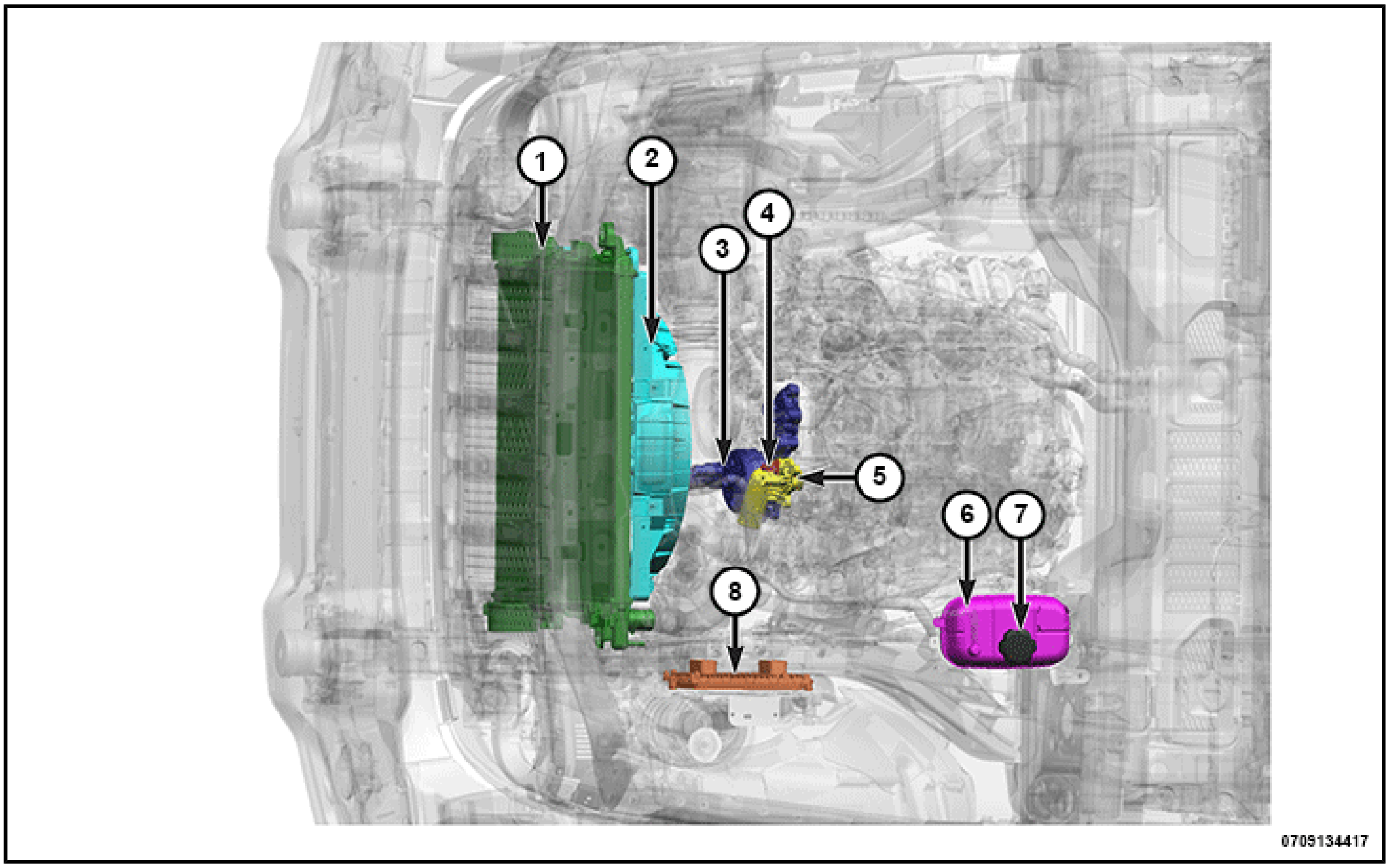
DESCRIPTION AND OPERATION

DESCRIPTION



The cooling system consists of the following components:

Component Index

1.	Radiator
2.	Electric Cooling Fan
3.	Water Pump
4.	Engine Coolant Temperature (ECT) Sensor
5.	Thermostat and Housing Assembly
6.	Pressurized Coolant Bottle
7.	Cooling System Pressure Cap
8.	Powertrain Control Module (PCM)
—	Coolant

OPERATION

The cooling system regulates engine operating temperature. It allows the engine to reach normal operating temperature as quickly as possible, maintains normal operating temperature and prevents overheating.

