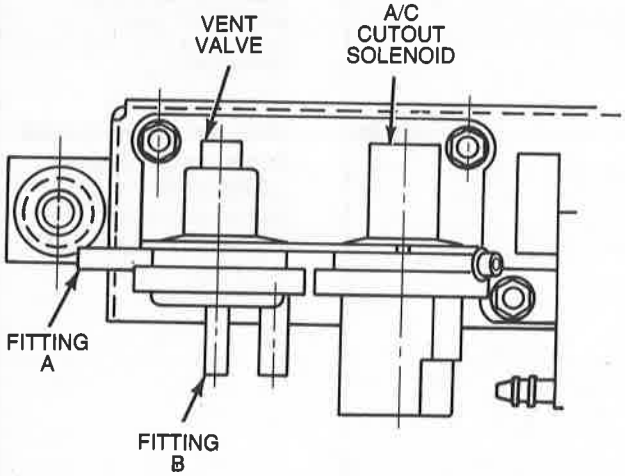
TEST STEP	RESULT ▶	ACTION TO TAKE
L1 CHECK SYSTEM VACUUM • Connect a 0-30 inch Hg vacuum gauge with a T-fitting between the aneroid (located on the cowl) and the aneroid vacuum line (connection A).  • Disconnect BR wire at EGR microswitch on injection pump. • Run engine at idle. • Refer to chart below for system vacuum reading specifications for certain altitudes. 33 to 39 kPa (9.6 to 11.6 inches Hg) at Sea Level 25 to 31 kPa (7.4 to 9.4 inches Hg) at 2000 feet 18 to 23 kPa (5.1 to 7.1 inches Hg) at 4000 feet 10 to 16 kPa (2.9 to 4.9 inches Hg) at 6000 feet 2 to 8 kPa (0.6 to 2.6 inches Hg) at 8000 feet	(OK) ▶ (OK) ▶	System OK. CONNECT BR wire at EGR microswitch. If vacuum reading is below specifications, LEAVE EGR microswitch disconnected. GO to L3. If above specifications, CONNECT BR wire to EGR microswitch. GO to L2.
L2 CHECK EGR MICROSWITCH • With engine running at idle, connect BR wire to EGR microswitch on injection pump and observe vacuum gauge. • Vacuum gauge should return to zero (0). **NOTE: Be sure injection pump lever is activating microswitch.**	(OK) ▶ (OK) ▶	System OK. GO to L8.
L3 CHECK FOR ORIFICE IN VACUUM LINE • Check that there is a 0.5mm orifice in the vacuum supply line located in the 4-way vacuum fitting near the vacuum pump.	(OK) ▶ (OK) ▶	REPLACE aneroid and REPEAT Test Step L1. REPLACE 4-way vacuum fitting with one containing a 0.5mm orifice.

Altitude Control System Diagnosis — Pinpoint Test L

TEST STEP	RESULT ▶	ACTION TO TAKE
L4 CHECK SYSTEM VACUUM SUPPLY • Remove vacuum hose from aneroid and connect the vacuum gauge to the hose. • Run engine at idle and check that vacuum is at least 54 kPa (16 inch Hg), with BR wire at EGR microswitch disconnected.	(OK) ▶	REPLACE aneroid. CONNECT BR wire at EGR microswitch. REPEAT Test Step **L4**.
	(OK) ▶	RECONNECT hoses. GO to **L5**.
L5 CHECK VACUUM PUMP • Connect vacuum gauge directly to the vacuum pump outlet. • Run engine at idle. • Vacuum should be a minimum of 54 kPa (16 inch Hg).	(OK) ▶	RECONNECT hoses Go to **L6**.
	(OK) ▶	REPLACE vacuum pump. REPEAT Test Step **L5**.
L6 CHECK VACUUM HOSES • Remove vacuum hose from injection pump at connection B and connect vacuum gauge to injection pump. • Run engine at idle. • Vacuum should be a minimum 54 kPa (16 inch Hg). 	(OK) ▶	REPAIR or REPLACE hose from injection pump to aneroid. REPEAT Test Step **L6**.
	(OK) ▶	REPAIR or REPLACE hose from injection pump to the vacuum pump as necessary. If no leak is found, GO to **L7**.

