

the **EndWrench**[®]

A Publication for Professional Repair Technicians from Subaru N.E.W. Horizons Dealers | www.endwrench.com



SUBARU

August 2005 | Number 30 | \$6

Navigating the **Subaru Technical Information Website**

••• Also Inside:

- What to Do When the MIL Comes On
- Pre-OBD II Diagnostics & Ignition
- MAF Sensors
- Eighty-Eight Years!



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People love their Subaru cars so much, they hold on to them longer. And they're willing to invest in them to maintain peak performance.

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SUBARU
GENUINE PARTS

* Based on the Polk Company Retail Registration statistics for the period ending 6/30/03.

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Caution: Vehicle servicing performed by untrained persons could result in serious injury to those persons or others.

Information contained in this publication is intended for use by trained, professional auto repair technicians ONLY. This information is provided to inform these technicians of conditions which may occur in some vehicles or to provide information which could assist them in proper servicing of these vehicles.

Properly trained technicians have the equipment, tools, safety instructions, and know-how to perform repairs correctly and safely. If a condition is described, DO NOT assume that a topic covered in these pages automatically applies to your vehicle or that your vehicle has that condition.

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inside



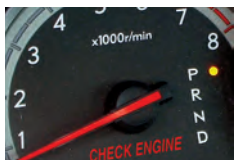
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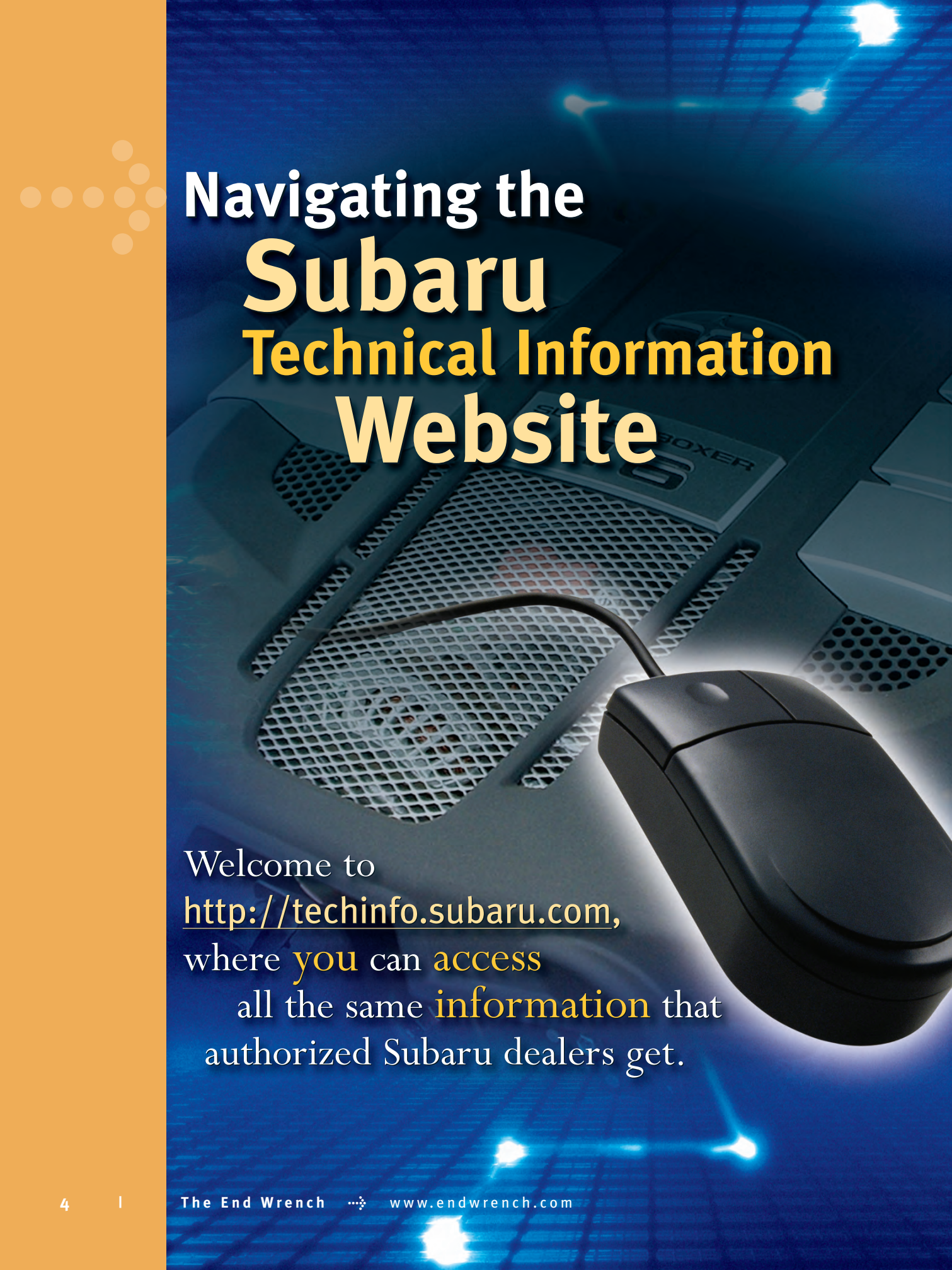
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Subaru Internet Resources

Additional Subaru parts and service information is available online. The End Wrench can also be found at www.endwrench.com. Log onto <http://techinfo.subaru.com> for access to Subaru service manuals, service bulletins, Tech Tips, newsletters and owner's manuals. You can also select from a range of SPT Performance Parts at www.spt.subaru.com.



Navigating the Subaru Technical Information Website

Welcome to
<http://techinfo.subaru.com>,
where **you** can **access**
all the same **information** that
authorized Subaru dealers get.

It won't be news to you that the Internet is a great source of information on how to tackle an unfamiliar or difficult repair. Not surprisingly, however, that information can sometimes be contradictory, is often incomplete, and, worse still, not up-to-date with the latest revisions and modifications.

The Subaru solution to making sure that the most accurate and timely information is always at your fingertips when you're working on one of its vehicles is to host a website designed with you, the repair technician, in mind. The following is a look at the features of that site, and how to navigate it most efficiently. We'll be talking about the content found under "Reference Publications" this month, and save "Diagnostic Service Information" for a future issue of *The EndWrench*.

Address

The URL for the Subaru website is <http://techinfo.subaru.com>, and once accessed you are presented with a screen like the one shown in Figure 1. This screen provides a basic overview of how the site works, including the different levels of subscriptions to the site from a minimum of 72 hours through a full 365 days. A very helpful FAQ (Frequently Asked Questions) hotlink is provided that gives details on subscription fees (a chart is provided later in this article), how to manage PDF (Portable Document Format) files, the shopping cart and more.

At the bottom of the page you will find some helpful hotlink icons to sites for *The EndWrench*, SPT performance parts, Kent-Moore Tools and the Y.E.S. (Youth Educational Systems) automotive web page.

If you are already a subscriber to <http://techinfo.subaru.com>, then at the top of the page there is an area for you to enter your user name and password. If you aren't yet a subscriber, you can still access the website by using the features to the left of the page, which will aid you in your search for information. Let's take a closer look at that part of the web page, which is divided into three sections that allow the three different types of searches shown in Figure 2.

Point to the "Reference Publications" tab and select a model year and model from the pop-up menu, or simply click on the "Reference Publications" tab. When opened, it gives you a selection of publications from which to choose, as shown in Figure 3. Once a publication is chosen, the text can be entered in the box below to further refine your search. The more specific the text inquiry, the better your chances are of getting where you want to go on the first try.

Bulletins

For example, let's choose "Subaru Bulletins" as the publication type. Once we do so, the web page activates and you are directed to the following screen (Figure 4).