The cooling system also provides a means of heating the passenger compartment, cooling the exhaust gases entering the Exhaust Gas Recirculation (EGR) Cooler, and cooling the engine oil. The cooling system also helps heat up the transmission oil by flowing through the transmission oil heater.

The cooling system is pressurized and uses a centrifugal water pump to circulate coolant throughout the system. A separate and remotely mounted, pressurized coolant bottle is used. When the engine is cold the thermostat is closed and the cooling system has no flow through the radiator or the transmission oil heater. The coolant flows through the engine, engine oil cooler, water pump, EGR Cooler, and passenger compartment heater core while the thermostat is closed. When the engine is warm the thermostat is full open and coolant will then flow through the radiator and transmission oil heater.

Coolant

Component Index

The cooling system is designed around the coolant. The coolant must accept heat from engine metal in the cylinder head area near the exhaust valves and engine block. Then coolant carries the heat to the radiator where the tube/fin radiator can transfer the heat to the air. The use of aluminum cylinder blocks, cylinder heads, and water pumps requires special corrosion protection. Mopar® Antifreeze/Coolant, or the equivalent ethylene-glycol base coolant with organic corrosion inhibitors (called OAT, for Organic Additive Technology) is recommended. This coolant offers the best engine cooling without corrosion when mixed with 50% ethylene-glycol and 50% distilled water to obtain a freeze point of -37°C (-35°F). If it becomes contaminated, drain, flush, and replace with fresh properly mixed coolant solution.

Cooling System Pressure Cap

Component Index

All radiators are equipped with a pressure cap. This cap releases pressure at some point within a range of 145 kPa (21 psi). The pressure relief point (in pounds) is printed in yellow on top of the cap. The cooling system will operate at pressures of 145 kPa (21 psi) above atmospheric pressure. This results in a higher coolant boiling point allowing increased radiator cooling capacity. The cap contains a spring-loaded pressure relief valve. This valve opens when system pressure reaches the release range of 145 kPa (21 psi). A rubber gasket seals the cap to maintain vacuum during coolant cool-down and to prevent leakage when system is under pressure.

Electric Cooling Fan

Component Index

The electric cooling fan is integral to the fan shroud and is located between the radiator and the engine. The electric fan is controlled by the PCM. The electric cooling fan is not serviceable. Any failure of the fan blade, electric motor or fan shroud requires replacement of the fan module. The electric cooling fan is powered by a fuse located in the Power Distribution Center (PDC).

Engine Coolant Temperature (ECT) Sensor

Component Index

The ECT sensor is used to sense engine coolant temperature. The sensor protrudes into the thermostat housing. The ECT sensor is a two-wire Negative Thermal Coefficient (NTC) sensor. Meaning, as engine coolant temperature increases, resistance (voltage) in the sensor decreases. As temperature decreases, resistance (voltage) in the sensor increases. With the ignition switch in the ON position, the PCM sends out a regulated 5 volt signal to the ECT sensor. The PCM then monitors the signal as it passes through the ECT sensor to the sensor ground (sensor return). When the engine is cold, the PCM will operate in open loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

Powertrain Control Module (PCM)

Component Index

The PCM is located next to the washer solvent reservoir. The PCM is a digital computer containing a microcontroller. The PCM receives input signals from various switches and sensors that are referred to as PCM Inputs. Based on these inputs, the PCM adjusts various engine and vehicle operations through devices that are referred to as PCM Outputs.

The PCM is powered by a fuse located in the PDC. The PCM uses the Controller Area Network-Chassis (CAN-C) bus to perform engine diagnostics and flash operations.

