SECTION 13

Fuel Delivery System

Contents

Description and Operation

ENGINE APPLICATIONS

All Engines

The Fuel Delivery System supplies fuel to the Fuel Injectors at a constant high pressure and in the correct volume for efficient combustion. Major components of the system include the Fuel Tank, connecting fuel lines, Fuel Pump, Fuel Filter, Pressure Regulator, Pressure Regulator Control Solenoid, Fuel Rail, Injectors, Fuel Pump Switch built into the Vane Air Flow (VAF) Meter, Fuel Pump Relay, and an Inertia Switch.

ECA Control of Air/Fuel Ratio

The Electronic Control Assembly (ECA) controls the rate of fuel injection in response to signals received from the driver controls and from sensors and switches which monitor engine conditions. The ECA adjusts the fuel rate for all operating modes including normal driving, acceleration, deceleration, engine overspeed fuel shut off, turbo overboost pressure relief, and A/C cut out during cranking.

Electric Fuel Pump

When the ignition is switched to the START position, the Fuel Pump Relay is energized and voltage is supplied to the Fuel Pump. The ECA regulates the duration of fuel injection. The Inertia Switch is a safety device which interrupts Fuel Pump voltage in the event of a collision. If the Inertia Switch is "tripped", it must be reset by depressing the button on top of the switch. The Inertia Switch is located under the load floor in the trunk of the vehicle.

Fuel Pump Relay

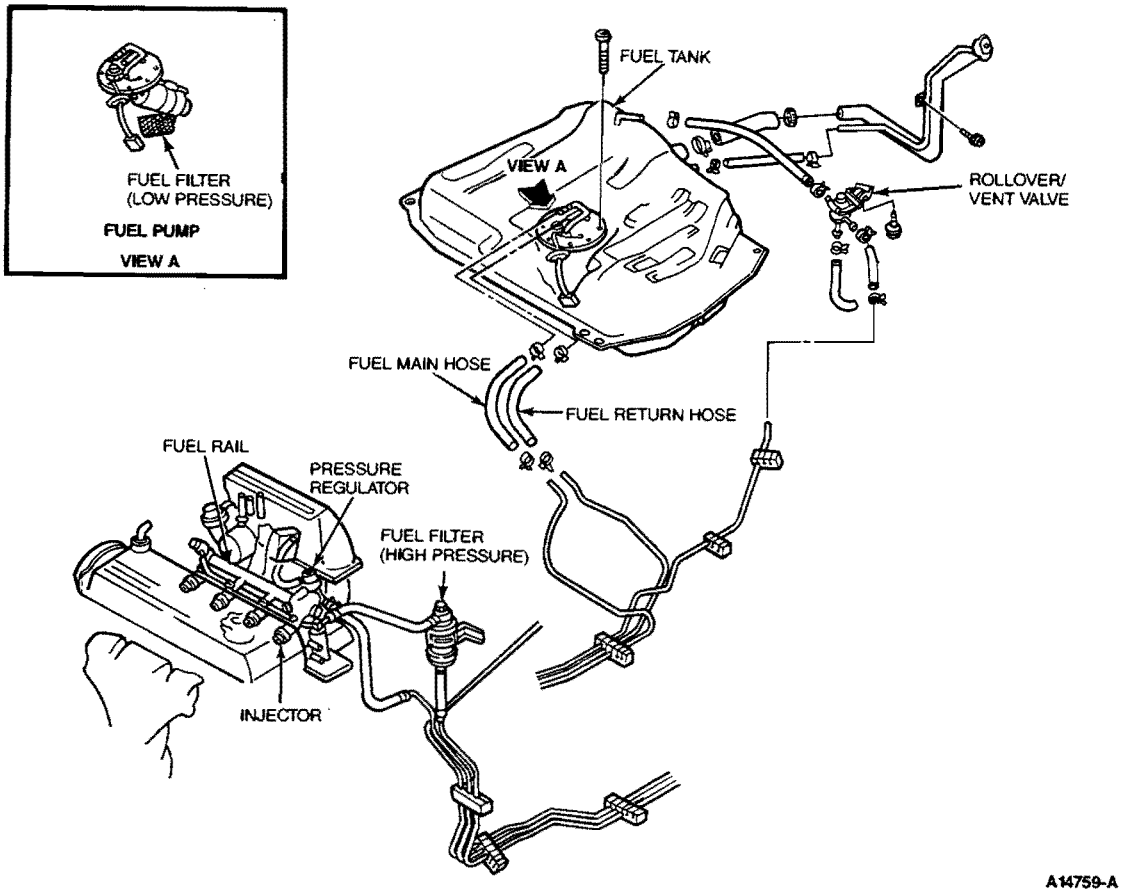
While cranking, Fuel Pump Circuit ground is provided at the Fuel Pump Relay to operate the Fuel Pump. After the engine starts, the Fuel Pump Circuit ground is provided through the Fuel Pump Switch located in the VAF Meter.

