Engine Condition Analysis

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Engine Vacuum

- Engine vacuum readings compare intake manifold pressure to atmospheric pressure
- Vacuum is commonly measured in inches of mercury
- Manifold vacuum is measured below the throttle plates
- An engine's manifold vacuum is a good indicator of the engines condition
- Ported vacuum is measured just above the throttle plates

Normal Vacuum Readings

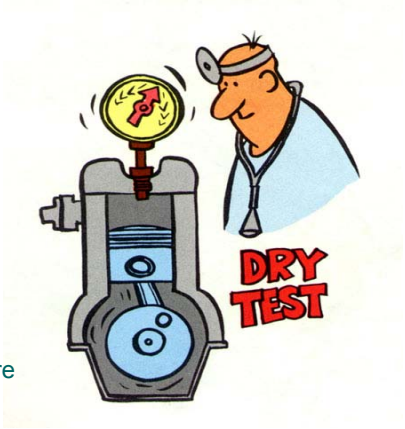
	Idle	Cruise	WOT	Deceleration
Manifold Vacuum	15" to 22"	16" to 23"	0"	22" to 28"
Ported Vacuum	0"	16" to 23"	0"	0"

Interpreting Manifold Vacuum

- Low and steady
  - retarded ignition timing
  - ignition misfire
  - low compression not related to intake valve
  - vacuum leak
- Low and pulsating
  - intake valve problem
- Low and drifting
  - air fuel ratio problem
  - erratic idle speed
- Vacuum decreases at higher no load engine RPM
  - restricted exhaust
- Needle drops intermittently
  - sticking intake valve
- Needle fluctuates at idle but steady off idle
  - worn valve guides

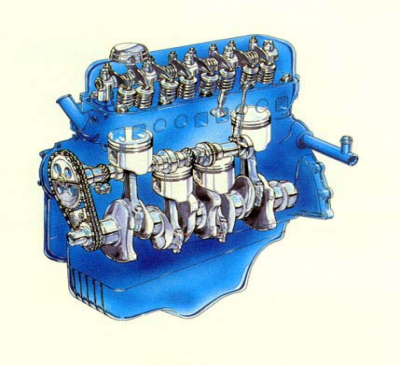
Compression Test

- Engine at normal operating temperature and battery fully charged
- Remove all spark plugs
- Block open throttle plates
- Disable the ignition and fuel injection system
- Connect compression gauge and crank the engine over 5 compression strokes
- Record the pressure reading for each cylinder
- The compression should not vary more than 25% between the highest and lowest cylinder's reading



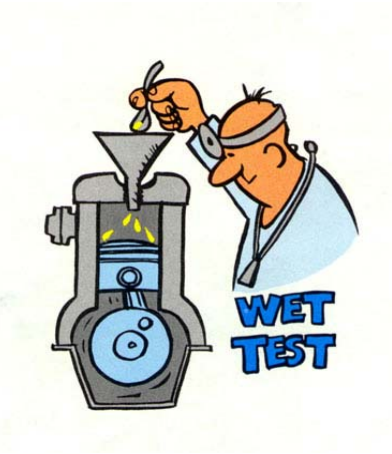
Causes of Low Compression

- Burned valve face
- Burned valve seat
- Blown head gasket
- Internal engine damage
- Worn rings
- Jumped timing belt/chain



Wet Compression Test

- A wet compression test is performed after the initial compression test to check the condition of the piston rings
- Squirt a teaspoon of oil into the suspect cylinder(s)
- Crank the engine over a few revolutions to distribute the oil
- Recheck the cylinder's compression
- If the reading goes up significantly the piston rings are a likely cause of the low compression

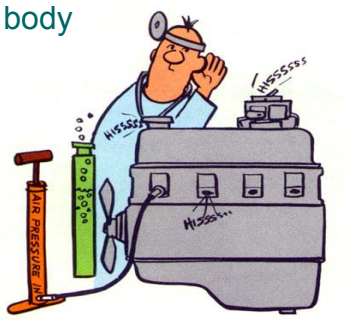


Cylinder Leakage Test

- Engine at normal operating temperature and battery fully charged
- Bring the cylinder being tested to top dead center on the compression stroke
- Connect the cylinder leak down tester and pressurize the cylinder
- The measured leakage should not exceed 20%

