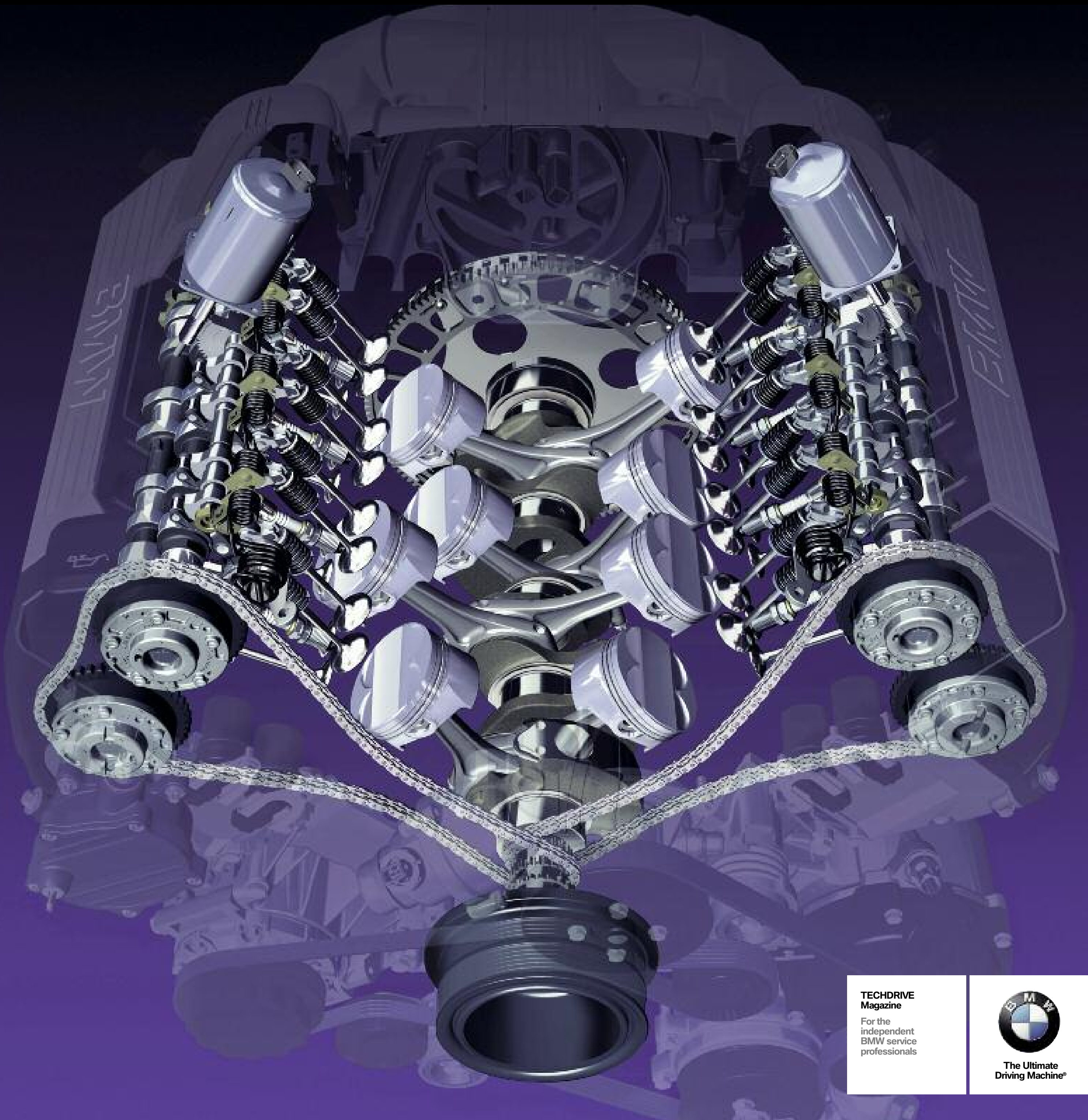
TECHDRIVE

Original BMW Parts

VOLUME 1 NUMBER 1

A PUBLICATION FOR INDEPENDENT BMW SERVICE PROFESSIONALS PREMIERE ISSUE



TECHDRIVE Magazine

For the independent BMW service professionals

The Ultimate Driving Machine®

MIL ON? • ENGINE LEAKS • BRAKE PROBLEMS

TO OUR READERS

— What could be more useful to independent service technicians who work on BMWs than a publication dedicated specifically to them?