A resistor and a capacitor are built into the Fuel Pump Relay to permit discharge current to flow to the relay coil during rapid deceleration. This prevents the vehicle from stalling when the VAF Meter door closes suddenly, shutting off the Fuel Pump Switch.

All vehicles have a Fuel Pump Test Connector that will turn the Fuel Pump ON whenever the terminals are jumped together. The Fuel Pump Test Connector is located on the passenger side rear corner of the engine compartment.

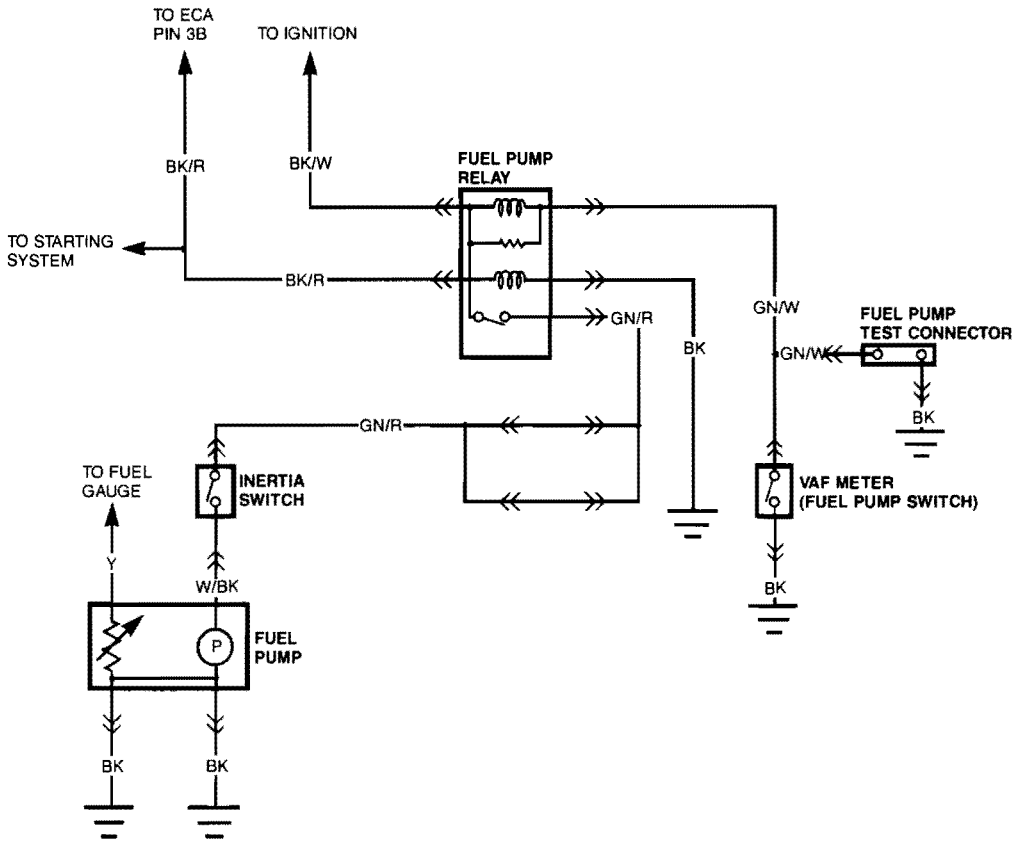
Description and Operation

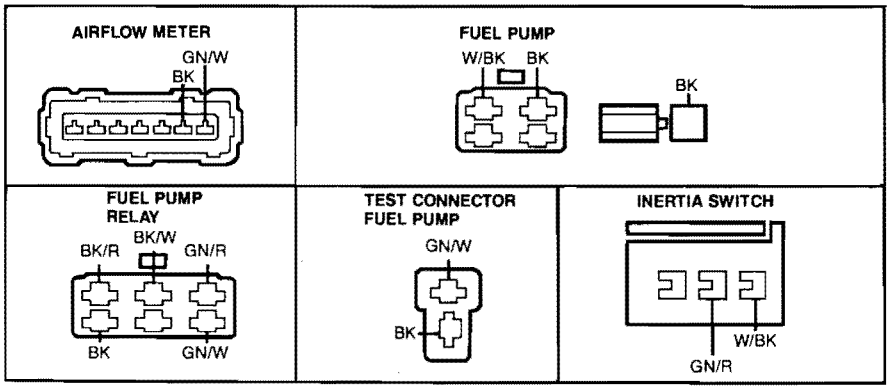
COMPONENT LOCATION



Description and Operation

ELECTRICAL SCHEMATIC





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Diagnosis and Testing

SYSTEM INSPECTION

1. Visually inspect the components of the Fuel Delivery System.

   Look for:

Electrical	Mechanical
• Discharged Battery • Damaged Connectors • Damaged Insulation • Blown Fuse(s) • "Tripped" Inertia Switch	• Loose, Leaking or Damaged Fuel or Vacuum Lines • Leaking Fuel Injectors • Poor Driveability Symptoms (rough idle, hard start, misses, surges, hesitation, backfires, etc.)

2. Check to see if the level of fuel in the fuel tank is sufficient.
3. Exercise the wiring and connectors for electrical components in the Fuel Delivery System to detect problem due to looseness, corrosion, or other damage. This must be done until the engine is fully warmed so as to activate the system controls.
4. If a component is suspected as the obvious cause of a malfunction, correct the cause before proceeding to the next step.
