Turbocharger

General Equipment
Ford diagnostic equipment

Principles of Operation

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices. For information about these, REFER to: Diagnostic Methods (100-00 General Information, Description and Operation).

The turbocharger assembly is an exhaust-driven centrifugal compressor. Its purpose is to increase power output by supplying compressed air to the engine. The turbocharger components are cooled with oil, coolant and air. Engine oil is circulated through the housing. The ball bearings are lubricated by engine oil. Oil is pumped directly from the cylinder block, through the turbocharger pedestal to the turbocharger, then circulated through the turbocharger housing and returned to the oil pan through the oil drain in the turbocharger pedestal. Coolant enters the turbocharger through the turbocharger pedestal and flows out of the turbocharger coolant outlet tube to help maintain a lower operating temperature.

The turbocharger for the 6.7L engine is designed to provide boost control at low and high speeds for improved throttle response. The variable geometry turbocharger is electronically controlled and electronically actuated. When the vanes of the turbocharger are closed, the engine has a higher exhaust back pressure and creates more heat which warms the engine faster in cold ambient conditions.

During engine operation at low engine speeds and load, little energy is available from the exhaust to generate boost. To maximize the use of available energy, the vanes are closed allowing the exhaust gas to be accelerated between the vanes and across the turbine wheel. In general, this allows the turbocharger to behave as a smaller turbocharger than it actually is. Closing the vanes also increases the back pressure in the exhaust manifold which is used to drive the exhaust gas through the exhaust gas recirculation cooler and valve into the intake manifold. This is also the position for cold ambient warm up.

Vanes mounted around the internal circumference of the turbine housing are connected to a unison ring. The unison ring links all the vanes together and when the unison ring moves, all the vanes move. The unison ring is moved by the turbocharger actuator. Turbocharger control is a closed-loop system using the exhaust pressure sensor to provide feedback to the powertrain control module. In response to engine speed, engine load, manifold pressure and barometric pressure, the powertrain control module controls the turbocharger actuator position to match manifold boost to the requirements of the engine.

Expanding exhaust gases drive the turbine shaft assembly to speeds over 100,000 rpm. Filtered air entering the turbocharger compressor side of the turbocharger is compressed and delivered the charge air cooler. The very hot compressed air is cooled by the charge air cooler, and then continues on to fill the intake manifold at a pressure higher than atmospheric pressure. Because considerably more air is forced into the intake manifold, the results are increased power, fuel efficiency and the ability to maintain power at higher altitudes.

Inspection and Verification

NOTE: *This section provides mechanical diagnosis of the turbocharger assembly. If there is a MIL illuminated, or a DTC is present, these should be diagnosed prior to performing turbocharger mechanical diagnosis.*

1. For a PCM DTC,
   REFER to: Electronic Engine Controls (303-14B Electronic Engine Controls - 6.7L Power Stroke Diesel, Diagnosis and Testing).
   For driveability symptoms without a DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3 Symptom Charts.
2. Verify the customer concern.
3. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical

Mechanical	Electrical
▪ air cleaner element ▪ air cleaner intake pipe ▪ air cleaner outlet pipe ▪ Air leaks ▪ Charge air cooler ▪ Charge air cooler intake pipe ▪ Charge air cooler outlet pipe ▪ Coolant leak(s) ▪ Exhaust leaks ▪ Inspect oil (dirty, incorrect level or diluted) ▪ Loose hose clamps ▪ Loose or broken charge air cooler tube clip ▪ Missing or damaged charge air cooler tube O-ring ▪ Oil leak(s) ▪ Restricted intake or exhaust ▪ Turbocharger coolant return tube ▪ Turbocharger housing ▪ Turbocharger intake tube	▪ Damaged/plugged or disconnected MAP (manifold absolute pressure) sensor ▪ Electrical connector(s) ▪ PCM (powertrain control module) ▪ Turbocharger actuator ▪ Wiring harness(es)

4. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
5. If the concern is not visually evident, verify the symptom and refer to the Diagnostic Tab in the Ford diagnostic equipment.