Excessive Cylinder Leakage

- Air escaping at intake throttle body
  - Intake valve
- Air escaping at tailpipe
  - Exhaust valve
- Air escaping at oil filler cap
  - Rings, cylinder or piston
- Air escaping at radiator
  - Head gasket
- Air leaking into adjacent cylinder
  - Head gasket

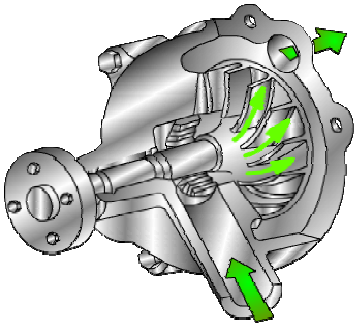


Combustion to Coolant Leaks

- Pressurize combustion chamber and check for bubbles in cooling system
- Check radiator for combustion gasses with an infrared analyzer
- Check radiator for combustion gasses with a chemical block tester
  - the dye will change from blue-green to yellow if combustion gasses are present

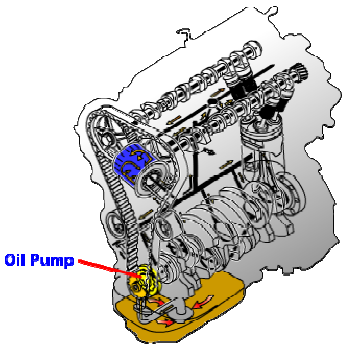
Cooling System Diagnosis

- Overheats at all times
  - low coolant/leaks
  - defective thermostat
- Overheats at low vehicle speeds
  - air flow related
- Overheats at high vehicle speeds
  - coolant flow related
- Water Pump Video



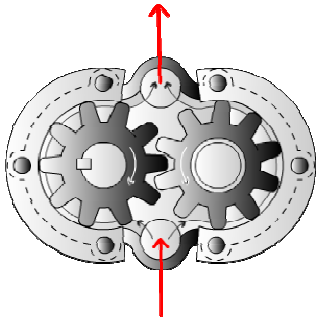
Oil Pressure Test

- Connect a manual pressure gauge and compare the engine's readings to specifications
- Most vehicles have 20 to 30 PSI at idle and 40 to 60 PSI at cruise



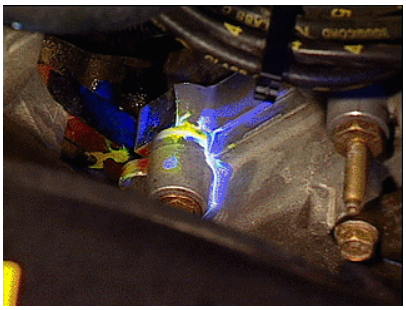
Incorrect Oil Pressure

- Low oil pressure
  - a defective oil pump and/or pressure regulator valve
  - a restricted oil pickup screen or assembly
  - a cracked oil pickup tube
  - excessive crankshaft bearing clearance
  - incorrect oil
- Excessive oil pressure
  - a defective pressure regulator valve



Fluid Leak Service

- Visual Inspection
  - What is leaking
- Confirm Leak
  - clean affected area and locate the source of the leak
  - test with ultraviolet light and dye if necessary
- Make the Repair
- Verify the Repair

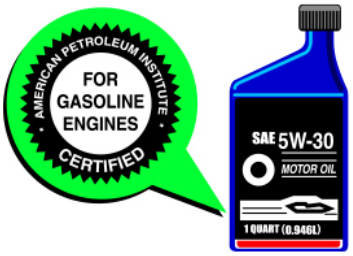


Exhaust Smoke Diagnosis

- Blue Smoke
  - excessive oil is entering the combustion chamber
  - rings, valve guides/seals
- White Smoke
  - coolant is entering the combustion chamber
  - head gasket failure
- Black Smoke
  - excessive fuel is entering the combustion chamber
  - EEC system malfunction, leaking fuel injector