— That's the idea behind the magazine you're holding, TECHDRIVE. BMW of North America both sponsors the publication and provides much of the information that's included in it. A big part of the rationale behind TECHDRIVE is the belief that if you are able to diagnose, repair and maintain BMW vehicles properly and efficiently, your reputation and ours will be enhanced.

— TECHDRIVE's combination of feature service articles (written from both BMW tech information and interviews with successful independent BMW specialists), new technical developments, systems evolution, as well as the correct BMW replacement part, and service bulletins are intended to help you fix that BMW right the first time, on time. Our list of BMW dealers will assist you in finding Original BMW Parts.

— There's more to this effort, including highly-informative and user-friendly web sites, which we'll explain in future issues.

— We want to make TECHDRIVE the most useful and interesting technical magazine you receive, and you can help us do that. Please let us know what topics you'd like to see covered, and provide any other comments you might have. With your involvement, this publication can evolve into one of your most important tools.

Thanks for your continued interest.

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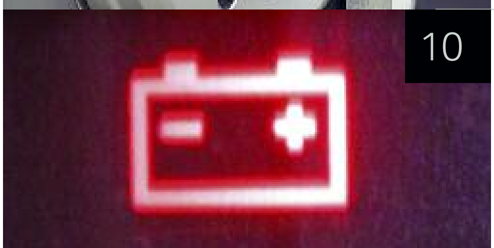

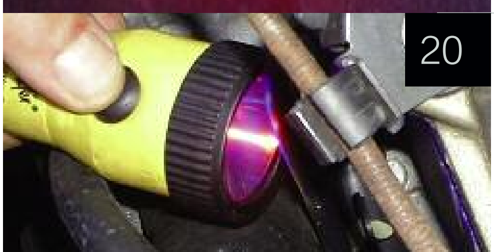

Departments

Modern high-performance lightweight brakes are far too critical to permit the use of old-fashioned service practices.

Brake Wear & Pulsation Investigated

Finally, the whole truth about two major service issues

Where stopping power is concerned, BMW has been at the forefront for decades. Take a look at the vehicle tests in any of the car buff magazines and you'll see that the stopping distances of this company's products are consistently shorter than those of the competition. This shows a fundamental concern not only for safety, but also for a superior driving experience.

But brakes take a terrific beating in the process of converting inertia into heat, so even the best systems in the world will develop problems and need care at some time in their service lives. Lining and rotor wear and pedal pulsation are chief among these eventualities, so here we will investigate the causes and cures.

Once, machining rotors at every reline was S.O.P. in most shops. Not anymore.

Primitive approach

If you were to design a brake system with a very thick, heavy rotor and soft asbestos linings, the discs would probably never wear out, and all that would be needed to keep going forever would be an occasional pad replacement. Of course, that would go against all modern engineering goals. Not only would the brake be dangerously prone to fade, but unsprung weight would be too high for good handling. Also, nobody would want to have asbestos, that dangerous fibrous mineral, around either in a manufacturing plant or a service shop.

No, to get high performance braking you need an aggressive, up-to-date lining recipe and sophisticated metallurgy in the rotor, both matched to the application, and this is the approach BMW engineers have taken. The trick is in balancing lining and rotor wear against stopping power and pedal feel, and compromises come at the expense of wear, which is just as it should be.

Lathes for sale

It wasn't that long ago that it was standard operating procedure in most shops to automatically turn rotors on a lathe during a reline, providing they weren't down to their legal throw-away thickness. No more, at least among the highest-quality repair facilities. As one successful European car specialist says, "We've gotten rid of our brake lathe. The tolerances on late models are so close, any appreciable wear demands that the rotors be replaced." Also, new discs will be extra insurance against a recurrence of a pulsation complaint simply because they haven't been cut, so are thicker.

So that leaves replacement, which, besides being fast, amounts to a profitable parts sale for the shop. But how do you choose among the available options? Do you try to save the customer a few dollars, or would you rather feel confident that the job won't come back to haunt you?

