

FUEL DELIVERY

SECTION 9

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FUEL DELIVERY

FUEL DELIVERY SYSTEM

BASIC OPERATION

The fuel delivery system supplies fuel to the fuel injectors at a constant pressure and in the correct volume for efficient combustion. Major components of the system include.

- Fuel Tank
- Fuel Lines
- Fuel Pump
- Fuel Filter
- Fuel Pressure regulator
- Fuel Rail
- Fuel Injectors
- Fuel Pump Relay
- Inertia Fuel Shutoff Switch
- Fuel Pump Switch

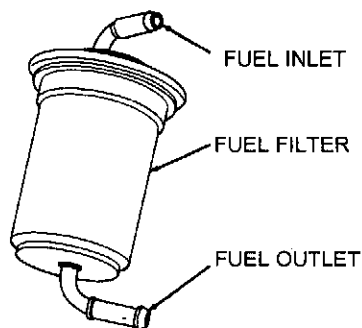
POWERTRAIN CONTROL MODULE (PCM) CONTROL OF AIR/FUEL RATIO

The Powertrain Control Module (PCM) controls the rate of fuel injection in response to the signals received from the operator controls and from the sensors and switches which monitor the engine conditions. It adjust the fuel delivery rate for all major operating modes including.

- Normal Driving
- Cold Engine Start-up
- Acceleration
- Deceleration
- Transaxle Shift (CD4E and 4EAT only)
- Engine Overspeed Shutoff
- A/C Cutout during Cranking

FUEL FILTER

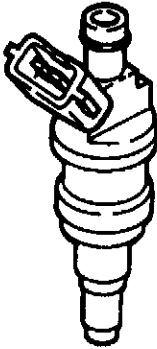
The fuel filter strains particles from the fuel through a paper element. This filtration process removes solid particles from the fuel that may clog the small orifices inside the fuel injectors. It is mounted near the LH front strut tower.



FUEL DELIVERY

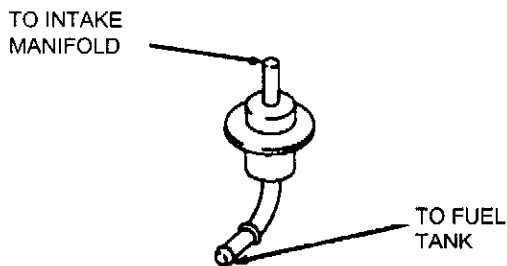
FUEL INJECTOR

The Fuel Injectors (INJ) are solenoid operated needle valves that control fuel flow into the engine. The injector valve body consists of a solenoid actuated pintle or needle valve assembly that sits on a fixed orifice. The fuel pressure, maintained by a fuel pressure regulator is variable depending on intake manifold vacuum. Fuel flow to the engine is regulated by how long the injectors are activated by the Powertrain Control Module (PCM) and by fuel pressure. The 1.3L engine uses top feed injectors.



FUEL PRESSURE REGULATOR

The fuel pressure regulator adjusts the amount of fuel pressure supplied to the injectors. The fuel pressure regulator is controlled by a vacuum actuated diaphragm inside the regulator. The diaphragm vacuum is supplied by the Fuel Pressure Control (FPRC) solenoid, except on the 1.3L engine which supplies vacuum directly from the intake manifold.

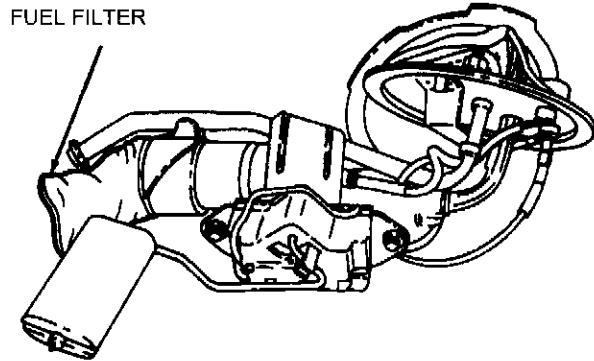


ENGINE	LOCATION
1.3L.	Mounted to the end of the fuel rail on the LH side of the engine.

FUEL DELIVERY

FUEL PUMP

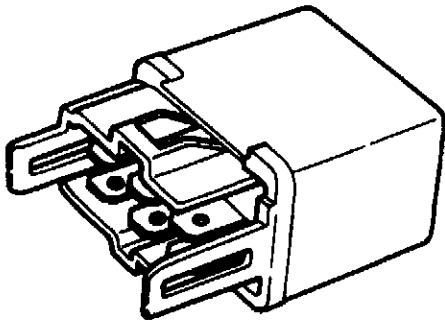
The Fuel Pump (FP) filters the solid particles from the fuel and causes pressure which allows the fuel to be transmitted from the fuel tank to the engine. the fuel pump is driven by an internal motor, which creates pressure in the fuel lines. the fuel pump circuit ground is controlled by the Powertrain Control Module (PCM) to operate the fuel pump.