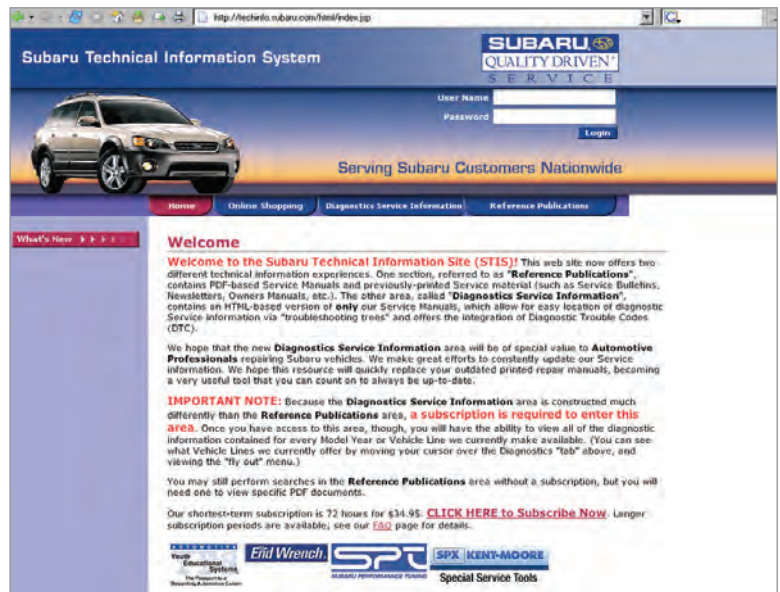


Figure 1: Most of us grew up with paper service manuals, then graduated to information on CD and DVD. Thanks to the Internet, now we can be sure of always having the most complete and up-to-date information possible.

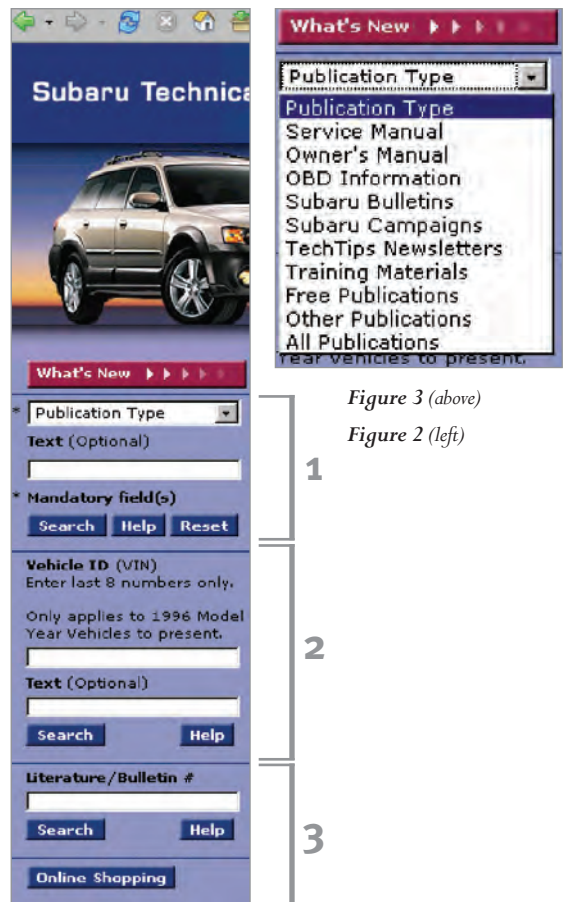


Figure 3 (above)

Figure 2 (left)

continued on page 8

Use Our Sure-Fire Subaru Specials to Keep Your Service Bays Filled This Fall

With a little planning, carefully targeted sale ideas can attract new customers, bring back past ones and convince drive-bys to stop in for your superior service.

Fall is in on the way and it's not too early to start planning for ways to bring in business between the summer radiator repairs and the winter electrical system checks. Promoting with eye-catching signs, bold newspaper ads and effectively targeted direct mail and phone reminders can help you beat your competition to the punch and draw in extra business.

Everyone feels the pain of sky-high gasoline prices, so help your customers trim their fuel costs with a tune-up sale geared toward helping fuel efficiency. Offer an inexpensive fixed-price **"Fabulous Fall Fuel Efficiency Tune-Up Sale. Just \$00"** and you'll generate plenty of interest among regular and prospective customers alike. The tune-up should include new filters, and can also offer tire tread wear and pressure checks as well as wheel

balance and alignment tests.

Shops that handle auto bodywork and detailing will want to consider running this sale: **"Subaru Auto Spa Special! Revitalize Your Ride for Only \$000"** An attractive price will surely get prospects thinking. Plus, by arranging it so your special covers your area of expertise, be it detailing, bodywork, performance tuning or a total bumper-to-bumper diagnostic checkup, you'll qualify prospects and bring in the type of work you do best.

Finally, a brake repair special such as **"Subaru \$00 Brake Safely Sale"** puts your inexpensive brake repair message right out front where prospective customers can stop in and book appointments on the spot. So, put your marketing plan into action and keep your appointment calendar filled for the whole season.

SUBARU CAPTURES PIKES PEAK SUMMIT ONCE AGAIN!

High in the Colorado Rockies, Subaru drivers clasped hands and hugged each other in exuberant celebration of their winning not just first place but capturing seven out of the top ten spots this year in the prestigious Pikes Peak Road Rally.

Stephan Verdier and co-driver Chrissie Beavis won the event with over a minute to spare in a fast and powerful Open Class Subaru WRX STI. In the Group N category, Stig Blomqvist and Pat Richard had an unbelievably close battle. Blomqvist, former World Rally Champion, clinched the Group N Class win by a mere 0.6 seconds over Team Richard. Dedicated drivers and wonderfully responsive machines scaling a mountain with 1000-foot high cliffs made for thrilling racing and another memorable chapter in the Subaru performance story.

And here's an intriguing subplot you can tell the performance enthusiasts who come to your shop. A Production GT WRX driven by Tanner Foust and Scott Crouch finished the rally first in class and ninth overall. That's a production class car winning the admiration of drivers everywhere! If that doesn't inspire you and your



customers to add a little sizzle to their street machines, then we're not talking the same language. So talk up this win, share the glory, tell your customers to visit www.rally.subaru.com for more about the win, and make some performance parts sales along the way. Rally on!

GENUINE SUBARU AUTOMOTIVE CHEMICALS HAVE THE RIGHT STUFF

A large part of keeping Subaru vehicles operating at peak efficiency lies in the factory-fill fluids and aerosols you use.

When you use Genuine Subaru Automotive Chemicals to top off or change your customers' fluids, there's no doubt that you're putting in exactly what their vehicles need. Whether it's the brake fluid, factory fill coolant, transmission fluid/power steering fluid or even factory fill windshield washer concentrate, each product is formulated to deliver the performance your customers expect from their Subaru vehicles. In many cases, these fluids are even required for warranty work. So pour only Genuine Subaru Automotive Chemicals and you'll always be sure your customers' cars have the right stuff.



EASY STREET IS ANYTHING BUT QUIET!

Easy Street Motorsports does everything it can to ballyhoo performance for Subaru drivers.

Anyone who visits Easy Street's website at www.esxmotorsports.com can't help but get caught up in the excitement generated by this Web site featuring Subaru performance cars. From the attention-grabbing red tractor-trailer rig hauling Subaru performance machines and parts to shows across the country to blazing hot specially staged performance kits that independents can purchase to upgrade the WRX and STI models of their customers, Easy Street is out to make big noise about

Subaru performance capabilities and wave the flag on the Subaru racing pedigree. The people behind the site are obviously dedicated to putting out the hottest Subaru street machines on the roads, the drag strip and the rally sites around the U.S.

Check out the site, tell your customers and see if you don't catch a huge dose of performance fever from the moment you click in!

JUST DOWN THE ROAD...

More applications are coming your way from Subaru. Over the next couple of months, look for new adjustable strut/spring sets for '05-'06 STI models, remanufactured hybrid short block applications for 2000 to 2004, plus remanufactured 4-speed automatic transmissions for 2005 model year vehicles. They're all Genuine Subaru Parts.

SEMA ALERT! PERFORMANCE PARTS EXTRAVAGANZA LOOMS NEAR

Ready for a great change of pace? This year, may we suggest a trip to Las Vegas to see the hottest performance parts and heart-stopping Subaru cars that satisfy everyone's inner speed-demon. At the annual Specialty Equipment Market Association show you'll see all the latest toys the automotive world has to offer. It all happens November 1 to 4, 2005 so come join the fun and be sure to stop in at the Subaru booth (#000).

Navigating the Subaru Website

There's a lot of useful information on this page on how to proceed with your search, and a hotlink that helps you understand how the TSBs (Technical Service Bulletins) are grouped categorically. That is, from *01 General Specifications* to *18 Service Manual Corrections*.