As an independent BMW service shop owner tells us, "We've tried premium aftermarket rotors from one of the biggest disc manufacturers in the world, but we got warpage and comebacks. So, we did a little research and found that these parts weighed about two lbs. less than the original equipment discs. When we told the manufacturer about this, they said, essentially, 'take it or leave it.' We left it, and now we use only BMW O.E. rotors."

It takes careful measuring to uncover the thickness variation that causes pulsation.

Bumpy braking

Pedal pulsation is an extremely common condition that tends to repeat. Sure, the car goes out of your shop with smooth braking action, but in a distressingly high percentage of cases, it shows up at your door again within a couple of months, and there's a good chance the customer will have lost his or her faith in your work.

Greg McConiga, former ASE Technician of the Year, has a theory about why pulsation problems increased when semi-mets supplanted asbestos. He believes it's related to what happens when you stop at a light. By their very nature, semi-mets conduct heat away from the rotor, whereas asbestos is nothing if not a good insulator. This was intended, but it has an unintended consequence: The area of the disc that's gripped by the pads cools faster than the metal around it, causing warpage.

A logical question at this point might be, "Shouldn't floating and sliding single-piston calipers just ride with the runout? What's making those pulses?"

The answer: When it comes right down to basics, the direct cause of pulsation is DTV (Disc Thickness Variation), which can also be seen as a lack of parallelism between the two sides of a rotor. Wobble causes the rotor to wear unevenly as it hits those abrasive pads in one spot on each side every revolution of the wheel, and the contact areas will end up thinner than the rest of the disc. Some authorities claim that .002 in. of runout can cause about .0004 in. of DTV in 3,000 to 5,000 miles. Typically, thickness variation should be held to .0002 in., although we know brake experts who say it'll take .0004 to generate a complaint. Either way, you're going to have to take your time checking for discrepancies this tiny.

Zeroing in

As a diagnostic preliminary, make sure the condition is indeed due to the friction components and not the result of a malfunctioning ABS. The module could misinterpret a bad signal from a damaged or contaminated wheel speed sensor to be a skidding tire, so may pulse the hydraulics. If you take the time to carefully experience the condition, however, your technician's instincts should allow you to differentiate between the two.

Next, you've got to determine whether the pulses are coming from the front or the rear (or both). Commonly, DTV in the front will cause the steering wheel to rock or shudder on light brake applications at low speeds. You'll feel the side-to-side movement if you hold the wheel with just a few fingers. To find out if the rears are at fault, find an uncrowded street, coast in neutral at about 20-25 mph, and apply the parking brake gradually.

Get the car safely up in the air, but don't pull the wheels yet. Instead, measure runout on the inside of the rotor with the wheel installed and the lugs torqued, if possible. This will tip you off to real-world runout.

Potato chips?

Besides ordinary runout, there's disc flatness, the kind of warpage that makes the rotor resemble a potato chip. With your dial indicator, check for this at points 90 deg. apart and close to the outer edge of the wear surface. Find the high point and mark it "1," rotate the disc one-quarter turn, mark it "2" and record the reading. Do the same thing twice more to establish points "3" and "4." The difference between "1" and "3" will be max runout, whereas the biggest deviation from flatness will be between "1" and "2," "2" and "3," "3" and "4," or "1" and "4."

In the past we were told we could check for flatness with a straightedge and feeler gauges, but most authorities today say that's apt to be inaccurate and misleading.

Uncovering DTV requires that you pay attention. Measure thickness at eight evenly-spaced points around the disc.

Everything we've mentioned so far

Adaptive Brake Lights

If somebody told you in a normal voice, "The car ahead is stopping," you'd react at a normal pace, right? But if he shouted it, you'd jam your foot onto the brake pedal instantly.

That's the idea behind the adaptive brake lights found on new selected models, but visually. The main taillight units are outboard, and incorporate three-dimensional LEDs for their tail- and brake lights. Additional tail lamps and the backup light are in a light band across the trunk lid. This set-up lets following drivers know how hard you're stepping on the pedal, or if the ABS has engaged.

Under normal braking, the outboard and 3rd brake lights illuminate as usual. During hard braking or when the ABS is activated, the taillights join the brake lights (at the same lighting intensity as the brake lights) for a significant increase in visual warning.

