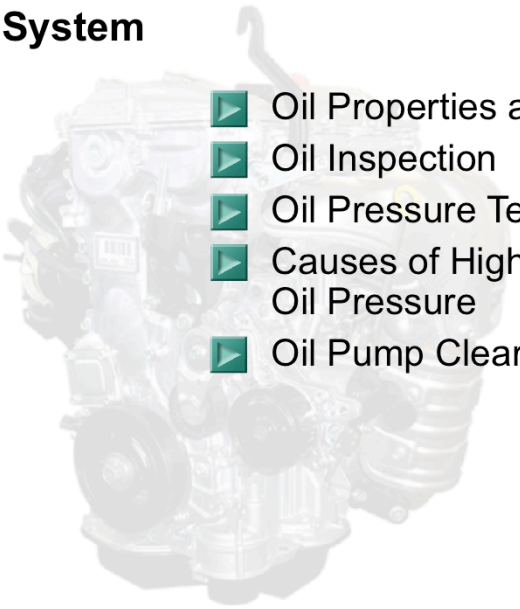
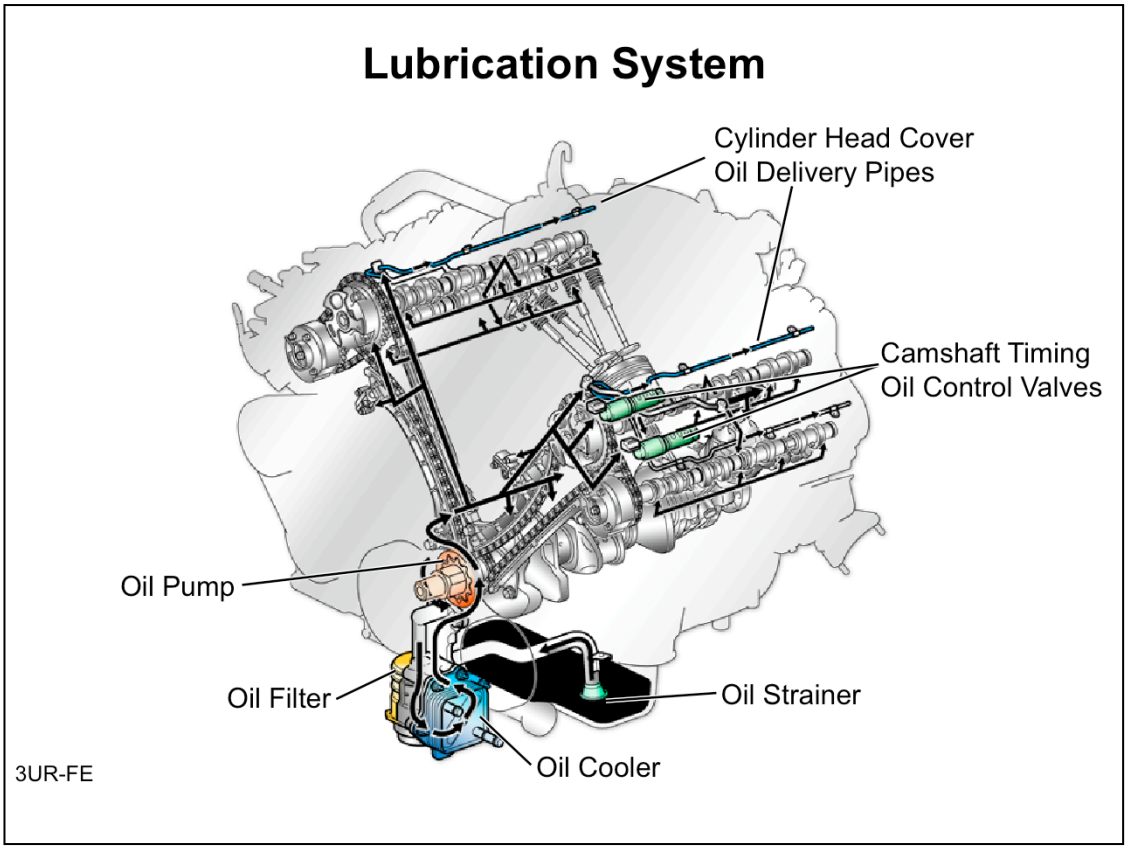
Section 7 Topics