Symptom Chart

Symptom	Possible Sources	Action
• Loss of power/performance	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Restriction upstream of the turbocharger compressor	• REMOVE the restriction.
	• Partially blocked charge air cooler (engine oil)	• REPAIR or INSTALL a new charge air cooler. • TEST the system for normal operation.
	• Damaged charge air cooler	• INSTALL a new charge air cooler. • TEST the system for normal operation.
	• Low compression	• REPAIR as needed.
	• Turbocharger compressor air intake hoses leaking	• REPAIR or INSTALL a new hose or clamps as needed.
	• Loose connections or damage to air intake hoses and tubes	• TIGHTEN the hose clamps and REPAIR as needed. • INSPECT for damage. • REPAIR as needed.
	• Malfunctioning fuel system	• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.
	• Poor fuel quality	• DRAIN and FILL with fresh fuel.
	• Engine wear (piston rings, valve guides)	• REPAIR as needed.

	• Turbocharger turbine or compressor wheel damage	• INSPECT the turbocharger. • REFER to the check for free rotation â€” on vehicle below.
	• Damaged exhaust or exhaust leaks at the turbocharger inlet pipes	• INSPECT for leaks. Leaks can usually be detected audibly or visually, with a smoke test. • REPAIR as needed.
	• Turbocharger actuator not functioning	• TEST the turbocharger actuator operation. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.
	• PCM (powertrain control module) â€” DTC (diagnostic trouble code)	• REFER to: Electronic Engine Controls (303-14B Electronic Engine Controls - 6.7L Power Stroke Diesel, Diagnosis and Testing).
	• Restricted flow through the exhaust gas recirculation cooler due to coolant intrusion	• REMOVE the exhaust gas recirculation temperature cooler outlet temperature sensor. • INSPECT for signs of coolant. • If coolant is present, REMOVE the exhaust gas recirculation cooler and pressure test. • INSPECT for blockage or coolant intrusion. • REPAIR as needed.

Symptom	Possible Sources	Action
• Excessive oil consumption (blue or gray exhaust smoke)	• Incorrect type or grade of oil • Excessive oil level	• DRAIN and FILL with specified oil.
	• Extended oil change intervals	• CHANGE oil as recommended.
	• Oil in exhaust manifold	• REPAIR as needed.
	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Restriction upstream of the turbocharger compressor	• REMOVE the restriction. • INSPECT the closed crankcase ventilation (CCV) system. • REPAIR as needed.
	• Blocked or restricted turbocharger oil drain	• INSPECT the turbocharger oil drain. • REPAIR as needed.
	• Damaged or collapsed air intake hoses and tubes	• TIGHTEN hose clamps. • INSPECT for damage. • REPAIR as needed.
	• Turbocharger oil seals leaking	• REFER to turbocharger internal oil leak test below.

	• Turbocharger top oil plug leaking	• REPAIR as needed.
	• Turbocharger to pedestal or turbocharger gasket failure	• INSTALL a new turbocharger to pedestal or turbocharger gasket. • TEST the system for normal operation.
	• Turbocharger pedestal to engine block gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.
	• Damaged or restricted crankcase ventilation system	• Visually INSPECT the crankcase ventilation system. • REPAIR as needed.

Symptom	Possible Sources	Action
• Excessive coolant consumption (white exhaust smoke) or leaks	• Turbocharger coolant tube seals and/or coolant tube leaking	• Visually INSPECT the turbocharger coolant return tube and the turbocharger coolant tube seals. • REPLACE the turbocharger coolant return tube and the turbocharger coolant tube seals.
	• Turbocharger side cup plug failure	• INSTALL a new turbocharger. • TEST the system for normal operation.
	• Turbocharger to pedestal gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.
	• Turbocharger pedestal to engine block gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.

Symptom	Possible Sources	Action
• Noise or vibration	• Loose connections or damage to air intake hoses and tubes	• TIGHTEN hose clamps. • INSPECT for damage. • REPAIR as needed.
	• Air leaks at intake manifold or charge air cooler	• REPAIR as needed.
	• Leaks at turbocharger inlet and outlet connections	• REPAIR as needed.
	• Exhaust leaks at turbocharger housing, exhaust manifolds, turbocharger inlet pipes	• INSPECT for leaks. Leaks can usually be detected audibly or visually, with a smoke test. • REPAIR as needed.
	• Turbocharger imbalance due to foreign object/damage	• REPAIR as needed.
	• Turbocharger compressor housing seals	• INSTALL a new turbocharger. • TEST the system for normal operation.

