

FUEL INJECTION PUMP DIAGNOSIS

Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Shut-off solenoid not functioning properly; or wiring lead loose or broken	Test for voltage at injector pump terminal. If present, test for fuel at injectors.
	Injection pump not correctly timed	Adjust injection pump timing.
	Defective injection pump	Remove pump from engine and repair.
Slow Idle Speed Irregular	Automatic advance faulty or not operating	Repair or replace injector pump.
	Nozzle faulty or sticking	Clean, adjust, or replace nozzles.
	Automatic advance faulty or not operating	Repair or replace injector pump.
Engine Horsepower Low	Injection pump not properly timed	Check pump timing.
	Defective injection pump	Remove pump and repair.
	Pump not properly timed	Check timing.
	Insufficient throttle arm travel	Inspect and adjust.
Engine Horsepower Low	Automatic advance faulty or not operating	Adjust or repair.
	Nozzle faulty or sticking	Repair.
	Defective injection pump	Remove pump and repair.



AIR INTAKE SYSTEM DIAGNOSIS

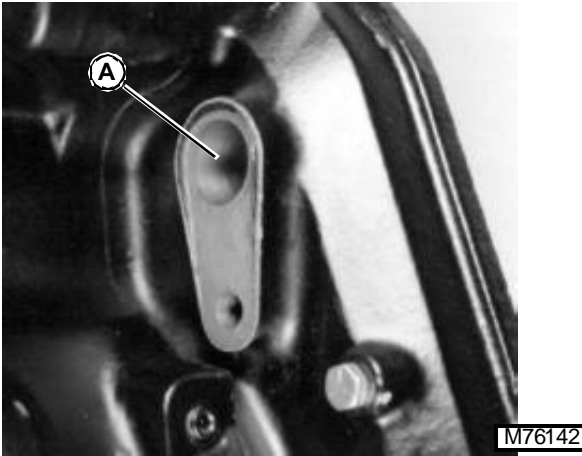
Symptom	Problem	Solution
Engine Starts Hard or Won't Start	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required.
Erratic Engine Operation	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required.
Engine Emits Excessive Black Smoke	Air cleaner element restricted	Clean or replace elements (See operator's manual).
Engine Idles Poorly	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required.
Engine Does Not Develop Full Power	Air cleaner restricted	Clean or replace elements (See operator's manual).
	Air leak on suction side of system	Check hose and pipe connections for tightness; repair as required.
Turbocharger "Screams"	Turbocharger defective	Repair or replace.
	Air leak in manifold	Check intake manifold gasket and manifold; repair as required.

TESTS AND ADJUSTMENTS

VALVE ADJUSTMENT

NOTE: Valve clearance can be checked with engine cold or warm.

1. Remove rocker arm cover and ventilator tube .



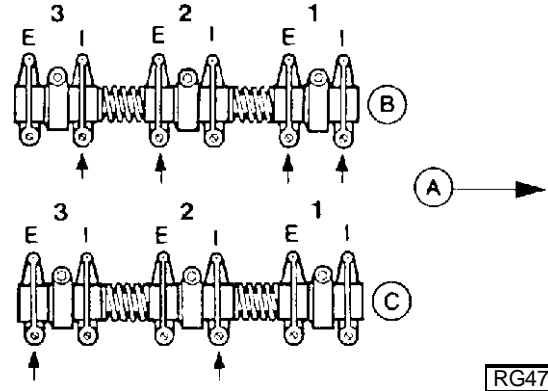
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2. Remove cover plug from engine timing holes (A) .
3. Using engine rotation tool, rotate engine in running direction (clockwise viewed from front of engine, or rear of Skid-Steer Loader) until No. 1 cylinder is at top dead center of compression stroke .

