SECTION 12

Turbocharger Systems

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Description and Operation

TURBOCHARGER SYSTEMS

Engine Applications

1.6L Turbo

Basic Operation

The Turbocharger System is comprised of the Turbocharger assembly (consisting of a turbine wheel, the compressor wheel, full-floating bearings, oil control seal rings, and the turbocharger housing) the Boost Pressure Control System (waste gate and actuator), the Overboost Protection and Warning System (including Boost Indicator Gauge), the Intercooler, and the Engine Knock Protection System (including the knock sensor and the knock control unit).

The Turbocharger System improves engine power by compressing the inlet air. A substantial increase above atmospheric pressure is attainable. Some of the energy in the hot exhaust gas is utilized to turn the turbine wheel. Since considerable heat is added to the air during compression, the air is cooled by routing it through a heat exchanger, the Charge Air Intercooler. This reduces the possibilty of pre-ignition and engine overheating damage. From the intercooler the cooler is ducted to the engine intake plenum.

Boost Pressure Control

The Boost Pressure Control System consists of a waste gate valve and a waste gate actuator. The actuator, which is controlled by turbo boost pressure, controls the waste gate valve, which opens and closes the exhaust gas bypass passage.

The amount of turbocharger boost is limited to a maximum of 56 kPa (8.1 psi) by the waste gate and actuator. Under normal to moderate loads, the waste gate valve is closed and the intake air pressure changes in accordance with the engine rpm and the amount of exhaust gas. Under heavy loads, the intake air pressure in the air inlet duct reaches 56 kPa (8.1 psi) the pressure acts on the diaphragm and overcomes the force of the spring within the actuator, and the waste gate valve opens the bypass passage. As a result, the flow of exhaust gas applied to the turbine wheel drops, the rpm of the turbine wheel drops, and the boost pressure drops accordingly.

Description and Operation

Overboost Protection and Warning System

If the actual intake manifold pressure reaches 77 kPa (11 psi) and the calculated intake manifold pressure (calculated from the amount of intake air and engine speed) reaches a predetermined level, fuel injection will be cut to prevent engine damage. Under this condition the turbo boost gauge will be indicating in the red sector of the gauge.

Engine Knock Protection System

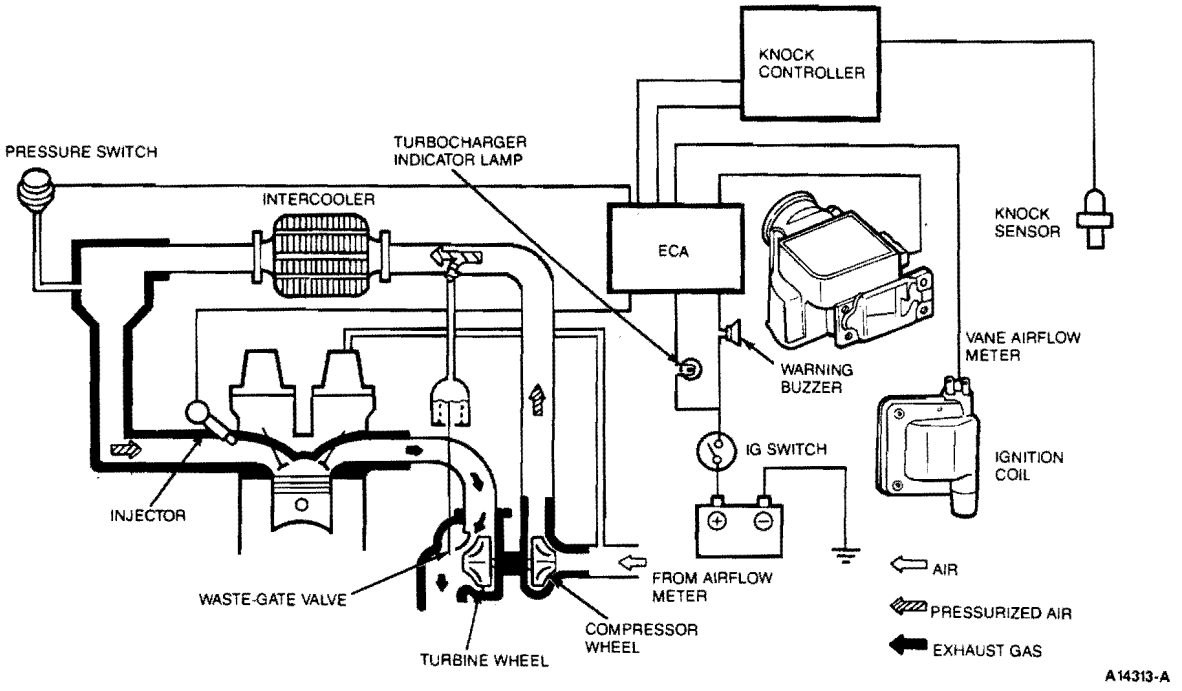
The Engine Knock Protection System includes a Knock Sensor, installed on the engine block, and a Knock Control Unit, mounted on the right side of the engine compartment.