On the left side of the page there is also now a list of six fields, all of which

contain drop-down information. Your choice in the first box is type of bulletin: Technical, Warranty, or State IM. The next drop-down box lets you choose the model year, your range of choices being 1990 to 2005. After you select the model year, the next box lets you choose the model. This is all-encompassing, showing every Subaru model sold in the U.S. from 1990 to

the current model year. As you move down to the next fields, you are asked to select the transmission type, then engine size, and, finally, drive train (AWD, FWD or 4WD). You need not complete all these fields, especially since you may not know all the information at the time of your search. The more information you enter, however, the quicker you will "drill down" to the information you seek. You can refine your search further still by adding key text to help you get to where you want to be. Pretty impressive, yet that's only one way of getting to the information you want. There are other avenues.

VIN

Having a VIN (Vehicle Identification Number) is always helpful when trying to find information about a vehicle. A VIN is quite long, however, and can be easy to copy down wrong by transposing numbers. Luckily, the Subaru system is such that all you need are the last eight digits of the VIN.

Once you enter the VIN into the field shown in section #2 of Figure 2 you will then need to add some text to help the search engine understand what it is you're looking for. In our example, we are looking up a 1999 Forester and seeking information about the throttle body. Our result is shown in Figure 5.

Specificity

Ever helpful, the search engine gives you two groups of hotlinks to ponder. The first set of hotlinks is grouped under the heading, "This information is specifically related to your vehicle," and lists three publications: Service Manual, Owners Manual, and Product/Service Campaign Bulletins. The next grouping — "This general information may or may not be specific to your vehicle" — has broader, less specific information related to our search similar to what is covered in a new model overview. Time should be taken to click through the listed options to make sure there isn't something on the list that might be relevant.

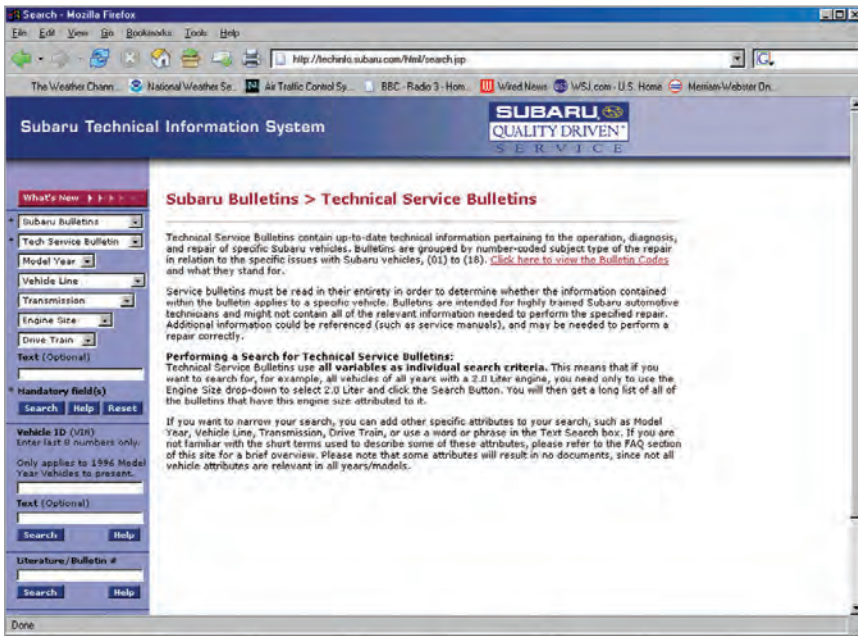


Figure 4

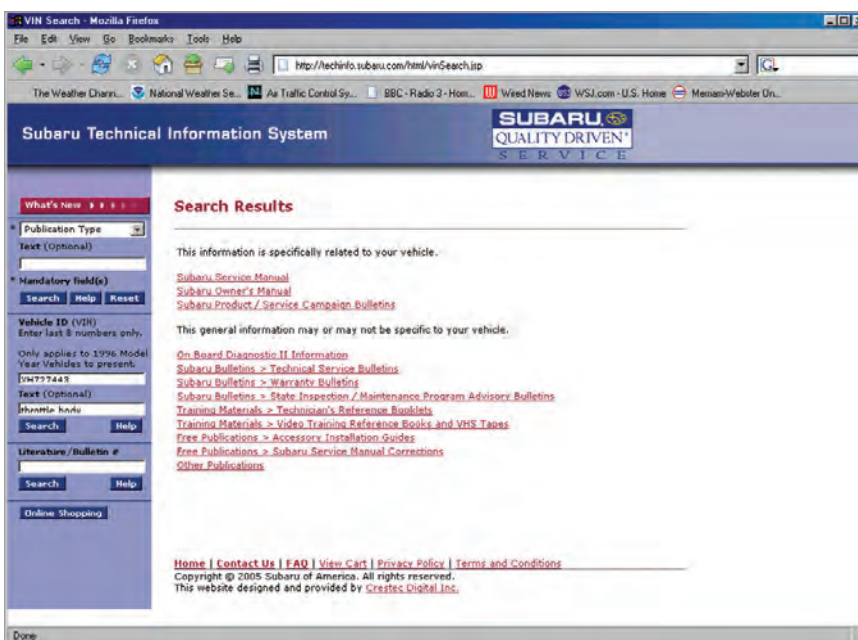


Figure 5

REMANUFACTURED PARTS

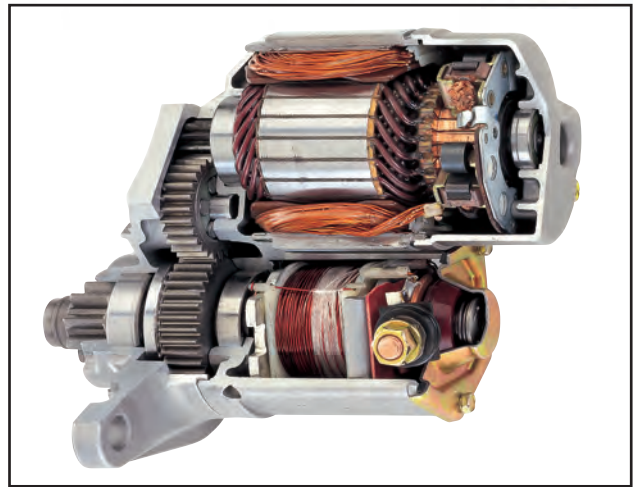


...meet original equipment specifications, perform like new and save money.

Want to save money on big-ticket auto parts without risking a thing? Consider using Genuine Subaru Remanufactured Parts. All of them meet the strictest OEM specifications and fit and function like new Genuine Subaru Parts.

They cost less because they cost less to build. Built using only the best cores that are disassembled, cleaned, machined and refitted to strict quality standards, each Genuine Subaru Remanufactured Part is designed to offer trouble-free driving and unsurpassed reliability. Of course, they're all backed by the Genuine Subaru Parts Limited Warranty.

So call your local authorized Subaru dealer for prices and details or visit www.endwrench.com today.



Genuine Subaru Remanufactured Parts Mean Business

Brake Calipers	Includes front and rear calipers
Electrical	Includes alternators, starters and digital dashes
Automatic Transmissions	Includes AWD and FWD
Drive Train	Includes rear differentials and front axles

This brings up two points not yet discussed. First, as you might have noticed, so far as we've dug deeper into the <http://techinfo.subaru.com> website we haven't been asked for a user name or password. We'll get to that soon, but, believe it or not, we can dive in deeper still to access information about our 1999 Forester throttle body before we are asked to pay for anything. And that takes us to our second point, which is how do we know which publication we want?

Let's go back a step to the first set of hotlinks in Figure 5. As you click through the three offered options you will find that the Service Manual option is the only one with useful information about our throttle body. When "Owners Manual" is clicked, it comes up with a message that essentially tells you that there isn't any throttle body-related information in the Owners Manual, so that's a dead end. When "Product/Service Campaign Bulletins" is accessed, you come up empty again.



Figure 6

Welcome BFreud! [Logout]
Your subscription expires 09/16/2005 04:50:19 PM EST

View Cart

Literature #	Item Name	Quantity	Unit Price (US \$)	Total (US \$)	Delete
SUTTIPS0104	January 2004 TechTIPS Newsletter	1	5.00	5.00	
SUTTIPS1203	December 2003 TechTIPS Newsletter	1	5.00	5.00	
MSA5TCD99F	1999 Forester Service Manual	1	199.95	199.95	
Subtotal				209.95	

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Figure 7

This is good because you can now feel confident that the information in the Service Manual will be up-to-date, provided a Technical Service Bulletin hasn't been issued, or a correction to the Service Manual made. You can check on this, and should have already done so in our exercise above, by clicking through the links shown on the same page.

