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Diagnostic Procedure for Engine Overheating

Normal operation: The normal operating temperature of an engine is about 200 – 210 degrees F. On the temperature gauge on the dash this is about center or ½ way up. At speeds above 40 mph there is enough air passing through the radiator to keep the engine cool at about 200 – 210 degrees F. At low speeds, the only way to get air though the radiator is the cooling fan. Most vehicles today use electric cooling fans to cool the radiator. The computer turns on the cooling fans at about 230 degrees F. At idle and speeds below 40 mph the temperature gauge will move from the center position to the ¾ position and the cooling fan will turn on. Then the gauge will return to the center position. This up and down is normal. This is a good time to note that when your Air Conditioning is turned on the cooling fan should turn on.

- Before we get into diagnosing an overheat problem, we need to talk to the person that has been experiencing the problem. We need to go over the normal operation of the cooling system with the person experiencing the problem. It is possible what they are experiencing is normal operation. With a real overheating problem the temperature gauge will go above the ¾ mark on the temperature gauge and continue going up.
- Does the problem occur at speeds below 40 mph or above 40 mph.
 Below 40 mph _____ Above 40 mph _____
- 3) Since the cooling fans today are electric it is good practice to test the fuses immediately as our first test.
 Locate and test the fuse using a test light. Fuse condition Good _____ Bad ____
 If the fuse is bad, replace it. If the fuse blows immediately find and repair the short before continuing.
 If the fuse does not blow immediately continue with the test procedure.
- 4) Any time we have an engine overheat problem or work on the air conditioning we need to inspect the AC condenser and the radiator to see that the fins are not plugged with debris. Usually from trees and plants but can even be paper. If air cannot pass through the condenser and radiator the engine will run hot and can overheat. Also, the air conditioning will not cool properly.

Is the condenser and radiator clean of debris? Yes/No _____

If you cannot see through them clean them out with any kind of spray cleaner and a garden hose.

 5) Inspect the coolant level in the cooling system.
 Low
 Full

 6) Test the antifreeze to be sure it is good for at least -30 degrees F.
 Yes_____
 No_____

If the coolant is low, there are 2 possibilities. First there could be a leak and the coolant got low, which caused the engine to overheat or second the coolant could be low because the engine overheated and blew the coolant out.

If the coolant is low, Fill the system and pressure test the cooling system and look for leaks.

How much coolant did you add?

If the coolant is full that means the engine did not overheat enough to blow the coolant out of the system. Refer to the normal operation described above. Be sure we have an overheating problem.

Water boils at 212 degrees F. We can see from the normal operation above if the antifreeze is not good enough it will boil just because of the normal operating temperature of the engine. Also in very cold weather when temperatures are below 0 degrees F the coolant can freeze in which case the engine can overheat before it melts and starts circulating and cooling the engine.

- 7) Pressure test the radiator cap to be sure it holds the proper pressure. The correct pressure is critical on some vehicles and they will overheat if the cap does not hold the proper pressure.
 What is the factory specification?
 Does the cap hold the proper pressure?
 Yes _____
 No _____
- 8) The next tests are for the coolant temperature sensor and the thermostat

The coolant temperature sensor is a vital part of todays engine systems. The computer not only turns the cooling fan on or off based on the coolant temperature sensor, but it is the first sensor the computer looks at when we start the engine. The computer determines how much fuel to put into the engine to start the engine without flooding it.

Connect a scan tool to the data connector and get the data readout. Start with the coolant temperature sensor.

There are two ways to confirm the reading of the coolant temperature sensor. If the engine has been sitting and is normalized to the outside air temperature you can simply compare the engine coolant temperature sensor reading with the intake air temperature sensor reading. They should be close.

If the engine is not normalized to the outside air temperature use an infra-red thermometer. You can locate the coolant temperature sensor on the engine and test the temperature with the infra-red thermometer then compare that to the reading from the data read out.

Coolant Temperature Sensor reading_____Intake Air Temperature Sensor reading_____Infra-red temperature reading_____

If the coolant temperature sensor is not reading correctly it will throw off the way the computer operates the engine and the way the cooling fans are operated.

9) The next is the thermostat. Most thermostats start to open before 200 degrees F. Check the manufacturers specification for opening temperature. We can tell when the thermostat opens a number of ways. One is to feel the upper radiator hose. When the thermostat opens the hose will get hot. On some cars we can run the engine without the radiator cap installed and we can see the coolant flow in th e radiator. We can also use an infra-red thermometer to measure the temperature increase at the radiator. Which ever procedure you use note the opening temperature.

Opening temperature _____ degrees F

If the thermostat does not operate according to specifications it will need to be replaced.

10) Now we test the cooling fan operation. As the engine temperature goes up the cooling fan should turn on around 230 degrees F.

Temperature cooling fan turns on at. _____ degrees F

11) If the cooling fan does not turn on, we need to test for power to the relay, relay operation and cooling fan operation. The way manufacturers operate the cooling fans change all the time. There are some now that operate based on frequency command from the ECM. The best way to test those systems is with an oscilloscope. I will not cover that here. The procedure here applies to most vehicles but not all vehicles.

The best way to start is by locating the cooling fan relay. Remove the relay. Most relays have 4 terminals and even the relays with 5 terminals usually only use 4 of the 5 terminals.

A quick way to test the cooling fan relay is to find a relay that is like the cooling fan relay in the fuse box. Sometimes it will even be the horn relay. Test the system (horn) with the same relay as the cooling fan relay and see if it works. If it is the horn that is nice, see if the horn beeps. If the system (horn) works install the cooling fan relay and test the system (horn) and see if it works. If the system (horn) works with the cooling fan relay, the relay is good.

With the cooling fan relay pulled out of the fuse box you will see 4 connectors that the relay plugs into. You can test these terminals using a 12 volt test light. You can test for power and ground using the same light. There will be one power wire that is hot all the time and one that gets hot when the ignition is turned on. Find those 2 power wires and note which terminals they are.

Hot all the time yes/no ____ Hot with the key on yes/no ____

Next there will be 2 ground terminals. One that is grounded all the time and another that the computer grounds to activate the cooling fan. Find the terminal that is grounded all the time. That should be the wire to the cooling fan. You only need to find the one that is going to the cooling fan, the one that is grounded all the time.

Found the terminal grounded all the time yes/no _

- Make a jumper with a fuse in it the same size as the cooling fan fuse,
- Connect the always hot terminal to the always grounded terminal and the radiator cooling should start and run without blowing the fuse.

The last part of the cooling fan test is to be sure the wire from the cooling fan relay to the computer is good. Use your test light between the positive battery terminal and the connector that is not hot or grounded. That should be the computer wire.

- Run the engine so it gets hot while watching the coolant temperature on you scan tool.
- Around 230 degrees F the light should turn on indicating that the computer has grounded the relay and is commanding the radiator cooing fan to turn on.
- 12) There is one thing we have not covered here. That is overheating due to a head gasket problem. The only test I have found to be 100% accurate 100% of the time is to use an exhaust gas analyzer to see if exhaust is getting into the cooling system. The procedure is simple and easy.
 - Remove enough coolant so you will not suck it into your exhaust analyzer.
 - Place the exhaust analyzer pickup into the radiator or coolant tank keeping it away from any coolant.

- With the engine running watch the analyzer gauges.
- You should not see any Carbon Monoxide or Hydrocarbons, If you do there is a head gasket leak or a cracked head.

Readings CO ____ HC ____