If engine knock occurs, voltage is generated in the Knock Sensor and a signal is sent to the Knock Control Unit. The Knock Control Unit determines whether the signal from the Knock Sensor is actually caused by knocking or another source. If the Knock Control Unit determines that engine knock is occuring, the spark timing is retarded according to the intensity of the knock, to a maximum of 15 degrees.

Further information regarding the makeup of the system and its relationship to other engine emission systems may be found in the Schematic Diagram, Section 4 of this manual.

Description and Operation

SCHEMATIC/SYSTEM DIAGRAM



Diagnosis and Testing

SYSTEM INSPECTION

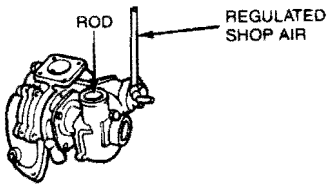
1. Visually inspect the components of the Turbocharger System.
   Look for:

ELECTRICAL	MECHANICAL
• Damaged Connections or Insulation. • Damaged Vane Air Flow Meter. • Damaged Knock Sensor. • Damaged Knock Control Unit. • Malfunctioning ECA. • Corroded/Damaged Connectors.	• Air Cleaner Element • Damaged/Leaking Air Ducts. • Damaged/Leaking/Misrouted Vacuum Hoses. • Damaged Waste Gate/Waste Gate Actuator. • Oil Leakage from Turbocharger • Unusual Engine Noise.

2. Exercise the wiring and connectors for the Knock Sensor, the Knock Control Unit, and the ECA to detect obvious problems due to looseness, corrosion, or other damage.
3. Check the air inlet and vacuum lines and connections for looseness, pinching, kinking, misrouting or other obvious cause for malfunction.
4. If a component is suspected as the obvious cause for malfunction, correct the defect before proceeding.
5. If all checks are OK, proceed to the Pinpoint Tests.

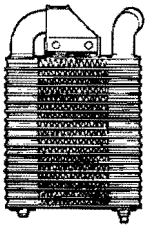
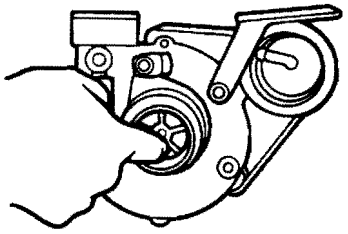
Diagnosis and Testing

TC

TEST STEP	RESULT ▶	ACTION TO TAKE
TC1 TURBOCHARGER BOOST PRESSURE INSPECTION		
• Disconnect waste gate valve air hose. • Connect pressure gauge to waste gate valve. • Connect tachometer to engine. • Start and warm engine to normal operating temperature. • Increase engine speed to 4000 rpm and note boost pressure on gauge. • **Is the boost pressure indicated on the gauge at least 2.0 kPa (o.28 psi)?**	Yes ▶ No ▶	RETURN to Diagnostic Routines, Section 2. GO to TC2.
TC2 WASTE GATE FUNCTIONING CHECK		
• Cool engine. • Disconnect the air hose to the Waste Gate Valve. • With regulated shop air, apply 48.1-58.9 kPa (7.0-8.6 psi) to the Waste Gate. • **Does the Waste Gate actuator rod move with air pressure applied?** CAUTION **Do not apply air pressure greater than 98 kPa (14 psi) to the Waste Gate.**  A14314-A	Yes ▶ No ▶	Go to TC3. REPLACE Turbocharger.

