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SUBARU

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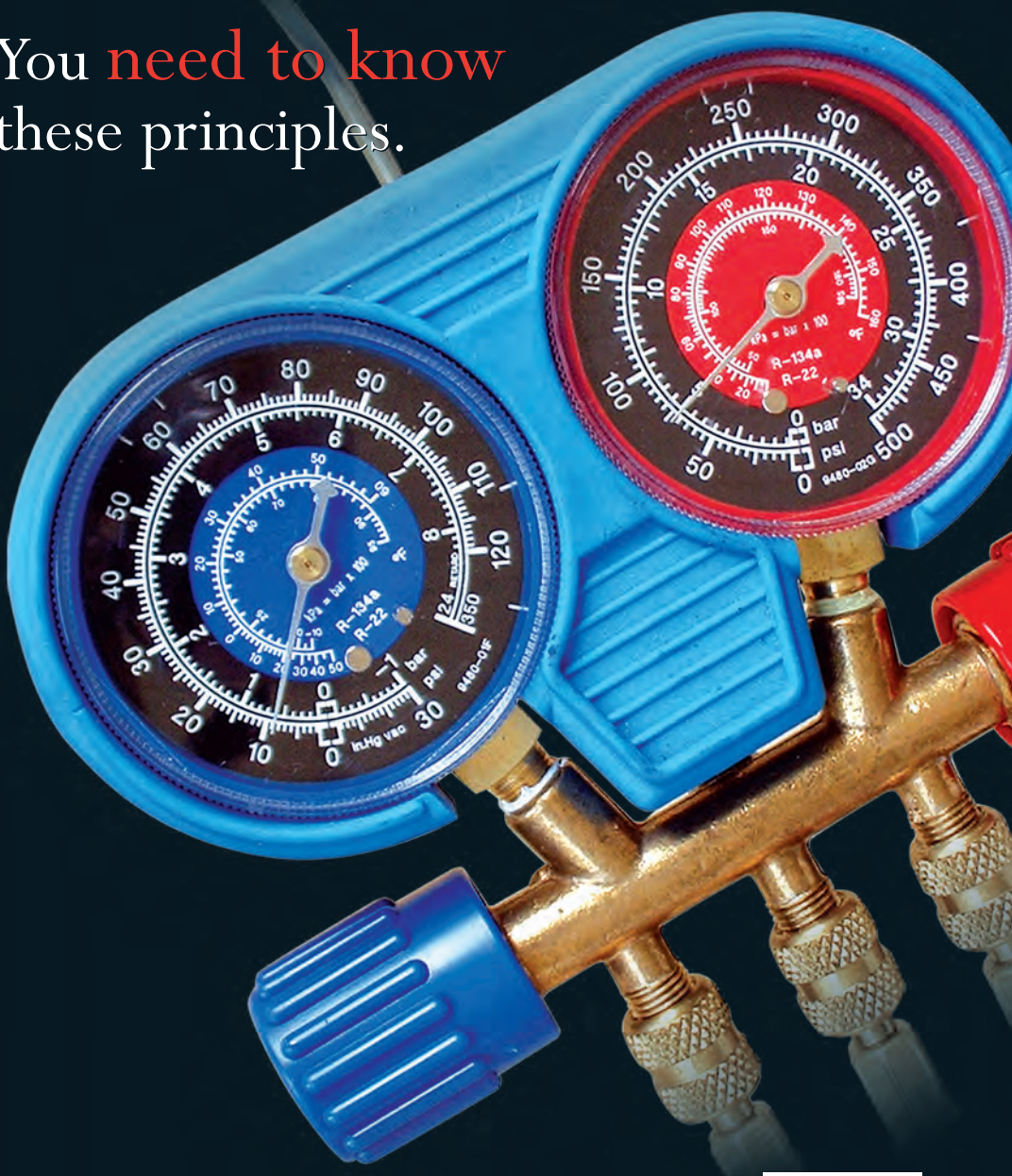
Refrigeration Revisited

You need to know these principles.



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SUBARU
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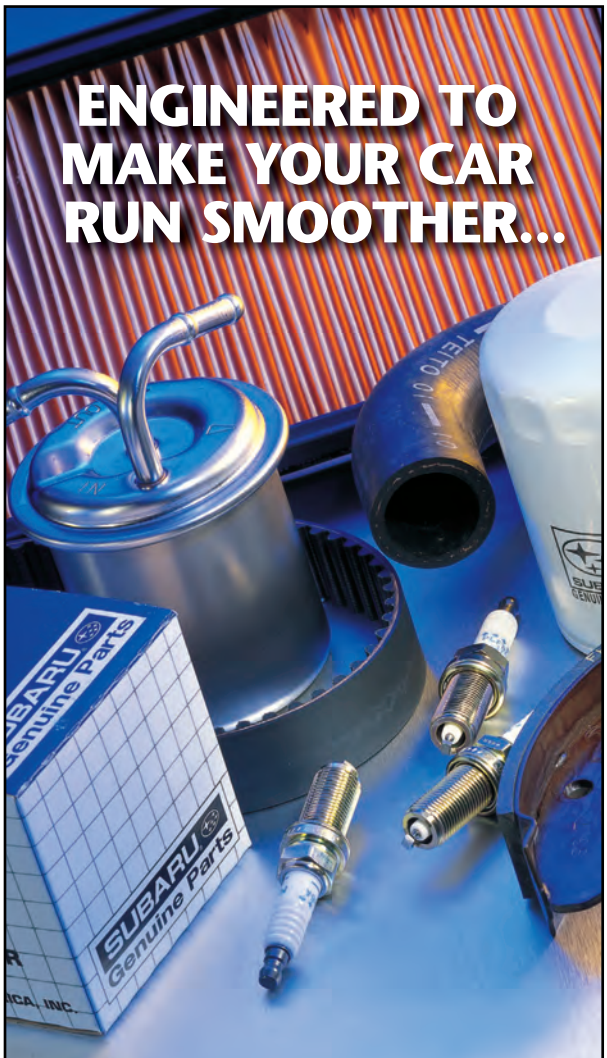

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SUBARU

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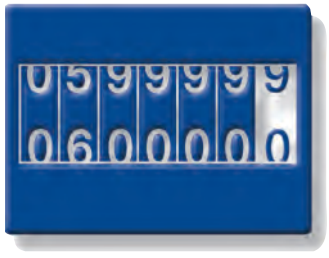

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Part Category	Description
Filters	Includes oil, air and fuel filters
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Brake Pads and Shoes	Includes front and rear plus repair kits
Belts	Includes timing, alternator and a/c belts

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SUBARU

inside

Refrigeration Revisited

You need to know these principles.

It's that time again — the height of the air conditioning service season. Are you truly ready? Sure, you've pulled out the recycling equipment, checked the filters, priced refrigerant, ordered PAG oil, O-rings, suction screen kits, dye, etc. But have you dusted off the basic knowledge that allows you to both troubleshoot accurately and do the job in a craftsmanlike way that avoids comebacks? No? Well, you're just sitting there reading anyway, so take a few minutes to reinforce your skills with the following look at the refrigeration principles that Subaru vehicles, and indeed all cars, rely on.

Blend

In order for any HVAC system to work, it has to have a source of hot air and a source of cold air, a means to draw fresh air from outside and a way to recirculate cabin air (to minimize the smell of a squashed skunk or the "fresh" country aroma of a pig farm, while improving heating/cooling efficiency under extreme conditions). The hot side comes from the engine via the heater core, and the cold side from the air conditioning system via the evaporator core, both located in the plenum under the dash. Manual or ATC, we blend hot and cold to get the duct temperature required for passenger comfort.

In order to make a humid 99-degree day tolerable inside that greenhouse we call an automobile, we have to enlist the laws of physics. This is accomplished by taking advantage of the fact that as a refrigerant changes state from liquid to vapor it absorbs heat — LOTS of heat — allowing us to redirect this heat to the outside via the compressor and condenser.

The process that produces cold air at the ducts seems almost magical until you really understand the physics.

Latent Heat Miracle

There are two kinds of heat, sensible and latent. Sensible heat is what you can feel and measure. Latent heat is hidden, heat that is absorbed or given off without changing the measurable temperature of the medium involved. We're all familiar with water, right? Start with a pound of water at 70 deg. F. It takes one British Thermal Unit (BTU) to raise the temperature of one pound of water one degree Fahrenheit. If we add 142 BTUs to our pound of water, we'll raise its temperature to 212 degrees. If we continue adding heat, we'll eventually boil the water away, changing its state from liquid to vapor. It takes an additional 970 BTUs to convert that one pound of water to one pound of saturated steam once the water is at 212, but the whole time the water is changing state from liquid to vapor its temperature remains at 212 degrees.

That 970 BTUs of energy is called the latent heat of vaporization, and, unlike the first 142 BTUs we added, it never raises the temperature of the water. It's the amount of heat needed to force the water molecules to jump from the surface of the boiling liquid with enough energy to escape. That's all heat is, anyway — a measure of molecular energy, of how rapidly the molecules of a substance are vibrating or moving.