Lubrication System

- System
- Oil Circuit
- Oil Pump
- Oil Jets
- Oil Filter
- Oil Cooler
- Oil Properties and Grades
- Oil Inspection
- Oil Pressure Test
- Causes of High or Low Oil Pressure
- Oil Pump Clearance

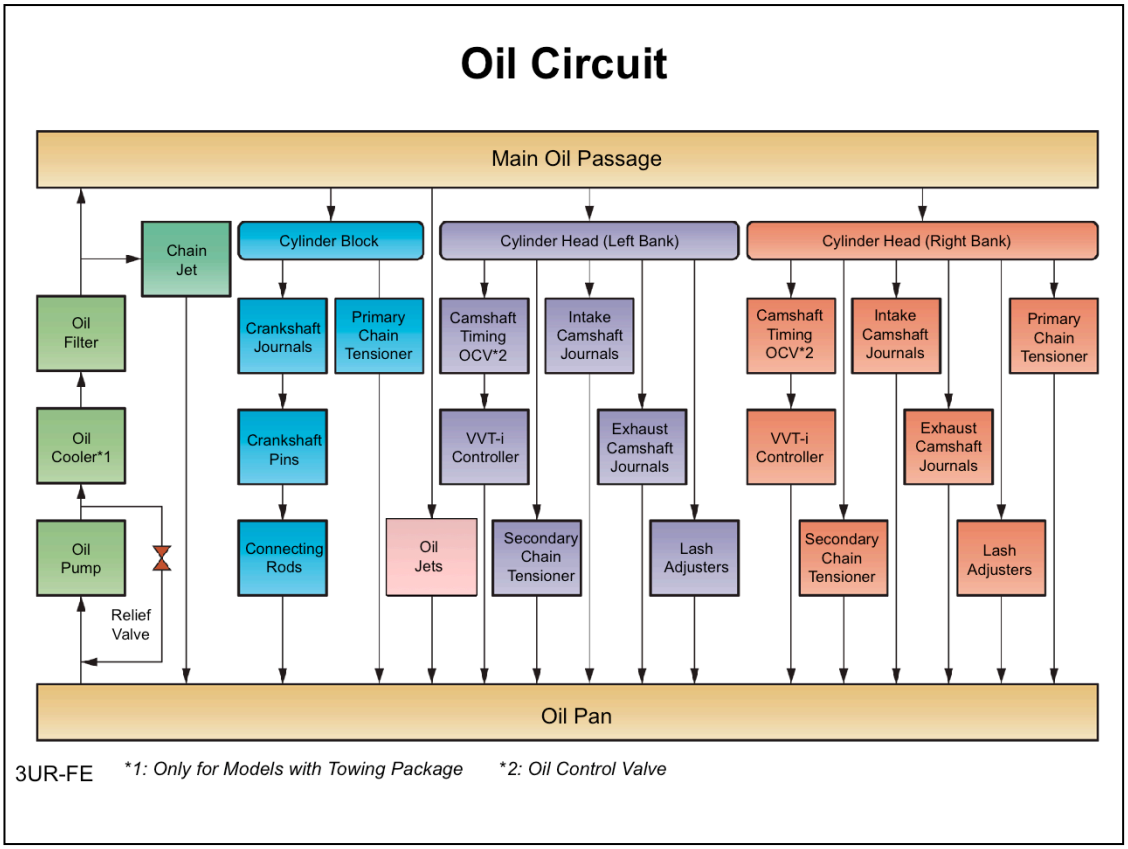




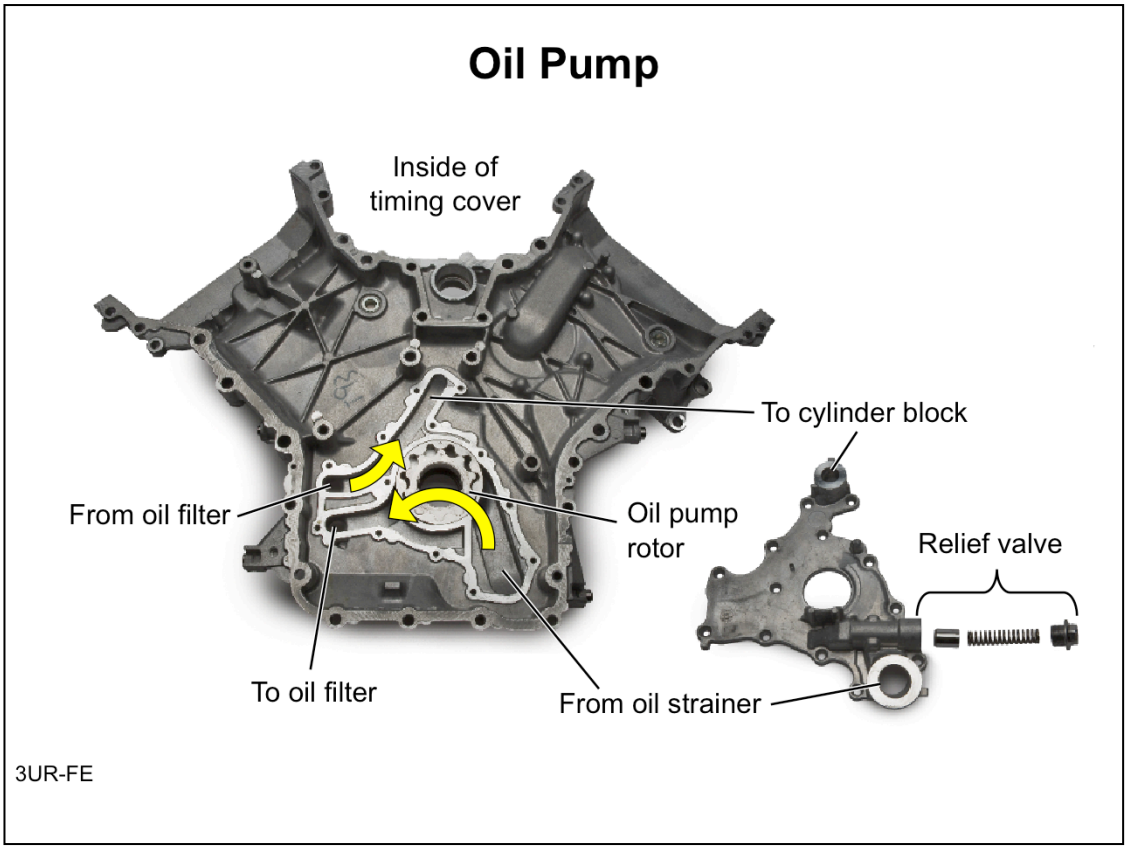
Lubrication System

Oil is the life blood of the engine. Oil cannot be compressed, so when it forms a thin film on engine components, it keeps them from contacting each other. If an engine component is starved for oil for just a short period of time irreversible damage can occur.

The purpose of the lubrication system is to be certain oil is constantly supplied to all components that require it. It pumps oil throughout the engine through small passages and tubes in the engine block and cylinder head.