Service Manuals

Okay, let's see what happens when we click on "Subaru Service Manual." What appears is a list of sections (Figure 6) from the Service Manual that are in some way related to the throttle body. In our example, three major sections are shown: Engine, Mechanical Components, and Diagnostic, under each of which there is a set of sub categories to help you further dial into what you need. The sections and sub categories are all hotlinks that when accessed give you further details about what's contained within. Keep in mind that the list that is being presented to us is specific to our request for information about a throttle body. But, honestly, it's still not enough information on which to make a decision about which specific documents you might want before having to get out the credit card.

Take note of a blue icon next to the field, "Add to Cart." When you click on it, a dialog box opens telling you what you will get should you decide to purchase a hard copy of the material. Another icon, this time red, is the PDF link that is used to open up the file online and access information immediately. Like the "Add to Cart" icon, this one requires you to reach into your pocket.

Registering and purchasing materials from the techinfo site is very similar to any other website purchase. First, you choose a user name, provide an e-mail address, then create a password, which you must then confirm. Don't forget to put a check in the box to be automatically notified of future updates and bulletins — a handy feature. The different types of subscriptions are shown in the figure below.

Hard Copy or PDF?

Once you have gone through the registration process and have determined what kind of subscription you want, you will find that you are directed back to the screen in Figure 6 from which you can decide what you want to do. You have two choices, purchase hard copies of the materials, or access the information online using the PDF

file format. Let's assume you choose the PDF file. You'll need Adobe Acrobat Reader. If you don't have it (it's freeware), Subaru provides a convenient link for you to go get it.

After installing Adobe Acrobat Reader click on the icon next to the piece of material you want and the file will open. You can print out all or part of the file and/or save it to your hard drive. Subaru does not recommend saving the file for concerns about how current the file will be should updates become available at a later date. However, it's faster to save the file to a hard drive and then print it out. A suggestion to ensure you always have the most recent information would be to change the name of the file to include the date of your download.

For Instance

As an example, when clicking on "Component Parts, Air Intake System (42.31 kb)," if you chose "save to file" as an option (which can also be done after the file opens using a menu option in Adobe Acrobat Reader), the file would appear on your hard drive as "MSA5TCD99F8085," not a very user-friendly file name. You can change the name of the file during download, or later, if you wish to something like *1999 Forester Air Intake Parts-System 7-30-05*. The good news is that almost all current computer operating systems will allow a long name like this. But if that doesn't work for you, set up a subdirectory in your "My Documents" folder for Subaru/Forester and a file name such as, "AirInSys7-30-05." Either way, at a quick glance you'll know how current the file is the next time a problem arises where you need this type of information. Even then you should always return to the techinfo site to make sure there aren't any updates.

Let's say you prefer to get a hard copy of the information instead. When you click on "Add to Cart" a window opens and tells you what's available. Like other websites, here you can modify your order by changing quantities or deleting items. Once you have

REPLACEMENT MUFFLERS

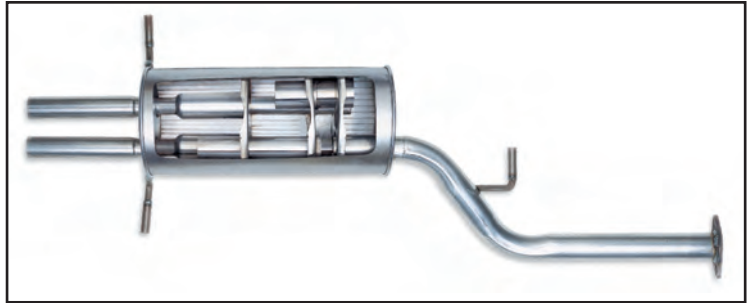


...provide perfect fit and function.

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

decided what you want, you can proceed to checkout and finalize the purchase. All rather simple.

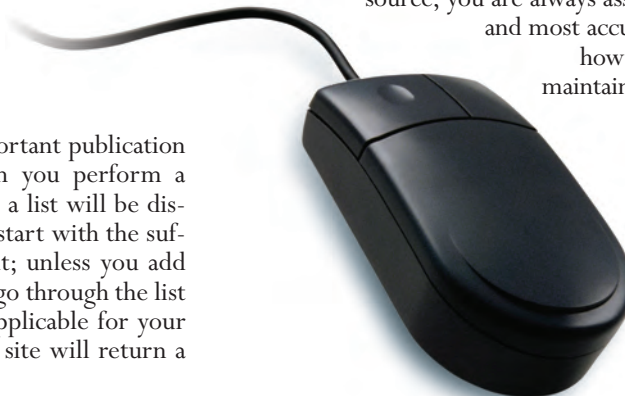
There's still one other method for finding information on the techinfo website. If you'll remember in Figure 2, the third section was a search option for finding a known publication. Subaru uses MSA numbers for manuals and such, which is what you would put in here. The following chart will help you interpret the Subaru publication parts numbering system and can also be a useful guide to what publication will have the most helpful information for the issue you're dealing with. A great feature is that the complete part number need not be known. All you need to do is enter one of the part number suffixes from the chart below.

Pub Numbers

For repair purposes, the two most important publication numbers are MSA5P and MSA5T. When you perform a wildcard search using these two numbers, a list will be displayed that shows all the publications that start with the suffix you entered. And that's a critical point; unless you add the rest of the part number you'll need to go through the list to determine which publication is most applicable for your need. Example: If MSA5T is entered, the site will return a

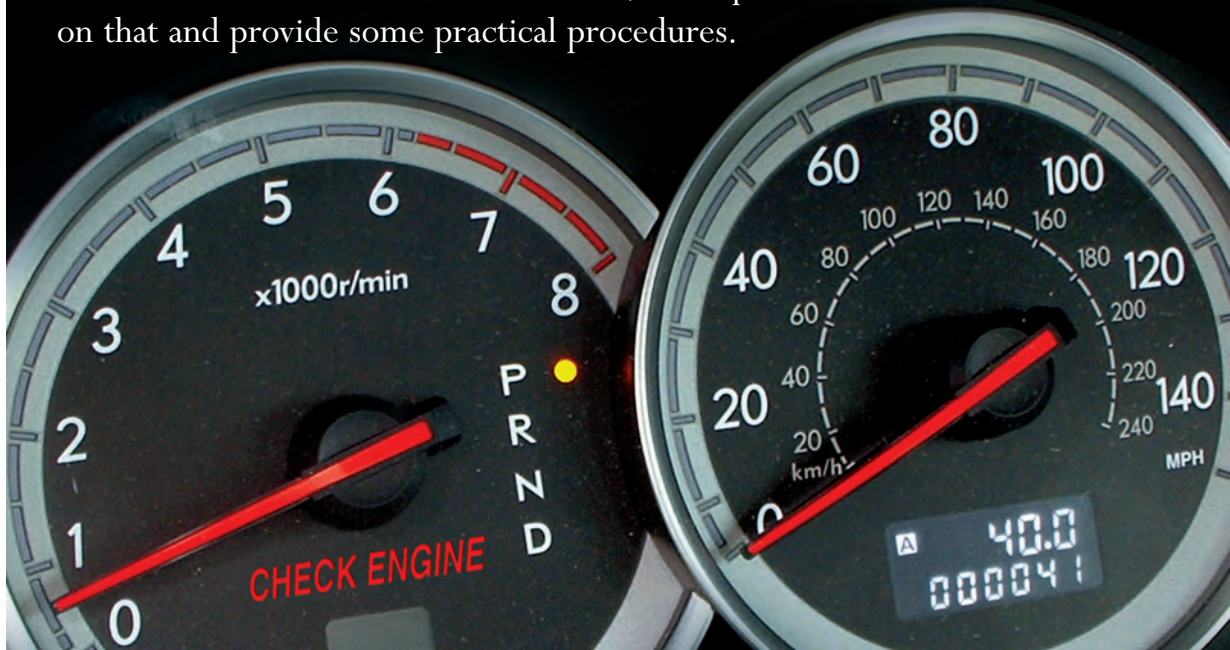
complete list of every service manual available in the system – not very helpful. When MSA5P is entered, a shorter list is returned, which is easier to sort through, but you still have to go through the synopses to determine applicability to the car you're working on.