NOTE: If No. 1 cylinder rocker arms are loose, the engine is at No. 1 "TDC-Compression". If No. 1 cylinder rocker arms are not loose, rotate engine one full revolution (360°)

4. Insert timing pin to lock flywheel at TDC for No. 1 cylinder

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- A. Front of Engine
- B. No. 1 TDC Compression Stroke
- C. No. 1 TDC Exhaust Stroke

4. Check valve clearance from rocker arm to valve tip with feeler gauge on No. 1 and 2 exhaust valves, and No. 1 and 3 intake valves. Adjust if necessary .

Intake Valve 0.35 mm (0.014 in.)

Exhaust Valve 0.45 mm (0.018 in.)

NOTE: Firing order is 1-2-3

5. Remove timing pin and turn crankshaft 36 0°. Lock No. 1 piston at TDC exhaust stroke .
6. Check valve clearance from rocker arm to valve tip with feeler gauge on No.3 exhaust valve, and No. 2 intake valve. Adjust if necessary .

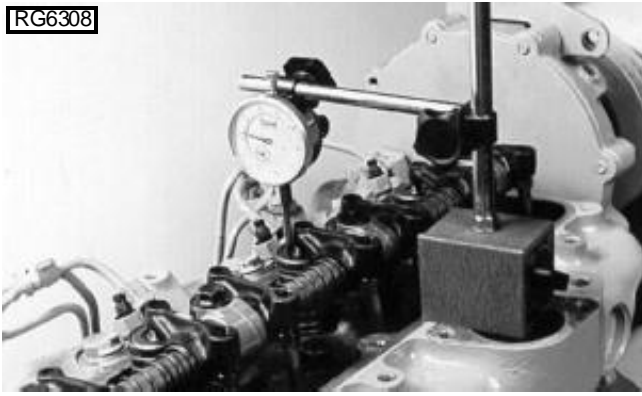
VALVE LIFT MEASUREMENT

NOTE: For a more accurate measurement, measure valve lift at 0.00 mm (in.) rocker arm-to-valve tip clearance.

1. Remove rocker arm cover .
2. Lock No. 1 piston at TDC compression stroke .
3. Set rocker arm-to-valve tip clearance to 0.00 mm (in.) for No. 1 and 2 exhaust, and No. 1 and 3 intake valves.

(See Valve Adjustment section for valve location)

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4. Place dial indicator tip on top of valve spring retainer or rotator. Preload indicator tip and set dial at 0.0 mm (in.)
5. Remove timing pin from flywheel and manually rotate engine one full revolution (360°) in running direction.
6. Observe dial indicator reading as valve is moved to full open. Record maximum reading and compare with specifications given below.

Valve Lift Specification (At 0.00 mm (in.) Valve Clearance)

Intake Valves 11.56-12.37 mm (0.455-0.487 in.)
Wear Limit 11.13 mm (0.438 in.)

Exhaust Valves 11.28-12.12 mm (0.444-0.477 in.)
Wear Limit 10.85 mm (0.427 in.)

7. If valve lift is within specifications, adjust valve clearance as specified in Valve Clearance Adjustment Section.
8. If valve lift on one or more valves is not within specification, remove and inspect entire valve train and camshaft.
9. Rotate engine one full revolution (360°). Lock engine at TDC of No. 1 exhaust stroke.
10. Set rocker arm-to-valve tip clearance to 0.0 mm (in.) for No. 3 exhaust and No. 2 intake valves.
11. Repeat steps 4-7.

PRELIMINARY ENGINE TESTING

The following preliminary tests will help determine if the engine can be tuned-up to restore operating efficiency, or if engine rebuilding is required.

1. After engine has stopped for several hours, loosen crankcase drain plug and watch for any water to seep out. A few drops due to condensation is normal, but more than this would indicate problems which require engine repair.

2. With engine stopped, inspect engine coolant for oil film. With engine running, inspect coolant for air bubbles. Either condition would indicate problems which require engine repairs rather than just a tune-up.
3. Perform a dynamometer test and record power output. Repeat dynamometer test after tune-up. Compare power output before and after tune-up.
4. Perform compression test.