All substances can exist in one of three states — solid, liquid or vapor — and all substances have latent or hidden heats of vaporization, condensation, liquefaction or solidification (sometimes called fusion). Anytime a substance changes state, hidden heat is released or absorbed in association with the change of state. The fact that steel normally exists as a solid at room temperature doesn't meant it can't exist as a liquid or vapor. It just takes a lot more heat to liquefy and subsequently vaporize steel than it does water. Water, the most abundant compound on earth, exists as liquid, solid and vapor within the normal range of temperature most of us experience in life, thus we've all seen it in its three states of ice, water and steam.

The Medium

Everything in our surroundings is subject to these rules, including refrigerants. In order for a compound to be useful as a refrigerant it has to have certain characteristics, cold enough boiling points for example. Even though we mainly deal with R-12 and R-134a, you'd be amazed at the number of refrigerants available — we know of at least 86. Even water has a refrigerant number: R718.

We need a refrigerant that's stable, changes state at temperatures that are useful to us (different applications use different refrigerants with different boiling points) and is non-corrosive. It should also be non-flammable, non-toxic and safe to handle. For all modern automotive applications, we use R-134a. It boils at about -16 deg. F. (for comparison, R-12 boils at -21.7), and has no chlorine to damage the ozone layer.

Summer Arrives with the Call of the Open Road!

ANSWER IT WITH THESE MAINTENANCE AND PERFORMANCE SPECIALS

For many Subaru owners, nothing quite matches the appeal of a curvy mountain road, the lure of a smooth straightaway or the enticing thrill of motoring through a turn at their favorite off-road site.

The responsive handling and all-wheel drive that Subaru offers in all its vehicles gives these driving venues a pleasure all their own. As summer approaches, you can help answer that wonderful call of the open road with maintenance and performance specials designed to ensure your customers' vehicles are in top shape for fine weather driving.

During warm weather months, maintenance specials that concentrate on cooling systems, brakes or a "Complete Car Care Checkup" usually do very well. As for performance specials, consider running a "Super Subaru Tune-up Sale," "Performance Muffler Remake" or "Short-Throw Shifter Conversion Special." All of them can bring extra work into your shop.

Just a note on air conditioning system specials: With a worldwide shortage of R134a refrigerant facing us, Subaru is doing all it can to offer an even supply of this product. We value your patronage and appreciate your patience during this period as alternates make their way to market.

GROWING SUBARU CAR POPULATION MEANS HEALTHY BUSINESS DOWN THE ROAD

If you seem to be seeing more Subaru vehicles than ever driving around, that's because there are now more than two million Outback, Legacy, Forester, Impreza, Baja and yes, even earlier generation models like the Leone/Loyale on the road. Of course, this continually expanding Subaru population is great news for you. It means you can expect a steady volume of maintenance and repair work for years to come.

SAVINGS CONTINUE TO INCREASE ON HYBRID REMANUFACTURED SHORT BLOCKS

Since the introduction of two Subaru hybrid remanufactured short blocks this year, the SOA450H100R1 and SOA450H200R1, Subaru owners have realized significant savings from the reduced labor costs and competitive pricing of these replacement engine components.

By including a new oil pump, oil pan, oil filter, water pump, thermostat and housing on these hybrids, along with a remanufactured short block, you now have a way to offer real savings on engine repairs to dual overhead cam vehicles from 1997 through 1999. Plus, in the near future, more hybrid applications will be rolled

out. So, you'll have more opportunities than ever to offer your customers original equipment quality plus the renowned reliability that only a Genuine Subaru Part can provide.

NEED FAST ANSWERS TO TOUGH TECH QUESTIONS?

When tricky technical questions arise during maintenance or repair work, whether on older Subaru models or on today's most sophisticated STI, turn to the site designed to solve specific problems: **http://techinfo.subaru.com**

This Web site offers the most complete official information resource available online for Subaru vehicles, including Owner's and Service Manuals, Service Bulletins, TechTIPS Newsletters, Training Manuals and more. You'll find service information for all current Subaru models manufactured between 1996 to the present. There are even service bulletins dating back to 1990 for working on older models. You can browse through various publication types, titles, descriptions, plus view the free publications available on the site, but you will need to purchase a subscription to access the actual content of most PDF files. Short-term 72 hour subscriptions are available that can provide the repair or maintenance information you need right on the spot! It's your prime resource for Subaru vehicle work.

SUBARU HIGH PERFORMANCE SHOWS UP BIG AT SNO*DRIFT RALLY

By capturing 7 out of the 8 top spots in the first rally of the 2005 rally racing season in Atlanta, Michigan, Subaru drivers in their WRX and STI vehicles set a blistering pace out of the gate this year.

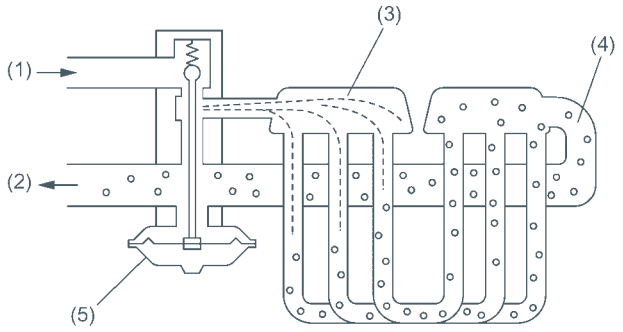
The action was brisk, especially considering the very slippery winter conditions. Pat and Natalie Richard battled with Seamus Burke for the lead through most of the event until Burke went off the road abruptly at the end of Stage 9 and damaged his car, allowing the Richards to finish seven minutes ahead of the rest of the field.

Matt Iorio drove a smart and confident race and managed to escape the tricky woods earning himself and his co-driver Ole Holter a second place overall finish, Iorio's best ever. With such tough conditions, it was a great effort.

By sharing these results with Subaru high performance enthusiasts via a racing bulletin board in your shop or in conversations, you can renew their interest in purchasing specialized performance parts of their own. With everything from STI Struts and Springs to SPT "Cat Back" Exhaust systems, you've got plenty of ways to give their cars the look and response of a Subaru performance vehicle. And for quick and easy profits, think about setting up a small display of inexpensive and desirable SPT merchandise such as handy travel mugs, key fobs and CD cases featuring the SPT and STI logos.

NEW "CAT BACK" EXHAUST SYSTEM FOR SUBARU STI ARRIVES

Performance-oriented STI owners will be thrilled to hear they can now put this popular exhaust system on their vehicles. Talk to your local authorized Subaru dealer for details about this newest addition to the SPT lineup.



1. From receiver drier
2. To compressor
3. Misty refrigerent
4. Vapor
5. Expansion valve

Here's where the flash-gas miracle takes place. A huge amount of heat is absorbed considering there may be as little as 16 ounces of refrigerant in the system.

