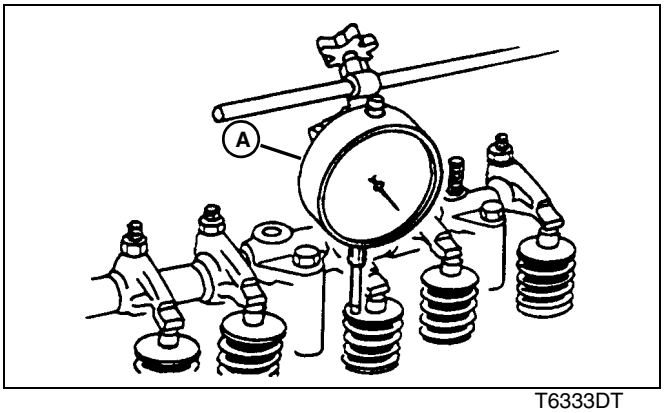


T6333DT

3. Fasten the dial indicator (A) to the engine, and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.

4. Zero the dial indicator.

5. Manually turn the crankshaft clockwise (as viewed from the fan end).

6. Observe the dial indicator as the valve is moved to the full open position.

7. Repeat for each valve.

Results

- The valve lift should be the same for all valves. If one or more valves show less lift than the others, remove and inspect the camshaft, followers, and push rods.
- If the camshaft, followers, and push rods are within specification, remove and inspect the cylinder head.

Cylinder Compression Pressure Test

Reason

To determine the condition of the pistons, rings, cylinder walls, and valves.

Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used to measure pressure in cylinders.
Adapter	JDG560	Used to attach compression gauge assembly to cylinders.

Procedure

1. Park machine safely. (See “Park Machine Safely” on page 3.)

2. Run engine for five minutes to bring to operating temperature.

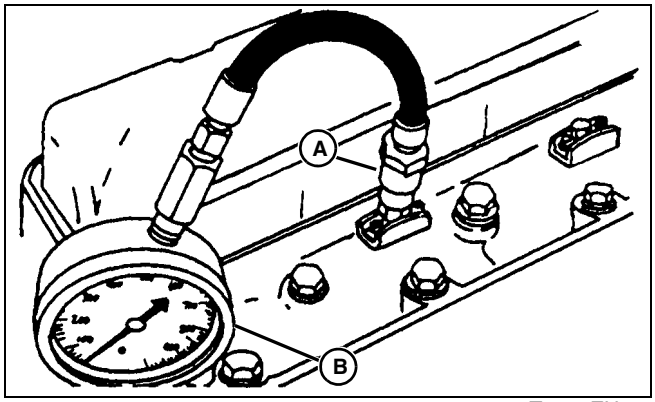
3. Turn key switch to STOP position.

4. Raise hood.

5. Move fuel shutoff valve on fuel filter to OFF position.

6. Disconnect the fuel shutoff solenoid wiring connector.

7. Remove fuel injection nozzles.



T6333EU

8. Install the TEFLON® heat protector in the injector port.

9. Install JDG560 Adapter (A) and JT01682 Compression Gauge Assembly (B) in injector port.

IMPORTANT: Avoid damage! DO NOT run starting motor for more than ten seconds at a time.

10. Crank engine for five seconds with starting motor.

11. Record pressure reading for each cylinder.

Results

NOTE: Pressure listed is for 300 m (1000 ft) above sea level. For naturally aspirated engines, reduce specification an additional 4% for each 300 m (1000 ft) of altitude.

- If pressure reading is below specification, squirt approximately two teaspoons of clean engine oil into cylinders through injector ports and repeat test.
- If pressure increases significantly, check piston, rings, and cylinder walls for wear or damage.
- If pressure does not increase significantly after retest, check for leaking valves, valve seats, or cylinder head gasket.