5. If all System Inspection checks are OK, proceed to Pinpoint Tests.

WARNING -INSTRUCTIONS

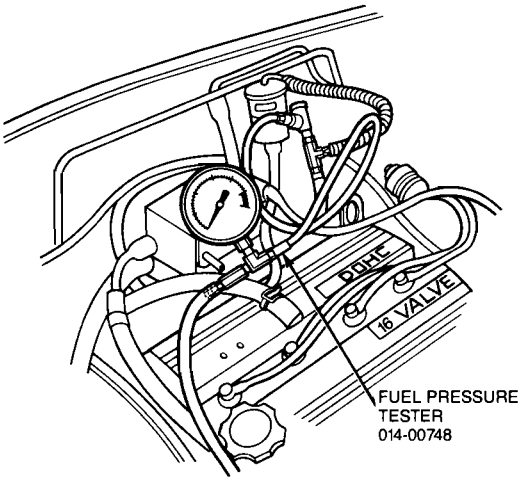
FUEL IN THE FUEL SYSTEM REMAINS UNDER HIGH PRESSURE EVEN WHEN THE ENGINE IS NOT RUNNING. TO AVOID INJURY OR FIRE, RELEASE THE FUEL PRESSURE FROM THE FUEL SYSTEM BEFORE DISCONNECTING ANY FUEL LINE. TO RELEASE THE PRESSURE FROM THE SYSTEM PERFORM THE FOLLOWING:

a. Start the engine.
b. Disconnect electrical connector to the VAF Meter (to stop fuel pump).
c. After the engine stalls, turn the ignition OFF.
d. Reconnect the VAF Meter.
e. Use a rag as protection from fuel spray when disconnecting the hoses. Plug the hoses after disconnection.

Diagnosis and Testing

All Engines

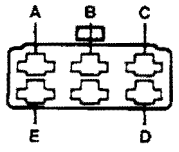
F

TEST STEP	RESULT ▶	ACTION TO TAKE
F0 FUEL PRESSURE TEST		
WARNING **BEFORE STARTING THESE TESTS, REDUCE THE RISK OF INJURY OR FIRE, AS OUTLINED IN "WARNING-INSTRUCTIONS".** • After releasing the fuel pressure as outlined on page 13-9, install the fuel pressure tester in the fuel line between the Fuel Filter and the Fuel Rail, with the tester main valve open and its drain valve closed. • Disable the ignition system by removing the ignition coil wire from the distributor cap and grounding the wire. • Jump Fuel Pump Test connector terminals together. • Crank engine for 3 seconds and turn the ignition key to RUN, to operate Fuel Pump. • **Is the fuel pressure within specifications? (refer to specifications, this Section).**  A14761-A	Yes ▶ No ▶	GO to **FD0**. If zero, GO to **FA0**. If low, GO to **FB0**. If high, GO to **FC0**.