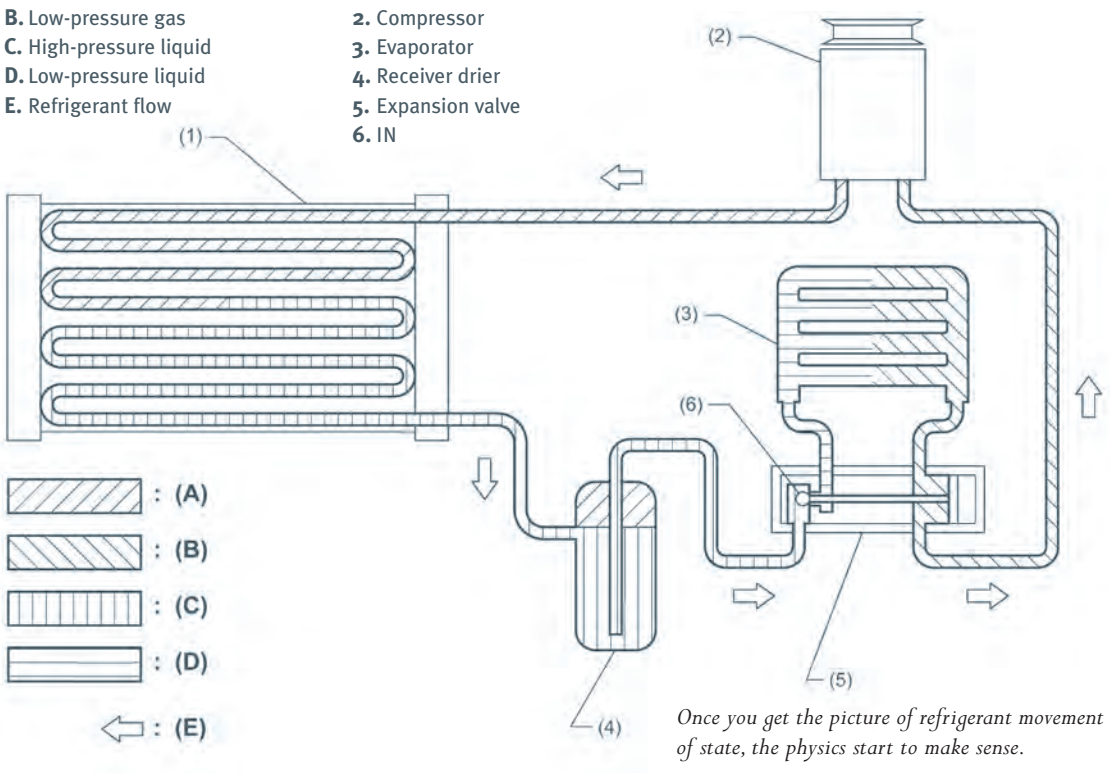
Expansion and Flash Gas

Obviously, air conditioning systems are designed to take advantage of both physics and the characteristics of the refrigerant. Let's start the process at the expansion device (you know, an open tank of refrigerant would make a fine refrigeration system if R-134a weren't so expensive — you could just plumb a big tank to the expansion device at the evaporator inlet and dump the outlet of the evaporator into atmosphere, and you wouldn't need a compressor or evaporator). By holding the refrigerant in the system under pressure, we keep it from boiling until it's delivered to a heat exchanger located where it can cool the cabin of the car. As the refrigerant passes the expansion device, it's atomized into small droplets, and in the low-pressure area of the evaporator the outer layer of each droplet boils away, lowering the temperature of the remaining liquid to -16 deg. F. This initial boil-off is called the "flash gas." The center of the droplet remaining after the flash gas boils off, now cooled to -16 degrees, enters the tubes of the evaporator. On the opposite side of the tubes the fins are attached, increasing the surface area of the core. The blower pushes air from the cabin through the fins. In doing so, the remaining portion of the droplet boils away to a low-pressure, low-temperature vapor, absorbing 84 BTUs of heat per pound as it changes state, and the cabin air is cooled and dehumidified.

We grab this vapor and recycle it over and over by attaching the suction side of a pump to the evaporator outlet, thus maintaining a low pressure area into which our refrigerant can expand. The pump will take a large volume of low-pressure, low-temperature gas and compress it into a high-pressure, high-temperature gas. We have to do this because the gas temp at the evaporator outlet is less than ambient, and in order for us to reject heat, the vapor temperature must be higher than ambient — heat only flows from a higher to a lower temperature, the first of those immutable laws of thermodynamics. We compress and concentrate not only the volume, but also the heat. Now that the vapor is warmer than ambient, we throw it into a condenser, where (because the vapor temp is

A. High-pressure gas
B. Low-pressure gas
C. High-pressure liquid
D. Low-pressure liquid
E. Refrigerant flow

1. Condenser
2. Compressor
3. Evaporator
4. Receiver drier
5. Expansion valve
6. IN



Once you get the picture of refrigerant movement and changes of state, the physics start to make sense.

now in the 130-165 degree range) it dumps heat to the air flowing through the condenser (90 looks pretty cool compared to 130-165). As it rejects its 84 BTUs per pound, the vapor is condensed into a high-pressure, high-temperature liquid, and as is routed once again to the expansion device, where it's atomized, flash gas drops the temperature of the remaining liquid, and it changes state in the evaporator once again, absorbing another 84 BTUs per pound of heat from the cabin.

So, those few ounces of R-134a (some late model Subaru systems hold only 16 to 18 ounces) change state over and over, pumping heat from the cabin to the atmosphere. The downside? As ambient temperatures rise, the system loses capacity because liquid line temperatures also rise, and more refrigerant is expended as flash gas to cool the increasingly hotter liquid coming from the condenser. Air conditioning would stop working altogether if the ambient temperatures and humidity rise to the point where insufficient heat is dumped and liquid line temperatures get high enough so that all of the refrigerant metered by the expansion device is consumed as flash gas, and no liquid makes it into the center of the evaporator to change state and absorb heat.

Practical Points

With that theory in mind, the following points will make more sense:

- Take a careful look at aftermarket condensers and evaporators to make sure they match the originals. A simple 3/8 in. tube-and-fin type won't work in a modern multi-flow application. Buy O.E., or only the best brand names.

- Apropos of the above, R-134a is commonly blamed for poor performance after retrofit when the real reason is often that the replacement condenser or evaporator is not up to O.E. standards for heat rejection.

- Another factor in the weak-cooling retrofit situation is air (NCGs — Non-Condensable Gases). We've seen the problem corrected by simply removing the charge and running the vacuum pump overnight. That's really what you're vacuuming, you know. You can't get much moisture out no matter how long or hard you pull the system down. That's the job of the dessicant.

- We used to have a large margin for error with compressors. Now, with speeds up to 14,000 rpm, terrifically tight internal tolerances, and lubrication issues, much more precision is needed in both remanufacturing and service.

Refrigeration Revisited

- Compressor lubrication priorities:
  #1 Have oil in there.
  #2 Have PAG oil in there.
  #3 Have the recommended viscosity PAG oil in there.

- The switch to 42-volt systems will bring electrically-powered compressors with it, but the numbers will be small for a long, long time.

- Speaking of compressors, whenever one has worn out or broken internally how do you protect the new unit from the shrapnel that's probably been pumped into the refrigeration circuit? Forget about flushing. It's just not going to do it. While add-on filters that you splice into a line are available, there's often not enough room, and you'll introduce the possibility of a leak. That's what makes the in-line suction-side screen kit so popular. It's easy to install, and will keep any big pieces of metal from getting into the fresh compressor.

While canister-type filters and screens are available, they're big, hard to install, and amount to a potential leak point. So, whenever you need to replace a compressor, you might want to consider adding an in-line suction screen. It'll help protect the new unit and your reputation.

- A smelly car interior takes the fun out of motoring and can also be downright embarrassing. Broad-spectrum disinfectant sprays and foams that you inject into the evap box are commonly used to kill the bacteria, mold, mildew, and fungi that grows in moisture, and some products also coat the fins with a water-shedding acrylic. These are vastly superior to the type you spray into the outlet ducts.

The best way to eliminate that musty odor is to deliver the disinfectant directly to the evaporator core fins.

- The EPA's Stratospheric Ozone Information Hotline is 1-800-296-1996, and its website is www.epa.gov/ozone/609/609/html

- The automobile is down to just over one percent of man-made ozone-depleting emissions, but the Europeans are pushing for a switch to CO2 systems anyway. ■

CO2 as a Refrigerant?

Just when we've all become nicely accustomed to R-134a, having paid heavily for that familiarity with huge upheaval, equipment expense and training time back in the '90s, the Europeans are pushing for another profound change. Hello CO2-charged A/C systems.

Whoopee. We're having enough trouble compressing and containing a few hundred psi, and now we're looking at refrigeration at 2,500 psi!

Why? For several reasons, actually. Engines are becoming so energy efficient, it'll soon get to the point that they won't reject enough heat to adequately warm the passenger compartment (think direct-injection diesel semis with their grilles buttoned up in winter). This, of course, becomes much more so with hybrid and electric cars. So, heat pump HVAC systems, which can move BTUs either out of or into the cabin, might be in our future, and CO2 lends itself to this application.

Also, carbon dioxide is about the most harmless thing in the world — you exhale it with every breath, and it makes plants grow. Even though the contribution of motor vehicle air conditioning is now down to not much more than one percent of the ozone-depleting gases our civilization produces, some people, particularly the seriously-green Europeans, say that's not good enough. For political reasons, they may ban R-134a.

We've heard it rumored that there's another, entirely economic, reason for the push. Since the German automakers and suppliers have this technology pretty well worked out, they figure they could corner the market for systems and components. If over-zealous ecological legislation aids that effort, they won't complain.

On the other hand, Denso, the world's biggest supplier of vehicle climate control systems, acknowledges that this switch will be furiously resisted by the U.S. and others, but nevertheless intends to develop suitable components.

The experimental CO2 transcritical systems we've heard about provide levels of comfort equal to what we've got now, but the drawbacks are considerable. Besides the 2,500-psi operating pressure, there's unusual noise, ice formation in the lines, potentially-troublesome heat exchanger microtubes (1/300th of a mm!), and the necessity of fabulously complex controls.

To put this in perspective, suppose the political, technological, and commercial scenarios play out in such a way that CO2 systems first appear by 2010 on a couple of upscale European makes. How long will it take for the other makes to grudgingly follow? Five years wouldn't be a crazy guess. So, R-134a-charged cars will remain in the majority for probably 20 years, then gradually fall off. We think that's plenty of time to amortize your investment in that nice, new do-it-all recycling machine. ■

Escape Routes

There's never justification for recharging until you've found and repaired any leaks that may be present. Do a careful visual inspection first using a strong light. Naturally, an accumulation of oil and dirt will tip you off to a seepage point.

Another good way to find out if a leak exists is to draw a deep vacuum and see if it holds (where it is located is another matter).

Electronic leak detectors? Well, as one technician we know says, "I have one, but it's up on the shop roof." He got so frustrated with it while working outside in the parking area that his temper took over and he just let it fly. Many other techs dislike electronic leak detectors, too — they require a lot of patience and can trick you.

That's one reason the nearly-foolproof ultraviolet light and dye method has become so popular. Pass the UV lamp (those yellow glasses intensify the effect) over all the components, hoses, connections and condensate drains, and leaks will show up in bright yellow. ■

A/C, Subaru Style

As one independent Subaru service specialist tells ***The End Wrench***, "The systems are good. We don't have much trouble with them."That's high praise from a person in the trenches of auto repair. Still, any A/C system, no matter how well designed and manufactured, will eventually need service. The following is intended to make sure you're aware of some important specifics about that work on Subaru vehicles.