Specifications

Cylinder Compression

Models 1600/1620 (Min) . . . . . 2744 kPa (398 psi)

Model 1600 Turbo (Min) . . . . . 2447 kPa (355 psi)

Difference between Cylinders (Max) 296 kPa (43 psi)

Engine Oil Pressure Test

Reason

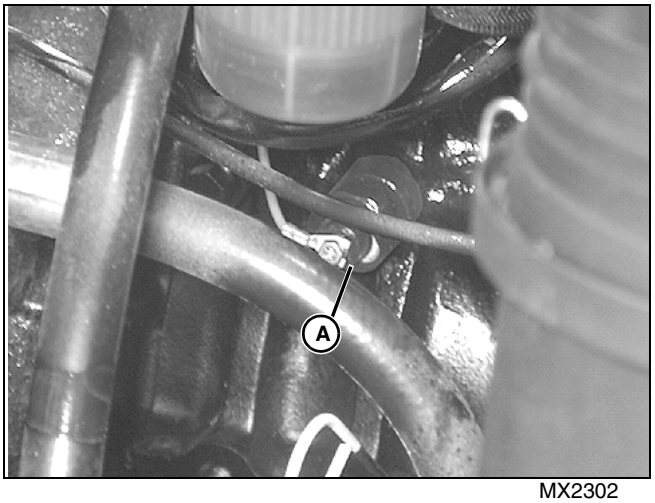
To determine if the engine bearings or lubrication system components are worn.

Required Tools

Tool Name	Tool No.	Tool Use
Hose Assembly	JT03017	Used to connect pressure gauge to connector.
Pressure Gauge 700 kPa (100 psi)	JT07034	Used to measure oil pressure.
Connector	JT03349	Used to connect hose assembly to oil pressure switch.

Procedure

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Raise hood.



MX2302

3. Remove oil pressure switch (A).
4. Install JT03349 Connector.
5. Connect JT03017 Hose Assembly and JT05577 Pressure Gauge.

IMPORTANT: Avoid damage! If oil pressure reading is below 58 kPa (8.5 psi), STOP ENGINE IMMEDIATELY and determine cause.

6. Monitor oil pressure while cranking engine. If no oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.
7. Start engine and run engine at SLOW idle (700 rpm) for approximately five minutes to heat oil.
8. Run engine at FAST idle (3200 rpm) and check oil pressure. Gauge should read a minimum oil pressure to specification.

Results

If oil pressure is not within specification, inspect oil pump and oil pressure regulating valve for wear or damage. Replace parts as needed.

Specifications

Engine Oil Pressure at 3200 RPM 344 ± 48 kPa (50 ± 7 psi)

Air Intake System Leakage Test

Reason

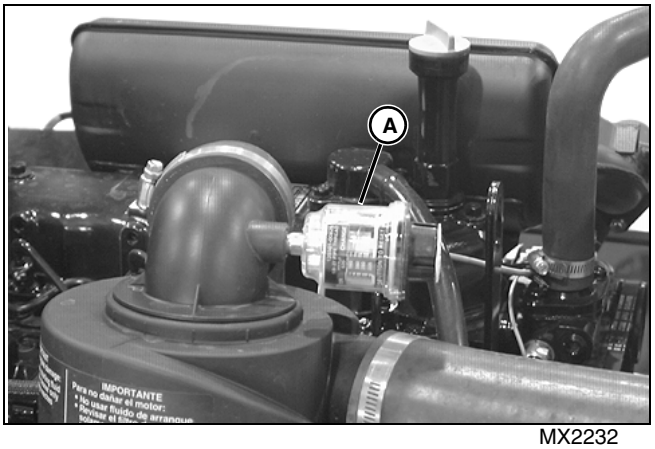
To check for leaks in the air intake system.

Required Tools

Tool Name	Tool No.	Tool Use
Air Pressure Regulator	NA	Used to regulate air pressure from manifold.
Test Fitting	NA	Used to connect air hose to manifold.

Procedure

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Raise hood.



MX2232

3. Remove air filter restriction indicator (A) and install test fitting to pressurize air intake system.

4. Connect air pressure regulator to manifold using hose and fitting from air cleaner.

M82124

5. Remove air cleaner cover and both filter elements.

6. Put small plastic bag over end of small filter element. Install small filter element into air cleaner housing.

7. Pressurize air intake system to specification. If air intake system cannot be pressurized, turn engine slightly to close valves.

8. Spray soap solution over all connections from air cleaner to intake manifold and check for leaks.

Results

Find leaks and repair or replace parts as necessary.