The PCM manages the cooling fan activation and speed selection by sending a desired Pulse Width Modulated (PWM) duty cycle (%) at a specified frequency (Hz) to the radiator fan. The PCM controls activation and deactivation of cooling fan to protect the engine from been over heated. During the fan activation, speed selection and deactivation of the radiator fan is based on the value of engine thermal variables that the PCM continuously monitors through direct equipped sensors, estimated algorithms, or it could be through request via Controller Area Network-Chassis (CAN-C) Controller Area Network-Electronic Powertrain (CAN-EPT).

The PCM is powered by a fuse located in the PDC.

CAN-C Inputs

- Electronic Climate Control (ECC)/Heating, Ventilation, & Air Conditioning (HVAC) request
- A/C refrigerant pressure sensor information
- Engine oil temperature
- Engine coolant temperature
- Engine RPM
- Engine run status
- Intake air temp
- Engine thermal management demand
- Vehicle speed
- Commanded ignition switch status
- Hood ajar status
- Ambient temp sensor voltage
- Maximum A/C demand to powertrain
- Transmission fluid temperature

CAN-C Outputs

- Radiator fan PWM duty cycle command [%]

CAN-EPT Inputs

- Air flow request

CAN-EPT Outputs

- Radiator fan request

Hardwire Outputs

- PWM command signal to the radiator cooling fan

Pressurized Coolant Bottle

Component Index

A multi-chambered liquid coolant receiving bottle unitized from upper and lower plastic parts forming part of the closed coolant system of an internal combustion engine. When unitized the bottle comprises a pressurized coolant deaeration chamber separated by a convexly curved stationary pressure wall from overflow chamber. The chambers are arranged laterally side-by-side and are hydraulically connected to one another by a hose external of the bottle. The upper plastic part forming an upper portion of the coolant chamber supports a coolant filler neck that operatively mounts a pressure cap thereon. The pressure cap has a lower primary seal, an upper secondary seal and a vacuum breaker valve and cooperates with the filler neck so that coolant is transmitted to the overflow chamber from the deaeration chamber when the coolant of the system expands and from the overflow chamber to the de-aeration chamber when the system coolant contacts and creates a vacuum.

Radiator

Component Index

A heavy duty cross-flow aluminum/plastic radiator is used. The radiator consists of an aluminum core and plastic end tanks, which are fastened to the core with clinch tabs and sealed with a high temperature rubber gasket. Vehicles equipped with automatic transmissions use a separate A/C condenser and transmission oil cooler located on the front of the radiator. If the plastic tank has been damaged, individual parts are not available, and the radiator must be replaced. As air passes through the radiator core, the heat within the coolant is dissipated into the ambient air.

Thermostat and Housing Assembly

Component Index

A diaphragm-type thermostat controls the operating temperature of the engine by controlling the amount of coolant flow to the radiator. The thermostat is located inside of the thermostat housing and is serviced with the housing as one unit. On all engines the thermostat begins to open at 88°C (190°F) to allow flow to the radiator. The thermostat is fully open by 100#C (212#F). This provides quick engine warm up and overall temperature control. The same thermostat is used for winter and summer seasons. An engine should not be operated without a thermostat, except for servicing or testing. Operating without a thermostat causes other problems such as longer engine warm-up time, unreliable warm-up performance, increased exhaust emissions and crankcase condensation. This condensation can result in sludge formation. The wax motor is located in a sealed container at the spring end of the thermostat. When heated, the internal wax expands, overcoming closing spring tension and water pump pressure to force the valve to open.

Water Pump

Component Index

A centrifugal water pump circulates coolant through the water jackets, passages, intake manifold, radiator core, cooling system hoses and heater core. The pump is driven from the engine crankshaft by a single serpentine main drive belt. The water pump impeller is pressed onto the rear of a shaft that rotates in bearings pressed into the housing. The housing has two small holes to allow seepage to escape. The water pump seals are lubricated by the antifreeze in the coolant mixture.

No additional lubrication is necessary. The water pump is mounted directly to the timing chain cover and is equipped with a non serviceable integral pulley. The water pump is used to circulate coolant through the cooling system. The coolant is pumped through the engine block, cylinder head, heater core, EGR cooler, oil cooler, transmission oil heater, and radiator.

