

| Getting Cooling System Diagnosis Right The First Time

From the customer interview,
pressure testing and antifreeze to fans,
thermostats and radiator capacity.

A cooling system is simple. Right? It's so simple the whole system can be summarized in only one sentence -- Heat from the engine is absorbed by coolant in the water jacket, then pumped through the thermostat to the radiator, where it's released when air flows across the fins from a cooling fan or the movement of the car.

Despite its seeming simplicity, getting cooling system diagnosis right the first time can be a challenge. Getting it wrong is not only frustrating for everyone involved, it can lead to additional damage and cost. This article will provide you with tips to help ensure your customers need only come in once to have their cooling system problems fixed.

| Talking To The Customer

Good cooling system diagnosis starts with a good interview when the car is dropped off. Spending a few moments talking to your customer before you begin can save a lot of time once the meter is running. If the customer reports the car only overheats on the freeway, you know to look for a flow problem such as a restricted radiator, a thermostat that does not fully open, blocked radiator fins, or -- in rare cases -- an eroded water pump impeller. If the customer reports the car overheats when driving around town, but cools at higher speeds, you'll know to check the fan operation.

It's also a good idea to ask customers how they know the car engine is overheating. Is the gauge reading high? Is there steam coming from under the hood?

Are there puddles of coolant on the ground? By asking these questions, you avoid spending time "diagnosing" a dripping A/C evaporator, or investigating a car that "felt hot" when your customer was adding oil to the engine.

It's also important to find out whether the customer has added any coolant. If the car overheated due to low coolant caused by a slow leak or lack of maintenance, but the customer filled the system before bringing the car in, knowing this tidbit may be very helpful in your diagnosis.

The interview also gives you an opportunity to gauge your customer's knowledge about the cooling system and provide a better understanding if necessary. For instance, if your customer says, "It was overheating for about five minutes before I heard the knocking noise," you'd explain that pulling over and stopping as soon as it's safe to do so is the best course of action when the car starts to overheat.

| Start with some quick basic checks

Take a few moments to look for signs of engine damage before you start your cooling system diagnosis. Checking for melted plastic parts, such as a timing cover or the radiator filler neck, is a quick way to gauge how hot the engine was. Most plastics melt at over 400 deg. F. If the engine was over 400 degrees, damage is more likely than if the engine was "only" at 270 degrees. Testing the head gasket is also a good idea, but more on that later.

Informing your customer that

there is a high likelihood of damage, and recommending appropriate additional testing before he or she spends money fixing the cooling system, will help to adjust your customer's expectations to match reality. If everyone is on the same page, it's far more likely that your customer will be satisfied, even if the needed repair turns out to be a large one.

You should also make a habit of checking the oil before you begin testing. This may seem unrelated to the job at hand, but it's not. When an engine is overheating, it will consume far more oil than an engine running at normal operating temperature, so it's possible the oil level is dangerously low. Failing to adjust the oil level before testing could lead to disaster during testing.

This quick check also gives you an opportunity to look for coolant contamination or overheated oil. If the oil has been "cooked" it will have a characteristic burnt odor and should be changed. If the motor oil has a coffee and cream color, or looks like a strawberry milkshake, there is likely a problem with the engine sealing or the transmission cooler.

Before you start the car, refer to the appropriate Nissan/Infiniti ESN for instructions on filling the cooling system. Basically, the procedure includes filling the radiator and overflow bottle, and bleeding the system to ensure there is no trapped air. Most Nissans have one or more bleeders that make removing trapped air easier. On models without bleeders, use the J-45695 Cooling System Refill Tool or equivalent to draw a vacuum on the cooling system

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before filling. You should also test the coolant ratio before starting the car. If you wait until the engine has been warmed up, you'll need to work around a pressurized system. Another reason to test coolant at room temperature is hydrometer and non-temperature-compensated refractometer tests are not accurate when performed with warm coolant.

A weak mixture is unlikely to be the sole cause of overheating, since the boiling point of straight water is 265 deg. F. at 15 PSI, and water is an excellent conductor of heat. However, a rich mixture can cause overheating. Straight coolant does have a very high boiling point -- about 387 deg. F. at sea level -- but 100% coolant is a very poor conductor of heat. A rich mixture may cause symptoms similar to a bad radiator or flow restriction.