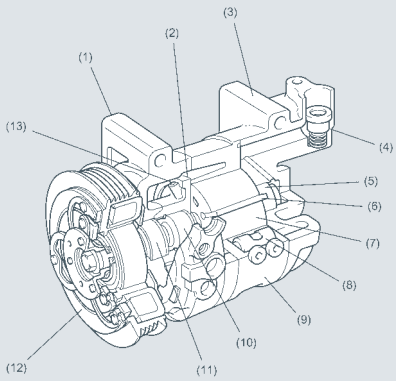
To begin with, these cars don't have a valve that stops coolant flow to the heater core. So, the first thing to think about when a customer complains that the air coming out of the ducts isn't cold enough is to make sure the blend or mix doors are working and sealing properly.

All Subaru vehicles use a cycling-type air conditioning system. That is, when the evaporator approaches freeze-up temperature the ground circuit to the compressor clutch is interrupted. This has the advantage of fast cool-down.

Three types of A/C compressors have been used since 1990:

Fortunately, late-model Subaru vehicles have the A/C compressor at the top of the engine for easy access. Note also the convenient high-side service port.

- Axial piston, which is found on the SVX and the Legacy up to '93. The SVX version was of a wobble-plate design that provided variable displacement as controlled by the ECM. The ZEXEL system of the Legacy had a swash plate. Axial piston compressors will knock if the refrigerant pressure is too high.



1. Front head
2. Side block
3. Rear head
4. Check valve
5. Rear bearing
6. Vane
7. Rotor
8. Roll valve
9. Cylinder
10. Front bearing
11. Shaft seal
12. Magnet clutch
13. Trigger valve

Most of the Subaru vehicles on the road today use a rotary vane compressor, which is highly durable and dependable.

- Rotary vane compressors are the most common on late models. The trigger valve, which routes system pressure to the shaft side of the vanes at low rpm to help them extend, can cause a buzz. While they won't knock, a chattering noise indicates an internal problem.

- Scroll compressors were introduced this year and promise great performance and longevity. You probably won't be seeing one in your shop for quite a while, however.

Every SOA service compressor comes with a full system charge of the proper oil (PAG — nothing else is acceptable). To keep from over-oiling the system, which can result in poor cooling performance and even damage to the compressor, you may need to drain some oil from the new unit. So, remember to measure the amount of oil you dumped out of the old compressor.

Nothing will work right if the charge is too low, or too high. The A/C label you'll find under the hood gives you the basic amount of R-134a that the system is designed to operate on. If you're not evacuating the A/C, however, you need to hook up your gauge set and check pressures. For most Subaru models, proceed as follows:

- With the ambient temperature between 86 and 95 deg. F., park the car in the shade.
- Open the windows.
- Hold rpm at 1,500.
- Set the controls on Max and Recirc, and switch the blower to high.
- Read your gauges. Low side pressure should be between 18 and 28 psi, that of the high side 213 to 242 psi.

Remember, common causes of high head pressure are a condenser that's blocked by trash and electric fans that aren't turning on.

The automatic temperature control feature is certainly convenient, but it's a complex system. Starting in '03, a self-diagnostic mode was added. We'll refer you to the training materials on http://techinfo.subaru.com for a description of how to use it. ■

Cooling System Overview

Read this, or risk faulty diagnoses.

Any internal combustion engine produces far more heat than it can convert to mechanical work. Some is lost to the atmosphere as exhaust, but there's a stubborn last third or so that has to be forcibly extracted. Hence, our heat sink, the cooling system, which, if everything is working as designed, carries away the excess, thus keeping the engine below the point of self-destruction. Actually, it's this way for nearly all mechanical systems — especially those that generate usable power. We have no alternative to making excess heat that's not being turned into useful work, or to using marginal, relatively-crude mechanical systems to extract or convert the energy, then finding ways to shed the excess BTUs before they destroy our fragile mechanical contrivances. We're getting better, though. Electronic engine management, and improved coatings, materials, lubes and designs are gradually increasing the amount of energy we can get from our chemical reactions, but into the foreseeable future we are going to be stuck with cooling systems on cars.

The operative word here is "system." It's a radiator, it's a pump, it's flexible hoses to connect an engine that rocks with torque to a stationary chassis. It's coolant, fans, belts, thermostats, restrictors, reservoirs and radiator caps … and one thing out of shape will put us over the top and into thermal overload. We all know the results of neglected cooling systems. Muddy coolant aside, there are scored pistons, blown head gaskets, overheated and destroyed engine and transmission oils. The modern cooling system is a violent place, full of localized hot spots, boiling, pressure surges, cavitation and flow restrictions, slag or pockets that create low pressure swirls that flash hot coolant into foam.

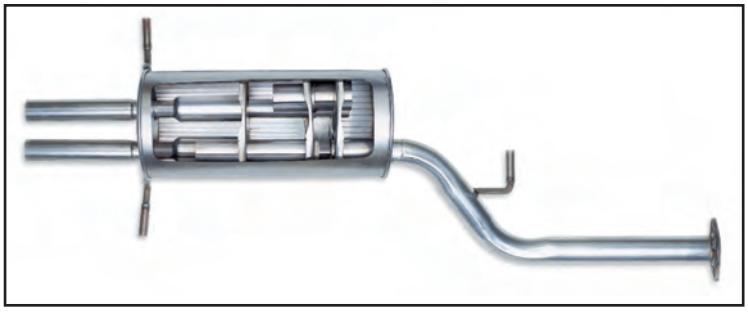
Above: *Subaru vehicles have always been designed with sensible airflow patterns. Even the latest models have grilles that admit plenty of air for proper cooling. That's different from other makes that depend on bottom breathing that can be defeated by a lost deflector or shroud.*

Keep it Moving

Water pumps are an interesting subject. In designing an engine, you want to put the pump as low as possible so that it won't start to cavitate if the coolant level should fall. That's where all powerplants have it except for one French car we remember that actually had it at the very top — it's no wonder that that make isn't being imported anymore.

REPLACEMENT MUFFLERS

...provide perfect fit and function.



Still trying to force fit or jury-rig non-genuine mufflers to save a little money? Save time and all that hassle with competitively priced Genuine Subaru Replacement and Performance Mufflers. They're specifically designed so that mounting parts precisely match the original Subaru assembly for easy, safe, no-rattle replacement.

Each Subaru muffler is a heavy-duty integrated unit of thicker materials than typical aftermarket mufflers, plus the sound absorbing materials of Subaru Replacement Mufflers help subdue sound without hampering performance. Special corrosion-resistant aluminized steel construction helps them last longer, too.

Naturally, every Genuine Subaru Replacement Muffler is backed by a Genuine Subaru Parts Limited Warranty that covers the entire integrated unit, including welded-on pipes, clamps and hardware. Call your local Subaru dealer for details and prices and visit www.endwrench.com today.

Genuine Subaru Mufflers Mean Business

Replacement Mufflers	Includes associated hangers, gaskets, bolts, nuts, etc.
Performance Mufflers	Applications for Impreza 2.5 RS, WRX and Legacy GT models

Subaru vehicles power the water pump with the back of the cam belt, or, in the case of the 3.0L six, by means of the timing chain. This makes it impossible to run the engine without the pump shaft spinning, thus avoiding the possibility of truly disastrous overheating.

Thermal Map

The hottest area is the head, particularly around the back of the exhaust valves/ports. There's less heat as you approach the crankshaft since cylinder pressure and temps drop as the piston is pushed away

Right: *Another smart thing Fuji Heavy Industries did when designing Subaru high-performance vehicles was to position the turbocharging system intercooler on top of the engine so that it breathes through a hood scoop. Other makes seem to think it's okay to put it in front of the radiator, thus increasing the heat load on the cooling system. Go figure.*

from the combustion chamber, which is concurrent with the flame extinguishing in the cylinder.

Why hold boiling point up? Obviously, we need to keep the coolant inside the system, so tightly capping it accomplishes this, but also raising overall pressure keeps the coolant from boiling in tight turns or sharp radii inside the system and at the suction side of the pump. Foam or vapor is a lousy heat transfer medium. The walls need to be fully bathed to transfer heat. Plus, the collapse of vapor bubbles in the system as they transition from low pressure to high leads to a condition called cavitation erosion, typically seen on aluminum surfaces near the water pump.

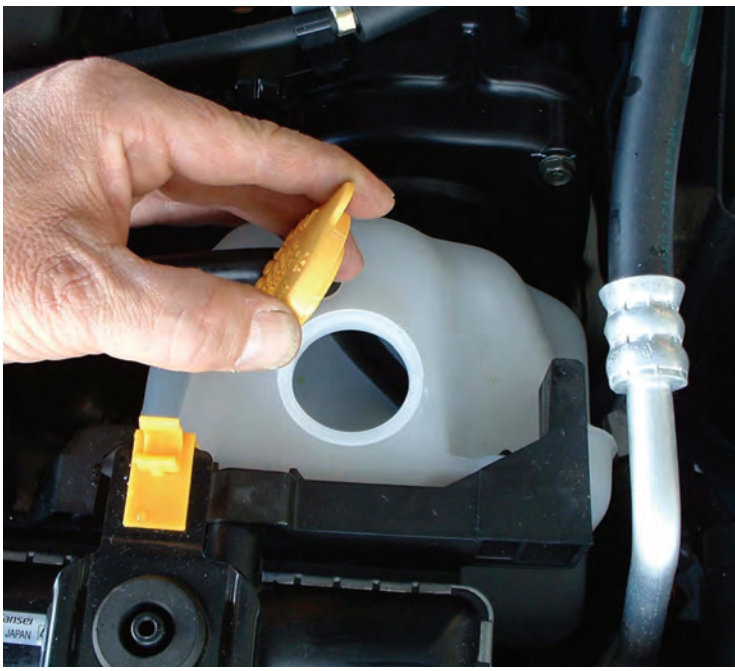
Radiator hose clamp positioning actually does matter. You might as well do what you can to prevent any areas from having trapped coolant, which will promote corrosion.