AERATION

If coolant level drops below a certain point, aeration will occur drawing air into the water pump resulting in the following:

- High coolant temperatures.
- Loss of coolant flow.
- Corrosion in the cooling system.
- Water pump seal may run dry, increasing the risk of premature seal failure.

NOTE: Combustion gases leaking into the engine coolant can also cause the above problems.

DEAERATION

As air is removed from the cooling system, it gathers in the pressurized coolant bottle. When this pressure exceeds the maximum pressure specification on the pressure cap, it is released into the atmosphere through the pressure valve located in the coolant bottle cap.

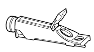
NOTE: Deaeration does not occur in the engine cooling system at engine idle, higher engine speeds are required. Normal driving will deaerate the engine cooling system.

To effectively deaerate the system, multiple thermal cycles of the system may be required.

COOLANT CONCENTRATION TESTING

Special Tools:

Click here to launch the form to order any tools you need.

	8286 - Refractometer

CAUTION: Do not mix types of coolant - corrosion protection will be severely reduced.

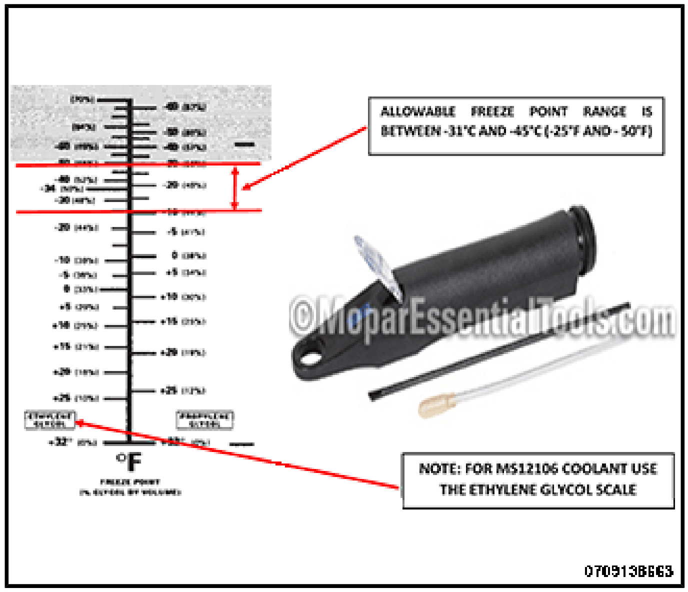
CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

Check coolant concentration when any additional coolant is added to the system, or after a coolant drain, flush and refill. Use of a hydrometer or the Refractometer 8286 can be used to test coolant concentration.

- A hydrometer tests the amount of glycol in a mixture by measuring the specific gravity of the mixture. The higher the concentration of ethylene glycol, the larger the number of balls that will float, and the higher the freeze protection (up to a maximum of 60% by volume glycol).
- The Refractometer 8286 tests the amount of glycol in a coolant mixture by measuring the amount a beam of light bends as it passes through the fluid.
- Some coolant manufacturers use other types of glycols in their coolant formulations. Propylene glycol is the most common new coolant. However, propylene glycol based coolants do not provide the same freezing protection and corrosion protection and are not recommended.

1. Visually inspect the coolant for contamination. Must be free of engine oil, transmission oil, dirt and/or other materials that can adversely affect the cooling system.
    - If the coolant is **found to be contaminated** after a visual inspection, discard the coolant.
    - If the coolant is **found to be clear of contamination** after a visual inspection the test the coolant concentration.

2. Using a Refractometer 8286 or equivalent, following the manufacturer's instructions, test the coolant freeze point:
   - If the coolant freeze point **is between** -31°C and -45°C (-25°F and -50°F), save the coolant for reuse.
   - If the coolant freeze point **is not between** -31°C and -45°C (-25°F and -50°F), discard the coolant.