It should be mentioned that coolant has functions beyond transferring heat and increasing the boiling point. Weak or acidic coolant should be replaced to prevent future cooling system problems. Your customer is likely relying on you for maintenance advice as well as diagnosis of the immediate problem.

| Testing the Vehicle When the Coolant Level is Low

Low coolant is a common cause of overheating. If the coolant is low, you'll need to find out why. Coolant may be low because it has leaked out, boiled over, or been consumed by the engine.

Checking for a combustion chamber leak is a good place to start testing, not because it is the

most likely cause of overheating, but because it's helpful to know if you have a head gasket sealing problem early in the diagnostic process.

Using a five-gas analyzer to check for hydrocarbons (HC) is a quick and accurate method of finding out if combustion gases are entering the cooling system, typically through a blown head gasket. However, it's not without its pitfalls. As your five-gas analyzer manufacturer will surely tell you, "Moisture is the enemy of all five-gas analyzers." A steamy radiator neck is a very moist environment indeed. There are three steps you can take to avoid damaging your analyzer:

1. Use a polyethylene water bottle with a hole in the top to avoid accidentally sucking coolant into your analyzer.
2. Don't run the test any longer than necessary.
3. Let the analyzer run for 15 minutes after the test to allow moisture to evaporate.

Performing the test and analyzing the results properly are key to avoiding unnecessary repairs. Most five-gas analyzers require a warm-up period before they can deliver reliable readings. Some analyzers take longer than others, so you will need to be familiar with the characteristics of yours.

While the analyzer is warming up, it can be normal for the HC PPM reading to climb. It's important not to misconstrue the rise in HC PPM during warm up as an indication of combustion gas in the cooling system.

HCs can often be measured in

the overflow bottle on a car with a leaking head gasket. However, even very high readings in the overflow bottle (say 100 PPM or more) should not be viewed as a conclusive test. There can be other explanations for the presence of HCs -- contamination through additives, or someone filling the system with a poorly-chosen container are just two possible explanations.

In order to make a conclusive test you must measure an increase in HCs at the radiator neck, which is affected by revving the engine. In other words, snap the throttle several times to verify that the HC PPM goes up right afterwards, and then back down after the engine idles for a while.

Whether the results of the HC check are positive or negative, you should proceed with the rest of your testing. Head gasket failure may be the cause of the overheating, or it may be a result. If the test is positive, check for anything that might have caused the head gasket failure before you do the repair.

| UV Leak Detection

There are several methods of checking for cooling system leaks, but Nissan/Infiniti recommends the UV dye test. This is especially useful when you suspect there is a leak that is either intermittent or very small. Once the UV dye is added to the coolant, the car can be driven for hours -- even days -- until the coolant level drops. When a technician shines an ultraviolet light on the residue from the coolant leak, it will glow bright green or yellow. A UV dye test is useful whether the loss of coolant was due to an external leak or a boil-over. No matter where the



| Figure 1 – The Nissan/Infiniti-recommended UV method is a great way to find leaks, but make sure you use a dye formulated to work with water-based fluids, such as Part Number J-29545-6A.

coolant "disappeared" to, there will be a glowing trail to follow.

A word of caution though: always use dye designed for water-based fluids when working on Nissan cooling systems. Using a dye designed for oil-based fluids may damage cooling system components. A top quality Nissan approved cooling system dye, part number J-29545-6A, can be purchased through Tech-Mate -- <http://www.nissantechmate.com>

| Pressure Testing

A pressure test is straightforward, but there are a few things to

consider. First is the length of the test. A slow leak will not show up in 30 seconds, so be willing to move on to other work and give the system a little time to leak under pressure. Also, Nissan usually recommends pressure testing at a pressure higher than the cap relief pressure. For instance, on a 2005 Altima with a cap pressure of 14 PSI, the recommended testing pressure is 23 PSI.

Don't forget to test the radiator cap. If the cap can't hold its rated pressure, the system will lose about a quarter of its capacity to the overflow the first time it's warmed up. Also, be sure to check the return valve on the radiator cap by

pulling it out with your fingernails, especially if you find the overflow bottle overfull and the radiator low. If the rubber on the radiator cap seal is swollen, replace the cap and check for the presence of oil or other cooling system contaminants that might have caused the swelling.