Crevice corrosion occurs in tight spaces where a lack of flow keeps the trapped coolant from mixing with the main flow, thus depleting additives and setting up high rates of corrosion. This occurs mostly on hose nipples where the clamp is positioned improperly. They should be as near to the nipple flange as possible to keep coolant out of the space between the nipple and hose. It's not uncommon to see aluminum pocked with ruts and holes or steel nipples rotted through.

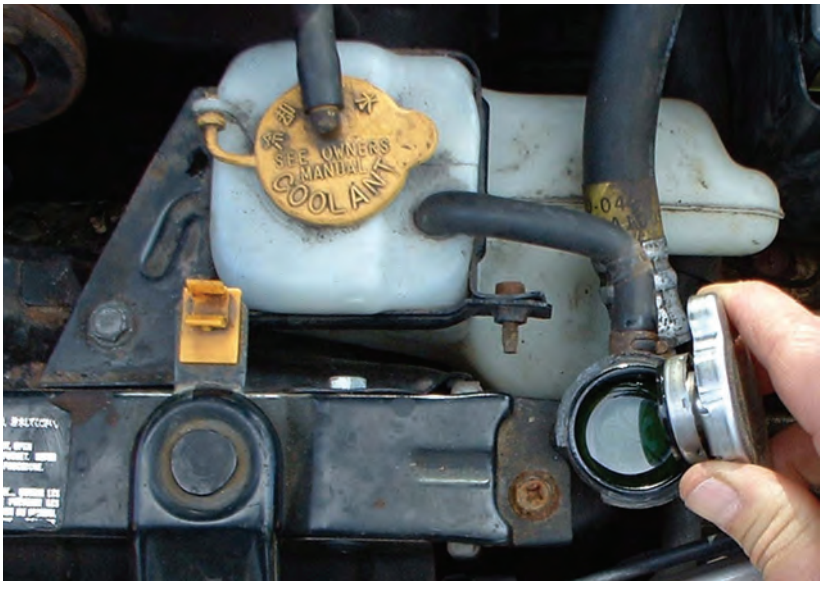
Coolant-Recovery System Snafu

The vented recovery system was a great invention, and Subaru has employed it for many years. One of the ongoing concerns with this system, however, is its failure to self-recover. If you drink a milkshake, you'll see what happens when you try to pull a viscous liquid through a small opening. You can easily breathe through the straw, since air is a lot less dense than the milkshake. The same thing happens in the coolant recovery system, which is why we find the recovery tank full and the radiator six inches low. The engine heats up, coolant leaks out. The system pulls a vacuum on cool down, but instead of drawing the viscous coolant through that same tube back into the radiator, it pulls air back in through the leak. In some cases, the leak occurs somewhere between warm up and cool down, so it's dropping fluid on the road, where it can't be seen by the customer. Or, it boils away as it escapes the pressurized cooling system, leaving nothing on the pavement to indicate a problem. The result is a recovery tank that maintains its level, while the radiator level is falling, unbeknownst to all parties concerned. If you're servicing a vehicle, you must pull the radiator cap! Just because the recovery bottle is full doesn't mean the radiator is full.

What kind of anti-freeze should you use in Subaru vehicles? Well, we believe you should avoid generic aftermarket brands, especially those that rely on organic acid technology for corrosion inhibition (they have a bad reaction to air in the system if the level should be allowed to fall). Nothing else protects Subaru engines, which are built with a very high percentage of light-alloy components, as well as genuine Subaru anti-freeze. See our sidebar, "Don't be Fooled by Semantics."



Just because the overflow bottle has a sufficient level of coolant in it doesn't necessarily mean the pressurized part of the system is actually full. You can only be sure by removing the radiator cap. You'll often find the level in the radiator to be low, which is a function of vacuum leaks that prevent coolant from being drawn back into the radiator from the bottle.



*We know what should be in that cooling system — Genuine Subaru Anti-Freeze, distilled or deionized water, and the approved cooling system conditioner — but what's **actually** in there? Only you can make sure your customers' cars get the right stuff for longevity and trouble-free operation.*

While pressure testing is probably your first diagnostic choice, nothing beats UV for zeroing-in on those sneaky leaks.

Troubleshooting

Handy items include dyes, a UV/black light, a pressure tester, a non-contact infrared thermometer, a belt tension gauge, and a refractometer (a bit pricey, but nothing else works nearly as well, or is as accurate). A way of measuring the actual flow rate to determine if the water pump is still moving a sufficient volume of coolant would be helpful in determining if that essential component needs to be replaced. Such a thing exists (the Radi-Cool from Hickock), but very few shops have it, or have even seen it. So, you'll probably have to use your own judgment. Take the coolant level down until it's just above the radiator fins and peer down into the neck with a flashlight.

You should see a robust flow, similar to what you'd expect from a garden hose. A variation on this is to remove a heater hose, stick the end in a bucket and start the engine. Since Subaru cooling systems don't use a valve that shuts off flow to the heater core, you should see a strong stream no matter where the controls are set. Finally, clear tubes are available that you attach in series with the upper radiator hose that allow you to see the flow.

Damage from poor coolant system management takes one of three forms. There's erosion, the thinning of material by mechanical force or impingement — remember we're dealing with the vigorous movement of coolant, and abrasives or debris slamming into aluminum, copper or brass can literally "sand blast" its way through such soft materials. There's also corrosion, the result of a chemical attack on the metals or rubber, much like acid would do. And there's electrolysis, the stripping of donor material from one source for deposit in another location — sort of a mini plating cell — created by stray electrical currents passing through the coolant stream. In all cases, one of the largest contributors to the destruction of the system is water. Chlorine, calcium and magnesium from treated or hard tap water dramatically accelerate the onset and progression of erosion and corrosion. Most experts are beginning to recommend de-ionized or distilled water for fill or makeup.

Looksee

As any believer in disciplined diagnostics knows, the first step in the process is visual inspection. How's the level? Is there a 50/50 mixture? Too much or too little anti-freeze, either is a problem, and not just in regard to the boiling/freezing points. Vehicles equipped with level sensing may misread an improper mixture leading the driver to believe that the coolant level is low when it's not, or full when it's low. Hoses all okay? Do we have leaks or are the core fins plugged with bug splat and cottonwood tree lint? Are the electric radiator fans working? How about the shroud? Or, the chin dam under the front bumper, which is used to create low pressure under the car that radiator air flow exhausts into. Is it intact?

Cooling System Overview

The convoluted plumbing of late models makes vacuum filling equipment attractive. It'll pull nearly all the air out for you and draw the fresh coolant into the deepest recesses as it fills. We've used this time-saver for years, and not only is it generally a lot neater to use, with less spillage and better inventory control, but it works the first time.

Details

On radiator caps, application is critical. Make sure you get exactly the right part. Don't just take something out of stock that may fit physically. Ditto for thermostats. Look it up. Gaskets and seals must work properly. Most manufacturers use a mild sealer/cooling system conditioner with the factory fill to prevent weeps and seeps. This is supposed to be replaced after service, but rarely is. If called for, make sure you are installing seal tabs after flush/fluid exchange.

All told, it's a miracle that modern cooling systems/coolants function as well as they do. We have systems with higher temperatures, pressures and flows, made of all sorts of different materials put together by all kinds of different processes. Everything from aluminum to plastic or impregnated resin end tanks and plastic/rubber or silicone sealing systems are in use, and, given human nature, they're commonly exposed to coolants pushed well past reasonable limits and diluted over their lifespan with corrosive make-up water. They do pretty well when you put it all in perspective. ■

A refractometer is fairly expensive, but nothing else comes close to its accuracy and speed of use. You don't have to wait for all those floats in a hydrometer to settle down to get an idea of the coolant concentration. Plus, it works with both EG and PG (the latter being the non-toxic anti-freezes, such as Sierra).

Don't be Fooled by Semantics

Even though you're a Subaru specialist, you've probably heard horror stories about the long-life antifreeze formula embraced by some other makes, most prominently the largest domestic manufacturer. This stuff is based on OAT (Organic Acid Technology), and its additive package can indeed last a long time. The trouble is, its anti-corrosion properties are defeated by one simple thing: air. If the coolant level in the system should be allowed to drop (if you don't have some customers who tend to neglect fluid maintenance, you live in a better world than we do) so that all surfaces aren't continually immersed, oxidation occurs rapidly. The dusty deposits that form accumulate into incredible amounts of crunchy glop that clogs up the works.