ENGINE	LOCATION
1.3L.	Located in the fuel tank.

FUEL PUMP RELAY

The Fuel Pump Relay (FPR) supplies voltage to the fuel pump when activated. When the ignition is switched into the on or start position, power is supplied to the FPR and to the Powertrain Control Module (PCM). The FPR is controlled by the PCM, which grounds the relay to activate it while the engine is cranking and running.



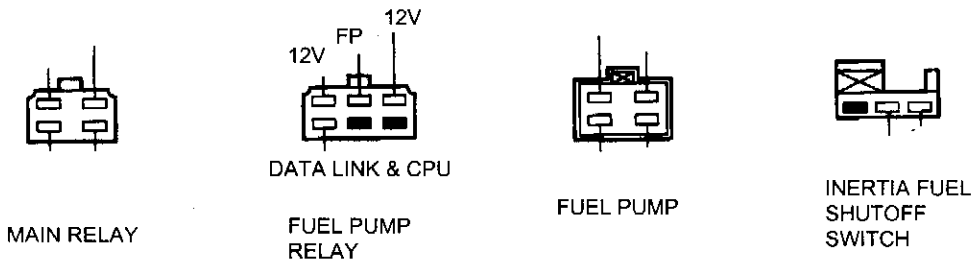
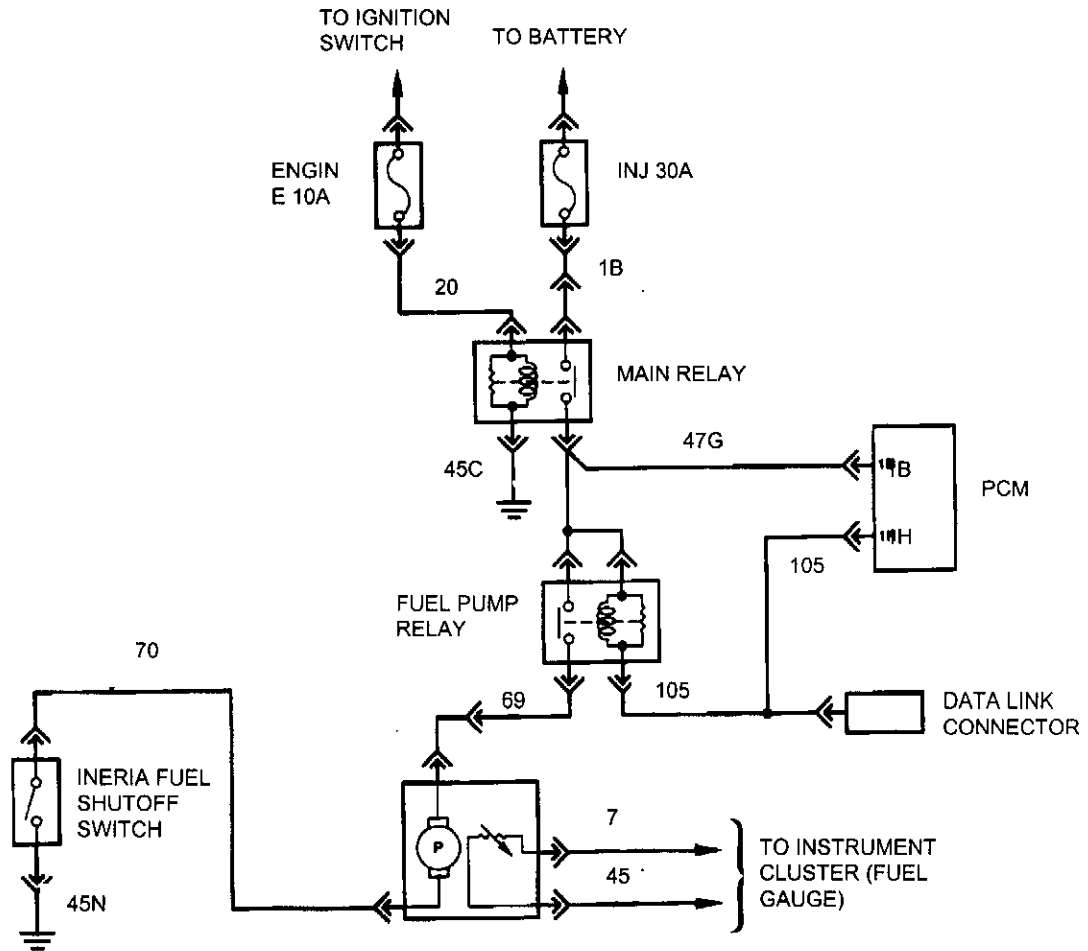
ENGINE	LOCATION
1.3L.	Located under the LH side of the instrument panel.