If you decide to pressure test with a warm engine because you suspect there's a leak affected by thermal expansion, be sure that you never have the engine running while your pressure tester is attached (there is no relief valve on a pressure tester, so you can damage your customer's car). Also, be aware that a pressure drop as a

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warm engine cools is normal, not a sign of a leak.

| Testing the Vehicle When the Coolant Level is OK

We've covered the possible causes for coolant loss and how to check for them, but what if the temperature gauge is reading too high and the coolant level is OK? Any good diagnostic effort must begin with an effort to confirm the customer's complaint. After checking the coolant level and doing a visual inspection, you can catch many cooling system problems using the in-bay methods that follow.

Starting cold, run the engine at 2,000 rpm in Neutral with the high beams and rear window defogger on. The electrical loads will cause the engine to work a little harder, reducing the time it takes to warm the engine.

Test thermostat operation by feeling the radiator hoses as the engine warms. Both the upper and the lower radiator hoses should be cold when you start. Let's assume the thermostat is in the lower hose water outlet. After the engine has run for a while, the upper hose should gradually warm as the engine warms the coolant, but the lower hose should stay relatively cold. Once the temperature gauge reaches the halfway point, the lower hose temperature should suddenly increase from cold to about the same temperature as the upper hose. If both hoses gradually warm together, there's a good chance the thermostat is stuck open. You will also be able to diagnose a thermostat that's stuck closed with this test -- the lower hose will stay relatively cold as the

gauge reaches the halfway point and beyond.

Read the description of the system in the appropriate ESM on the Nissan/Infiniti Service Information website so you'll understand exactly how it's supposed to work. Let's imagine what happens when the thermostat is stuck halfway open. Driving around town, the engine will run too cold because the thermostat allows coolant flow through the radiator all the time. The amount of flow would be more than sufficient to cool the engine. When driving on the freeway or up hills, the thermostat still allows flow all the time, but the volume of flow will be insufficient to cool the engine. A short time after the thermostat opens, the fan(s) should come on, then go off. Different models have different strategies for cooling fan operation. If in doubt, refer to the system description on the Nissan Service Information website (<http://www.nissan-techinfo.com>), or the Infiniti Service Information website (<http://www.infiniti-techinfo.com>).

No matter which model you're working with, make sure the air conditioning is off for the fan test, because you may mistake the fan's cycling with the A/C compressor for a normal fan cycle.

Finally, check temperature gauge accuracy. If your gauge is reading 7/8ths, and the coolant temperature is 195 deg. F., there is problem with gauge accuracy. Modern Nissan cars use the CTS, ECM, BCM, and CAN to provide gauge control. You can use the Consult II or Consult III for quick diagnosis of these systems. For older Nissan cars, you'll need to substitute resistors for the temperature sender, check wiring, check the instrument voltage regulator, etc.. All the specifications, diagrams, and

system descriptions are available in the appropriate Electronic Service Manual on the Nissan and Infiniti Service Information websites.

| Testing the Vehicle on the Road

One advantage to the in-bay test method is that you don't risk overheating while test driving far away from the shop. However, some problems won't show up in the bay. If the problem isn't apparent after the in-bay test, you'll need to test drive.