The anti-freeze that Subaru specifies and makes available through its dealership parts departments uses a different sort of anti-corrosion formula that combines the benefits of OAT and phosphate (non-amine) chemistry, which establishes a semi-permanent protective coating on metal surfaces even if the coolant level is allowed to fall (see the "Insider Info" section of this issue of ***The End Wrench*** for a new technical service bulletin that explains this, and also provides recommendations on hard water and cooling system additives —show it to any customers who want you to go the cheap route).

Genuine Subaru anti-freeze says "Long Life" right on the bottle, but that doesn't mean you should leave it in there seemingly forever. It simply refers to the fact that if the car's cooling system maintenance is neglected, there will be less damage from corrosion and clogging than would be the case with a less sophisticated formula.

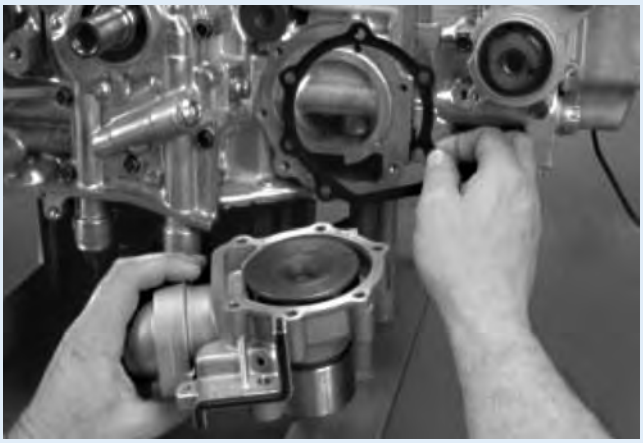
Fuji's engineers are more prudent than those of some other carmakers, and they want people to enjoy their Subaru vehicles for a long, long time without encountering expensive and inconvenient problems. So, they're sticking with the recommendation that the coolant be changed every two years or 30,000 miles. Sound wisdom in our opinion, and something you can easily justify to your customers.

visit our website:
www.endwrench.com

Subaru Cooling:

Pumps, Hoses & Additives

Three hot topics that concern Subaru vehicles.



Removing water pump.

Every make of car has cooling system service subtleties, some of them shared with other brands, some exclusive. Regardless, the following will help you be successful in this important maintenance and repair area on Subaru vehicles.

Coolant circulator

As you know, most of the Subaru engines out there have an OHC timing belt. Not only does it keep the cams and crank in synch, but it also drives that all-important water pump off its back side. One advantage to using this means of powering the pump is that if the belt should ever snap (something to be studiously avoided), the engine can't run, so doesn't run the risk of catastrophic overheating. As we're sure you've seen on other engines where the external serpentine accessory belt is ultimately responsible for moving coolant, that preoccupied motorist might very well keep driving, blithely unaware that he or she has lost the serp and is in the process of melting the engine down into a useless heap of scrap.

This brings up an important point to remember whenever you're replacing a Subaru water pump. Does it make any sense to do all the disassembly involved, then put the old T-belt back on? Certainly not, yet we still see people doing it. That's false economy taken to a high degree. After all, a new belt is a relatively inexpensive part. You should explain to your customers that it's your policy to replace both at once.

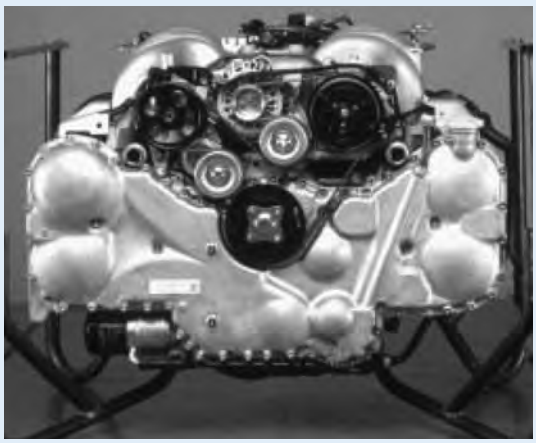
The flip side of this situation occurs when you're replacing a timing belt. Should you add a new pump while you're in there? Given that late-model Subaru vehicles carry a 105,000-mile belt replacement interval, definitely. Sure, the pump seal may go for quite a while longer, but certainly not until the next belt change.

While we're on the subject of pumps, we'd like to explode a couple of myths. Contrary to what you've probably heard, water pump seal failures are usually not due to warping or fracturing of the precisely-made rotating elements. What happens is the rubber cup or the boot that surrounds the spring disintegrates. Think about it. Haven't most of the pump failures you've seen occurred shortly after an overheating incident? When the element has to run dry, it gets extremely hot, which takes the rubber parts close to it way beyond the maximum temperature they can survive.

Then, there's the faulty idea that phosphate and silicate additives in the anti-freeze tend to wear out those precisely-made sealing elements of the shaft. Sorry to burst a balloon, but that's simply not so.

59 bolts!

How about that recent Subaru 3.0L six? A very cool motor, right? They've even eliminated the timing belt in favor of a forever timing chain, which also makes the engine a little bit shorter so it could be placed in existing chassis.



3.0 liter engine with stands.

Because it was introduced in 2001, many of you haven't had the opportunity to install a water pump in one yet. So, you may be surprised to hear that the pump is driven by the timing chain. That should make it stone dependable. On the other hand, the job of replacing the pump when it either starts leaking, or has an impeller problem, is a big undertaking. Believe it or not, there are 59 bolts of various lengths holding that nice cast timing cover on. Once you get that off and the chain out of the way, you can use two M8 bolts to force the pump out of its recess (it's sealed with an "O"-ring). Then comes the job of getting the chain back on in proper synch, and remounting the cover so that it doesn't leak oil.

This should signify two things to you. First, it makes good cooling system maintenance and regular hose replacement even more important than in other models where the water pump is relatively easy to change -- as we said, overheating will fry the pump's shaft seal. And, two, you want to be very sure the pump is actually the problem in a low-flow situation before you go in there and replace it. You can use a non-contact infra-red pyrometer to see if the heat "map" through the radiator appears normal, but that's not exactly a go/no-go test. A better way is to drain the coolant level in the radiator down to the tubes, get the engine hot, then shut it off for maybe 10 minutes and let it heat soak to make sure the thermostat is wide open. Or, you could remove the 'stat.

By showing you the pattern of heat dissipation in the radiator, a non-contact infra-red pyrometer can help you find blockage, but it's not a sure thing.

Now, fire it up again, run it at 3,000 rpm and you should see strong circulation, "almost like from a garden hose," as one radiator shop owner puts it. A simple variation on this is to remove the hose that comes out of the heater core, place it in a bucket and start the engine. Since Subaru vehicles don't have a shut-off valve to the heater, you should see a robust stream no matter where the controls are set.

ECD

The big buzz word on hose deterioration is ECD (Electro-Chemical Degradation), which is invisible damage that can result in unexpected failure. Hoses are susceptible to electrochemical attack because the combination of ethylene propylene rubber, coolant, and metal fittings actually forms a galvanic cell. The results are cracking of the tube and weakening of the surrounding reinforcement, and the deterioration is greatest within an inch or two of the connections.

Hose replacement every fourth year is appropriate since surveys that have shown two to three times as many failures in the fifth year as in the fourth.

Finally, you're probably aware of the head gasket leak campaign on the '00 to '02 Legacy, and the '99 to '02 Impreza and Forester with the 2.5L four. There's an extended warranty for this that runs for eight years, or 100,000 miles. That is, if the customer "promptly" visits the dealer to have Genuine Subaru Cooling System Conditioner (Part Number SOA345001) added. That shows the company's faith in this additive.

You, too, should be using it every time you drain and refill a Subaru cooling system. Fuji doesn't approve of any aftermarket additive whatsoever, so why argue? Take four ounces of coolant out of the radiator, shake the bottle, then pour the contents directly into the radiator filler neck, not the overflow jug. ■

How's the Water?

You know, of course, that a 50/50 mix of anti-freeze (preferably S.O.A.'s own) and water is specified for Subaru vehicles no matter whether they're operated in the Tropics, or the "Great White North." So, you're filling those boxer engines with the same amount of H2O as with anti-freeze.

Nobody in the automotive service business seems to have given this situation much thought, but there's an important point to be made here if you want to insure that your customers avoid trouble in the long run. That is, the characteristics of the water in the blend.

If directly from a well, tap water in the U.S. is apt to be "hard." That is, containing a high concentration of metals and minerals — iron, calcium, magnesium, etc. If from a municipal water supply system, there's also the

This is a textbook example of how hoses deteriorate. It's actually an electro-chemical reaction that causes the damage. This one was on the verge of blowing and perhaps causing an engine-killing overheating incident.

distinct possibility that a considerable amount of chlorine and fluoride has been added.

When you take such particular care to make sure lubrication and other services are done just right to preserve and enhance your reputation, why should you put potentially-damaging substances into your customers' cars when you do a coolant change, or even a top-off? Especially when you consider that distilled/deionized water costs less than a dollar a gallon, there's no sense in not avoiding problems such as internal corrosion and electrolysis and deposits that reduce flow and cut cooling efficiency.