In case of burnout of certain exterior bulbs, a nearby bulb (one normally used for a different function) is "commandeered" automatically until the defective bulb is replaced. The Check Control monitor system alerts the driver to the burned-out bulb.

applies to both front and rear discs. Since rears only account for maybe 20-30% of stopping power, however, they won't be the cause of as many complaints.

Prevention

One of the primary statements of the modern version of the Hippocratic Oath that physicians take is, "Never do harm." The same should be applied to what you do when you're performing brake service.

Cranking down those lugs with your impact wrench is a case in point. We all know that's how just about everybody out there in the trenches does it, but it can, and does, cause harm (even the use of torque sticks is suspect because they're simply not as accurate as a torque wrench). As one veteran brake expert explains it, "What happens is you tighten the first lug to 90 ft. lbs, and that cocks the wheel. Then, you may tighten the second to 90 also, but the wedge effect makes the other one actually closer to 130, which puts an uneven strain on the rotor. After a couple of months, or 1,500 to 4,000 miles, the iron relaxes to match the stress, and you've got a pulsation problem. You can avoid this by installing the wheel and tightening the lugs while the car's on the lift, lowering it, backing them each off half a turn, then torquing them."

Good point, and we'll add that you should use the proper tightening pattern, either star or criss-cross, depending on the number of lugs.

Even more important, though, is anything that interferes with the trueness of the rotor mounting. For example, corrosion on the flange that keeps the disc from seating properly, hence introducing runout. In our shop, we use our "whizzer" with abrasive discs and various powered wire brushes to get those flanges as clean as possible before mounting the rotor. If there was no pulsation problem and the disc is to be reused, we index a lug and the rotor "hat" with punch marks, paint, or a tire crayon.

It's a worthwhile precaution to check runout whenever a new rotor is installed. If it's less than .002 in., send the car out. If it's anything more, remove the rotor, rotate it one lug, remount it, and check again. Keep doing this until you arrive at the position with the least wobble.

Finally, please heed to the SIVs (Service Information Bulletin) and that BMW has issued over the years and always use OEM recommeded parts to avoid customer complaints.

There's a real science involved in formulating lining material to achieve good pedal feel, longevity, etc. If it's too hard, it'll amplify and transmit even the tiniest vibrations.

Original BMW Parts is a proud sponsor of **Formula BMW USA Racing**

History

First steps on the road to greatness.

BMW’s commitment to young driving talent goes back as far as the 1970s, when the company supported the BMW Junior Team and the spectacular Procar series over many years. From 1991 to 2001, BMW was involved in the Formula ADAC championship as engine supplier, helping gifted young drivers to progress from go-karts to Formula racing. In many cases, these drivers subsequently went on to compete in international motor sports. Indeed, over the past twelve years, well over forty beneficiaries of BMW ADAC Scholarship have made their way into Formula 3. The most famous “old boy” has to be Ralf Schumacher, who competed in his first Formula race on the Norisring in 1992 and is now one of the leading drivers in Formula One.

Philosophy

Excellence is catching.

Talent alone is not enough - it needs to be properly developed. So BMW doesn't just offer gifted young go-kart drivers a seat in a Formula racing car; we put them on pole position to enjoy a successful career. We provide them with first-class technology at an affordable price, rigorous safety standards, professional training and a scholarship program. 2002 saw the launch of a new concept, a new name and a new car. The previously separate Championship and Junior Cup have now been combined to form the international Formula BMW Championship. The main aim of this championship is to support Motorsports at the grassroots level by offering drivers the comprehensive training they need to make the move into Formula racing, and the new international dimension can only contribute to the process. The official racing car of the series is the Formula BMW FB2. The regulations require all participants to race with identical equipment, and teams are not allowed to enhance the car’s performance by making construction changes such as adding or removing parts. The only way in which they can alter its performance is by making limited alterations to the set-up.

This means that all the drivers compete on a level playing field, both financially and technically, and on a relatively low budget. “After all, the purpose of the exercise is to identify the best drivers, not the best car,” says BMW Motorsport Director Dr Mario Theissen.

For more information go to bmwusa.com>The BMW Experience>Motorsports>Formula BMW USA

MIL On?

