DIAGNOSIS AND TESTING

ENGINE DIAGNOSIS - INTRODUCTION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine maintenance.

These malfunctions may be classified as either performance (e.g., engine idles rough and stalls) or mechanical (e.g., a strange noise).

Refer to **ENGINE PERFORMANCE DIAGNOSTIC TABLE** and **ENGINE MECHANICAL DIAGNOSTIC TABLE** for possible causes and corrections of malfunctions.

Refer to **FUEL SYSTEM** article, for the fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that can not be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following diagnosis:

- Cylinder Compression Pressure Test. Refer to **CYLINDER COMPRESSION PRESSURE LEAKAGE**.
- Cylinder Combustion Pressure Leakage Test. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE**.
- Engine Cylinder Head Gasket Failure Diagnosis. Refer to **DIAGNOSIS AND TESTING**.
- Intake Manifold Leakage Diagnosis. Refer to **DIAGNOSIS AND TESTING - INTAKE MANIFOLD LEAKS**.

ENGINE PERFORMANCE DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	1. Weak battery	1. Charge or replace as necessary. Refer to **BATTERY, AGM, DIAGNOSIS AND TESTING** .
	2. Corroded or loose battery connections.	2. Clean and tighten battery connections. Refer to **CLEANING** .
	3. Faulty engine starting system.	3. Diagnose engine starting system. Refer to **DIAGNOSIS AND TESTING** .
	4. Faulty coil or control unit.	4. Replace ignition coil. Refer to **COIL, IGNITION, REMOVAL** .
	5. Incorrect spark plug gap.	5. Correct as necessary.
	6. Incorrect cam timing.	6. Verify cam timing. Refer to **VALVE TIMING, STANDARD PROCEDURE**.
	7. Dirt or water in fuel system.	7. Clean fuel system.
	8. Faulty fuel pump or wiring.	8. Repair or replace as necessary.
	9. Faulty Camshaft Position (CMP) sensor.	9. Replace sensor. Refer to **SENSOR, CAMSHAFT POSITION, REMOVAL** .

	10. Faulty Crankshaft Position (CKP) sensor.	10. Replace sensor. Refer to **SENSOR, CRANKSHAFT POSITION, REMOVAL** .
ENGINE STALLS OR ROUGH IDLE	1. Vacuum leak.	1. Inspect intake manifold and vacuum hoses, repair or replace as necessary.
	2. Faulty Crankshaft Position (CKP) sensor.	2. Replace sensor. Refer to **SENSOR, CRANKSHAFT POSITION, REMOVAL** .
	3. Faulty ignition coil.	3. Replace ignition coil. Refer to **COIL, IGNITION, REMOVAL** .
	4. Incorrect cam timing.	4. Verify cam timing. Refer to **VALVE TIMING, STANDARD PROCEDURE**.
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to **SPARK PLUG, REMOVAL** .
	2. Dirt or water in fuel system.	2. Clean fuel system.
	3. Faulty fuel pump.	3. Replace fuel pump. Refer to **MODULE, FUEL PUMP, REMOVAL** .
	4. Leaking cylinder head gasket.	4. Replace cylinder head gasket. Refer to **CYLINDER HEAD, REMOVAL**.
	5. Low compression.	5. Determine the cause and repair as necessary. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE**.
	6. Burned, warped or pitted valves.	6. Replace as necessary. Refer to **VALVES, INTAKE AND EXHAUST, REMOVAL**.
	7. Plugged or restricted exhaust system.	7. Inspect and replace as necessary.
	8. Faulty ignition coil.	8. Replace ignition coil. Refer to **COIL, IGNITION, REMOVAL** .
	9. Incorrect cam timing.	9. Verify cam timing. Refer to **VALVE TIMING, STANDARD PROCEDURE**.
ENGINE MISSES ON ACCELERATION	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to **SPARK PLUG, REMOVAL** .
	2. Dirt in fuel system.	2. Clean fuel system.
	3. Burned, warped or pitted valves.	3. Replace as necessary. Refer to **VALVES, INTAKE AND EXHAUST, REMOVAL**.
	4. Faulty ignition coil.	4. Replace ignition coil. Refer to **COIL, IGNITION, REMOVAL** .
ENGINE MISSES AT HIGH SPEED	1. Dirty or incorrectly gapped spark plugs.	1. Correct as necessary. Refer to **SPARK PLUG, REMOVAL** .
	4. Faulty ignition coil.	2. Replace ignition coil. Refer to **COIL, IGNITION, REMOVAL** .
	3. Dirt or water in fuel system.	3. Clean fuel system.