Specifications

Air Intake System Pressure . . . . 34-69 kPa (5-10 psi)

Extending Turbocharger Life - Model 1600 Turbo

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more), a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failure are:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

Lack of Lube Oil

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low pressure; a bent, plugged, or undersized oil lube supply line; plugged or resticted oil galleries in the turbocharger; or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length, and strength.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 30 seconds (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. “Hot” shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc., from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Ingestion of Foreign Objects

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to whobble.

IMPORTANT: Avoid damage! Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage:

- A blocked drain tube, due to either damage or a buildup of sludged oil.
- High crankcase pressure, due to restricted crankcase breather or excessive engine blow-by.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

Low Oil Level

Check engine oil level periodically according to your operator’s manual. Proper oil level will prevent turbocharger failure.

Operation on Excessive Side Slopes

Operating equipment on excessive side slopes will prevent oil from being transferred up to the turbocharger, causing overheating wear of moving parts.

Abnormally High Exhaust Temperatures

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. This can cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can cause wheel burst.

There are two basic causes of over-temperature:

- Resticted air flow
- Overpowering the engine

In either case, the engine has more fuel than available air for proper combustion. This overfueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include:

- Damaged inlet piping
- Clogged air filters
- Excessive exhaust restriction
- Operation at extreme altitudes

Overpowering generally is due to improper fuel delivery or injection timing. If over-temperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

Turbocharger Seven-Step Inspection - Model 1600 Turbo

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed, so the primary cause of failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons.

1. Identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

2. Proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

NOTE: To enhance the turbocharger inspection, use an inspection sheet (Form No. DS-2280 available from Distribution Service Center) to list the inspection steps in the proper order and show potential failure modes for each step. Check off each step of the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

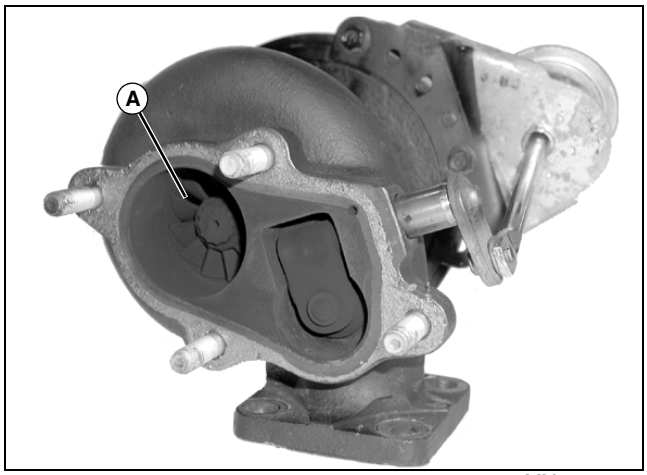
The seven recommended inspection steps, which are explained in detail on the following pages, are:

- Compressor Housing Inlet and Compressor Wheel
- Compressor Housing Outlet
- Turbine Housing Inlet
- Turbine Housing Outlet and Turbine Wheel
- External Center Housing and Joints
- Internal Center Housing
- Turbo Bench Test

Compressor Housing Inlet and Compressor Wheel

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate future damages.

Use a good light source for this check.