The Subaru techinfo site is certainly one of the handiest tools *not* in your toolbox for repairing a Subaru. Not only does the site give you immediate access to up-to-date service manuals, but also a listing of the latest repair techniques and corrected/revised procedures. Designed for the pace of today's business needs, Subaru gives you the flexibility of getting the information you need when you need it with just a few simple keystrokes and clicks of a mouse. By going directly to the source, you are always assured of having the best and most accurate information about how to diagnose, repair and maintain any Subaru vehicle. ■



Step-by-Step: What to Do When the MIL Comes On

In the Spring, '05 issue of *The End Wrench*, we gave you an overview of how OBD II does what it does. Here, we expand on that and provide some practical procedures.



Although it's hard to believe at this high-tech juncture, there was, of course, a time of NOBDAA — *No On Board Diagnostics At All*. “Back in the day” diagnosis was accomplished by visual inspection, measurement and disassembly 100% of the time. Pressure from California and the EPA starting in the late '70s gave us OBD I, a system that illuminated a Malfunction Indicator Lamp (MIL) when a fault was present and turned off the light when the fault went away. There was no provision for any performance monitoring — a continuous monitoring of all Powertrain Control Module (PCM — commonly referred to as an ECU for Electronic Control Module in Subaru vehicles) inputs and outputs — and no PCM directed testing sequence, or active means to check component failure. It was designed only to alert the driver in the case of a hard fault, more a fault monitoring and reporting system than anything else. Additionally, code retrieval and data gathering wasn't standardized and specific first generation scan tools were

required for specific cars; even the location and style of access connector varied from car line to car line.

The 1996 Watershed

It didn't take long for the California Air Resources Board (CARB) and the EPA to recognize that emissions improvement with that system was minimal at best, and would over time fail to meet clean air objectives. In addition to the “black electrical tape over the light” repairs of that era, car owners were reluctant to show up voluntarily to pay to fix what they perceived to be the annoyance of a simple warning light unless there was an irritating symptom attached to MIL illumination. Frustrated with the lack of air quality improvement, the CARB and the EPA, along with the Society of Automotive Engineers (SAE) and other interested parties, worked on the language, legislation and standardization that eventually become law in the Clean Air Act

ENGINE COMPONENTS



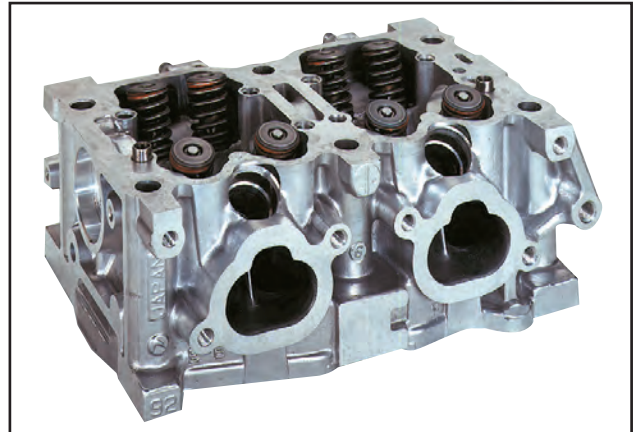
GENUINE PARTS

...offer exceptional fit, reliability and value.

Don't take chances with your reputation or your customers' satisfaction with rebuilt or inferior aftermarket parts.

Genuine Subaru Engine Components are manufactured to demanding original equipment specifications, they're competitively priced and they install easily. No force-fits! More value.

Your local authorized Subaru dealer has a ready supply for a wide variety of applications so you get fast turnaround on everything you order. Of course, every part is backed by the Genuine Subaru Parts Limited Warranty so you know you can trust them for first-rate performance. Call for details and prices or visit www.endwrench.com.



Genuine Subaru Engine Components Mean Business

Head Assemblies	Fully assembled with valves, springs, seals and retainers
Valve Train	Includes cam shafts, lifters, rockers, belts and pulleys
Clutch Parts	Includes clutch kits, discs, covers and bearings
Other Components	Includes short blocks, oil and water pumps

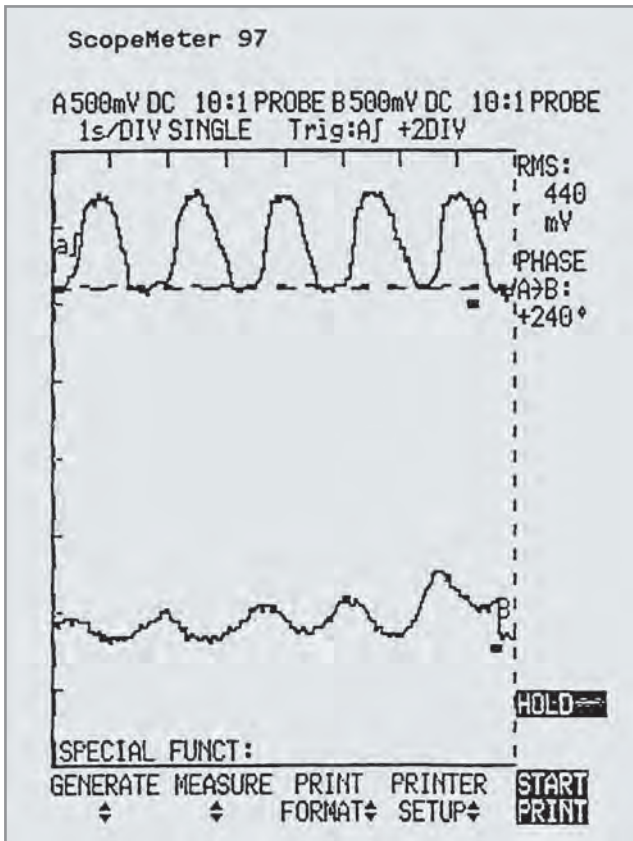
of 1990, which mandated that a new system, On Board Diagnostic System II (OBD II) be in place and operational on all cars sold in the United States in the 1996 model year (Subaru beat this by a year).

OBD II is radically different from its predecessor in a variety of ways. First, a host of standards were developed by SAE and adopted by manufacturers covering such things as protocols, information, terminology, generic and enhanced scan tool applications, security and languages. But more important to a technician, OBD II began using the PCM not only to continuously monitor inputs and outputs, but also to initiate intrusive (detectable by the driver under certain conditions during the test) and non-intrusive tests to determine degradation of system performance. Suddenly, a whole series of fault codes often numbering in the several hundreds were available to help pinpoint upcoming and developing failures.



The standardized OBD II connector showed up on Subaru vehicles in 1995, and assured that not only the terrific Select Monitor, but also aftermarket scan tools could be used for diagnosis of electronic engine management problems.

Step by Step



The EPA considers problems that could damage the catalytic converter of the utmost importance, so specified that such things as misfire be emphasized in OBD II. This lab scope pattern shows a healthy cat.



While generic scan tools can read DTCs and a few other things, it takes the genuine article — the Subaru Select Monitor — to thoroughly access the data stream, and to follow the factory service procedures efficiently.

These PCM-ordered diagnostic tests or “monitors” run on the evaporative emission system, the fuel trim system, the catalyst, the EGR, the air injection system (if so equipped), the oxygen sensors, and oxygen sensor heaters, and includes a comprehensive component monitor as well as a continuous misfire monitor. Monitors will only run after the PCM determines that specific vehicle preconditioning events have been completed to place the system in an optimum test posture prior to initiating the test sequence. This is done to assure repeatability and to prevent spurious Check Engine Lights.

Cracking the Codes

SAE standard J2012 defines Diagnostic Trouble Code (DTC) types and definitions. The five-digit alpha-numeric DTC can be deciphered as follows: The first position is a letter that designates which controller is reporting, or which controller has a problem. Body is “B,” chassis is “C,” powertrain is “P” and “U” is network (a holdover from UART, for Universal Asynchronous Receive and Transmit — a communications protocol).

The first number position can be a “0” for an SAE or generic code, or a “1” or “2” for a manufacturer-specific code. This provision is there in case a manufacturer decides to offer more functionality than required by law, a feature taken advantage of by virtually all carmakers. It’s important to note that manufacturer-specific codes often will not be read by generic scan tools. By law, only SAE-defined codes must be reported to non-manufacturer scan tools, although most will detect at least some of the non-required codes. The next digit indicates which vehicle system or sub-group is reporting. For example, P0100 is air metering and fuel system, P0200 is fuel system (injector only), P0300 is ignition or misfire, P0400 is emission control system, P0500 is idle speed control or vehicle speed sensor, P0600 is computer output circuit (such as a relay or solenoid), and P0700 pertains to transaxle or transmission faults. The final two digits are the specific fault designation for that code.