Oil Circuit These components and passages make up the oil circuit. The oil circuit starts with the oil pan or sump. The oil pump draws oil from the pan through a pick up screen and filter. The oil is then pressurized and sent to the main oil passage. From here the oil flows through a multitude of circuits and passages to feed various components and moving parts. Eventually, the oil drains back to the oil pan to start the journey all over again.

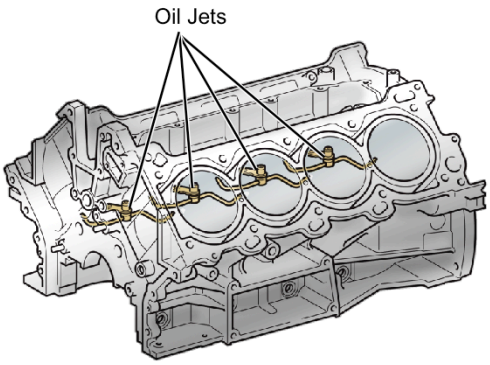


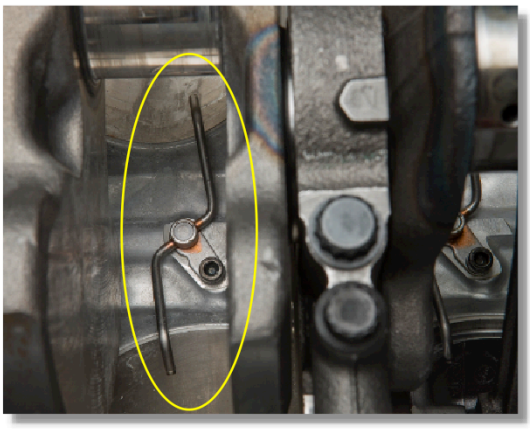
Oil Pump Modern Toyota engine oil pumps are mounted in the front timing cover. The oil pump is driven by the front shaft of the crankshaft. The oil pump draws oil from the oil pan and directs it through the oil filter then on to the main oil passage in the cylinder block.