FUEL DELIVERY

DIAGNOSIS AND TESTING

FUEL DELIVERY SYSTEMS

Electrical Schematic



FUEL DELIVERY

SYSTEM INSPECTION

- 1) Visually inspect the components of the fuel delivery system.

Visual Inspection Chart

MECHANICAL	ELECTRICAL
<ul style="list-style-type: none"> - Loose, leaking or damaged fuel or vacuum lines. - Leaking fuel injectors. - Adverse drivability symptoms, such as rough idle, hard to start, misses, surges, hesitates, backfires - Insufficient fuel in fuel tank. 	<ul style="list-style-type: none"> - Discharged battery. - Damaged connector. - Damaged insulation. - Damaged components in the fuel system. - Fuse integrity. - Tripped inertia fuel shutoff switch.

- 2) Exercise the wiring and connectors for the solenoids and other electrical components for obvious problems due to looseness, corrosion or other damage.
- 3) If a component is suspected as the obvious cause of a malfunction, correct the cause before proceeding to the next step.
- 4) If all systems inspection checks are okay, proceed to the Pinpoint Tests.

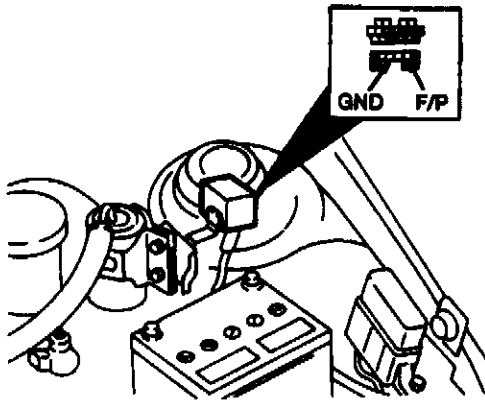
Warning; Fuel in the fuel system remains under high pressure even when the engine is not running. To avoid injury or fire, release the fuel pressure from the fuel system before disconnecting any fuel line. To release the pressure from the system follow these steps;

- a) Start the engine.
- b) To stop the fuel pump, disconnect the fuel pump relay found under the LH side of the instrument panel.
- c) After the engine stalls, turn off the ignition.
- d) Install the fuel pump relay.
- e) Using a rag as protection disconnect the fuel hoses. Plug the hoses after disconnection.
- f) Before testing or starting the vehicle , prime the system by grounding the fuel pump test pin and turning the key on for 10 seconds.
- g) Check for fuel leaks.
- h) Turn key off and remove ground.

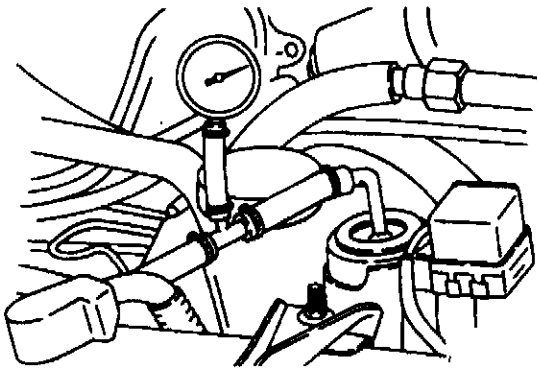
TEST STEP	RESULT	ACTION TO TAKE
<p>F1 PERFORM FUEL PRESSURE TEST</p> <p>Warning; Before starting these tests, release the fuel pressure from the fuel system to reduce the risk of injury or fire as outlined in “warning instructions”.</p> <ul style="list-style-type: none"> - After releasing the fuel pressure as outlined in System Inspection, install Rotunda Fuel Pressure Tester or equivalent with EFI Test Adapter in the fuel line between the fuel filter and the fuel rail with its main valve open and its drain valve closed. refer to illustration . - Jump the fuel pump test terminal to ground. - Key on. - Is the fuel pressure within specification (refer to specifications this section)? 	<p>YES</p> <p>NO (If zero) (If low) (If high)</p>	<p>Go to FD1.</p> <p>Go to FA1.</p> <p>Go to FB1.</p> <p>Go to FC1.</p>