Altitude Control System Diagnosis

Pinpoint Test L

TEST STEP	RESULT ▶	ACTION TO TAKE
L7 CHECK INJECTION PUMP • Remove both vacuum hoses from injection pump at connections B and C. • Cap one hose fitting and connect a hand vacuum pump to the other fitting. • Pump hand vacuum pump to 34 kpa (10 in. Hg). • Vacuum should hold for 30 seconds.	(OK) ▶ (OK) ▶	System OK. RECONNECT all vacuum hoses. REPLACE injection pump. REPEAT Test Step L7.
L8 CHECK VENT VALVE • Connect Rotunda Vacuum Tester, 021-00014, or equivalent, to fitting A on vacuum vent valve. • Connect Rotunda Vacuum Gauge, 059,00008, or equivalent, with a T-fitting, to fitting B. • With engine idling, vacuum should be present on vacuum gauge at fitting B. • Apply a minimum of 34 kPa (10 in. Hg), with the hand vacuum pump at fitting A. • Vacuum gauge at fitting B should indicate zero (0). 	(OK) ▶ (OK) ▶	System OK. RECONNECT all vacuum hoses. REPLACE vent valve.

Electric Lift Pump Diagnosis — Pinpoint Test M

TEST STEP	RESULT ▶	ACTION TO TAKE
M1 CHECK FOR POWER TO LIFT PUMP • Disconnect electrical connector from lift pump. • Turn ignition switch to Run position. • Using a voltmeter, check for battery voltage on PK/BK H wire.	OK ▶	LEAVE connector disconnected. GO to **M6**.
	~~OK~~ ▶	GO to **M2**.
M2 CHECK FOR POWER AT RELAY • With ignition switch in Run position, check for power on PK/BK H wire at fuel pump relay.	OK ▶	SERVICE open circuit in PK/BK H wire between relay and lift pump. REPEAT Test Step **M1**.
	~~OK~~ ▶	GO to **M3**.
M3 CHECK FOR POWER TO RELAY • Disconnect electrical connector at fuel pump relay. • Using a voltmeter, check for power in Y wire.	OK ▶	LEAVE relay disconnected. GO to **M4**.
	~~OK~~ ▶	SERVICE open circuit in Y wire and/or fuse link between relay and starter relay. REINSTALL fuel pump relay connector. RETURN to Engine Performance Diagnosis. REPEAT Test Step **EPC.7A**. If pressure is still low, GO to **EPC.7B**.

Electric Lift Pump Diagnosis — Pinpoint Test M

TEST STEP	RESULT ▶	ACTION TO TAKE
M4 CHECK FOR POWER TO RELAY • With ignition switch in Run position, check for power in R/YH wire of relay connector.	(OK) ▶	LEAVE connector disconnected. GO to **M7**.
	(OK) ▶	RESET fuel pump inertia switch located on LH decklid hinge support in luggage compartment. REPEAT Test Step **M4**. If still not OK, GO to **M5**.
M5 CHECK INERTIA SWITCH • Disconnect electrical connector from fuel pump inertia switch. • With ignition switch in Run position, check for power in both R/YH wires. One wire should have power.	(OK) ▶	REPLACE inertia switch. REPEAT Test Step **M1**.
	(OK) ▶	SERVICE open circuit in R/YH wire between inertia switch and Fuse 18. REPEAT Test Step **M1**.

Electric Lift Pump Diagnosis

Pinpoint Test M

TEST STEP	RESULT ▶	ACTION TO TAKE
M6 CHECK FUEL PUMP GROUND • Connect an ohmmeter between BK wire on fuel pump connector and ground. • Ohmmeter should indicate continuity.	OK ▶	REPLACE electric lift pump. RETURN to Engine Performance Diagnosis. REPEAT Test Step **EPC.7A**. If pressure is still low, GO to **EPC.7B**.
	OK ▶	REPAIR open circuit in BK wire between lift pump and ground. RETURN to Engine Performance Diagnosis. REPEAT Test Step **EPC.7A**. If pressure is still too low, GO to **EPC.7B**.
M7 CHECK FUEL PUMP RELAY GROUND • Connect an ohmmeter between BK wire in fuel pump relay connector and ground. • Ohmmeter should indicate continuity.	OK ▶	REPLACE fuel pump relay. RETURN to Engine Performance Diagnosis. REPEAT Test Step **EPC.7A.**. If pressure is still low, GO to **EPC.7B**.
	OK ▶	REPAIR open circuit in BK wire between relay and ground. RETURN to Engine Performance Diagnosis. REPEAT Test Step **EPC.7A**. If pressure is still too low, GO to **EPC.7B**.