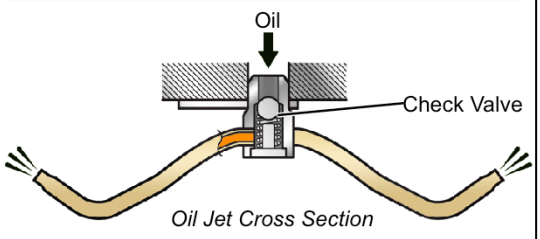
NOTE When installing the timing cover, it is important to remember to install the o-rings for the oil pump and oil filter. Low oil pressure may result if these o-rings are not installed.

Oil Jets

- Oil jets spray the cylinders for cooling and lubrication.







Oil Jet Cross Section

- A check ball prevents oil drain back when the engine is off.

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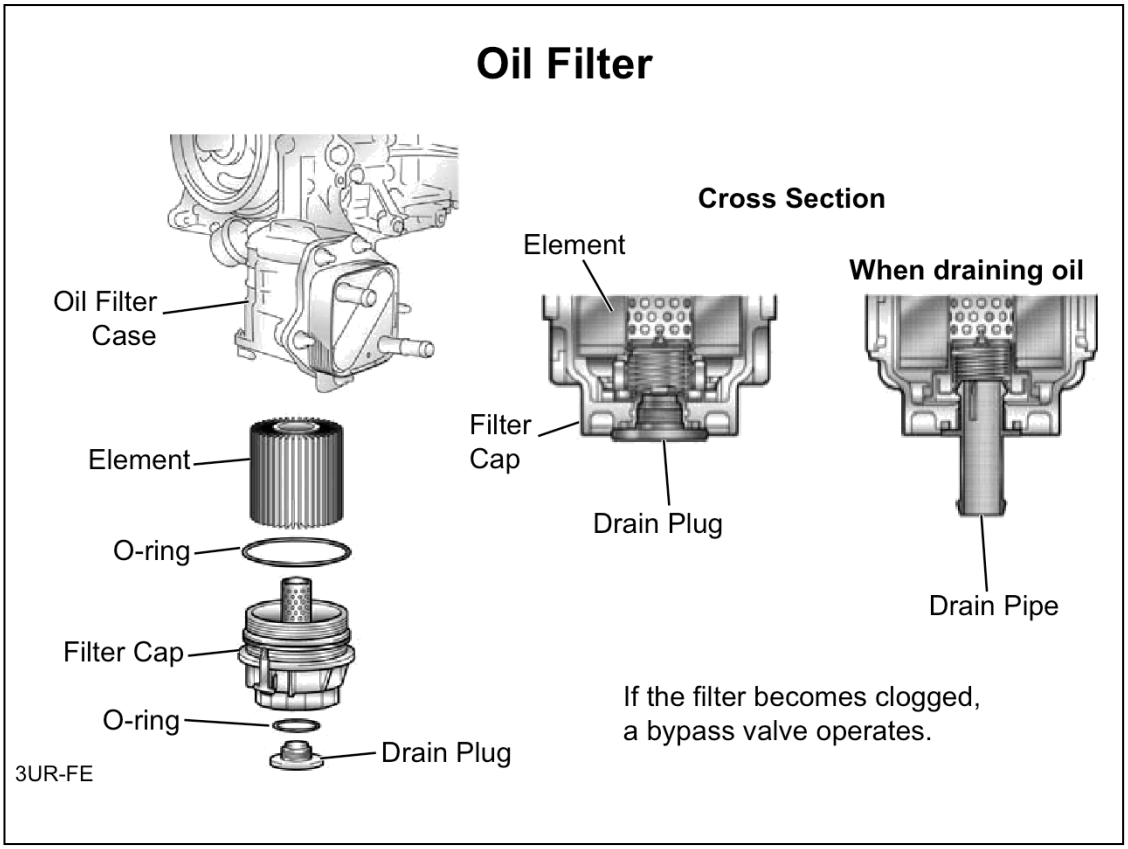
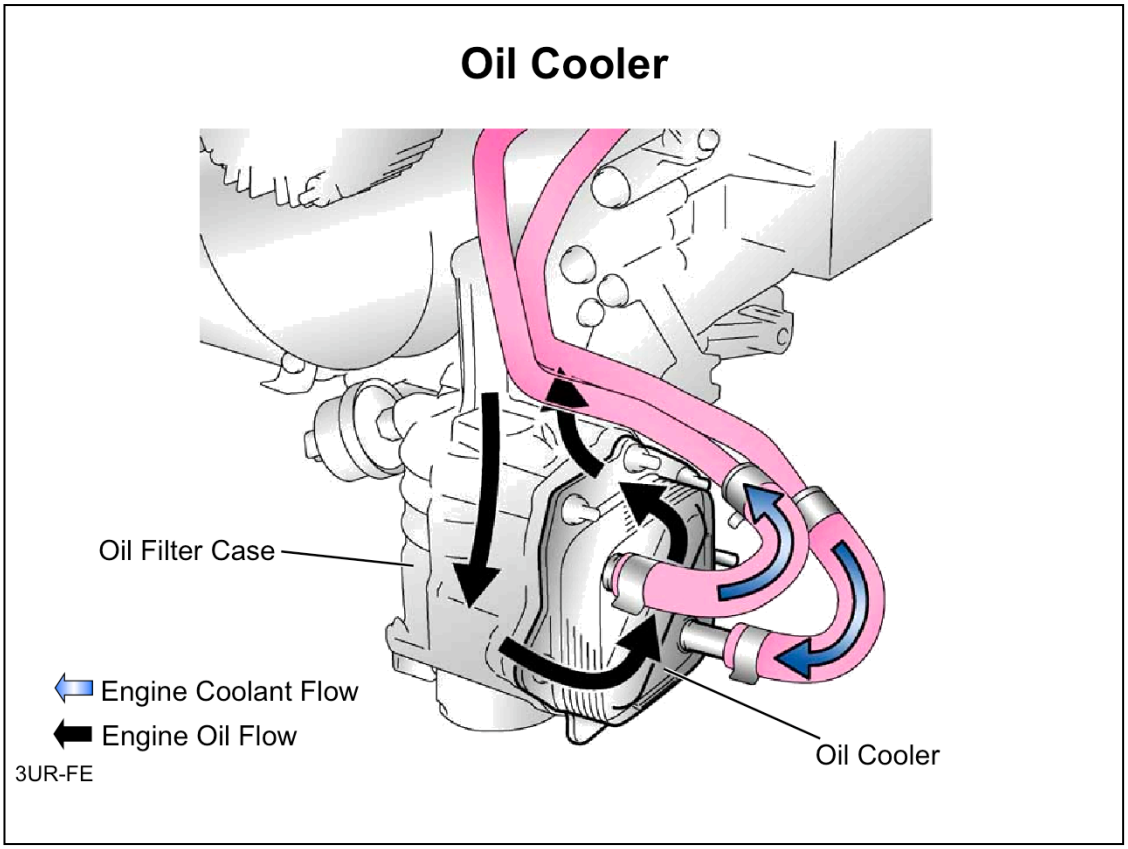
Oil Jets In the past, oil was splashed onto the cylinder walls either by excess oil from crankshaft journals or oil slung from the crankshaft passing through oil in the pan. Today, the crankshaft does not pass through the oil in the pan as it rotates thus reducing friction and engine load. Instead, oil is sprayed directly into the lower end of the cylinder by oil jets mounted in the cylinder block.

NOTE When inspecting for a lack of lubrication concern or during engine block replacement, it is important to check oil jet function. Use compressed air to test the check ball and make sure the oil passages are not blocked.



Oil Filter The oil filter illustrated above uses a replaceable paper element that comes with a drain tube. Before removing the filter cap to replace the element, remove the drain plug and insert the drain tube in the cap to drain the oil from the filter.

This type of oil filter requires SST 09228-06501 to remove and replace the filter cap. When tightening the filter cap, be careful not to over tighten. If the filter cap is over tightened, it might be damaged the next time someone attempts to remove it.



Oil Cooler

Like most automotive fluids, excessive heat reduces engine oil life. Under certain operating conditions – such as towing – auxiliary oil coolers are installed to help maintain engine oil temperature.

Oil coolers may introduce oil into the cooling system or vise versa if o-rings or other internal components fail. It is important to inspect oil coolers if fluids become cross contaminated.