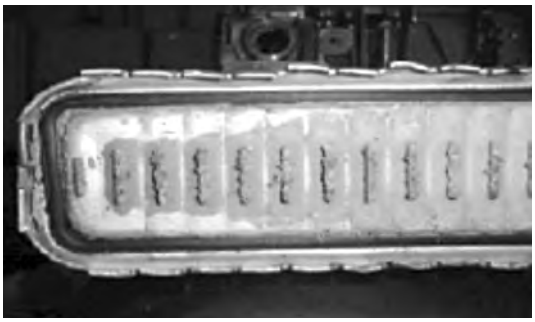
We should explain the difference between distilled and deionized. The former has been boiled, then condensed, which leaves the minerals and metals behind. The latter is "softened." In other words, it's passed through a bed that exchanges its calcium and magnesium ions for those of sodium. So, there's a little salt in it, but it's still far superior to what you'll get out of the tap in most locations.

This improvement in your car-care practices certainly isn't a difficult technological challenge. You can just go to the grocery store and buy plastic jugs of distilled/deionized water. So, it's a painless upgrade to the quality of the services you provide. Just do it. ■

A shop can distinguish itself from its competitors by advertising that it uses only distilled, or deionized, water to fill its customers' cooling systems. The cost is miniscule.

insider info

Coolant Cautions — All Subaru Models



This photo shows the condition of a clogged radiator that has been filled with non-genuine coolant. the residue is corroded aluminum.

Since the internal condition of the cooling system is a vital factor in engine durability, SOA gives us some strong admonitions concerning service:

- Always use Genuine Subaru Long Life Anti-Freeze Coolant, which is readily available at all Subaru dealership parts departments. Its formula incorporates phosphate (non-amine) to insure adequate anti-corrosion protection of the aluminum alloys in boxer engines. If a substitute anti-freeze must be used in an emergency, be certain not to substitute the long-life OAT type found in certain domestic cars. Use only a phosphate (non-amine) formula. Read the label carefully to be sure.

- If any cooling system-related repairs are to be paid for by SOA under any warranty or campaign, Genuine Subaru Long Life Anti-Freeze Coolant must be present in the system. Otherwise, the claim will not be honored.

- Do not use a flushing machine to service Subaru cooling systems. If the machine has been used to service other makes of vehicles that may have copper/brass radiators, a chemical reaction between the copper ions and Genuine Subaru Long Life Anti-Freeze Coolant may occur, which could cause clogging of the radiator.

- If flushing is required, use only pure tap water. Do not use aftermarket flushing agents. Also, avoid "hard" water — water with a high concentration of minerals will cause calcium and other deposits to form in the radiator, thus restricting its flow patterns.

- Whenever the coolant is changed for any reason whatsoever, you must add Genuine Subaru Cooling System Conditioner, which you can buy by the case from your local Subaru dealership parts department (12 bottles, Part Number SOA345001). This is the only additive that has been approved by SOA.

- Do not use any aftermarket coolant reinforcement agents or sealers as they may clog the radiator, or cause internal corrosion.

2.5L External Coolant Leak Campaign
2000 to 2002 Legacy and Outback; 1999 to 2002 Impreza and Forester

SOA has determined that over time the affected vehicles may develop small external coolant leaks at engine cylinder head gaskets. This is the result of normal expansion and contraction of engine components caused by the heating and cooling of these parts. To prevent cylinder head gasket leaks from developing, or to correct existing leaks, one bottle of Genuine Subaru Cooling System Conditioner should be added to the cooling system of these models.

Affected vehicles are identified in the VIN range chart on page 25.

For owners of affected vehicles who, after receiving a notification letter from the company on this issue, have Genuine Subaru Cooling System Conditioner added promptly, SOA is extending coverage under the Subaru Limited Warranty for cylinder head gasket external coolant leaks to a period of eight years, or 100,000 miles, whichever occurs first. Warranty coverage begins on the date the vehicle was delivered to the first retail purchaser. If the vehicle was used as a demonstrator or company vehicle before being sold at retail, warranty coverage begins on the date the vehicle was first placed in such service.

As a further condition for this extended warranty coverage to apply, the owner must properly maintain the vehicle's cooling system in accordance with the recommended maintenance schedule and Genuine Subaru Cooling System Conditioner must be added each time the engine coolant is replaced. Resulting damage caused by a lack of maintenance or low coolant level will not be covered. The cost of the conditioner used during inspection and maintenance services is not covered under the warranty.

Model			From	To
Legacy 2.5L	2000MY	Sedan	Y*200001	Y*218478
		Wagon	Y*300001	Y*313778
		Outback Wagon	Y*600001	Y*674127
	2001MY	Sedan	1*200001	1*216426
		Wagon	1*300001	1*311949
		Outback Wagon	1*600001	1*679753
	2002MY	Sedan	2*200001	2*202129
		Wagon	2*300001	2*301972
		Outback Wagon	2*600001	2*605593
Impreza 2.5L	1999MY	Coupe	X*400001	X*403359
	2000MY	Coupe	Y*400001	Y*403888
		Sedan	Y*500001	Y*505796
	2001MY	Coupe	1*400001	1*402563
		Sedan	1*500001	1*503187
	2002MY	Sedan	2*500001	2*513107
		Wagon	2*800001	2*812658
Forester 2.6L	1999MY	Forester	X*700001	X*750961
	2000MY	Forester	Y*700001	Y*731553
	2001MY	Forester	1*700001	1*789251
	2002MY	Forester	2*700001	2*726482

What is a Subaru N.E.W. Horizons Dealer?

N.E.W. NATIONAL • EXPANDED • WHOLESALE HORIZONS

Subaru N.E.W. Horizons Dealers have been recognized for their outstanding performance in serving the wholesale market. N.E.W. Horizons dealers provide you with a direct wholesale parts hotline and also maintain a large inventory of competitively priced Genuine Subaru Parts, which means you can get most parts immediately. If not, the N.E.W. Horizons dealers' direct access to the Subaru Parts Distribution Network means it can get you almost any part you need quickly. If you have a question about a specific part or repair job, just ask. No one knows a Subaru, or the parts needed to repair them, like a Subaru N.E.W. Horizons Dealer.

Please note: Left column telephone numbers provide direct access to Subaru N.E.W. Horizons Parts Departments. Right column numbers provide general access to Subaru N.E.W. Horizons Dealers.