Diagnosis and Testing

All Engines

FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA0 CHECK VOLTAGE TO FUEL PUMP RELAY		
• Disable starter motor by disconnecting black one-pin connector from starter motor. • Access Fuel Pump Relay. • Measure the following voltages at the Fuel Pump Relay: **Terminal / Key Pos. / Voltage** BK/W / RUN / Greater Than 10V BK/R / START / Greater Than 10V • **Are the voltages OK?**	Yes ▶ No ▶	GO to **FA1**. SERVICE wire in question.
FA1 CHECK FUEL PUMP RELAY		
• Key off. • Remove Fuel Pump Relay from vehicle. • Connect Terminals "A" and "B" to 12 volts. • Measure voltage at Terminal "C" under the following conditions: **TERMINAL "D" / TERMINAL "E" / VOLTAGE at "C"** Open / Open / Less Than 1V Grounded / Open / Less Than 1V Open / Grounded / Greater Than 10V Grounded / Grounded / Greater Than 10V  A14762-A	Yes ▶ No ▶	REINSTALL relay. GO to **FA2**. REPLACE Fuel Pump Relay.
FA2 CHECK FUEL PUMP RELAY GROUND		
• Key off. • Measure resistance of "BK" wire from Fuel Pump Relay and ground. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA3**. SERVICE "BK" wire for an open.

Diagnosis and Testing | All Engines | FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA3 CHECK VAF METER FUEL PUMP SWITCH GROUND		
• Key off. • Measure resistance of "BK" wire from VAF Meter to ground. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA4** . SERVICE "BK" wire for opens.
FA4 CHECK VAF METER FUEL PUMP SWITCH		
• Key off. • Disconnect VAF Meter. • Measure resistance between the indicated VAF Meter terminals under the following conditions: • **Are the resistances OK?**	Yes ▶ No ▶	GO to **FA5** . REPLACE VAF Meter.
FA5 CHECK VAF METER TO FUEL PUMP RELAY		
• Key off. • Measure resistance of "GN/W" wire between Fuel Pump Relay and VAF Meter. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA6** . SERVICE "GN/W" wire for open.
FA6 CHECK FUEL PUMP RELAY TO INERTIA SWITCH		
• Key off. • Measure resistance of "GN/R" wire between the Fuel Pump Relay and the Inertia Switch. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA7** . SERVICE "GN/R" for an open.
FA7 CHECK INERTIA SWITCH TO FUEL PUMP		
• Key off. • Measure resistance of "W/BK" wire between the Inertia Switch and ground. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA8** . SERVICE "W/BK" wire for an open.

VANE DOOR	RESISTANCE
Open	Less Than 5 ohms
Closed	Greater Than 10,000 ohms

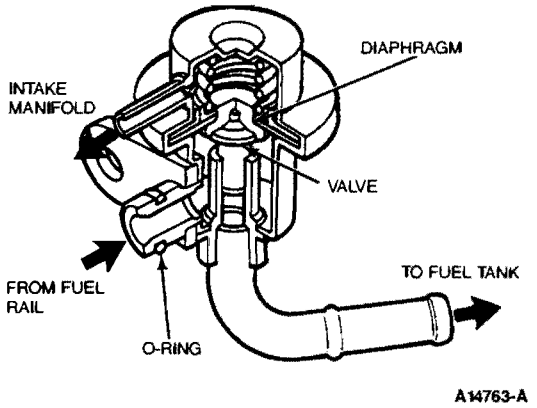
Diagnosis and Testing | All Engines | FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA8 CHECK FUEL PUMP GROUND		
• Key off • Measure resistance of "BK" wire between the Fuel Pump and ground. • **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **FA9** . SERVICE "BK" wire for an open.
FA9 CHECK INERTIA SWITCH		
• Key off. • Disconnect and remove Inertia Switch from vehicle. • Sharply shake the Inertia Switch to verify that the switch "trips". • Measure resistance between the indicated terminals of the Inertia Switch under the following conditions: **SWITCH POSITION** / **RESISTANCE** Open ("tripped") / Greater Than 10,000 ohms Closed (set) / Less Than 5 ohms • **Are the resistances OK and does the switch "trip" when shaken sharply?**	Yes ▶ No ▶	REINSTALL Inertia Switch and reset. REPLACE Fuel Pump. REPLACE Inertia Switch.