Oil Properties and Grades

Purpose

- Lubricate
- Cool
- Clean
- Seal

Viscosity – How easily does it pour?

- Low viscosity pours easily (thin)
- High viscosity pours slowly (thick)

0W-20

Viscosity at 212ºF

Viscosity at 0ºF
(W = Winter)

? *How can oil be thinner at 0ºF than at 212ºF?*
Why would that be desirable?

- Current Toyota engines use multigrade engine oil meeting the ILSAC GF-4 specification for 2005 and newer engines.
- Oil with the API SM rating is ILSAC GF-4 compliant.

The ILSAC (International Lubricant Standardization and Approval Committee) Certification Mark is found on some oil containers.

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Oil Properties and Grades

The purpose of oil is not just to lubricate to reduce wear. Oil also cools, cleans and helps seal the pistons.

Multigrade oil is signified with two **viscosity** measurements. Look at 0W-20 grade motor oil for example. The 0W indicates a low viscosity when cold. Oils with a low value before the W allow for easier engine starting in cold weather.

The 20 in 0W-20 indicates a higher viscosity when the oil is at its operating temperature. An oil with an even higher viscosity may be recommended if the vehicle is operated at high speeds, or under extreme load conditions.

Viscosity and Temperature

Viscosity describes how easily a liquid pours. Low viscosity liquids pour easily. They may be described as “thin.” Water has a low viscosity. High viscosity liquids pour slowly. They may be described as “thick.” Pancake syrup has a higher viscosity than water,

As temperature decreases, a liquid’s viscosity goes up. Example: syrup pours more slowly when it’s cold. As temperature increases, a liquid’s viscosity goes down. Example: syrup pours more easily when it’s hot.

NOTE

Multigrade oils include additives that cause the oil to become thicker when heated. That is why 0W-20 is thinner when it’s cold and thicker when it’s hot.

Current Toyota engines use multigrade engine oil meeting the ILSAC GF-4 specification for 2005 and newer engines. Oil with the API SM rating is ILSAC GF-4 compliant.

Oil Inspection

Oil Condition	Indication
Brown (coffee-with-cream color)	Coolant in the oil; blown head gasket; cracked block/ head
Thick, sludgy	Overheating or long time since last oil change
Gritty or visible metallic material	Excessive wear of internal components
Thin, smells of fuel	Fuel in the oil

Thick, sludgy oil deposits in the camshaft housing

Oil Inspection

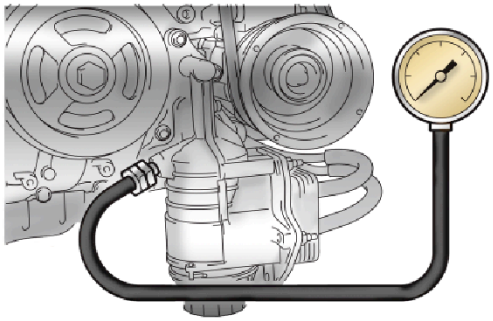
An initial oil inspection should be performed during every service.

First, the engine oil level should be noted. If the engine oil level is low and there are no signs of an external leak it may be necessary to pursue a possible oil consumption concern.

Second, the oil should be inspected for its condition. Note color, smell, and quality. If any of these seem out of the ordinary, further inspection may be necessary.

Oil Pressure Test

Remove the oil pressure sender gauge and install an oil pressure gauge.



- Warm up the engine and record oil pressure at the engine RPMs specified in the Repair Manual.
- If the oil pressure is not as specified, inspect the oil pump.
- After reinstalling the oil pressure sender gauge, inspect for oil leaks

Oil Pressure Gauge and Adapters

Oil Pressure Test

An oil pressure test provides a good indication of oil pump operation. Unfortunately, this test does not guarantee oil pressure is being delivered throughout the entire lubrication system.

For example, if good readings are shown at idle with the oil pressure tester but severe lifter noise is present, this may indicate a restriction is present somewhere in the system.

Like a good doctor does, however, you should verify the “heart” or pump is working adequately first before condemning another component or system.