Better Review OBD II Strategies

It's been a decade since OBD II first hit the streets, so it's definitely time to review your understanding

The Check Engine light, generically named the Malfunction Indicator Lamp (MIL) under SAE J-1930, is intended to be a red flag for the driver, but the fact that it's illuminated is also important information for the technician. That is, providing he or she understands the basic strategies that make OBD II such a valuable diagnostic aid.

So, we'd better take a look at the big picture of OBD II's logic -- what actions is it intended to take when it detects a problem?

Essentials

To boil it down to essentials, the program will turn on the MIL if a system or component fails or deteriorates to the point where emissions could rise to one and one-half times the Federal Test Procedure standards. Of course, the conditions under which such a rise could occur have been determined through diligent research with real engines on dynamometers and on test tracks.

From an emissions standpoint, a misfire is about the most dangerous malfunction that can occur in a vehicle. Not only does it pump raw hydrocarbons out of the dead cylinder, but this extra fuel can cause the reaction inside the catalyst to become so hot that the cat either loses its ability to do its job, or actually melts down, perhaps clogging the exhaust system.

So, the instant the management software detects a misfire, it doesn't just switch the MIL on, it flashes it once per second. The flashing stops only when the vehicle is being operated outside of the load and speed modes that could damage the cat. Even then, the MIL stays on steadily.

In fact, misfire is considered so important that on some models the software not only turns on the MIL when it detects this problem, but actually stops injecting fuel into the misfiring cylinder.

For most other tests, the OBD II management software won't turn the MIL on until it sees two failures. That way, there won't be numerous errors, hence motorist-irritating, warnings.

A trip or a cycle?

Before we get to the actual self-tests, we'd better explain what's known as a "trip." First, there's "enable criteria," which are the exact conditions the management software requires before it will run a particular self-diagnostic test.

So, a trip is a key-on cycle during which all the enable criteria for a particular test monitor are met, followed by turning the key off. This differs for each DTC.

More comprehensive than a single-monitor trip is the OBD II Drive Cycle—a set of driving conditions that satisfies the requirements of all OBD II monitoring sequences. The instructions on how to operate the vehicle to achieve the complete cycle are too detailed to include here, but we will say that a mix of accelerating, decelerating, idling, and steady-state cruising is required.

Don't confuse trips or OBD II drive cycles with warm-up cycles, which the PCM counts to clear DTCs and freeze frames. A warm-up cycle is defined as a coolant temperature rise of at least 40 deg. F., reaching at least 160 deg., during which no new faults occur.

Multiple major monitors

OBD II's self-testing consists of seven major monitors, or eight if you count the oxygen sensor tests as two, plus a comprehensive component monitor, which is a catch-all for any emissions-control systems problems. The testing strategies used in each are interesting, and illustrate relationships among components that you may never have realized existed.

For the extremely important misfire monitor, the engineers looked at a number of different detection techniques, and settled on the acceleration and deceleration of the crankshaft during the combustion cycle (as you'd expect, it should slow down on the compression stroke, and speed up on the power stroke). The PCM monitors the acceleration and deceleration during combustion events and calculates a mean.

Through dynamometer research, the engineers found out that misfiring eight to ten percent of the time will damage the cat, so they labeled that percentage a "Type A" misfire. Then, they designed the system to keep track of misfires over a 200-revolution time frame -- a buffer keeps the average. If the software sees no acceleration where there should be some, but sees deceleration instead, it registers a misfire immediately. The MIL will start flashing, and some systems will even cut fuel to that cylinder.

A "Type B" misfire isn't quite so dangerous, but is bad enough to cause emissions to exceed one and a half times the standard. This is monitored over 1,000 revolutions by a different set of buffers. It doesn't light the MIL the first time, but only on the second drive cycle. Typically, this is a one- to two- percent misfire. Note that misfire DTCs overwrite any other codes, and can only be removed with a scan tool.

How go the HEGOs?

OBD II runs two types of tests on HEGO (Heated Exhaust Gas Oxygen) sensors. One monitors the sensor's activity, and the other checks the sensor's electrical heating element. These tests are run only once per trip, and must be failed twice to illuminate the MIL.

An O2 sensor can fail the activity monitor for slow response rate, which is sometimes called a "big slope" for the way the wave looks on an oscilloscope. Or, it can fail for having too small a change in voltage output from rich to lean and vice versa.