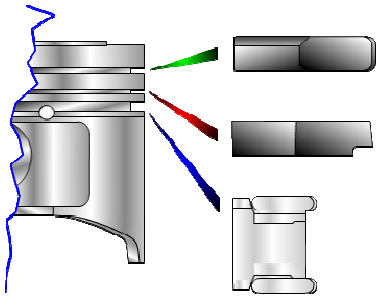
Oil Consumption Diagnosis

- What is normal oil consumption?
- If an engine burns one drop of oil every firing stroke it would use one quart every two miles
- The rate of oil consumption is affected by engine size, oil viscosity and the speed of engine operation
- High speed operation consumes motor oil
- New engines use more oil while the cylinder walls and rings become conditioned



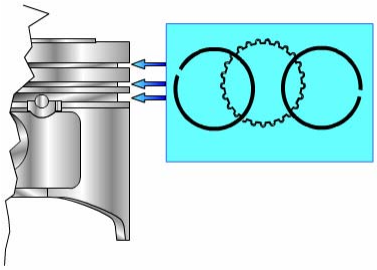
Poor Ring Sealing

- An improper seal between the piston rings and cylinder wall allows oil to enter the combustion chamber resulting in excessive oil consumption



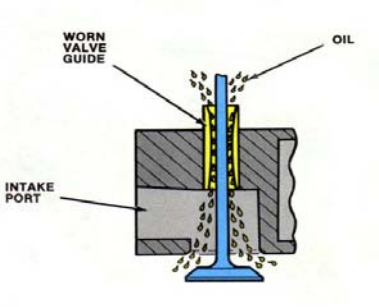
Excessive Ring End Gap

- Excessive ring end gaps allow oil to flow around the rings and enter the combustion chamber resulting in excessive oil consumption



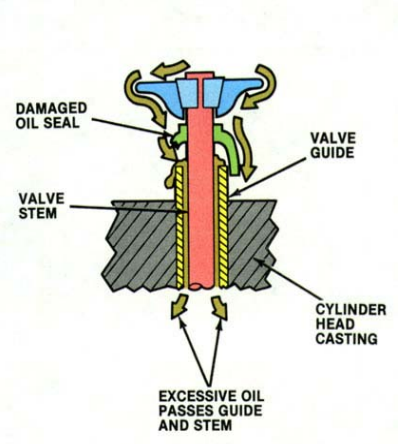
Valve Guides

- Excessive valve guide to valve stem clearance allows oil to be drawn into the combustion chamber resulting in excessive oil consumption



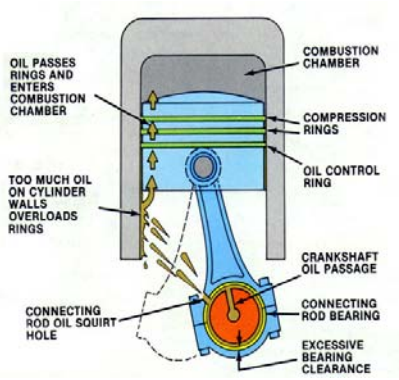
Valve Guide Seals

- Worn or damaged valve guide seals allows allows oil to be drawn into the combustion chamber resulting in excessive oil consumption



Excessive Bearing Clearance

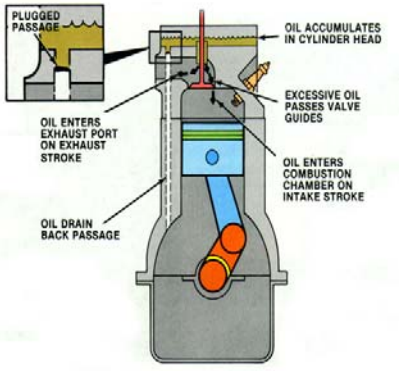
- Excessive bearing clearance results in large amounts of oil being slung onto the cylinder walls
- The rings are unable remove all of the oil
- The remaining oil enters the combustion chamber resulting in excessive oil consumption