ENGINE MECHANICAL DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSES	CORRECTIONS
NOISY VALVES	1. High or low oil level in crankcase.	1. Refer to **Engine/Lubrication/OIL - Standard Procedure**.

	2. Thin or diluted oil.	2. Change oil and filter.
	3. Low oil pressure.	3. Check oil pump, if Ok, check rod and main bearings for excessive wear.
	4. Dirt in lash adjusters.	4. Replace as necessary.
	5. Worn rocker arms.	5. Replace as necessary.
	6. Worn lash adjusters	6. Replace as necessary.
	7. Worn valve guides.	7. Inspect the valve guides for wear, cracks or looseness. If either condition exists, replace the cylinder head. Refer to **CYLINDER HEAD, REMOVAL**.
	8. Excessive runout of valve seats on valve faces.	8. Refer to **Engine/Cylinder Head/VALVES, Intake and Exhaust - Standard Procedure**.
CONNECTING ROD NOISE	1. Insufficient oil supply.	1. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
	2. Low oil pressure.	2. Check oil pump, if OK, check rod and main bearings for excessive wear.
	3. Thin or diluted oil.	3. Change oil and filter.
	4. Excessive bearing clearance.	4. Replace as necessary.
	5. Connecting rod journal out-of-round.	5. Service or replace crankshaft.
	6. Misaligned connecting rods.	6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply.	1. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
	2. Low oil pressure.	2. Check oil pump, if OK, check rod and main bearings for excessive wear.
	3. Thin or diluted oil.	3. Change oil and filter.
	4. Excessive bearing clearance.	4. Replace as necessary.
	5. Excessive end play.	5. Check thrust washers for wear.
	6. Crankshaft journal out-of round.	6. Service or replace crankshaft.
	7. Loose flywheel or torque converter.	7. Tighten to correct torque

CYLINDER COMPRESSION PRESSURE LEAKAGE

NOTE: The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

NOTE: Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

1. Clean the spark plug recesses with compressed air.
2. Remove the spark plugs and record the cylinder number of each spark plug for future reference.

3. Inspect the spark plug electrodes for abnormal firing indicators such as fouled, hot, oily, etc.
4. Disable the fuel system and perform the fuel system pressure release procedure. Refer to **FUEL DELIVERY, GAS, STANDARD PROCEDURE** .
5. Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
6. Record the compression pressure on the 3rd revolution. Continue the test for the remaining cylinders.

NOTE: The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.

7. Compression should not be less than 689 kPa (100 psi) and not vary more than 25 percent from cylinder to cylinder.
8. If one or more cylinders have abnormally low compression pressures, repeat the compression test.

NOTE: If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem in the cylinder in question.

9. If one or more cylinders continue to have abnormally low compression pressures, perform the cylinder combustion pressure leakage test. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE**.

CYLINDER COMBUSTION PRESSURE LEAKAGE

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating).
- Leaks between adjacent cylinders or into water jacket.
- Any causes for combustion/compression pressure loss.

1. Check the coolant level and fill as required. DO NOT install the radiator cap.
2. Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.
3. Remove the spark plugs.
4. Remove the oil filler cap.
5. Remove the air cleaner hose.
6. Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1, 379 kPa (200 psi) maximum and 552 kPa (80 psi) recommended.
7. Perform the test procedures on each cylinder according to the tester manufacturer's instructions. Set piston of cylinder to be tested at TDC compression. While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

FOR EXAMPLE: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART**.

CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace as necessary.
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace as necessary.
AIR ESCAPES THROUGH RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

OIL CONSUMPTION TEST AND DIAGNOSIS

DIAGNOSTIC PROCEDURES

The following diagnostic procedures are used to determine the source of excessive internal oil Consumption, these procedures and tests apply to vehicles with 50, 000 miles or less.

NOTE: Engine oil consumption may be greater than normal during engine break-in. Repairs should be delayed until vehicle has been driven at least 7, 500 miles.

Severe service (high ambient temperature, short trips, heavy loading, trailer towing, taxi, off-road, or law enforcement use) may result in greater oil consumption than normal.

Sustained high speed driving and high engine RPM operation may result in increased oil consumption.

Failure to comply with the recommended oil type and viscosity rating, as outlined in the owner's manual, may impact oil economy as well as fuel economy.

Oil consumption may increase with vehicle age and mileage due to normal engine wear.

NOTE: Because a few drops of external oil leakage per mile can quickly account for the loss of one quart of oil in a few hundred miles, ensure no external engine oil leaks are present.

- **Oil leakage is not the same as oil consumption and all external leakage must be eliminated before any action can be taken to verify and/or correct oil consumption complaints.**
- **Verify that the engine has the correct oil level dipstick and dipstick tube installed.**
- **Verify that the engine is not being run in an overfilled condition. Check the oil level 15 minutes after a hot shutdown with the vehicle parked on a level surface. In no case should the level be above MAX or the FULL mark on the dipstick.**

OIL CONSUMPTION TEST

1. Check the oil level at least 15 minutes after a hot shutdown.
2. If the oil level is low, top off with the proper viscosity and API service level engine oil. Add one bottle of MOPAR® 4-In-1 Leak Detection Dye into the engine oil.
3. Tamper proof the oil pan drain plug, oil filter, dipstick and oil fill cap.
4. Record the vehicle mileage.
5. Instruct the customer to drive the vehicle as usual.
6. Ask the customer to return to the servicing dealer after accumulating 500 miles, Check the oil level at least 15 minutes after a hot shutdown. If the oil level is half way between the "FULL" and "ADD" mark continue with the next step.
7. Using a black light, re-check for any external engine oil leaks, repair as necessary, if no external engine oil leaks are present, continue with oil consumption diagnosis.

OIL CONSUMPTION DIAGNOSIS

1. Check the positive crankcase ventilation (PCV) system. Make sure the system is not restricted and the PCV valve has the correct part number and correct vacuum source (18-20 in. Hg at idle below 3000 ft. above sea level is considered normal).
2. Perform a **CYLINDER COMPRESSION PRESSURE LEAKAGE** and **CYLINDER-TO-CYLINDER LEAKAGE TEST** using the standard leak down gauge following manufacturers suggested best practices.

   NOTE: Verify the spark plugs are not oil saturated. If the spark plugs are oil saturated and compression is good it can be assumed the valve seals or valve guides are at fault.

3. If one or more cylinders have more than 15% leak down further engine tear down and inspection will be required.

TOP 19 REASONS THAT MAY LEAD TO ENGINE OIL CONSUMPTION

1. **Tapered and Out-of-Round Cylinders**

   The increased piston clearances permit the pistons to rock in the worn cylinders. While tilted momentarily, an abnormally large volume of oil is permitted to enter on one side of the piston. The rings, also tilted in the cylinder, permit oil to enter on one side. Upon reversal of the piston on each stroke, some of this oil is passed into the combustion chamber.

2. **Distorted Cylinders**

   This may be caused by unequal heat distribution or unequal tightening of cylinder head bolts. This

condition presents a surface which the rings may not be able to follow completely. In this case, there may be areas where the rings will not remove all of the excess oil. When combustion takes place, this oil will be burned and cause high oil consumption.