FUEL DELIVERY

FUEL PUMP CONNECTOR



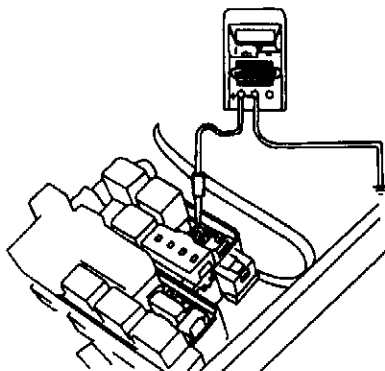
FUEL PRESSURE TEST SETUP



TEST STEP	RESULT	ACTION TO TAKE
FA1 CHECK FUEL PUMP MOTOR <ul style="list-style-type: none">- Relieve the fuel pressure; follow the procedures as outlined in Warning Instructions in System Inspection at the beginning of the Diagnosis Testing and Procedures.- Connect Rotunda Fuel Pressure Tester or equivalent to the fuel filter with main valve closed and drain valve closed. Refer to illustrations in Test Step F1.- Jump the fuel pump test terminal to ground. Refer to illustrations in Test Step F1 for terminal locations.- Key on.- Is the maximum fuel pressure within specifications (refer to Specifications in this section)?	YES NO	Go to FA2. Replace the fuel pump.

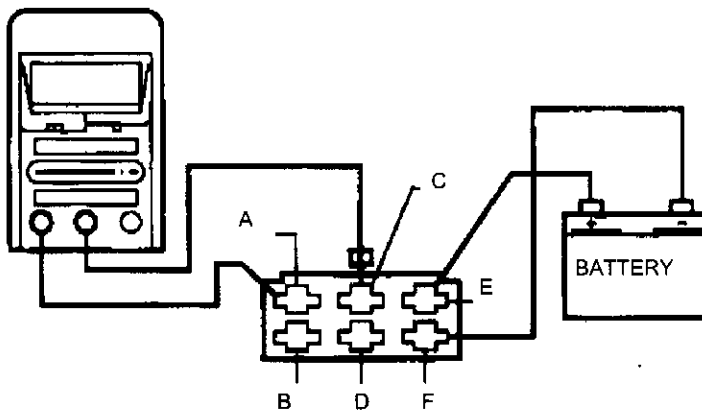
FUEL DELIVERY

<p>FA2 CHECK VOLTAGE TO FUEL PUMP</p> <ul style="list-style-type: none"> - Key off. - Jump the fuel pump test terminal to ground. Refer to illustration in Test Step F1 for terminal locations. - Disconnect the fuel pump connector at the fuel pump assembly. - Key on. - Measure the voltage on the following wires at the fuel pump connector. <table border="0"> <tr> <td>Engine</td> <td>Wire #</td> </tr> <tr> <td>1.3L.</td> <td>69</td> </tr> </table> <p>- Is the voltage between 10-14 volts? Note; Check inertia fuel shutoff switch for tripped condition. result if tripped.</p>	Engine	Wire #	1.3L.	69	<p>YES</p> <p>NO</p>	<p>Go to FA14.</p> <p>Go to FA3.</p>								
Engine	Wire #													
1.3L.	69													
<p>FA3 CHECK FOR SHORT(S) TO GROUND</p> <ul style="list-style-type: none"> - Key off. - Disconnect the fuel pump relay. - Disconnect the Powertrain Control Module (PCM) on 1.3L. - Disconnect the fuel pump connector at the fuel pump assembly. - Measure the resistance between the following wires at the fuel pump relay connector and ground. <table border="0"> <tr> <td>Engine</td> <td>Wire #</td> </tr> <tr> <td>1.3L.</td> <td>69, 105</td> </tr> </table> <p>- Are the reistances greater than 10,000 ohms?</p>	Engine	Wire #	1.3L.	69, 105	<p>YES</p> <p>NO</p>	<p>Go to FA4.</p> <p>Service the wire(s) in question for short.</p>								
Engine	Wire #													
1.3L.	69, 105													
<p>FA4 CHECK POWER SUPPLY TO FUEL PUMP RELAY</p> <ul style="list-style-type: none"> - Key off. - Disconnect the fuel pump relay. - Key on. - Measure the voltage on the following wires at the fuel pump relay connector. <table border="0"> <tr> <td>Engine</td> <td>Wire #</td> <td>Key</td> <td>Voltage</td> </tr> <tr> <td>1.3L.</td> <td>110</td> <td>ON</td> <td>10-14 volts</td> </tr> <tr> <td></td> <td>110</td> <td>ON</td> <td>10-14 volts</td> </tr> </table> <p>- Is the voltage approximately battery voltage?</p>	Engine	Wire #	Key	Voltage	1.3L.	110	ON	10-14 volts		110	ON	10-14 volts	<p>YES</p> <p>No</p>	<p>Go to FA5.</p> <p>Go to Pinpoint Test VPWR in EEC Pinpoint Test, Section 6. If VPWR is okay, service wire(s) for open(s).</p>
Engine	Wire #	Key	Voltage											
1.3L.	110	ON	10-14 volts											
	110	ON	10-14 volts											