It’s important to note that for some monitors to run, you must have fuel levels and charging system voltages within certain parameters, and in some cases a whole series of events must occur or be maintained for a specified period of time prior to the PCM authorizing test initiation. It’s equally important to know that not every code sets on a single trip or event. Some require multiple failures on consecutive trips to set. I mention this because it’s important to know not only what OBD II can do --- you, but also *to* you during your test process! Some of the most painful lessons a tech might learn can occur because of assumptions made about sequencing, test initiation and vehicle preconditioning.

When the MIL Comes On

A successful repair begins at the service write-up session with just a bit of customer education, and a careful use of words. We prefer to never use the terms “diagnose” or “diagnostics” when discussing the problem with the customer. These terms might best describe what we’re doing, but they sound too clinical to most customers, and since they’re used in the medical field their use conveys a contextual meaning of “very expensive”, immediately putting you and the customer at odds. We’ve found that the words “testing”, “tests”, “inspection,” “evaluation,” or “evaluate” are less confrontational to the customer, and we try to use those words exclusively. For example, we might say, “We’ll need to perform some preliminary inspections to properly evaluate your concern today. I’ll have the technician road test your car to confirm the condition, and he’ll then run tests to determine the reason the light came on.”

To best illustrate how the MIL operates to a customer, use the fire alarm and apartment building analogy. We know we have a fire, and we know it’s somewhere in the building, but we don’t know what floor it’s on, or the apartment number in which it’s contained. Go on to explain that extinguishing a fire on the tenth floor, apartment number five doesn’t mean that other fires might not occur later on other floors

or in other apartments, or that multiple fires might not have broken out. It’s important to convey the fact that this one single lamp alerts the driver to faults in a number of systems and its job is to monitor thousands of parts. Covering this with the customer helps eliminate misunderstandings later should the MIL come back on a short time later due to a subsequent unrelated failure.

Another analogy that will help customers understand the testing process is that of a ladder. Explain that system testing is similar to climbing a ladder. Each rung must be intact to allow the tech to progress up the ladder, and that broken rungs will need to be replaced as they are encountered. Broken rungs that are bypassed or skipped over may change test results further up the ladder, so skipping past a known fault isn’t a good option.

A technician can never have enough information when chasing intermittent difficulties, so the customer contact person needs to ask the right questions. Subaru has an excellent interview checklist that can be found in the service manual section of the website (<http://techinfo.subaru.com>) by going to “year/model/service manual/engine/engine diagnosis/check list for interview.” We know some people don’t like structured interview tools, but they sure can help when you’re chasing a difficult problem because they will help you nail down the circumstances under which the fault occurred.

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Step by Step



Before you jump to any unsound conclusions about the condition of those expensive electronic components, make sure the basics are okay. Ground connections are a prominent example.

If you doubt the need for such tools, log onto the website and look under OBD information and you'll see a table listing the system or component under test, the failure codes generated, the malfunction criteria and threshold values that trigger the code. Contained in those same tables is a list of secondary systems and their required status to run the monitor, in addition to the amount of time the fault needs to be present before setting the MIL and the number of consecutive failed drive cycles needed before MIL illumination.

As you can see from the table, not every code sets on the first failed drive cycle, and not every drive cycle meets the criteria needed for running the test, and that's why it's critical to capture the kinds of information found on the check list. It records all sorts of data, like fuel brands, weather, temperatures, highway or city, smooth or rough roads, engine temperatures, speeds, driving conditions and the status of various accessories (on or off). It's well written and in our opinion deserves a place in your customer contact process.

Back in the Bay

Once we've got the complaint and customer information captured, the hard work of confirmation, testing and repair begins. Even though the Subaru diagnostic process doesn't say so, a brief road test will sometimes reveal other symptoms that escaped the customer's notice, and will confirm MIL illumination.

The MIL comes on any time the OBD II system detects a fault that exists for the required time interval for that code with all enabling criteria met. Some codes set immediately, some codes only require one drive cycle to set, other codes require two consecutive drive cycles to set, while still others set immediately and flash the MIL. If the failure is catalyst damaging, the MIL will flash, alerting the driver to the urgency of the condition.

Once the vehicle performs and passes the monitor for three consecutive trips the MIL is turned off, but a trouble code is stored until the clear memory mode is entered, the battery is disconnected, or the vehicle passes the monitor forty consecutive times. Until the memory is cleared, a failure record containing limited data captured at the time of failure will be retained to aid in diagnosis. Depending on the type of code and failure, the powertrain controller may enter a fail-safe mode, which can affect vehicle operation and generate additional comments about low power or poor performance.

There are a couple of sections in the service information that are invaluable aids to diagnosing the MIL. One regarding failure code detecting criteria can be found at "year/model/service manual/engine/general description/DTC detecting criteria," and lists the outline of diagnosis, the enable criteria, the driving cycle, the diagnostic method, the DTC clear conditions, the MIL clear conditions, the fail safe provisions and ECM operation at the time of code set. This is VERY valuable stuff in a quick and easy-to-understand format. The second resource is found at "year/model/service manual/engine/engine diagnostics/drive cycle." This section will give you the needed information to properly road test the car after repairs to confirm the fix, and it lists the required road test by DTC number. Those of you who have road tested a car for 60, or even 100 miles in an attempt to get a monitor to rerun after repair will love this tool.

Once in the bay, use the scan tool to confirm the codes, note and record the failure record for intermittent codes. The basic Subaru diagnostic procedure, found at "year/model/service manual/engine/engine diagnostics/basic diagnostic procedure," only confirms that the engine will run and that the MIL is on before taking you directly to the flow chart for that DTC. You will find the DTC trouble charts at "year/model/service manual/engine/engine diagnostics/diagnostic procedure with DTC." These trouble charts are excellent, with schematics, connector end-view and pin-outs right at the chart. While there are occasional glitches in the Japanese-to-English translations, they are still outstanding, and follow the familiar "if this, then that" step-by-step walk-through the diagnostic process we've become accustomed to using in our shops.

Having the right tools makes all the difference in fixing the car and Subaru has done a commendable job of making the most important tool — comprehensive information — available to every tech working on these tough, dependable cars. ■



A Word of Praise

In our research, we found all the factory Subaru information a tech would ever need by logging onto <http://techinfo.subaru.com> (it's a subscription service — see the other feature in this issue of *The End Wrench*), and clicking on the “What’s New” link on the left sidebar. This brings up a new page, and on the left sidebar of that page there is a link for publication type with an expansion arrow. Under that heading we found two important things: One was OBD information (sometimes called Mode Six data), and the other was the service manuals. Fill out the fields marked mandatory and the appropriate service manual pops up.

We noticed that we had to hit the search button between the fields for the site to fill in the selection boxes. This might have been a quirk of our computer system, or of SOA's, but if you hit search and get the error message, the next search box will then fill in. We had to hit service manual, then search, then year and search, then model and search. Takes an extra minute, but it's not a big deal. It helps to have a fast Internet connection and you'll need a PDF file reader.

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The Way They Were: Pre-OBD II Diagnostics & Ignition



Where longevity is concerned, nothing beats a Subaru. Statistics? Well, 96 out of 100 sold in the last 10 years are still on the road.* Then there are the real-world examples we've all seen, such as the '85 wagon that showed up at a New England press preview with an odometer reading of 325,000 — and there's no lack of salt on the roads up there. Or, this statement from a California specialist: "We see Subarus with 250,000 miles on them that have never had engine work." And, if you'll recall, the original Legacy in stock turbo trim held the World Speed Endurance record of 138 mph for 100,000 kilometers for years and years.

This kind of durability breeds rabid loyalty among owners. It also means that you're apt to be working on quite a few older models. Ergo, we figured we'd better refresh your memory about the electronic engine management diagnostics used in Subaru vehicles of yesteryear.

Until the advent of OBD II, Subaru self-diagnostics were different from anybody else's. There were four modes: U-Check, D-Check, Read Memory, and Clear Memory.