Injection Nozzle Testing

Where ideal conditions of good combustion, specified engine temperature control, and absolutely clean fuel prevail, nozzles require little attention. Nozzle trouble is usually indicated by one or more of the following symptoms:

- Smoky exhaust (black)
- Loss of power
- Misfiring
- Increased fuel consumption
- Combustion knock
- Engine overheating

When faulty nozzle operation is suspected on an engine that is misfiring or puffing black smoke, a simple test can be made to determine which cylinder(s) is causing the problem.

- Run the engine at the rpm which makes the problem most pronounced.
- Momentarily loosen the high pressure fuel inlet line connection on one nozzle assembly one half to one turn. Then, tighten connection to specification.
- Check each cylinder in the same manner.
- If one nozzle is found where loosening makes no difference in the misfiring, or the puffing black smoke stops, that nozzle should be tested.

After removing the nozzle(s) from the engine, the Injection Nozzle Test should be performed. This test will provide valuable information regarding the condition of the nozzle(s). A clean workbench, clean washing fluid containers, clean tools, and clean hands are all essential to produce satisfactory results.

NOTE: It is advisable to test the nozzles before cleaning them.

Injection Nozzle Testing

Figure 46 shows the Rotunda Injection Nozzle Tester, Model No. 014-00300, used for this test.

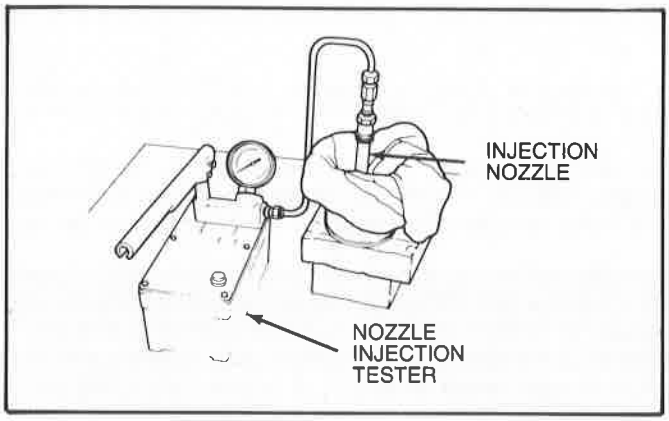


Figure 46 Injection Nozzle Tester

1. Prepare stand for making tests. Fill stand reservoir with clean Calibration Fluid. Open tester valve slightly and operate tester handle to expel air from tester and outlet pipe. Operate tester until solid fluid (without air bubbles) flows from end of outlet pipe. Close tester valve.
2. Connect injection nozzle to test stand. Care should be taken to avoid "cross-threading." Tighten connector nut securely with end wrench. The Nozzle Adapter which is supplied with tester has right hand thread to nozzle assembly and left hand thread to tester piping.
3. Bleed air from nozzle. Open stand valve and operate tester handle for several quick strokes to expel (bleed) air from injection nozzle. Fluid should spray from the spray holes in nozzle tip.

   WARNING: ALWAYS WEAR APPROVED SAFETY GLASSES WHEN OPERATING THE TESTER. VOLATILE LIQUIDS CAN BE EXTREMELY FLAMMABLE WHEN VAPORIZED. AVOID ANY CONDITIONS (SPARKS, OPEN FLAMES, LIT CIGARETTES, ETC.) WHICH MIGHT IGNITE THE FLUID USED DURING THE TEST PROCEDURE. THE ONLY LIQUID APPROVED FOR USE IN THIS TESTER IS SAE CALIBRATION NO. 208629, OR EQUIVALENT CALIBRATION FLUID (SAE J968D OR ISO 4113).