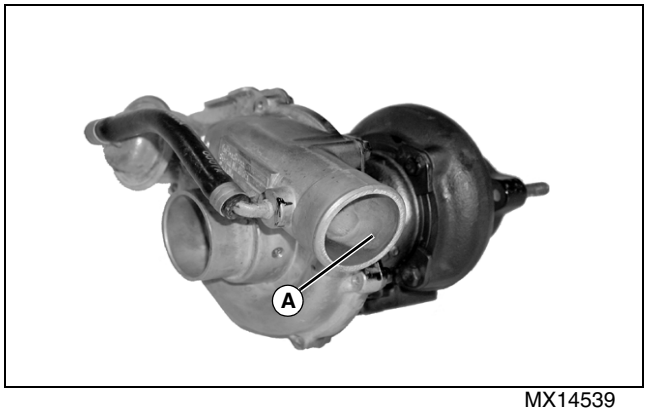
MX14541

1. Check compressor inlet and blade (A) for foreign object damage.

2. Check compressor inlet for wheel rub on the housing. Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

3. Mark findings on your checklist and continue the inspection.

Compressor Housing Outlet

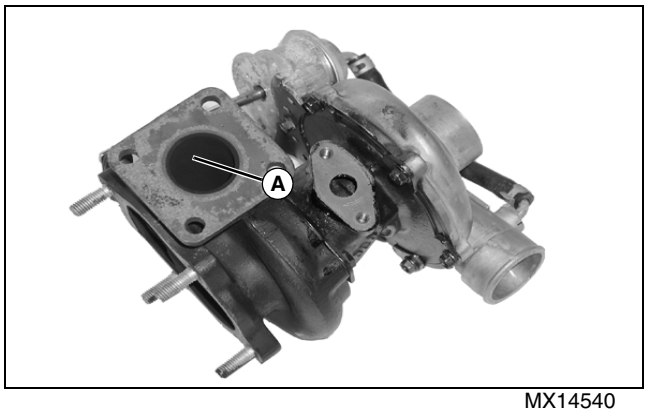


MX14539

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark the checklist if dirt or oil is found and continue the inspection.

Turbine Housing Inlet

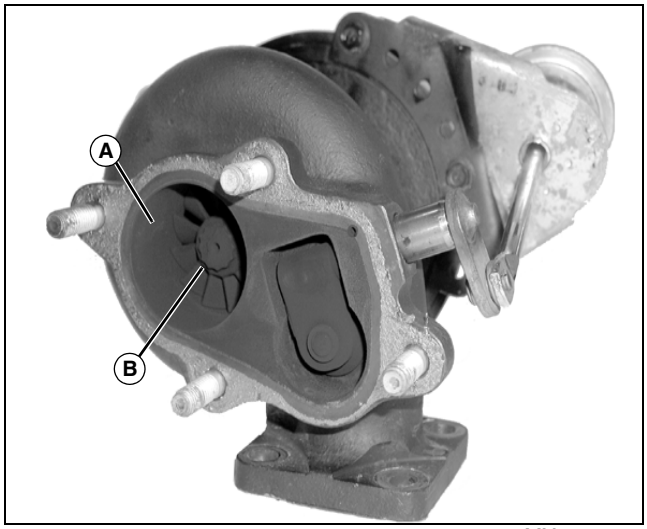


MX14540

Check the turbine housing inlet port (A) for oil in housing, excessive carbon deposit, or erosion of walls.

NOTE: If the inlet is wet with oil or has excessive carbon deposits, an engine problem is likely. Wall erosion (cracking or missing pieces) indicates excessive exhaust temperature.

Turbine Housing Outlet and Turbine Wheel

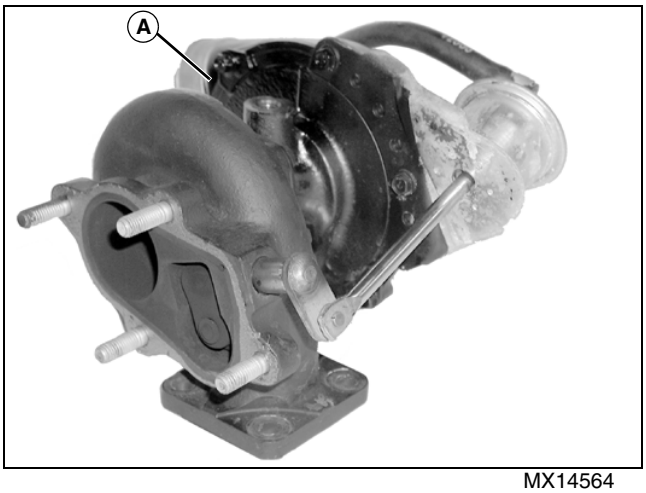


MX14541

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.

2. Inspect the wheel blades and housing for evidence of wheel rub. Wheel rub can bend the tips of the blades with the housing showing wear or damage.