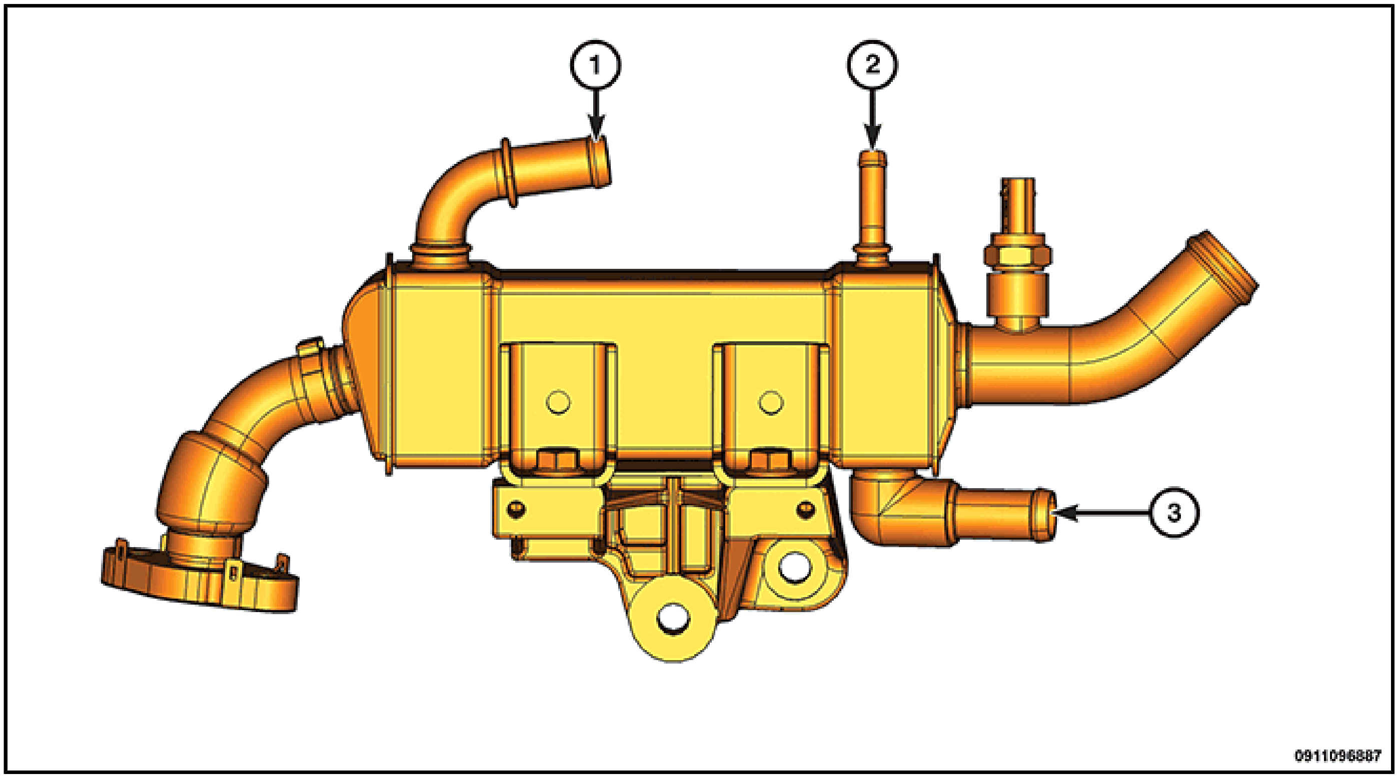


EGR COOLER LEAK TEST

1. First perform a cooling system pressure test (Refer to 07 - Cooling/Diagnosis and Testing) .

   NOTE: If the cooling system has been losing coolant and there are no external leaks showing, the Exhaust Gas Recirculation (EGR) cooler may be leaking internally.

2. If the leak has not been found, using this method, it may be necessary to remove the EGR cooler and perform a bench test.



3. Install a plug into the EGR cooler coolant inlet port (1) and outlet port (3).
4. In the smaller inlet port (2), install the vacuum test adapter.

   NOTE: The plug and the adapter must have an air tight fit to prevent misdiagnosis.

5. Pump up the commercially available vacuum tool, while observing the pressure gauge, the vacuum should remain steady.
6. If the EGR cooler does not hold a vacuum, the EGR cooler has an internal leak and must be replaced.
7. If the EGR cooler holds vacuum, then refer to the engine internal leakage inspection (Refer to 07 - Cooling/Diagnosis and Testing) .