Diagnosis and Testing | All Engines | FB

TEST STEP	RESULT ▶	ACTION TO TAKE
FB0 FUEL FILTER (UNDER HOOD) CONDITION CHECK		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Remove the Fuel Filter (under hood) from the vehicle for inspection. • Inspect the Filter for contamination, blockage or any other obvious signs of damage. • Compare the customer's service record and driving conditions as compared to the recommended maintenance schedule. • **Is the Fuel Filter free of contamination, blockage or other damage, and within recommended maintenance schedule replacement interval?**	Yes ▶ No ▶	GO to FB1 . REPLACE the Fuel Filter and RERUN Test F0 .
FB1 FUEL PRESSURE REGULATOR DIAPHRAGM CONDITION CHECK		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Install the fuel pressure tester in the fuel line between the fuel filter and fuel rail, with its main valve open and its drain valve closed. • Start engine and run for 10 seconds. • Stop engine and wait 10 seconds. • Start engine and run for 10 seconds. • Stop engine and remove vacuum hose from the Pressure Regulator. • Examine the vacuum port in the Pressure Regulator for evidence of fuel leakage through the diaphragm. • **Is the vacuum port free of any fuel or other contamination?**	Yes ▶ No ▶	GO to FB2 . REPLACE the Fuel Pressure Regulator and RERUN Test F0 .

Diagnosis and Testing	All Engines	FB

TEST STEP	RESULT ▶	ACTION TO TAKE
FB2 PRESSURE REGULATOR FUEL PRESSURE LEAKDOWN		
• With the fuel pressure tester still installed on the engine from Test Step **FB1**, run the engine for 30 seconds. • Stop the engine and observe the fuel pressure for a minimum of 60 seconds. • **Is the fuel pressure leakdown rate less than 34 kPa (5 psi) after 60 seconds?**	Yes ▶ No ▶	GO to **FB3**. REPEAT this test step. If fuel pressure still drops more than the specified maximum, REPLACE the Fuel Pressure Regulator and RERUN Test **F0**.
FB3 PRESSURE REGULATOR VALVE SEAT LEAKAGE CHECK		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Remove Fuel Pressure Regulator from vehicle. • Check the O-ring, gasket, and mounting surfaces for any damage or defects that may affect sealing. • Connect a vacuum tester to the fuel return tube and apply a 20 in – Hg of vacuum. • Observe the vacuum gauge for at least 10 seconds. • **Does the vacuum drop less than 10 in – Hg in 10 seconds?**  	Yes ▶ No ▶	GO to **FB4**. REPLACE the Fuel Pressure Regulator and RERUN Test **F0**.

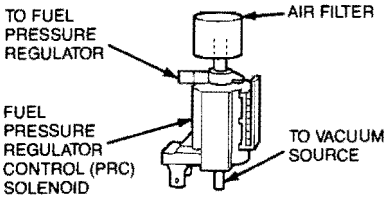
Diagnosis and Testing | All Engines | FB

TEST STEP	RESULT ▶	ACTION TO TAKE
FB4 FUEL PUMP FLOW VOLUME		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Install the fuel pressure tester in the fuel line between the fuel filter and fuel rail, with its main valve closed and its drain valve open. • Place the by-pass (yellow) hose in a measuring vessel inside an empty overflow vessel. • Disable the ignition system by removing the ignition coil wire from the distributor cap and grounding the wire. • Jump the Fuel Pump test connector terminals together. • Crank the engine for 3 seconds and allow the key to return to RUN position. This will allow the Fuel Pump to operate. • Collect fuel in the measuring vessel for 10 seconds. • **Is the Fuel Pump output within the specifications listed in this Section?**	Yes ▶ No ▶	GO to **FB5** . SERVICE the Fuel Pump Inlet Screen and RERUN this Test. If the fuel flow is still not within specified limits, REPLACE the Fuel Pump and RERUN Test **F0** .
FB5 FUEL PUMP CHECK VALVE LEAKDOWN CHECK		
• Observe **WARNING — INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Connect the fuel pressure tester between the fuel filter and the fuel rail with both the main and drain valves closed. • Disable the ignition system by removing the ignition coil wire from the distributor cap and grounding the wire. • Jump the Fuel Pump test connector terminals together. • Crank the engine for 3 seconds and allow the key to return to RUN position. This will allow the Fuel Pump to operate. • Run the Fuel Pump for at least 30 seconds. • Shut off fuel pump by removing jumper wire and observe fuel pressure on the gauge for 3 minutes. • **Is the Fuel Pump Check Valve leakage rate less than 2 psi in 3 minutes?**	Yes ▶ No ▶	GO to **FD0** . REPLACE the CHECK Valve and RERUN Test **F0** .