The U (for User)-Check is simply what turns on the MIL (Malfunction Indicator Lamp, also known as the Check Engine light) when any EFI components necessary for basic starting and driving functions are found wanting. The D (for Dealer)-Check is the most useful — it's where you'll find codes for the whole engine management system.

To enter this mode, get the engine up to normal operating temperature, shut it off, connect the two green test plugs (under the dash by the steering column, or on the engine side of the firewall by the master cylinder), turn on the ignition, and watch the Check Engine light (on pre-1990 models, look at the O2 monitor lamp, which is visible through a hole in the MPFI control box under the steering column).

* Based on the Polk Company Retail Registration statistics for the period ending 6/30/03.

Mode	Engine	Read Memory Connector	Test Mode Connector
U-check	Ignition on	Disconnect	Disconnect
Read memory	Ignition on	Connect	Disconnect
D-check	Ignition on, engine on	Disconnect	Connect
Clear memory	Ignition on, engine on	Connect	Connect

On pre-OBD II Subaru vehicles, follow this chart to access the four self-diagnostic modes of the electronic engine management system.

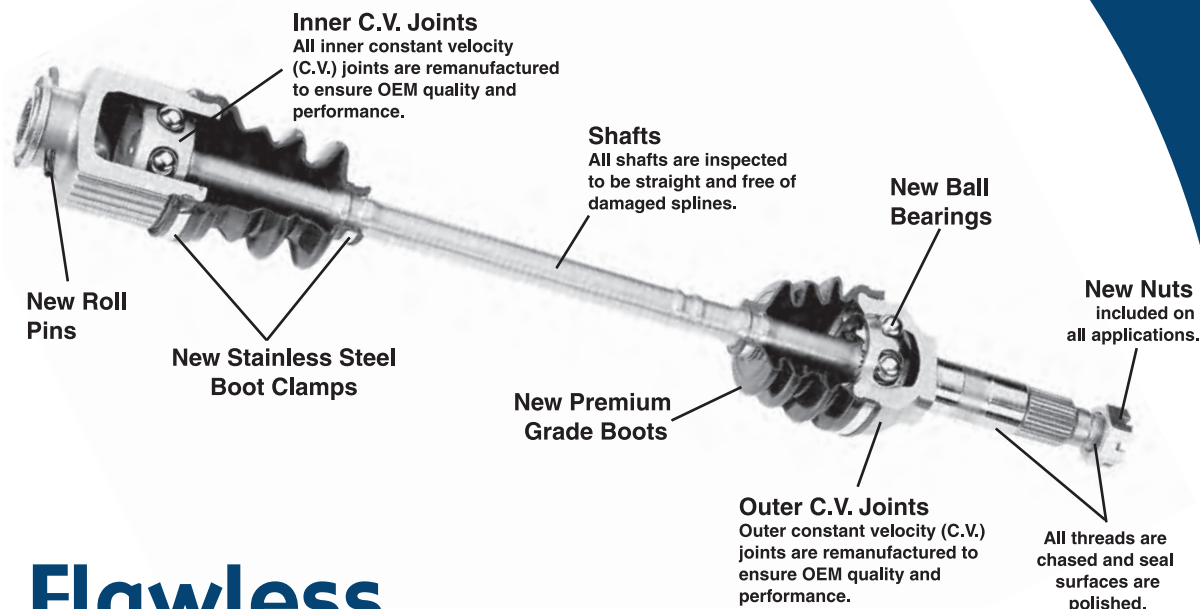
If a fault is currently present, a code will be flashed out. Read it as follows: Each long flash (1.2 seconds) represents ten, and each short flash (0.2 second) one. So, Code 23 would appear as two long flashes, then three short flashes. After a pause of 1.8 seconds, the message is repeated.

“On pre-1990 models, it’s easy to tell if the oxygen sensor is working,” says a former SOA training manager. “Get it up to normal operating temperature, then look at the LED on the computer. If it’s flashing, the sensor’s working.”

Glitches

Driveability and emissions items specific to Subarus lend themselves to a list, to wit:

- The fuel cut control unit on ‘89-’93 Loyales provides the ground for the fuel pump. So, if you get one that won’t start and has no fuel pressure, check out the unit, which is mounted near the hood release.



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The Way They Were



A customer who's fond of fording streams may show up at your door with the Check Engine lamp on. If you get a code 32, the oxygen sensor was probably flooded with water. Simply clear the code and the car will be good to go.

- On '85 and later Loyale MPFI cars, cutting out and dramatic surging over 2,000, mostly while cold, could be caused by excessive charging system voltage. Anything over 15V makes the computer lose its mind.
- A Legacy with a strange whistling noise may have a bend in the catalytic converter's inlet shield ring. Pull it apart and blow compressed air around the ring to see if you get the sound.
- Another source of whistling is a carboned-up ISC valve.
- Stalling or idle surge may also be caused by the ISC valve — you can't adjust it, so get a new one.
- '95 Legacy vehicles have a speed limiter that kills injection at 113 mph. So, a malfunctioning vehicle speed sensor that sends a signal indicating that number or higher will shut down the engine. A customer who complains because he can't go faster than that should be ejected from your place of business.
- A Legacy's idle quality can actually degrade from corrosion in the connection between the spark plug terminal and the wire.
- If the oxygen sensor of a Legacy gets flooded with water, it could illuminate the MIL and set a code 32. The sensor will be fine, so just clear the memory.
- Make sure that Impreza is fully warmed up and at normal idle speed before you even think about making a throttle position switch adjustment.
- Stalling or even an instantaneous backwards crank can set a false code 11 or 13.
- If you're ever fortunate enough to get a tune-up on an SVX (the test drive will be a blast — that flat six is one great motor), you should be aware that there are two frame rail access holes for R&R of #5 and #6 spark plugs. The holes are only big enough in diameter for your 3/8th extension, which you stick through then attach to the socket.
- You can run an emissions test on any '87-1/2 and up four-speed automatic AWD Subaru using a two-wheel dyno. Just install a fuse in the receptacle you'll find under the hood near the driver's side shock tower that's labeled "FWD." This completes the ground path of a circuit that controls power flow to the rear wheels.
- Again on emissions checking with a dyno, TCS-

equipped Subarus should have the switch on the dash turned off AFTER starting the engine, but before any testing begins.

- Reduced performance, a glowing MIL, and a code 22 (or 28 on the SVX) may mean that the knock sensor has a broken internal lead wire.
- By causing a lean mix, a clogged fuel filter can set a code 41 in a Legacy.
- A code 42 in a '90 Legacy, possibly accompanied by hard shifting of the 4EAT, may be due to corrosion in the three-pin connector F23/F24 (clear, and located near the battery and main harness connectors).
- F.Y.I., in '97s the charcoal canister uses manifold vacuum instead of ported vacuum, and in '96 and up models a loose fuel cap will illuminate the MIL as part of the OBD II strategy.

On all older models except Legacy and Impreza, variable spark lead is used to stabilize idle speed, so you should be aware of the checking/setting procedure for ignition timing. First, you'll have to remove the spare tire, which resides in the engine compartment (the timing marks are on the fly-wheel, and the viewing port has a rubber cover — that is, except on the Justy, which has a more conventional three and regular marks on the crank pulley), then plug the two green test connectors together as you do to get trouble codes. Make sure you're at curb idle speed with the idle contacts closed, then shine the light.

A variation on this is the '85-'86 turbo, for which you unplug the five pin knock sensor connector, then set the timing.

Another ignition-related point is that '86-'94 SPI (Single Port Injection — the old two-belt 1.8L) engines have distributors with a photo-sensitive diode and a shutter wheel with 360 tiny slits. Make sure the slits aren't blocked with dirt or grease. Subaru models with MPFI have a magnetic pickup/reluctor ignition. Cylinder #1, by the way, is at the front of the passenger's side, and the firing order is 1-3-2-4. ■

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Suppose you were in the business of selling air. You could calculate the amount delivered by using a complicated formula that takes pressure, temperature, and the diameter of the valve into account, but that would be slow, unwieldy, and probably not very accurate.

You'd improve the efficiency of your operation considerably if you had a way of directly measuring the volume flowing into your customers' air canisters in cubic feet per minute. That would sure speed things up, but it wouldn't be perfect, either. On cold days, they'd be getting a big bargain because any gas is denser when it's cold than when it's hot — in essence, you'd be giving them a baker's dozen and then some. Sales would go way up (and profits way down) in winter as soon as your patrons realized that fact of physical reality. And they'd always try to buy at sea level in dry weather because altitude and humidity affect density, too.