Engine Repair

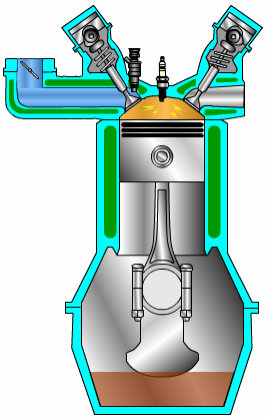
Blocked Oil Drains

- When the oil drain back hole become restricted, oil can accumulate in the head
- The oil level can rise above the valve guides and be drawn into the combustion chamber resulting in excessive oil consumption



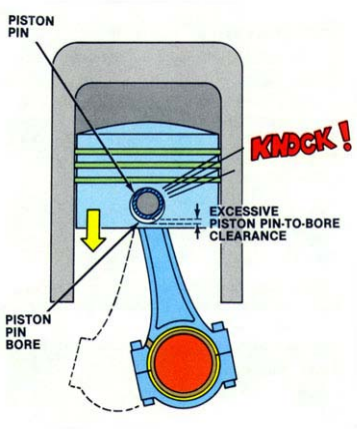
Engine Noise Diagnosis

- Verify the concern
- Engine run-up tests
  - Is the noise engine speed or engine load related
- Listen to the engine
  - Where is the noise coming from
  - What type of sound is it
- Confirm the diagnosis
  - Inspect or measure the suspect components



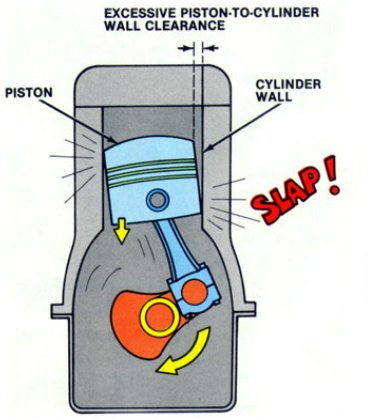
Piston Pin Knock

- High in the block
- Usually a double clicking or rapping most noticeable at idle
- The noise will usually increase when spark or fuel is removed from the affected cylinder



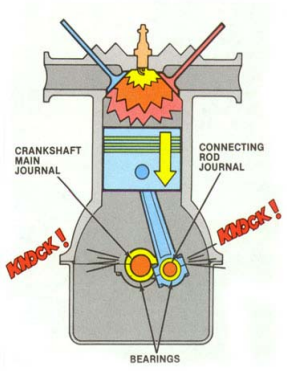
Piston Slap

- High and to one side of the engine block
- Hollow knocking
- Piston slap is relative to the speed of the engine and is louder when the engine is cold
- May disappear when the engine is warm
- Retarding ignition timing often reduces piston slap



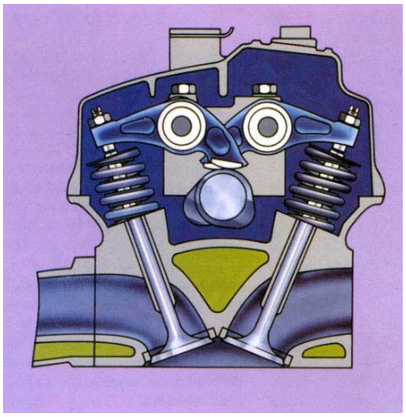
Rod and Main Bearing Knock

- Main Bearing Knock
  - Low in the engine block
  - Heavy knocking
  - Louder under load
- Front Main Bearing Knock
  - Front of engine near timing cover
  - Medium knocking
  - Increases with A/C compressor on
- Rod Bearing Knock
  - Low in the engine block
  - medium to heavy knocking
  - Usually disappears when spark is removed from the affected cylinder



Valve Train Noise

- Valve Spring Noise
  - Grinding or rumbling
  - Near the valve cover
- Valve Guide Noise
  - Ticking
  - Near the valve cover
- Valve Lifter Noise
  - Ticking
  - Near the valve cover



Other Engine Noise Sources

- Timing Belt
  - Knocking, whining or grumbling
- Water Pump
  - Whining or grumbling
- Power Steering Pump
  - Knocking, whining or grumbling
- Torque Converter
  - Knocking
- Fuel injectors
  - Ticking