Diagnosis and Testing	All Engines	FC

TEST STEP	RESULT ▶	ACTION TO TAKE
FC0 FUEL PRESSURE REGULATOR CHECK FOR CAUSE OF HIGH PRESSURE		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Check leaks in the engine vacuum system due to loose or mis-threaded fittings, cracks, or blockages that could cause insufficient vacuum to properly control the Fuel Pressure Regulator. • Check the Fuel Pressure Regulator housing for damage or dents that could cause a higher spring load on the Pressure Regulator diaphragm. • Check the integrity of the Pressure Regulator diaphragm as described in Test Step **FB1** . • **Is the fuel system free of defects that could cause the Pressure Regulator to produce excessive fuel pressure (Refer to Fuel Pressure Specification in this section)?**	Yes ▶ No ▶	REPLACE the Fuel Pressure Regulator and RERUN Test Step **F0** . If fuel pressure is still high, GO to **FC1** . SERVICE damaged components as required and RERUN Test Step **F0** . If fuel pressure is still high, GO to **FC1** .
FC1 FUEL RETURN LINE CHECK FOR CAUSE OF HIGH FUEL PRESSURE		
• Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Remove the fuel return line at the Pressure Regulator and at the Fuel Tank. • Place a suitable fuel receptacle at the tank end of the fuel return line to avoid fuel spillage. • Check the fuel return line for blockage, kinking, pinching, or any other restriction by blowing through the line with shop air regulated to 5-10 psi. • **Is the fuel return line free of any restriction that could cause excessive fuel pressure?**	Yes ▶ No ▶	GO to **FC2** . SERVICE damaged components as required to remove the causes of high pressure. RERUN Test **F0** .

Diagnosis and Testing | All Engines | FC

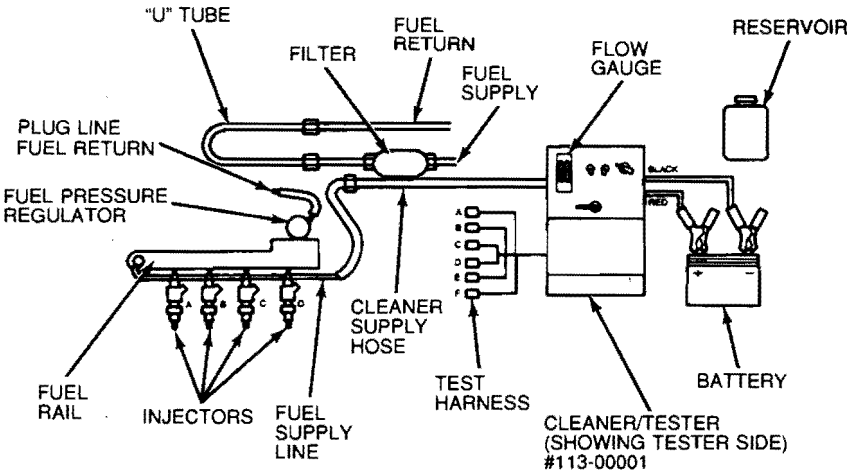
TEST STEP	RESULT ▶	ACTION TO TAKE
FC2 PRESSURE REGULATOR CONTROL (PRC) VALVE VISUAL CHECK		
• Visually Inspect the PRC Valve, vacuum hoses, and electrical connectors for signs of obvious damage. • **Are there any visible defects?**  	Yes ▶	SERVICE the PRC Valve System as required. RERUN Test Step [F0] . If fuel pressure is still high, GO to Section 16, Pinpoint Tests.
	No ▶	GO to Section 16, Pinpoint Tests.