To keep from losing your shirt, you'd still have to use a formula that varied the price per cubic foot according to temperature, altitude, and moisture content. Wouldn't it be a lot easier, faster, and more precise if you had a meter that read out in the actual weight instead of just the volume? Sure it would.

Which brings us to engines. Speed-density EFI systems, such as you might find on typical older Japanese cars, use computer power to calculate the

Above: A requirement of OBD II regs, the Mass Air Flow sensor tells the computer the whole truth about how much air the engine is ingesting.

mass of intake air from input on rpm, vacuum, throttle position, and intake air temperature sensor input. But, as we said, a direct reading by means of an airflow sensor aids swiftness and accuracy, which are both critical if optimum performance, high fuel efficiency, and low emissions are to be achieved. Since air/fuel ratios are by weight (stoichiometric is 14.7 lbs. of air to one lb. of gasoline — in gallons it would be about 2,000 to one), however, measuring mass makes even more sense, so for many years we've had the MAF that does just that. In fact, it's always been a basic requirement for meeting OBD II regs, which became mandatory in '96 (Subaru beat that by a year). It looks like research and development of virtual sensors may soon allow the carmakers to fulfill this requirement without using an actual MAF — sort of a much more sophisticated version of the speed-density concept — but don't hold your breath.

A mass air flow sensor has some other advantages besides its ability to account for density: no moving parts, restrictions, or compensating sensors. A typical MAF has a wire or film element that's kept heated to a specified temperature above ambient and is

exposed to intake air. Through a Wheatstone bridge circuit and dedicated electronics, the amount of current required to maintain that temperature becomes the signal to the computer. High air flow obviously has a greater cooling effect than low, but so does the denser air of cold days and low altitudes, so the PCM gets the true data on mass it needs to provide the longer injector pulse width that extra oxygen needs to fire dependably. Some units produce an analog voltage output, while others send out a varying frequency digital signal — a square-wave.

From various authorities, we've compiled quite a list of probable symptoms of MAF trouble. Some tell you to expect starting problems both hot and cold, hesitation, stalling (especially under load), rough idle, and low power output. Others say the engine will fire up, then die. Still others give stalling, poor idle, black smoke, and engagement of the fail-safe mode as evidence of air mass measurement problems.

Contamination of the sensing element, which slows response, will result in stumble, which brings us to the most prominent logical effect of a bad or non-existent MAF signal: transient throttle glitches, including stalling, sagging, and missing. If it's far enough out of range to cause the PCM to shift to LOS (Limited Operating Strategy), overall performance and driveability will be lousy.

But don't let these symptoms cause you to jump to an unfortunate conclusion and automatically replace that expensive sensor. Plenty of other malfunctioning components can result in the same kinds of annoying and inefficient engine behavior. So, as we say over and over in *The End Wrench*, check the basics first. That means ignition, compression, fuel pressure and volume, etc. A restricted air filter element may make trouble, too. Then there are all the other sensors and the wiring and connections that are part of every electronic engine management system. In short, don't blame the MAF right off because most of them have proved to be pretty dependable.

A simple problem that would be embarrassing to overlook is a hole or rip in the duct between the sensor and the throttle body, which admits unmeasured air and leans out the mixture. We remember our first encounter with this situation. A car was being driven into the bay next to ours, and it was running badly — made us think of an old carbureted car with a huge vacuum leak, say from a disconnected brake booster hose.

While the other tech was unpacking his favorite scan tool, we popped the hood and took a look around. Having just read an article on MAF sensors, we felt under the duct to the throttle body and our fingers went right through. As mentioned above, it was a case of what's known in the business as "false air" — it's getting in downstream of where measurement of

intake mass is taken, thus causing the PCM to provide an injector pulse width that's way too short, which leans out the blend (BTW, an open PCV can do the same thing).

Just to back up the obvious, we put some duct tape over the holes, started it up, and it idled and revved like the good engine it was. That's what we call efficient diagnosis, and it illustrates two important points: One, always check the basics before you engage in high-tech troubleshooting. And, two, OBD, whether I or II, can't do everything.

A nagging question remains, though: What causes holes or splits in that duct? Gnawing mice, or maybe contact with a belt or pulley? Neither seems too likely. Perhaps it's rough handling during previous service, or just that hot environment under the hood.



Left: A look down the throat of an early Subaru MAF, circa 1985 or so.

Below: Not only holes in the intake duct itself, but any vac leak in a hose that connects to it can cause the false air problem.



88 Years!

If you think the company we know as Subaru is a latecomer, think again.



In 1884, Chikuhei Nakajima was born, the son of a farmer in Gunma Prefecture, 40 miles north of Tokyo. He entered a naval academy, then, at the age of 19, heard about the Wright brothers' incredible flights and started dreaming of adventures in the skies. Chikuhei's first aviation efforts were in developing aircraft for the Japanese navy. Being an intelligent and enterprising young man, however, he decided to go out on his own, so he left the navy and set up the Aircraft Research Laboratory in 1917 (the root of what would eventually become the parent company of Subaru). Reorganized as Nakajima Aircraft Co., Ltd. in 1931, this firm became Japan's leading aircraft manufacturer.

The demand for airplanes came to a screeching halt at the end of WWII, and Chikuhei's company restructured again to become Fuji Sangyo Co., Ltd. with the goal of finding other products and markets for the technical expertise gained in aircraft production. Its first success was the Rabbit motor

The Leone 4WD wagon helped differentiate Subaru from other makes.



scooter, which had a 135 cc two-horsepower engine and rolled on the surplus tail wheels of fighter planes. Since Japan's transportation situation was in a state of dire disarray due to the destruction and upheaval of war, this new means of getting around met with great interest.

In 1950, Fuji Sangyo was divided into 12 smaller corporations according to the Japanese Corporate Credit Rearrangement Act, but between 1953 and 1955 four of these business entities and another corporation merged to form the Fuji Heavy Industries we know today.

The new corporation adopted the Subaru cluster of stars (we call this constellation the Pleiades) as the official logo for its line of automobiles. In 1955, Fuji Heavy Industries rolled out the P-1 with the consumer designation of the Subaru 1500. It was quite advanced for its day, having the first Japanese-manufactured monocoque body. Unfortunately, sales had to be terminated due to funding difficulties.

continued on page 30



Fuji Sankyo's post-war Rabbit motor scooter had a 135 cc, two-horsepower engine.

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Introduced in Japan in 1966, the 1000 was the first Subaru to use what's become the company's trademark drive system: a horizontally-opposed "boxer" engine and FWD.



The Subaru 360 was powered by a two-stroke twin and got 66 mpg. It was imported into the U.S. starting in 1968.

Back on its feet in 1958, FHI introduced the Subaru 360, a cute, fun-to-drive four-passenger car powered by an air-cooled two-cylinder two-stroke 22 horsepower rear-mounted engine. It was an immediate hit in Japan.

Ten years later, due to various vicissitudes of the import business, Malcolm Bricklin and Harvey Lamm started to import the 360 into the U.S. It sold for \$1,297 (about 2/3rds of the price of a VW Beetle at the time) and got a sensational 66 mpg. It was bashed by the automotive press, mostly because those journalists were used to heavy American iron and the 360 was a flyweight. Regardless, hundreds were sold and a great advertising campaign established Subaru in the American consciousness. If you should happen to come across one in a barn somewhere, buy it. It's a collector's item. It also served to get Subaru of America started.

Then came the FF-1, the first front wheel-drive car from Japan, and also the first Subaru with a water-cooled four-cylinder boxer engine that was to become the company's trademark. It was sold from 1969 to 1972.

Besides the bulletproof opposed four-cylinder engine, Subaru distinguished itself with 4WD, a first for cars sold in the U.S. This came about when S.O.A. execs visited Japan and saw the vehicles Fuji Heavy Industries supplied to the country's Forest Service. A light went on, and, as the hackneyed saying goes, the rest is history — and an extremely successful history at that. As a mid-'70s ad puts it, a Subaru 4WD car, "Climbs like a goat, works like a horse, eats like a bird." ■

What's "Subaru" Mean, Anyway?



SUBARU

"SUBARU" is the Japanese word for "unite," as well as the term for a cluster of six stars, which the Greeks called the Pleiades (part of the Taurus constellation). According to Greek mythology, the daughters of Atlas turned into this group of stars.

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