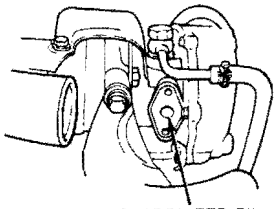
Diagnosis and Testing

TC

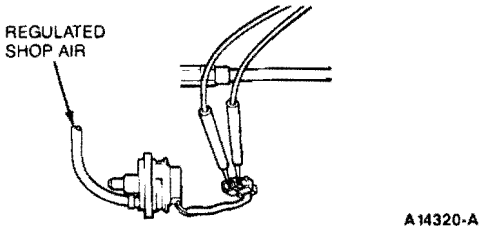
TEST STEP	RESULT ▶	ACTION TO TAKE
TC3 INTERCOOLER INSPECTION		
• Visually inspect the Intercooler for leaks, cracks, restrictions, or other damage. • **Is Intercooler OK?**  A14315-A	Yes ▶ No ▶	GO to TC4 . SERVICE Intercooler.
TC4 TURBOCHARGER ROTOR ASSEMBLY INSPECTION		
• Cool engine. • Remove Turbocharger Inlet Air Duct. • Check movement of rotor by hand. • **Does the rotor move smoothly and quietly, without scraping the Turbocharger housing?**  A14316-A	Yes ▶ No ▶	GO to TC5 . REPLACE Turbocharger.

Diagnosis and Testing

TC

TEST STEP	RESULT ▶	ACTION TO TAKE
TC5 TURBOCHARGER ROTOR VANE INSPECTION • With the Turbocharger Inlet Air Duct still removed, inspect the condition of the Turbocharger Rotor Vanes. • **Are rotor vanes free of any signs of wear, damage, or contamination?**	Yes ▶ No ▶	GO to TC6 . REPLACE Turbocharger.
TC6 TURBOCHARGER LUBE SYSTEM INSPECTION • Cool engine. • Remove the Turbocharger Oil Inlet Line. • **Are the Turbocharger oil passage and oil inlet free from blockage or carbonized oil?**  CARBONIZED OIL A14319-A	Yes ▶ No ▶	GO to TC7 . REPLACE Turbocharger. REPLACE oil inlet line if necessary.
TC7 TURBOCHARGER SEAL LEAKAGE CHECK • Cool engine. • Disconnect Turbocharger pipes and hoses. • Examine removed hoses, pipes, and Turbocharger passages for signs of oil and/or coolant leaks. • **Are there any signs of leaks or contamination?**	Yes ▶ No ▶	REPLACE Turbocharger. RETURN to Diagnostic Routines, Section 2.

Diagnosis and Testing — LP

TEST STEP	RESULT ▶	ACTION TO TAKE
LP1 PRESSURE SWITCH FUNCTION CHECK		
• Key on, engine running. • Disconnect hose to pressure switch. • Apply 71.6-79.5 kPa (10.4-11.5 psi) to pressure switch. • **Does engine run poorly or stall with air pressure applied to Pressure Switch?**	Yes ▶ No ▶	RETURN to Diagnostic Routines, Section 2. GO to **LP2** .
LP2 PRESSURE SWITCH VOLTAGE CHECK		
• Key on. • Aplly 71.6-79.5 kPa (10.4-11.5 psi) to Pressure Switch. • Measure voltage on the "LG/BK" wire at the Pressure Switch connector. • **Is voltage greater than 10 volts with air pressure applied to the Pressure Switch and 0 volts with no air pressure applied?**  A14320-A	Yes ▶ No ▶	RETURN to Diagnostic Routines, Section 2. GO to **LP3** .
LP3 PRESSURE SWITCH INSPECTION		
• Key off. • Disconect Pressure Switch connector. • Apply 71.6-79.5 kPa (10.4-11.5 psi) to Pressure Switch. • Measure continuity between the terminals of the Pressure Switch. • **Is there continuity between the Pressure Switch terminals with air pressure applied and no continuity with no air pressure applied?**	Yes ▶ No ▶	RETURN to Diagnostic Routines, Section 2. REPLACE Pressure Switch.

Specifications/Special Service Tools

SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Boost Pressure, Maximum	56 kPa (8.1 psi)
Turbo Waste Gate--Air Pressure to Open	56 kPa (8.1 psi)

SPECIAL SERVICE TOOLS

ROTUNDA NUMBER	DESCRIPTION
059-00008	Vacuum and Pressure Tester
021-00037	Vacuum Tester
055-00101	Vacuum Tachometer