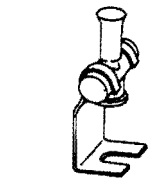
Diagnosis and Testing | All Engines | FD

TEST STEP	RESULT ▶	ACTION TO TAKE
FD0 FUEL INJECTION FUNCTION CHECK • With the engine warmed and idling (or cranking if engine does not start), use a mechanic's stethoscope or equivalent to listen for regularly spaced operating sounds at each fuel injector. • **Is operating sound present?**	Yes ▶ No ▶	GO to FD3 . GO to FD1 .
FD1 FUEL INJECTOR RESISTANCE CHECK • Observe **WARNING-INSTRUCTIONS** on page 13-5 to avoid fuel spillage and injury. • Remove the Fuel Injectors from the engine (if required). • With a DVOM, measure the resistance of each injector. Refer to specifications in this section. • **Are all the injector resistances within specification?**	Yes ▶ No ▶	GO to FD2 . REPLACE the damaged Injectors. RERUN Test Step FD0 and if OK, GO to FD3 .
FD2 FUEL INJECTOR ELECTRICAL SIGNAL CHECK • Check for continuity of Injector harness between each Injector and the ECA as follows: • Disconnect the Injector lead and insert the continuity checker from the Fuel Injector Tester/ Cleaner (or a 12 volt test lamp) into the Injector lead connector. • Start the engine. • Observe whether the continuity checker (or test lamp) blinks-indicating continuity of the Injector circuit being tested. • Repeat this check for each Injector. • **Do all Injector Circuit leads show continuity?**	Yes ▶ No ▶	GO to FD3 . SERVICE Injector leads as required. REFER to Quick Test, Section 15 of this manual.

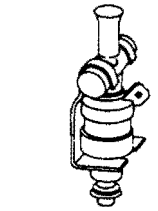
Diagnosis and Testing | All Engines | FD

TEST STEP	RESULT ▶	ACTION TO TAKE
FD3 FUEL INJECTOR CLEANING AND LEAKAGE CHECK		
• Observe **WARNING-INSTRUCTIONS** page 13-5 to avoid fuel spillage and injury. • Using the Fuel Injector Tester/Cleaner and instructions provided with the Tester/Cleaner, clean the Fuel Injectors. • With the Tester/Cleaner still installed, note any significant pressure loss due to Injector leakage when the tester pump is turned off. • Check the Fuel Injectors individually for leakage using the injector bench fixture and the fuel injector bench testing procedure associated with the Tester/Cleaner and verify that injector leakage rate is within the 1 drop per minute maximum specification. • **Is the leakage rate for individual Injectors within specification?**	Yes ▶ No ▶	RETURN to Diagnostic Routines, Section 2. REPLACE damaged Fuel Injectors as required.





INJECTOR BENCH TEST FIXTURE



INJECTOR SHOWN IN BENCH TEST FIXTURE

A14047-B

Specifications/Special Service Tools

SPECIFICATIONS

DESCRIPTION	SPECIFICATION		
	kPa	kg/cm2	psi
Fuel Pump Outlet Pressure	441-588	4.5-6.0	64-85
Fuel Injection Pressure (Engine Running)	196-216	2.5-2.85	37-41
Fuel Pump Volume	220-380cc (13.4-23.2 cu. in.)/10 seconds		
Fuel Pump Check Valve Leakage	2 psi maximum in 3 minutes		
Fuel Injector Leakage	1 drop maximum per minute		
Fuel Injector Resistance	12-16 ohms		
Fuel Pressure Regulator Pressure Leakdown	34 kPa (5 psi) maximum in 60 seconds		
Fuel Pressure Regulator Vacuum Leakage at Valve Seat	10 in-Hg maximum/10 seconds when starting with 20 in-Hg		

SPECIAL SERVICE TOOLS

ROTUNDA NUMBER	DESCRIPTION
014-00748	Fuel Pressure Testing Kit
007-00001	Digital Volt-Ohmmeter
021-00037	Vacuum Tester
059-00009	Vacuum/Pressure Tester
113-00001	Fuel Injector Tester/Cleaner