FUEL DELIVERY

<p>FA5 CHECK FUEL PUMP RELAY</p> <ul style="list-style-type: none"> - Key off. - Remove the fuel pump relay. - Apply 12 volt across the following terminals on the fuel pump relay. - Follow the chart below and measure the resistance between the C-terminal and the A-terminal. <table border="0"> <tr> <td>Engine</td> <td>Terminals E & F</td> <td>Resistance at C & A</td> </tr> <tr> <td>1.3L.</td> <td>12 volts applied</td> <td>Less than 5 ohms</td> </tr> <tr> <td></td> <td>0 volts applied</td> <td>Greater than 10,000 ohms</td> </tr> </table> <ul style="list-style-type: none"> - Are the resistance's reading okay? 	Engine	Terminals E & F	Resistance at C & A	1.3L.	12 volts applied	Less than 5 ohms		0 volts applied	Greater than 10,000 ohms	<p>YES</p> <p>NO</p>	<p>Go to FA6.</p> <p>Replace the fuel pump relay.</p>
Engine	Terminals E & F	Resistance at C & A									
1.3L.	12 volts applied	Less than 5 ohms									
	0 volts applied	Greater than 10,000 ohms									



<p>FA6 CHECK FUEL PUMP RELAY TO PCM CONTINUITY</p> <ul style="list-style-type: none"> - Key off. - Remove the fuel pump relay. - Disconnect the Powertrain Control Module (PCM). - Install the Rotunda Breakout Box or equivalent. - Measure the resistance of the following wires between the fuel pump relay and the PCM. <p>Engine 1.3L.</p> <p>PCM Pin - 1H BOB Pin - 55 PCM Wire # - 105 Fuel Pump Relay Wire # - 105</p>	<p>YES</p> <p>NO</p>	<p>Service the GN/Y wire between the fuel pump relay and the fuel pump.</p> <p>Service the wire(s) in question for open.</p>
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FUEL DELIVERY

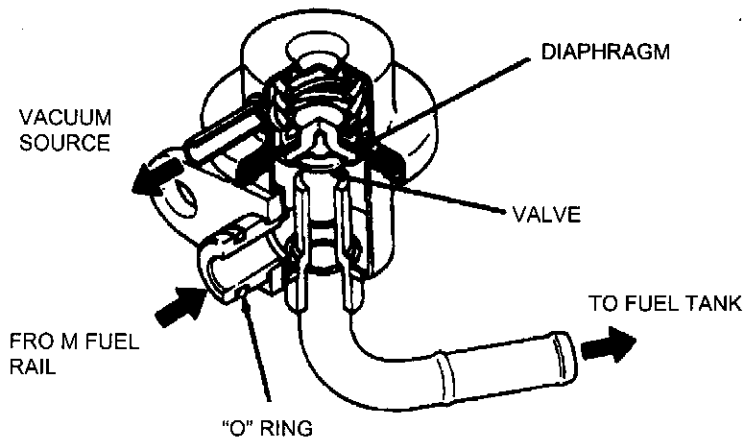
FA7 CHECK INERTIA FUEL SHUTOFF SWITCH <ul style="list-style-type: none">- Key off.- Disconnect and remove the inertia fuel shut off switch from the vehicle.- Shake the inertia fuel shut off switch sharply to verify the switch trips.- Measure the resistance between the indicated terminals of the inertia fuel shutoff switch under the following conditions. Resistance Check Points <p>Between the switch terminals that connect to the #70 and #45N wires.</p> <table><thead><tr><th>Switch Position</th><th>Resistance</th></tr></thead><tbody><tr><td>Open (tripped)</td><td>Greater than 10,000 ohms</td></tr><tr><td>Closed (set)</td><td>Less than 5 ohms</td></tr></tbody></table> <ul style="list-style-type: none">- Are the resistances okay and does the inertia fuel shutoff switch trip when shaken sharply?	Switch Position	Resistance	Open (tripped)	Greater than 10,000 ohms	Closed (set)	Less than 5 ohms	YES NO	Go to FA8. Replace the inertia fuel shutoff switch.
Switch Position	Resistance							
Open (tripped)	Greater than 10,000 ohms							
Closed (set)	Less than 5 ohms							
FA8 CHECK INERTIA FUEL SHUTOFF SWITCH GROUND <ul style="list-style-type: none">-Key off.- Disconnect the inertia fuel shutoff switch connector.- Measure the resistance between the inertia fuel shutoff switch connector and ground. <table><thead><tr><th>Engine</th><th>Wire #</th><th>Resistance (ohms)</th></tr></thead><tbody><tr><td>1.3L.</td><td>45N</td><td>Less than 5</td></tr></tbody></table>	Engine	Wire #	Resistance (ohms)	1.3L.	45N	Less than 5	YES NO	Go to FB2. Service the BK wire.
Engine	Wire #	Resistance (ohms)						
1.3L.	45N	Less than 5						