3. **Improper operation of "PCV "system**

   The main purpose of the Positive Crankcase Ventilation (PCV) valve is to recirculate blow-by gases back from the crankcase area through the engine to consume unburned hydrocarbons. The PCV system usually has a one way check valve and a make up air source. The system uses rubber hoses that route crankcase blow by gases to the intake manifold. Vacuum within the engine intake manifold pulls the blow by gases out of the crankcase into the combustion chamber along with the regular intake air and fuel mixture.

   The PCV system can become clogged with sludge and varnish deposits and trap blow by gases in the crankcase. This degrades the oil, promoting additional formation of deposit material. If left uncorrected, the result is plugged oil rings, oil consumption, rapid ring wear due to sludge buildup, ruptured gaskets and seals due to crankcase pressurization.

4. **Worn Piston Ring Grooves**

   For piston rings to form a good seal, the sides of the ring grooves must be true and flat - not flared or shouldered. Piston rings in tapered or irregular grooves will not seal properly and, consequently, oil will pass around behind the rings into the combustion chamber.

5. **Worn, Broken or Stuck Piston Rings**

   When piston rings are broken, worn or stuck to such an extent that the correct tension and clearances are not maintained, this will allow oil to be drawn into the combustion chamber on the intake stroke and hot gases of combustion to be blown down the cylinder past the piston on the power stroke. All of these conditions will result in burning and carbon build up of the oil on the cylinders, pistons and rings.

6. **Cracked or Broken Ring Lands**

   Cracked or broken ring lands prevent the rings from seating completely on their sides and cause oil pumping. This condition will lead to serious damage to the cylinders as well as complete destruction of the pistons and rings. Cracked or broken ring lands cannot be corrected by any means other than piston replacement.

7. **Worn Valve Stems and Guides**

   When wear has taken place on valve stems and valve guides, the vacuum in the intake manifold will draw oil and oil vapor between the intake valve stems and guides into the intake manifold and then into the cylinder where it will be burned.

8. **Bent or Misaligned Connecting Rods**

   Bent or misaligned connecting rods will not allow the pistons to ride straight in the cylinders. This will prevent the pistons and rings from forming a proper seal with the cylinder walls and promote oil consumption. In addition, it is possible that a bearing in a bent connect rod will not have uniform clearance on the connecting rod wrist pin. Under these conditions, the bearing will wear rapidly and

throw off an excessive amount of oil into the cylinder.

9. **Fuel Dilution**

   If raw fuel is allowed to enter the lubrication system, the oil will become thinner and more volatile and will result in higher oil consumption. The following conditions will lead to higher oil consumption;

   - Excess fuel can enter and mix with the oil via a leaking fuel injector
   - Gasoline contaminated with diesel fuel
   - Restricted air intake
   - Excessive idling

10. **Contaminated Cooling Systems**

    Corrosion, rust, scale, sediment or other formations in the water jacket and radiator will prevent a cooling system from extracting heat efficiently. This is likely to cause cylinder distortion thus leading to higher oil consumption.

11. **Oil Viscosity**

    The use of oil with a viscosity that is too light may result in high oil consumption. Refer to the vehicle owner's manual for the proper oil viscosity to be used under specific driving conditions and/or ambient temperatures.

12. **Dirty Engine Oil**

    Failure to change the oil and filter at proper intervals may cause the oil to be so dirty that it will promote accumulation of sludge and varnish and restrict oil passages in the piston rings and pistons. This will increase oil consumption; dirty oil by nature is also consumed at a higher rate than clean oil.

13. **Crankcase Overfull**

    Due to an error in inserting the oil dip stick so that it does not come to a seat on its shoulder, a low reading may be obtained. Additional oil may be added to make the reading appear normal with the stick in this incorrect position which will actually make the oil level too high. If the oil level is so high that the lower ends of the connecting rods touch the oil in the oil pan excessive quantities of oil will be thrown on the cylinder walls and some of it will work its way up into the combustion chamber.

14. **Excessively High Oil Pressure**

    A faulty oil pressure relief valve may cause the oil pressure to be too high. The result will be that the engine will be flooded with an abnormally large amount of oil in a manner similar to that which occurs with worn bearings. This condition may also cause the oil filter to burst.