	• Carbon build up in the turbine housing causing contact with turbine wheel	• REFER to the check for free rotation â€" On Vehicle, see below.
	• Leak in exhaust system before DPF	• REPAIR as needed.

Symptom	Possible Sources	Action
• Engine emits excessive smoke (black/blue/white)	• Clogged air cleaner element	• INSTALL a new air cleaner element. • TEST the system for normal operation.
	• Incorrect type or grade of oil	• DRAIN and FILL with specified oil.
	• Blocked or restricted turbocharger oil drain	• INSPECT the turbocharger oil drain. • REPAIR as needed.
	• Damaged/restricted or leaking turbocharger compressor air intake pipe	• REPAIR or INSTALL a new pipe as needed.
	• Engine wear (piston rings, valve guides)	• REPAIR as needed.
	• Plugged crankcase ventilation system	• Visually INSPECT the crankcase ventilation system. • REPAIR as needed.
	• Turbocharger oil seals leaking	• REFER to turbocharger internal oil leak test below.

Symptom	Possible Sources	Action
• High boost	• Leak in exhaust system before DPF	• REPAIR as needed.

Symptom	Possible Sources	Action
• External coolant leaks or coolant tube leaks	• Turbocharger coolant tube seals and/or coolant tube leaking	• INSPECT, visually the turbocharger coolant return tube and the turbocharger coolant tube seals/gaskets, hose and clamps. • REPLACE the turbocharger coolant return tube and the turbocharger coolant tube seals/gaskets, hose and clamps as needed.
	• Turbocharger side cup plug failure	• INSTALL a new turbocharger. • TEST the system for normal operation.
	• Turbocharger to pedestal gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.
	• Turbocharger pedestal to engine block gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.

Symptom	Possible Sources	Action
• External turbocharger oil leaks	• Turbocharger top oil plug leaking	• REPAIR as needed.

	• Turbocharger to pedestal gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.
	• Turbocharger pedestal to engine block gasket failure	• INSTALL a new turbocharger to pedestal gasket. • TEST the system for normal operation.

Component Tests

Turbocharger Internal Oil Leak Test

NOTE: *It is normal for a small amount of combustion gas to pass into the crankcase. This gas is scavenged into the air intake system through the closed crankcase ventilation (CCV) system, which incorporates an crankcase vent oil separator. Some engine oil, in the form of a vapor is carried into the air intake system with the blow-by gases (this engine oil also contributes to valve seat durability). This means that oil will collect inside the air intake components and the turbocharger. This is not an indication that the turbocharger oil seal has failed. The turbocharger oil seal will generally not fail unless the bearings fail first, which will cause the turbocharger to become noisy or seize. Do not install a new turbocharger due to oil inside the turbocharger or the air intake components. If a leak is detected in the oil supply connections, locate and rectify the source. Do not install a new turbocharger due to an oil leak.*

Check the turbocharger compressor inlet for evidence of oil. If excessive oil is present, this indicates that the failure could be in the engine or turbocharger.
REFER to: Engine (303-01B Engine - 6.7L Power Stroke Diesel, Diagnosis and Testing).
Or see the following turbocharger check. If excessive oil is found in the turbocharger compressor outlet, check the charge air cooler for oil contamination. If contamination is present, flush the charge air cooler.

For high oil consumption and/or exhaust smoke concerns, check the turbocharger turbine outlet for evidence of liquid oil. If found, examine the turbo inlet pipes from the exhaust manifolds for evidence of oil build-up. If found, the oil source is most likely the engine cylinders.

Check for Free Rotation â€” On Vehicle

NOTE: *The turbocharger must be pre-oiled before carrying out this check.*

NOTE: *Turbine and compressor wheels must spin freely when turned by hand. No housing contact is permitted.*

Inspect the turbocharger compressor and turbine fins for damage. If the compressor or turbine wheel fins are damaged, install a new turbocharger.

Press and rotate the turbocharger shaft. If either the compressor wheel or the turbine wheel contacts the housing, the bearings are bad and a new turbocharger must be installed.