FUEL DELIVERY

<p>FB1 CHECK POWER SUPPLY TO FUEL PUMP</p> <ul style="list-style-type: none"> - Key off. - Disconnect the fuel pump connector at the fuel pump assembly. - Jump the fuel pump test terminal to ground. Refer to illustration in Test Step F1 for terminal locations. - Key on. - Measure the voltage on the following wires at the fuel pump connector. <table border="0"> <tr> <td>Engine</td> <td>Wire Colour</td> </tr> <tr> <td>1.3L.</td> <td>GN/Y</td> </tr> </table>	Engine	Wire Colour	1.3L.	GN/Y	<p>YES</p> <p>NO</p>	<p>Go to FB2.</p> <p>Go to FA1.</p>
Engine	Wire Colour					
1.3L.	GN/Y					
<p>FB2 CHECK IN-LINE FUEL FILTER CONDITION</p> <ul style="list-style-type: none"> - Observe Warning Instructions in System Inspection at the beginning of the Diagnosis and Testing procedures to release the fuel system pressure to avoid fuel spillage and injury. - Remove the high pressure in-line fuel filter for inspection. - Inspect the filter element for contamination or blockage. - Compare the customer service record and driving conditions versus the recommended maintenance schedule. - Is the fuel filter free of contamination, blockage and within the recommended maintenance schedule? 	<p>YES</p> <p>NO</p>	<p>Go to FB3.</p> <p>Service the fuel filter as required. Rerun Test F1.</p>				
<p>FB3 CHECK FUEL PRESSURE REGULATOR DIAPHRAGM CONDITION</p> <ul style="list-style-type: none"> - Observe Warning Instructions in System Inspection at the beginning of the Diagnosis and Testing procedures to avoid spillage and injury. - Install Rotunda Fuel Pressure Tester or equivalent with EF1 test Adapter in the fuel line between the fuel filter and fuel rail with its main valve open and its drain valve closed. Refer to illustrations in Test Step F1. - Start the engine and run for 10 seconds. - Stop the engine and wait 10 seconds. - Start the engine again and run for 10 seconds. - stop the engine and remove the 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 okay? 	<p>YES</p> <p>NO</p>	<p>Go to FB4.</p> <p>Replace the fuel pressure regulator and rerun Test F1.</p>				

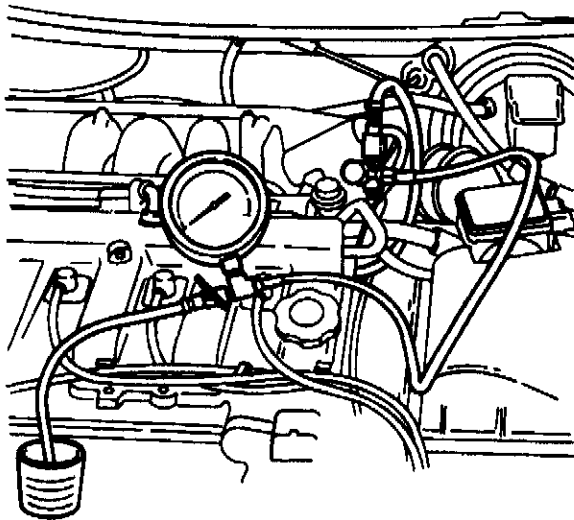
FUEL DELIVERY

<p>FB4 CHECK FUEL PRESSURE REGULATOR PRESSURE LEAKDOWN</p> <ul style="list-style-type: none"> - Reconnect the vacuum hose. - With the Rotunda Fuel Pressure Tester or equivalent still installed from previous test, run the engine for a minimum of 30 seconds. - Stop the engine and observe the fuel pressure after 5 minutes. - Is the fuel pressure greater than 147 kPa (921 psi) after 5 minutes? 	<p>YES</p> <p>NO</p>	<p>Go to FB5.</p> <p>repeat this test step. If the fuel pressure still drops more than specified, test the injector for leakage (refer to Test Step FD4). If injectors are okay, replace the fuel pressure regulator return test F1.</p>
<p>FB5 CHECK FUEL PRESSURE REGULATOR VALVE SEAT LEAKAGE</p> <ul style="list-style-type: none"> - Connect Rotunda Vacuum Tester or equivalent to the fuel return tube on the fuel pressure regulator and apply a 508 mm-Hg (20 in-Hg) vacuum. - Observe the vacuum gauge for at least 10 seconds - Does the vacuum drop lower than 254 mm-Hg (10 in-Hg) in 10 seconds? 	<p>YES</p> <p>NO</p>	<p>Replace the fuel pressure regulator rerun test F1.</p> <p>Go to FB6.</p>