ENGINE BLOCK HEATER

If the unit does not operate, possible causes can be either the power cord or the heater element. Test the power cord for continuity with a 110-volt voltmeter or 110-volt test light. Test heater element continuity with an ohmmeter or a 12-volt test light.

CAUTION: To prevent damage, the power cord must be secured in it's retainer clips and away from any components that may cause abrasion or damage, such as linkages, exhaust components, etc.

ENGINE COOLING SYSTEM OVERHEATING

Establish what driving conditions caused the complaint. Abnormal loads on the cooling system such as the following may be the cause:

- Prolonged idle in a confined location
- Very high ambient temperature
- Slow traffic
- Traffic jams
- High speed or steep grades
- Trailer towing
- Debris on front of the grill or the cooling module that are restricting airflow

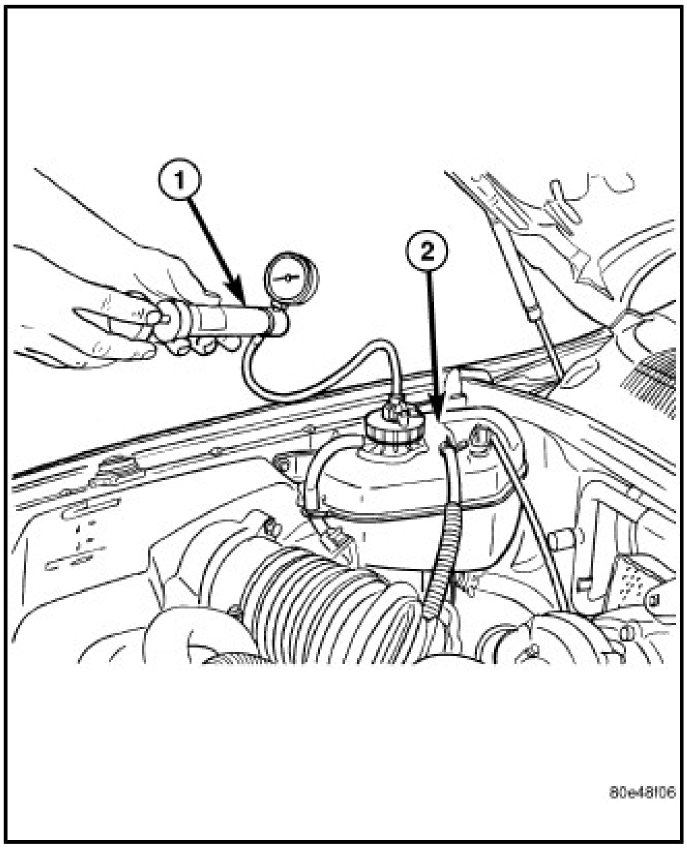
COOLING SYSTEM LEAKS

ULTRAVIOLET LIGHT METHOD

A leak detection additive is available through the parts department that can be added to the engine cooling system. The additive is highly visible under ultraviolet light (black light). Pour one ounce of additive into the engine cooling system. Place the heater control unit in HEAT position. Start and operate the engine until the radiator upper hose is warm to the touch. Aim the commercially available black light at the components to be checked. If leaks are present, the black light will cause the additive to glow a bright green color.

The black light can be used in conjunction with a pressure tester to determine if any external leaks exist.

PRESSURE TESTER METHOD



Pressure Testing Cooling System - Typical Cooling System Pressure Tester Shown.

WARNING: Hot, pressurized coolant can cause injury by scalding.

The cooling system being tested should be at normal operating temperature. Recheck the cooling system cold if coolant loss is not located during the warm system examination.

Make sure the system is not under pressure and carefully examine the pressure cap and the cap sealing surface for nicks, crack, paint, dirt and residue.

Inspect the outside of the filler neck. If damaged, seating of the pressure cap valve and tester seal could be affected.

Attach the SVT275 Cooling Pressure Tester (1) available from Mopar® Service Equipment, or an equivalent to the pressurized coolant bottle (2).

Note the maximum pressure specification on the pressure cap.