15. **Aftermarket Performance Chips and Modification**

    Increasing performance through the use of performance/power enhancement products to a stock or factory engine will increase the chance of excessive oil consumption.

16. **Lugging Engine**

Lugging is running the engine at a lower RPM in a condition where a higher RPM (more power/torque) should be implemented. Especially susceptible on vehicles equipped with a manual transmission. This driving habit causes more stress loading on the piston and can lead to increases in engine oil consumption.

17. **Turbocharged Engines**

    There is a possibility for PCV "push-over" due to higher crankcase pressure (as compared to naturally aspirated engines) which is normal for turbocharged engines. This condition causes varying amounts of engine oil to enter the intake manifold, charge air cooler and associated plumbing to and from the charge air cooler, also a leaking turbocharger seal will draw oil into the combustion chamber where it will burn (blue smoke from tail pipe may be present) and form carbon deposits which contribute to further oil consumption as they interfere with proper engine function.

18. **Restricted Air Intake**

    Excessive restriction in the air intake system will increase engine vacuum and can increase oil consumption, an extremely dirty air filter would be one example of this situation.

19. **Intake Manifold port seals**

    Engines that have a "V" configuration and a "wet valley" (3.3/3.8L) could draw oil into the intake ports due to improper sealing between the intake manifold ports and cylinder head. Causes may include improper torque of intake manifold bolts, corrosion (aluminum intake manifold) and or warped sealing surface.

ENGINE LUBRICATION DIAGNOSTIC TABLE

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Gaskets and O-rings. Misaligned or damaged.	1. Replace as necessary.
	(a) Loose fasteners, broken or porous metal parts.	(a) Tighten fasteners, Repair or replace metal parts.
	2. Crankshaft rear oil seal.	2. Replace rear crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, REMOVAL**.
	3. Crankshaft seal flange. Scratched, nicked or grooved.	3. Polish or replace crankshaft.
	4. Oil pan flange cracked.	4. Replace oil pan. Refer to **PAN, OIL, REMOVAL**.
	5. Engine timing cover seal, damaged or misaligned.	5. Replace seal. Refer to **SEAL, CRANKSHAFT OIL, FRONT, REMOVAL**.
	6. Scratched or damaged vibration damper hub.	6. Polish or replace damper.
OIL PRESSURE DROP	1. Low oil level.	1. Check and correct oil level.
	2. Faulty oil pressure sensor.	2. Replace sensor. Refer to **SENSOR, OIL PRESSURE, REMOVAL**.
	3. Low oil pressure.	3. Check main bearing clearance. Refer to **Engine/Engine**

		Block/BEARING(S), Crankshaft - Standard Procedure. 3. Check rod bearing clearance. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
	4. Clogged oil filter.	4. Replace oil filter. Refer to **FILTER, ENGINE OIL, REMOVAL**.
	5. Worn oil pump.	5. Replace oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.
	6. Thin or diluted oil.	6. Change oil and filter. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
	7. Excessive bearing clearance.	7. Replace crankshaft bearings. Refer to **Engine/Engine Block/BEARING (S), Crankshaft - Standard Procedure**. 7. Replace rod bearings. Refer to **BEARING(S), CONNECTING ROD, STANDARD PROCEDURE**.
	8. Oil pump relief valve stuck.	8. Replace oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.
	9. Oil pump pick-up tube loose, damaged or clogged.	9. Replace oil pump pick-up. Refer to **PICK-UP, OIL PUMP, REMOVAL**.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn or damaged rings.	1. Hone cylinder bores and replace rings. Refer to **Engine/Engine Block/RING(S), Piston - Standard Procedure**.
	2. Carbon in oil ring slots.	2. Replace rings. Refer to **ROD, PISTON AND CONNECTING, REMOVAL**.
	3. Worn valve guides.	3. Replace cylinder heads. Refer to **CYLINDER HEAD, REMOVAL**.
	4. Leaking valve guide seals.	4. Replace valve guide seals. Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.