FUEL DELIVERY

<p>FB6 CHECK FUEL PUMP FLOW VOLUME</p> <ul style="list-style-type: none">- Observe Warning Instructions in System Inspection at the beginning of Diagnosis and Testing procedures to avoid fuel spillage and injury.- Connect the Rotunda Fuel Pressure Tester or equivalent with EF1 Test Adapter between the fuel filter and fuel rail with the main valve closed and the drain valve opened. Refer to illustration Test Step F1.- Place the bypass hose (yellow) in a measuring container inside an empty overflow container.- Jump the fuel pump test terminal to ground. Refer to the illustration in Test Step F1 for terminal locations.- Key on.- Collect fuel in the measuring vessel for 10 seconds.- Is the amount of fuel collected within specifications (refer to specifications in this section?)	<p>YES</p> <p>NO</p>	<p>Go to FB7.</p> <p>Service the fuel pump inlet screen and rerun this test. if flow is still not within a specified limits. replace the fuel pump and rerun test F1.</p>
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FUEL DELIVERY

<p>FB7 CHECK FUEL PUMP VALVE LEAKDOWN</p> <ul style="list-style-type: none"> - Observe Warning Instructions in System Inspection at the beginning of the Diagnosis and Testing procedures to avoid fuel spillage and injury. - Connect the Rotunda Fuel Pressure Tester or equivalent with EFI test Adapter between the fuel filter and fuel rail with both the main and the drain valves closed. refer to illustration Test Step F1. - jump the fuel pump test terminal to ground. refer to illustration in Test Step F1 for terminal locations. - Key on. - Run the fuel pump for 30 seconds minimum. - Remove the jumper and note fuel pressure on the gauge for 3 minutes. - Does the output fuel pressure decrease more than 13.78 kPa (2 psi) in 3 minutes? 	YES	Replace the fuel pump. rerun Test F1.
	NO	Go to FD1.

TEST STEP	RESULT	ACTION TO TAKE
<p>FC1 CHECK FUEL PRESSURE REGULATOR FOR CAUSE OF HIGH PRESSURE</p> <ul style="list-style-type: none"> - Observe Warning Instructions in System Inspection at the beginning of the Diagnosis and Testing procedures to avoid fuel spillage and injury. - Check the fuel pressure regulator housing for damage or dents that could cause a higher spring load on the fuel pressure regulator. - Check the integrity of the fuel pressure regulator diagram (refer to the procedure described in Test Step FB3. - Is the fuel system free of defects that could cause the fuel pressure regulator to produce excessive fuel system pressure? (Refer to fuel pressure specifications in the specification chart.) 	YES	Go to FC2.
	NO	Repair or replace damaged components as required. Rerun Test Step F1. If the pressure is still high, go to FC2.
<p>FC2 CHECK FUEL RETURN FOR CAUSE OF HIGH FUEL PRESSURE</p> <ul style="list-style-type: none"> - Observe Warning Instructions in System Inspection at the beginning of Diagnosis and Testing procedures to avoid spillage and injury. - remove the fuel return line at the pressure regulator and at the fuel tank. - Provide a suitable fuel receptacle at the tank end of the return line to avoid fuel spillage. - Check fuel return line for restriction due to blockage, kinking or pinching by blowing through it with 34.5-68.9 kPa (5-10psi) regulated shop air. - is the fuel return line free of any restriction that could cause excessive fuel pressure? 	YES	Replace the fuel regulator rerun test step F1.
	NO	Repair the defects clean or replace the faulty components as required to remove the cause of high pressure. Rerun test F1.