Operate tester pump to apply pressure to system. Do not exceed the maximum pressure specification on the pressure cap. If hoses enlarge excessively or bulges while testing, replace as necessary.

Observe gauge pointer and determine condition of cooling system according to following criteria:

Holds Steady: If pointer remains steady for two minutes, serious coolant leaks are not present in system. However, there could be an internal engine leak that does not appear with normal system test pressure. If it is certain that engine coolant is being lost and leaks cannot be detected, inspect for internal engine leakage or perform the Internal Engine Leakage Test (Refer to 07 - Cooling/Diagnosis and Testing).

Drops Slowly: Indicates a small leak or seepage is occurring. Examine all connections for seepage or slight leakage with a black light or a flashlight. Inspect radiator, hoses, gasket edges and components.

Drops Quickly: Indicates that serious leakage is occurring. Examine system for external leakage. If leaks are not visible, inspect for internal engine leakage and internal transmission heater leaks are possible.

INTERNAL ENGINE LEAKAGE INSPECTION

One method is to operate the engine for a short period to churn the oil and the remove the engine dipstick, and inspect for water globules on the stick. Depending on the results, it may be necessary to remove the engine oil pan drain plug and drain a small amount of engine oil. If coolant is present in the pan, it will drain first because it is heavier than oil.

WARNING: With radiator pressure tester tool installed on radiator, do not allow pressure to exceed 145 kpa (21 psi). Pressure will build up quickly if a combustion leak is present. To release pressure, rock tester from side to side. When removing tester, do not turn tester more than 1/2 turn if system is under pressure.

Operate the engine without the pressure cap on the engine pressurized coolant bottle until the thermostat opens. Attach a Pressure Tester to the filler neck. If pressure builds up quickly, it may indicate a combustion leak exists. This is usually the result of a cylinder head gasket leak or a crack in the engine, or a leaking engine oil cooler. Repair as necessary.

If there is not an immediate pressure increase, pump the Pressure Tester until indicated pressure is within the system range of 110 kPa (16 psi). Fluctuation of the gauge pointer indicates compression or combustion leakage into the engine cooling system.

Because the vehicle is equipped with a catalytic converter, **do not** short out cylinders to isolate the compression leak.

If the needle on the dial of the pressure tester does not fluctuate, increase the engine RPM’s a few times to check for an abnormal amount of coolant or steam. This would be emitted from the exhaust pipe. Coolant or steam from the exhaust pipe may indicate a faulty cylinder head gasket, cracked engine cylinder head or cylinder block.

TRANSMISSION HEATER LEAKAGE INSPECTION

1. If the engine is overheating and the transmission is shifting harshly from reverse to forward.
    1. Inspect the coolant in the pressurized coolant bottle and try to determine the type contamination, is the contamination transmission oil or engine oil?

2. If transmission oil contamination is suspected then remove the transmission fill plug from the right rear of the transmission case and obtain a sample of the transmission fluid.
3. Is the transmission fluid normal in color or is it milky in color?
4. If the transmission fluid is milky in color then their is a very good chance the transmission heater has an internal leak.

COOLING SYSTEM PRESSURE CAP

Remove the cap. Be sure that the sealing surfaces are clean. Moisten the rubber gasket with water and install the cap on a commercially available pressure tester.

Using the cooling system tester, bring the pressure up to the pressure prescribed on cap. If the pressure cap fails to hold up to 21 psi, replace the cap.

NOTE: The cap is designed to hold up to 21 psi. If during the test, the pressure rapidly bleeds off prior to 21 psi, the cap has failed.

The pressure cap may test properly while positioned on the pressure test tool. It may not hold pressure or vacuum when installed on the pressurized coolant bottle. If the test passes on the tool but there is sufficient evidence that the cap fails on the bottle, inspect the coolant bottle neck for damage or debris that may prevent the cap from sealing properly.

CAUTION: Radiator pressure testing tools are very sensitive to small air leaks which will not cause cooling system problems. A pressure cap that does not have a history of coolant loss should not be replaced just because it leaks slowly when tested with this tool. Add water to tool. Turn tool upside down and recheck pressure cap to confirm that cap needs replacement.