External Center Housing and Joints

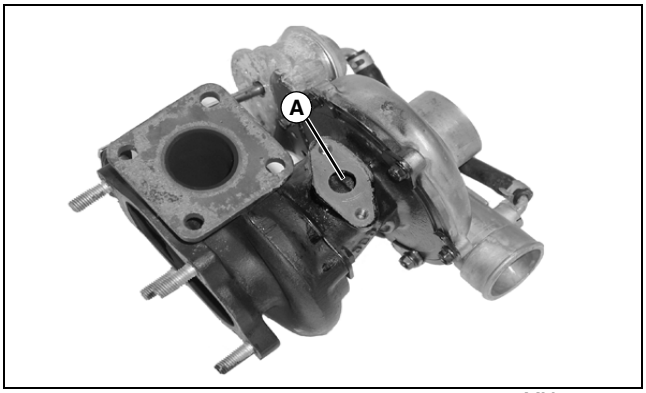


MX14564

Visually check the outside of the center housing (A), all connections to the compressor housing, and turbine housing for oil.

NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

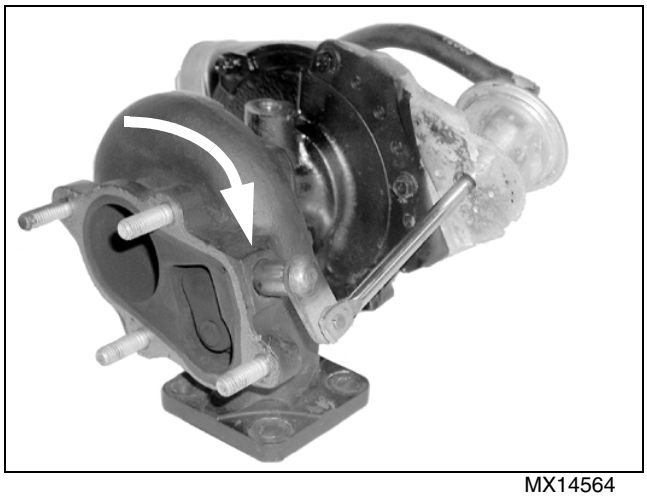
Internal Center Housing



MX14540

Using a flashlight, look through the oil return hole (A) to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.

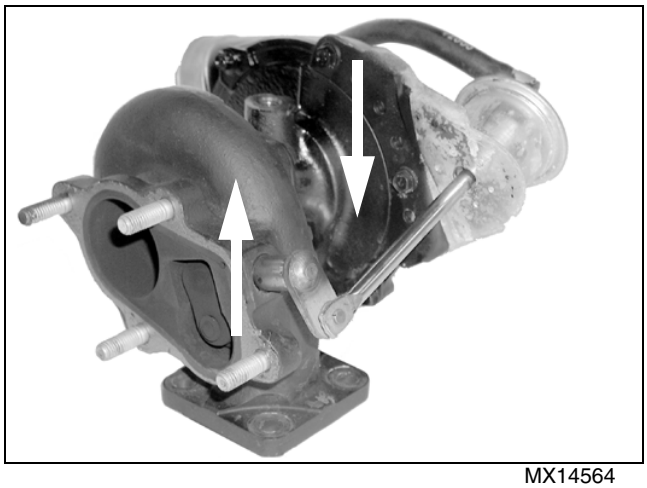
Turbo Bench Test



MX14564

1. Mount the turbocharger in a vise.

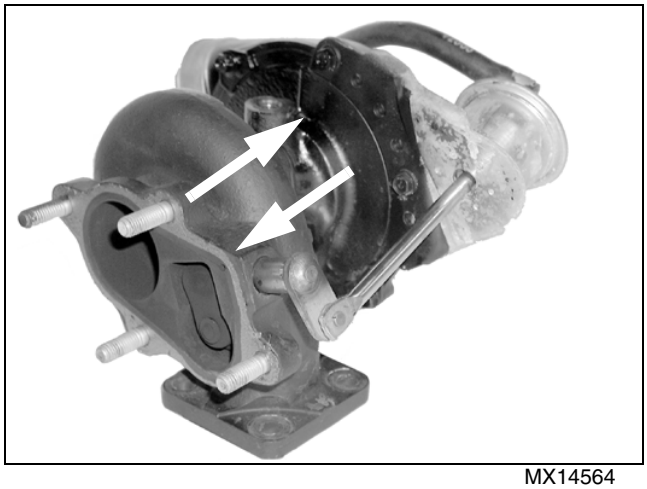
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.