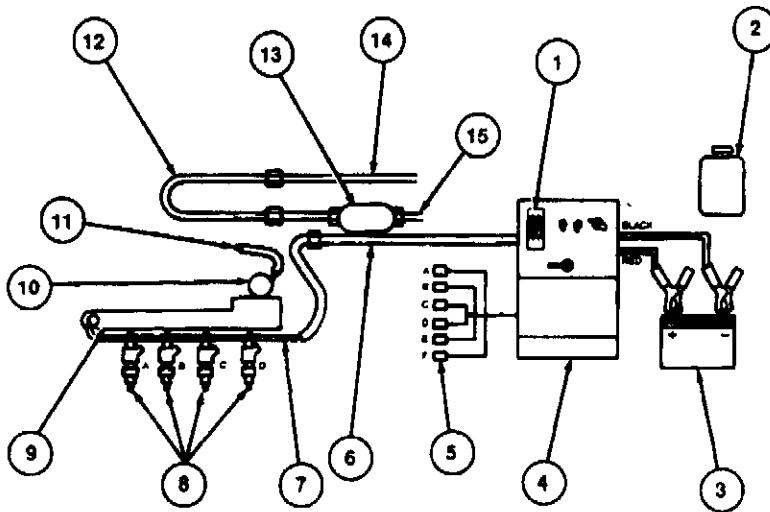
FUEL DELIVERY

TEST STEP	RESULT	ACTION TO TAKE
<p>FD1 CHECK FUEL INJECTION FUNCTION</p> <ul style="list-style-type: none"> - With the engine warmed and idling or cranking if it does not start) and using a mechanic's stethoscope or equivalent listen for regularly operating sounds at each fuel injector. - Is normal operating sound present? 	<p>YES</p> <p>NO</p>	<p>Go to FD4.</p> <p>Go to FD2.</p>
<p>FD2 CHECK FUEL INJECTOR ELECTRICAL SIGNAL</p> <p>Caution; Do not connect a test lamp to the injector harness. damage may result to the Powertrain Control Module (PCM).</p> <ul style="list-style-type: none"> _ Check the electrical continuity of the injector between each injector and the PCM as follows <ul style="list-style-type: none"> - Disconnect the fuel injector lead and insert the continuity checker from Rotunda Fuel Injector Tester/Cleaner or equivalent into the injector lead plug. - Start or crank engine. - Observe whether the continuity checker blinks (showing a completed circuit for injector being tested. - Repeat the check for each injector. - Do all injector circuit leads show continuity? 	<p>YES</p> <p>NO</p>	<p>Go to FD3.</p> <p>Check each for 12 volts at each injector wire with key on. Service wire as required. Refer to Pinpoint Test SCG in Section 6.</p>
<p>FD3 CHECK FUEL INJECTOR RESISTANCE</p> <ul style="list-style-type: none"> - Observe warning Instructions in System Inspection at the beginning of the Diagnosis and testing procedure to avoid spillage and injury. - Disconnect the electrical connector from the injectors. If necessary, remove the fuel injectors to gain access to the injector terminals. - Measure the electrical resistance across the terminal of each injector. - Is the resistance of each injector approximately 12-16 ohms (20C or 68F)? 	<p>YES</p> <p>No</p>	<p>Go to FD4.</p> <p>Replace the faulty injectors. Rerun test Step FD1 and if okay, go to Test Step FD4.</p>

FUEL DELIVERY

<p>FD4 CHECK FUEL INJECTORS (CLEANING AND LEAKAGE)</p> <p>Note: This procedure does not require the matching of injector colour with flow gauge band colour on the Fuel Injector tester/Cleaner.</p> <ul style="list-style-type: none">- Observe Warning Instructions in System Inspection at the beginning of Diagnosis and Testing procedures to avoid fuel spillage and injury.- Use the Rotunda Fuel Injector Tester/Cleaner or equivalent and accompanying instructions to clean the fuel injectors.- With the Fuel Injector Tester/Cleaner still installed on the fuel system note any significant pressure loss due to injector leakage when the tester pump is turned off.- Check each fuel injector individually for leakage as required using the fuel injector bench tester and fuel injector bench testing procedure associated with Fuel Injector Tester/Cleaner. Verify that each injector leakage rate is within specification (1 drop / 2 minutes maximum). <p>- Is the leakage rate for individual injectors within specifications?</p>	<p>YES</p> <p>NO</p>	<p>Return to the Diagnostic routines.</p> <p>Replace faulty fuel injectors as required.</p>
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FUEL INJECTOR TESTER/CLEANER



INJECTOR BENCH TEST FIXTURE



INJECTOR SHOWN IN BENCH TEST FIXTURE

FUEL DELIVERY

ITEM	DESCRIPTION
1	Flow Gauge
2	Reservoir
3	Battery
4	Cleaner/Tester
5	Test Harness
6	Cleaner Supply Hose
7	Fuel Supply Line
8	Injectors
9	Fuel Rail
10	Fuel Pressure Regulator
11	Plug Line Fuel Return
12	"U" Tube
13	Filter
14	Fuel return
15	Fuel Supply