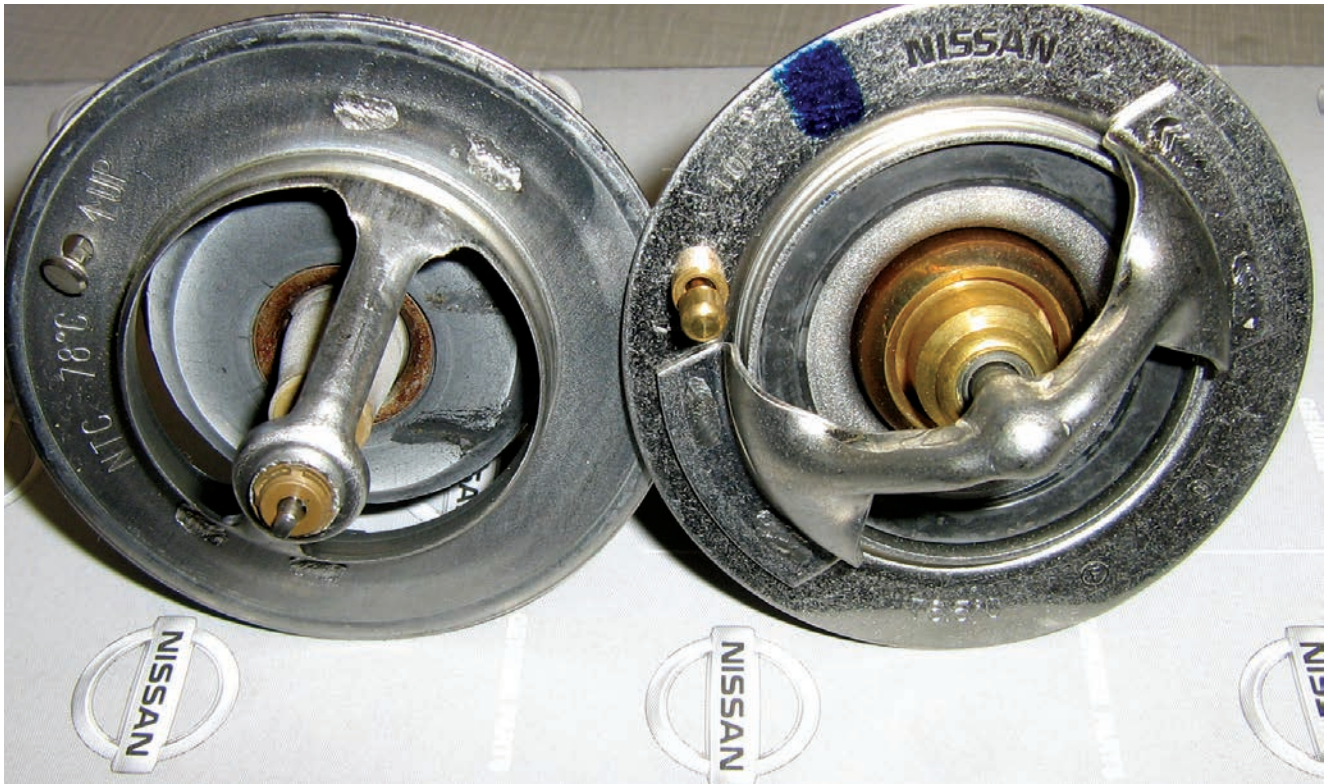
Before heading out towards the closest freeway grade or big hill, double check your visual inspection. Are all the fan shrouds and air dams in place? Is there debris in the radiator fins, or anything else that would block air flow? If the overheating problem is particularly wily, you may need to wait for a very hot day.

On your way to your favorite freeway or hill, note the temperature gauge reading.

Once you begin driving up hill, the needle shouldn't move from where it was during light-load driving. If it does, inadequate cooling system capacity is likely. Since all Nissan vehicles have ample cooling system capacity, this means there's a problem -- a thermostat that's not opening fully, or a radiator with a flow problem.

| Post Road Test Inspection

Once you're back at the shop, you'll need to do some additional testing based on your observations during the road test. If it looks like you have a flow volume or heat transfer problem, you'll need to test the thermostat and radiator. Directly testing the thermostat is



| Figure 2 – A thermostat stuck partially open

straightforward. Remove the thermostat from the car. Place it in a pot of water warmed to Nissan's thermostat opening specification (available online, but usually around 180 deg F). Then measure the valve lift (also available online, but usually around 10mm). If you don't have a hotplate and aluminum pot, you can purchase them inexpensively. They are necessary if you really care about doing diagnosis properly.

Regardless of whether or not the thermostat is OK, consider replacing it with a Genuine Nissan part. After all, the thermostat is a moving part that does wear with use. The primary reason to check it is not to decide whether or not to replace it; it's to decide whether the radiator or the thermostat is

causing the overheating.

Accurate radiator bench testing is impossible for most shops, so the basic rule of thumb is this: If the temperature gauge rises above its normal position under load, and the thermostat tests normally, the radiator is likely the culprit, and ought to be replaced before further testing. There are some less likely possibilities -- like a clogged by-pass tube or eroded water pump impeller -- but running down every possibility, no matter how unlikely, is not a good diagnostic strategy.

| **Quality control**

Regardless of what cooling system problems you find and correct on your customer's Nissan or Infiniti, attention to your

final quality control routine is very important. First, always use Genuine Nissan/Infiniti LLC (Long-Life Coolant) because nothing else meets all of the stringent specifications the engineers had in mind when they designed the engines for these vehicles. Finding and replacing a radiator with a cracked tank may seem like a slam dunk, but taking the time to verify that the whole system works properly after the repair is what separates the lucky mechanics from the good mechanics. This means verifying thermostat opening and fan operation, a good test drive, and letting the engine cool for a final coolant level check before delivering the vehicle, every time. |