MX14564

3. Pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel not the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.



MX14564

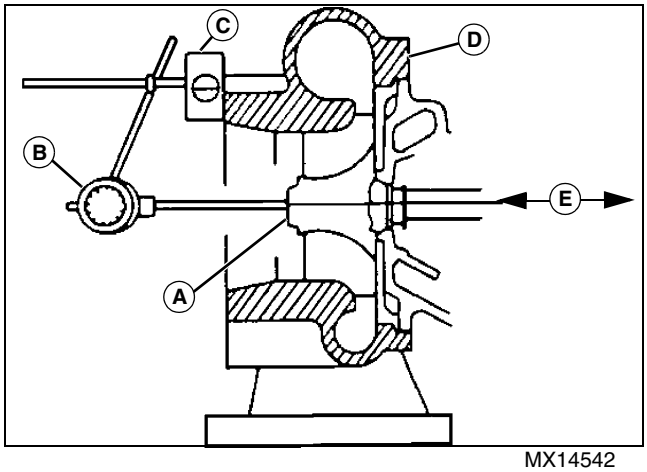
4. Check shaft end play by moving the shaft back and forth while rotating. There will be some end play, but not to the extent that the wheels contact the housing.

IMPORTANT: Avoid damage! Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended to check rotor shaft axial and radial play. (See procedures later in this group.) These procedures are not required if a failure mode has already been identified.

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure. It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

Check Turbocharger Rotor Shaft Axial Play - Model 1600 Turbo

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.



MX14542

A - Shaft End
B - Dial Indicator
C - Magnetic Base
D - Turbine Housing
E - Axial Direction

1. Mount magnetic base (C) so that indicator tip rests on end of shaft (A). Preload indicator tip and zero dial on indicator (B).
2. Move shaft axially back and forth by hand.
3. Observe and record total dial indicator movement.

If axial play is not within specification, replace turbocharger.

Specifications

Rotor Shaft Axial Play

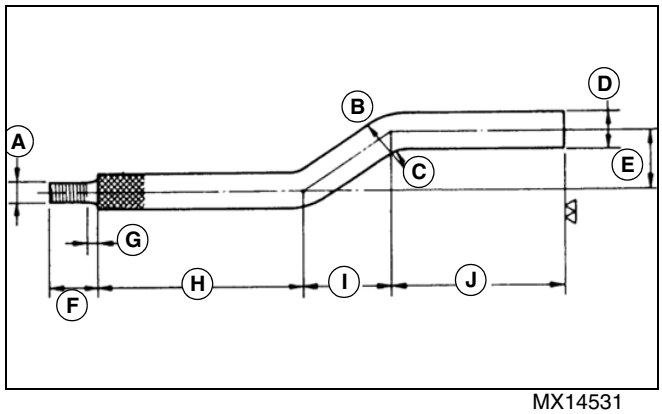
Standard . . . . . 0.03-0.06 mm (0.0012-0.0024 in.)
Wear Limit . . . . . 0.09 mm (0.0035 in.)

Check Turbocharger Rotor Shaft Radial Play - Model 1600 Turbo

This test will give an indication of the condition of the radial bearing within the center housing and rotation assembly.

NOTE: Prelube center housing bearing prior to performing radial play test. (See "Prelube Turbocharger - Model 1600 Turbo" on page 122.)

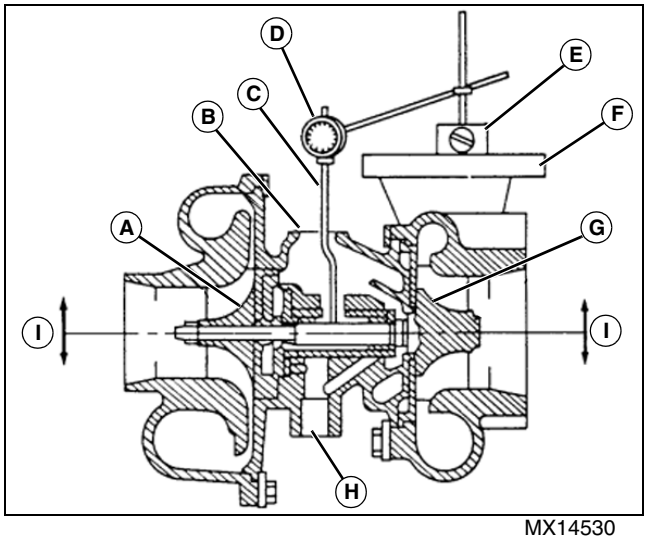
1. Purchase an extended indicator tip from a local supplier with the following approximate dimensions:
   - Length: 76 mm (3.0 in.)
   - Diameter: 5.0 mm (0.197 in.)