Alaska

Anchorage
Continental Subaru
800.478.7278 907.562.2722

Arizona

Phoenix
Camelback Subaru
602.277.8081 602.265.6600

Scottsdale
Power Subaru Scottsdale
800.537.5143 480.425.2800

Tucson
Emich Subaru
800.264.7733 520.721.2400

California

Albany
Albany Subaru
510.526.8791 510.528.1244

Carlsbad
Bob Baker Subaru
760.438.3113 760.438.2200

Costa Mesa
South Coast Subaru
888.418.7425 714.689.2103

El Cajon
Bob Baker Subaru – El Cajon
619.440.1213 619.440.0404

Fresno
Herwaldt Subaru
559.438.6934 559.438.6944

Fullerton
Renick Subaru
888.923.8201 714.871.9300

Lake Forest
Irvine Subaru
949.452.0100 949.837.3500

Long Beach
Timmons Subaru
888.489.5001 562.595.4601

Monrovia
Sierra Subaru
626.932.5614 626.359.8291

Oakland
Downtown Subaru
510.653.0350 510.547.4424

Ontario
Exclusively Subaru
909.230.9670 909.605.5810

Redwood City
Carlsen Subaru
650.365.2600 650.365.6390

Roseville
AutoWest Subaru
888.220.4269 916.786.6611

Sacramento
Senator Subaru
800.533.6567 916.427.1234

Sacramento
Maita Subaru
800.383.7278 916.486.8000

San Bernardino
Subaru of San Bernardino
877.378.2278 909.888.8686

San Diego
Rancho Subaru
858.495.9090 858.278.7100

San Jose
Stevens Creek Subaru
408.984.1006 408.984.2001

San Rafael
Marin Subaru
415.257.4690 415.454.9240

Santa Cruz
Subaru of Santa Cruz
831.420.1402 831.420.1500

Santa Monica
Santa Monica Subaru
310.319.3609 310.393.9881

Santa Rosa
Prestige Subaru
707.575.1051 707.545.6602

Shingle Springs
Shingle Springs Subaru
800.345.7778 530.677.8771

South San Francisco
Ron Price Subaru
650.583.4040 650.589.9788

Thousand Oaks
Subaru of Thousand Oaks
800.742.0122 805.371.5555

Van Nuys
Big Valley Subaru
818.475.6237 818.787.0800

Walnut Creek
Diablo Subaru
925.937.6990 925.937.6900

Colorado

Aurora
Shortline Subaru
303.364.3368 303.364.2200

Boulder
Flatirons Subaru
800.634.6621 303.443.0114

Colorado Springs
Heuberger Subaru
800.675.2227 719.475.1920

Durango
Morehart Subaru
970.385.0202 970.247.2121

Englewood
Burt Subaru
800.525.8402 303.761.7453

Englewood
John Elway Subaru South
720.985.0814 303.792.0330

Fort Collins
Dellenbach Subaru
970.530.0945 970.226.3100

Golden
John Elway Subaru West
877.974.2489 303.590.6600

Grand Junction
Rocky Mountain Subaru
800.244.2902 970.241.2414

Greeley
Ehrlich Subaru
970.346.3542 970.353.7707

Longmont
Valley Subaru – Longmont
303.447.9531 303.776.0443

Thornton
Mike Shaw Subaru
303.438.7524 303.438.7500

Connecticut

Danbury
Colonial Subaru
800.229.2656 203.744.8383

Milford
Dan Perkins Subaru
800.367.9335 203.882.5680

New Britain
Schaller Subaru
860.826.2040 860.223.2230

Torrington
Center Subaru
877.652.2229 860.489.1301

Watertown
Chase Parkway Garage, Inc.
800.327.9002 860.274.8866

Florida

Delray Beach
Delray Subaru
888.830.7337 561.276.7800

Fort Walton Beach
Lee Subaru
800.745.3171 850.243.3171

Gainesville
Palm Subaru
800.541.4011 352.372.2561

Jacksonville
Subaru of Jacksonville
800.393.3455 904.641.6455

Miami
William Lehman Subaru
800.999.9118 305.653.7123

Sanford
Bob Dance Subaru
866.283.7034 321.206.1792

Tampa
Mastro Subaru
800.683.2532 813.884.7513

Georgia

Cumming
Troncalli Subaru
770.889.2061 770.889.8951

Decatur
Royal Subaru
800.445.0948 404.296.9100

Duluth
Subaru of Gwinnett
800.584.8727 678.475.3500

Smyrna
Ed Voyles Subaru
800.421.1521 770.952.8881

Idaho

Boise
Larry Miller Subaru
888.941.2218 208.323.6300

Moscow
Ambassador Subaru
800.422.0297 208.882.2722

Illinois

Chicago
Mid City Subaru
773.282.3530 773.282.6200

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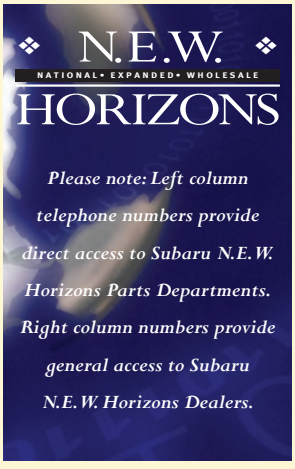

Insufficient A/C Cooling Performance
2001 to 2002 Legacy H-6

If a customer complains that his or her air conditioner isn't giving satisfactory performance, perhaps the compressor is "short-cycling" due to an open circuit in the compressor revolution sensor.

To diagnose:

1. Unplug the three-pole electrical connector on top of the compressor.
2. Identifying the poles on the compressor side as A, B, and C left to right, check for continuity between B and C.
3. If there's no continuity, suspect the revolution sensor.
4. Check one more thing before replacing the sensor: Resistance at room temperature should be 2 kOhms, and warmed up 1.6 kOhms.

To replace the revolution sensor, proceed as follows:

1. Get as much oil back into the compressor as possible by running the engine at 1,500 rpm, turning on the A/C and setting it to Max, Recirc, and high blower, and leaving it on for 10 minutes.
2. Shut off the engine and disconnect the negative battery cable (note the radio presets).
3. Recover the refrigerant using the proper recycling equipment.
4. Remove the compressor from the vehicle after installing the plugs provided in the kit and applying electrical tape over the ends of the high and low side hoses. This will prevent dirt, dust, moisture, and other foreign material from contaminating the system.
5. Clean the area around the revolution sensor.
6. Disconnect the ground wire for the revolution sensor from its bracket and retain the screw for re-use.
7. Remove the revolution sensor connector from its bracket.
8. Remove the rear retaining clip (brown) from the connector and remove the black wire leading to the air conditioner compressor clutch from the connector. Do this with the appropriate electrical pin terminal removal tool.
9. Remove the rear retaining clip (brown) from the connector and remove the yellow and black terminal pins (leading to the revolution sensor) from the revoultion sensor connector after taking note of their original positions.
10. Remove the revolution sensor from the compressor being careful not to damage the sealing surface of the compressor.
11. Thoroughly coat the replacement O-ring, supplied in the kit, with compressor oil and carefully install it on the revolution sensor.
12. Confirm that the O-ring is fitted correctly and install the revolution sensor to the specified torque of 11.6 ft-lb./16 Nm.
13. After reinserting the two teminal pins back into the revoultion sensor connector and ensuring their engagement, replace the rear retaining clip (brown) into the back of the connector with the one supplied in the kit.
14. Reinstall the connector to its bracket and ensure its engagement.
15. Connect the grounding wire of the revolution sensor to its original position and tighten to the specified torque of 2.2 ft-lb/3 Nm.
16. Charge the system with the proper amount of refrigerant and perform system performance test to confirm correct system operation.

The modified revolution sensor is Part Number 73190AE000, and the factory flat rate is two hours.

MIL On and Rough Idle
2001-2003 Legacy and Baja

If you encounter a MIL-on (Malfunction Indicator Lamp) condition and rough idling after you've disconnected the battery of a four-cylinder, non-turbo model for a short time (less than half an hour), suspect a glitch in the ECU's memory.

This can easily be corrected by clearing the memory with the Select Monitor, or equivalent aftermarket scan tool. Or, you can just disconnect the battery again for over 30 minutes, which will allow the ECU enough time to clear itself. ■

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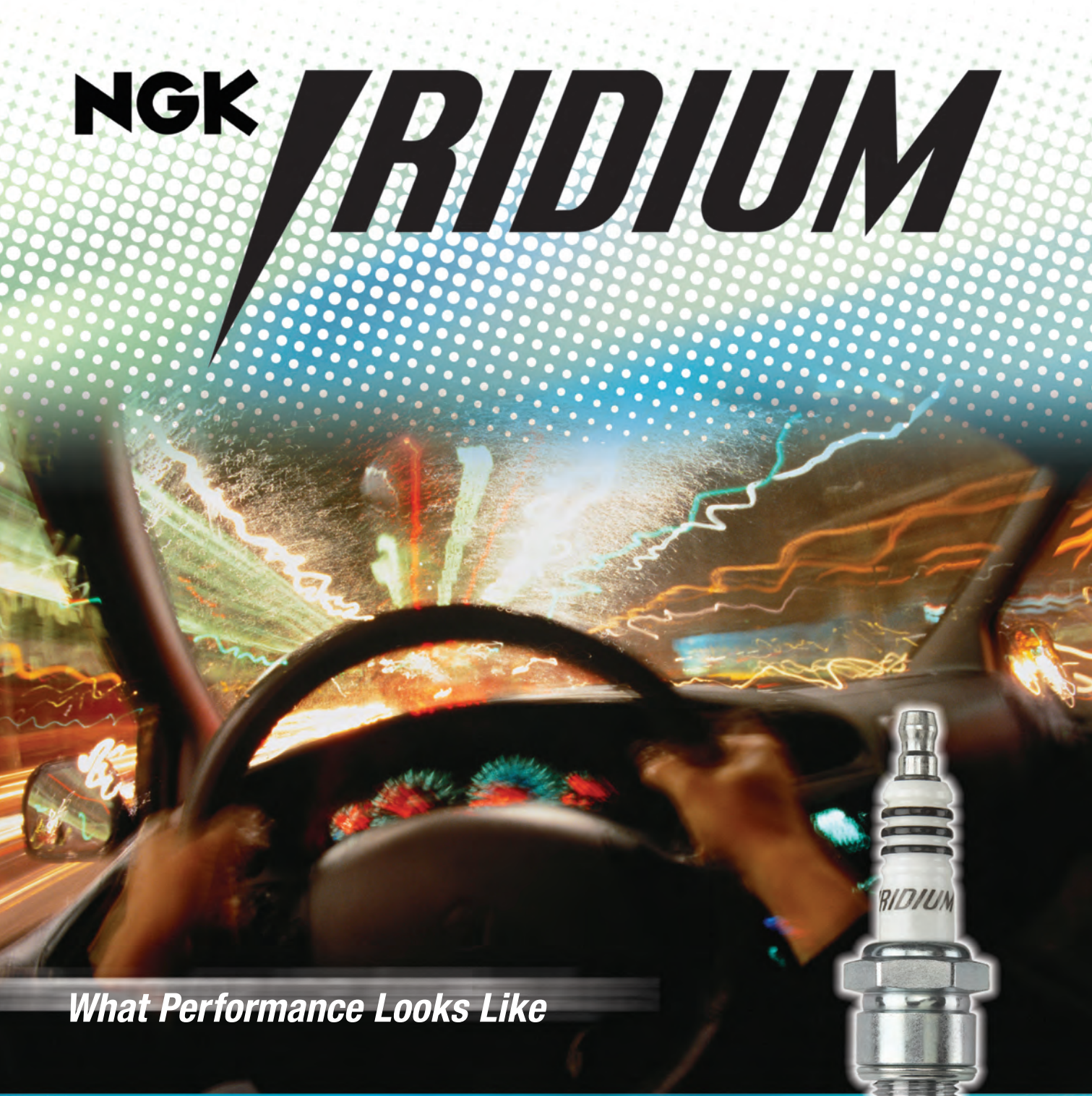

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