   WHEN A NOZZLE IS BEING TESTED OR IS IN OPERATION, KEEP HANDS AND OTHER PARTS OF THE BODY AWAY FROM THE SPRAYING NOZZLE. THE LIQUID SPRAY LEAVES THE NOZZLE TIP WITH SUFFICIENT FORCE TO PENETRATE THE SKIN AND CAUSE SERIOUS INJURY. THE NOZZLE TIP SHOULD BE ENCLOSED IN A TRANSPARENT RECEPTACLE IF AVAILABLE.
4. Check nozzle opening pressure. Open gauge valve and build up line pressure by slowly depressing handle until nozzle opens (sprays fuel). Observe gauge to determine pressure at which nozzle opens, then repeat operation until accurate opening pressure is established. Normal opening pressure of the nozzle is 1957-2291 psi (13,500-15,800 kPa).

   If opening pressure is not within specification, replace faulty injector nozzle.

   NOTE: Maximum difference between highest and lowest opening pressure should not exceed 1500 kPa (218 psi).

   NOTE: Chatter will vary from nozzle to nozzle as will the sound. While nozzle chatter is acceptable, a lack of chatter is not criteria for considering the nozzle to be defective.

Injection Nozzle Testing

5. Check to tip leakage. Wipe nozzle tip dry. Operate test pump to maintain pressure at 200 psi (1379 kPa) below opening pressure of the nozzle. Nozzle tip should remain dry without an accumulation of fuel drops at spray holes. A slight wetting after about 5 seconds is permissible if no droplets are formed.

   NOTE: Do not wipe tip with fingers as this will tend to draw the fuel present in the sac hole through the orifice and falsely indicate a leak, causing rejection of a good nozzle.

6. Check fuel leak-off. Operate test pump in quick strokes and observe flow of fluid from fuel return ports of nozzle. A very slight leak-off, one to two drops per stroke, is normal. If fluid squirts from fuel return port when test pump is operated, nozzle is faulty and must be replaced.

7. Check spray pattern. Operate test pump in smooth, even strokes and observe pattern of fluid spraying from nozzle tip. Only the first 76mm (3 inches) of spray from the end of the nozzle is important. The spray should be finely atomized in an even, straight pattern. The nozzle is defective if the spray pattern is lopsided (not concentric with nozzle axis) or uneven, or if fuel comes out in droplets or in a solid stream (Fig. 47). If nozzle fails spray pattern test, clean nozzle as described in Step 8 and repeat test.

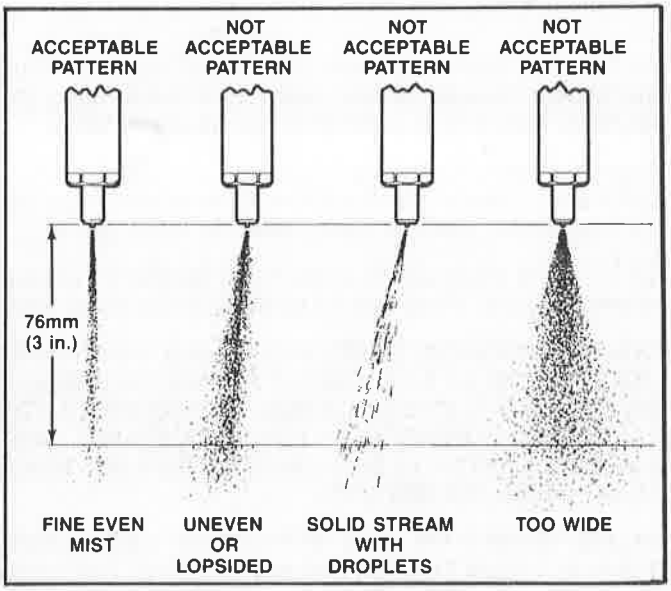


Figure 47 Injection Nozzle Spray Pattern

If nozzle passes the prior tests, it is suitable for further service in the engine following external cleaning and removal of accumulated carbon. Nozzles showing irregular spray pattern, leakage at nozzle tip spray holes, excessive fuel leak-off or opening pressure below minimum permissible limit should be replaced.

8. Clean nozzles. After testing, place nozzle(s) in a cold Rotunda Decarbonizing Solution, or equivalent, for one hour, or clean with an appropriate sonic cleaner and cleaning fluid. After removing nozzle(s) from the solution, clean accumulated carbon with a brass wire brush and scrapers from nozzle cleaning kit 014-00301 (Fig. 9). With carbon removed, wash off the outside surfaces of the nozzle(s). Wash protective caps and reinstall on nozzle ends.