MX14531

A - M2.6, P0.45
B - Radius: 10 mm (0.3937 in.)
C - Radius: 5 mm (0.1968 in.)
D - Diameter: 5 mm (0.1968 in.)
E - Distance: 7 mm (0.2755 in.)
F - Length: 8 mm (0.3149 in.)
G - Length: 1 mm (0.0393 in.)
H - Length: 40 mm (1.5748 in.)
I - Length: 10 mm (0.3937 in.)
J - Length: 15 mm (0.5905 in.)

2. Heat and bend to size as shown.



MX14530

A - Compressor Wheel
B - Oil Return Cavity
C - Extension Adapter
D - Dial Indicator
E - Magnetic Base
F - Turbocharger Mounting Flange
G - Turbine Wheel
H - Oil Inlet
I - Radial Direction

3. Position dial indicator (D) with extension adapter (C) onto turbocharger mounting flange (F), so that tip rests on shaft by extending through oil return cavity (B).

4. Grasp rotation shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows) by applying moderate force.

5. Observe and record total indicator movement.

6. If total indicator reading is not within specification, replace turbocharger.

Specifications

Rotor Shaft Radial Play

Standard . . . . . 0.08-0.13 mm (0.0031-0.0051 in.)

Wear Limit . . . . . 0.17 mm (0.0067 in.)

Fuel Pump Supply Pressure Test

Reason

To determine supply pump operating pressure.

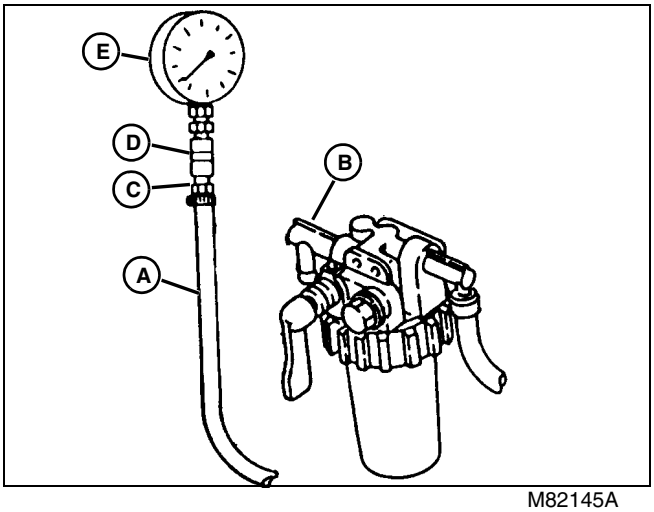
Required Tools

Tool Name	Tool No.	Tool Use
Hose Fitting	JT03274	Used to connect gauge to supply pump-to-filter filter hose.
Female Quick Coupler	JT01609	Used to connect hose fitting to gauge.
Gauge w/ Male Quick Coupler (0-150 psi)	JT03115	Used to measure pressure.

Procedure

1. Park machine safely. (See “Park Machine Safely” on page 3.)

2. Raise hood.



M82145A

3. Disconnect supply pump-to-filter hose (A) at fuel filter (B).

4. Assemble JT03274 Hose Fitting (C), JT01609 Female Quick Coupler (D), and JT03115 Gauge (E).

5. Connect gauge/fitting assembly to supply pump-to-filter hose (A).

6. Disconnect wire connector to fuel shutoff solenoid.

IMPORTANT: Avoid damage! DO NOT run starting motor for more than ten seconds at a time.

7. Crank engine using the starting motor. Gauge should read more than specification.

Suggest:

If the above button click is invalid.

Please download this document

first, and then click the above link

to download the complete manual.

Thank you so much for reading