ENGINE COMPRESSION PRESSURE TESTING

NOTE: Before beginning test, insure that batteries are fully charged and injection nozzle area is thoroughly cleaned. Adapters and test fittings are part

1. Run engine to bring up to normal operating temperature. (From a cold start, operate engine 10-15 minutes at slow idle.)
2. Remove fuel injection nozzles. (See Fuel Repair Section.)



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3. Install JT01679 Adapter with O-ring in injection nozzle bore. Use JT02017 Holding Clamp to hold JT01679 Adapter in position. Install hold down screw in clamp and tighten screw to **37 Nm (27 lb ft)**. Attach JT016582 Test Gauge to adapter.
4. Remove wire from connector on top of fuel injection pump to prevent engine from starting. Turn crankshaft for 10-15 seconds with starting motor (minimum cranking speed—150 rpm cold/200 rpm hot).
5. Compare readings from all cylinders.

6. Compression pressure must be **2400 kPa (24 bar) (350 psi)** minimum. The difference between the highest and lowest cylinder must be less than **350 kPa (3.5 bar) (50 psi)**.
7. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through injection nozzle bore. Do not use too much oil. Do not get oil on the valves.
8. Test compression again. If pressure is high, worn or stuck rings are indicated. If pressure is still low, it is possible that valves are worn or sticking.



ENGINE OIL PRESSURE TEST

1. Remove oil pressure sender and install pressure gauge capable of 0-100 psi from JTO5470 Pressure Test Kit.

IMPORTANT: Warm up engine to allow the lubricating oil to reach operating temperature, or high oil pressure readings will occur.

2. At 850 rpm engine speed and 93° C (200° F) oil temperature, gauge should show a minimum pressure of 140 kPa (1.4 bar) (210 psi).
3. At 2100 rpm and 105° C (220° F) oil temperature, gauge should show a pressure of 380 ± 103 kPa (3.80 ± 1.03 bar) (55 ± 15 psi) on all engines.

NOTE: Tolerance extremes and gauge fluctuations can result in a gauge reading of up to 582 kPa (5.82 bar) (85 psi). This is not detrimental to the engine.

INTAKE MANIFOLD PRESSURE (TURBO BOOST) TEST



1. Remove manifold heater from intake manifold and install JT03470 fitting (A) from JDE147 Kit. Connect gauge and test line to fitting.
2. Before checking boost pressure, warm up engine to allow the lubricating oil to reach operating temperature.

IMPORTANT: Engine speed and load should be stabilized before taking readings on gauge. Be sure that gauge works properly.

Pressure checks are only a guide to determine if there is an engine problem (valve leakage, defective nozzles, etc.). Low readings are not a valid reason for increasing injection pump fuel delivery. Pump adjustment should be within specification as established by an authorized pump repair station.

3. Observe pressure reading on gauge. Reading should be at least **60 kPa (0.6 bar) 9 psi** when engine is developing rated power at full load rated speed.
 - If boost pressure is too high, remove and test fuel injection pump for high fuel delivery.
 - If boost pressure is too low, check for the following :
 - Restricted air filter elements.
 - Restricted fuel filter elements.
 - Incorrect fast idle adjustment.
 - Incorrect injection pump timing.
 - Exhaust manifold leaks.
 - Intake manifold leaks.
 - Faulty fuel transfer pump.
 - Low compression pressure.
 - Faulty fuel injection nozzles.
 - Carbon buildup in turbocharger.
 - Turbocharger compressor or turbine wheel rubbing housing.
 - Low fuel injection pump fuel delivery.
 - Restricted exhaust.
4. After testing, remove test gauge and fittings.
5. Install air manifold heater using thread sealant.
6. Install manifold heater electrical wire to terminal.

CRANKCASE VENTILATION SYSTEM INSPECTION

1. Inspect crankcase ventilation system for restrictions. Lack of ventilation causes sludge to form in crankcase. This can lead to clogging of oil passages, filters and screens, resulting in serious engine damage.
2. Clean crankcase vent tube with solvent and compressed air if restricted. Install and tighten hose clamps securely.



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