Causes of High or Low Oil Pressure

Low Oil Pressure Causes

- Low oil level
- Oil level too high
- Diluted oil
- Excessively high oil temperature
- Worn engine bearings/ excessive oil clearance
- Worn oil pump
- Missing oil plugs
- Sticking pressure relief valve
- Air leak in oil pickup tube
- Plugged oil filter
- Wrong viscosity

High Oil Pressure Causes

- Sticking pressure relief valve
- Restriction in an oil passage in the engine block
- Wrong viscosity

Causes of High or Low Oil Pressure

Some of the causes of low or high oil pressure include:

Oil Level Too High – When the oil level is too high, the crankshaft may splash the oil, causing it to become aerated. Air in the oil is compressible and reduces pump efficiency.

Missing Oil Plugs – Some of the oil passages are formed by drilling into the block and then plugging the entry hole. A missing plug creates a leak in the system preventing it from being able to pressurize.

Plugged Oil Filter – A plugged oil filter creates a restriction in the system that reduces the oil pressure in the oil circuit after the filter. Most filters have a bypass valve that opens when the restriction from a plugged filter becomes too high. The oil still flows, but the oil pressure is reduced to what is permitted by the bypass valve.

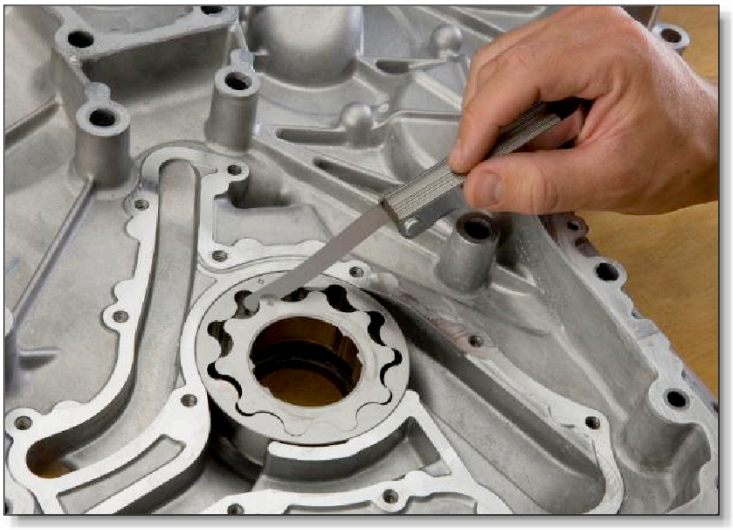
Sticking Pressure Relief Valve – The oil pump pressure relief valve is designed to open when oil pressure is too high, allowing some of the pressurized oil to leak back into the oil pan. If the relief valve is sticking, it may not be able to open when necessary to reduce oil pressure. If the relief valve is stuck open, the system will be unable to pressurize adequately.

Worn Engine Bearings or Excessive Oil Clearance – The tiny space between the bearings and journals creates the resistance necessary to pressurize the oil system. If the space between bearings and journals is greater than normal, then it allows oil to leak out faster than normal resulting in lower oil pressure.

Air Leak in Oil Pickup Tube – If the oil pump is getting air in it, the pump will not work efficiently because the air is compressible.

Inspect Oil Pump Tip Clearance

Measure the clearance between the drive and driven rotor tips.



If the tip clearance is greater than the maximum specified in the Repair Manual, replace the timing chain cover sub-assembly.

Oil Pump Inspection-Tip Clearance

The tip clearance dictates the oil pump's effectiveness. The greater the clearance, the less effective the pump is at generating output pressure.

Typically, modern engine oil pumps generate adequate pressure when driving down the road but it is important to generate sufficient pressure at all driving conditions, even idle. A too-tight clearance may cause the pump to bind and prematurely fail.

Inspect Oil Pump Side Clearance

Measure the clearance between the rotors and a steel square.

If the side clearance is greater than the maximum specified in the Repair Manual, replace the timing chain cover sub-assembly.

Oil Pump Inspection-Side Clearance

Oil pump side clearance ensures the pump does not bind inside the housing. If clearance is too excessive, oil pressure will be low. If clearance is too tight, the pump will prematurely wear and eventually fail.

Inspect Oil Pump Body Clearance

Measure the clearance between the timing chain cover and driven rotor .

If the body clearance is greater than the maximum specified in the Repair Manual, replace the timing chain cover sub-assembly.

Oil Pump Inspection-Body Clearance

Oil pump body clearance ensures the pump does not bind inside the housing. If clearance is too excessive, oil pressure will be low. If clearance is too tight the pump will prematurely wear and eventually fail.