A typical HEGO response test is done after the system achieves closed loop, and during steady state speed and load. The test forces fuel control changes at high frequency, switching rapidly between rich and lean. Can the HEGO respond to this high frequency, or has it become too sluggish and lazy? And, can it produce big enough voltage swings? If it can't satisfy both standards, it fails.

Since any oxygen sensor is only accurate when it's hot—at least 600 deg. F.—the HEGO heater monitor is intended to make sure the sensor is indeed properly heated. In a common approach, the heating element itself isn't tested. Instead, the change in electrical resistance that the sensor's output circuit experiences at various temperatures is watched.

After the ignition has been turned off, the PCM sends a five-volt signal to the sensor every 1.6 seconds. As the sensor cools down, its resistance increases, changing the voltage, which the PCM reads as temperature. Once the sensor is cool enough, the PCM commands a relay to complete the circuit to the heating element, then it watches as the sensor gets hotter and hotter. If it sees the proper voltage for several pulses, it passes the sensor.

Cat capacity

Obviously, the performance of the three-way catalytic converter is crucial to emissions control, and a cat's efficiency is dependent upon its ability to store and release the oxygen needed to complete its reactions. If the engine's air/fuel ratio is rich for too long, the oxygen stored in the catalyst can be used up. When this happens, the cat won't be able to do its job of cleaning up the exhaust stream, and this situation is called catalyst "punch through."

Since oxygen storage is related to catalyst performance, that's what the catalyst monitor tests. The PCM compares the activity of the upstream HEGO to that of the one downstream. A good cat will have large oxygen storage capacity, so it will absorb fluctuations in the oxygen content of the exhaust, somewhat as an electrical capacitor smooths voltage variations.

So, the PCM expects to see a big difference between the amount of voltage change activity—actually, the number of rich/lean switches per unit of time—in the upstream O2 sensor and the downstream O2 sensor. If, instead, it sees that the ratio between the two is close to one, the catalyst fails its monitor.

Evap mishap?

The evaporative system monitor watches for leaks that could allow raw gasoline fumes to escape into the atmosphere. Originally, it was required to identify a leak equal to what could pass through an orifice .040 in. in diameter, but that's now down to .020 in.

OBD II's HEGO monitors test both the response rate and the heating element.

In a typical version of this monitor, the PCM shuts off the charcoal canister vent solenoid and opens the purge solenoid at steady-state cruise. This allows manifold vacuum to affect the pressure in the fuel tank, which is read by a pressure transducer. It maintains this condition until the pressure drops to a specific value, then it closes both solenoids to see if this vacuum holds for 10-20 seconds. No? Then the evap system fails, and a pending code is registered. Two failures in a row and a DTC is set and the MIL is turned on.

Common DTCs are P0442 (small leak) and P0455 (large leak), which tell you that the evaporative emissions monitor has detected a gasoline vapor leak. Commonly, this is set because the gas cap wasn't screwed on completely after refueling, or that the cap itself is faulty. On some late-model BMWs, however, there was a problem in the filler pipe itself that caused a failure of this monitor, and replacing the cap or advising the customer to make sure he or she tightens it completely wouldn't head off a reoccurrence.

DTC P0442 or P0455 may be set most often because somebody didn't install the gas cap properly, but don't automatically jump to that conclusion because real system leaks are also a possibility.

Recirculation examination

OBD II regulations state that EGR must be monitored for abnormally low or high flow rates, which can dramatically increase the production of NOx. In one common approach to accomplishing this test goal, the principle applied is that the position of the EGR valve pintle will have a direct effect on manifold pressure, as read by the MAP sensor. In other words, opening the EGR valve decreases manifold vacuum, and vice versa.

To test EGR flow, the PCM forces the valve open during closed-throttle deceleration, or forces it closed during a steady-state cruise, depending on the model. The management software then compares MAP sensor readings over several valve actuations and calculates EGR flow. If this is out of range, the system fails the first test of the two in a row it will take to set a DTC and illuminate the MIL.

Pumped air and fuel trim

Secondary air is what's injected into the exhaust stream during open loop operation to help oxidize HC and CO, so it obviously affects emissions. While this system isn't used on as many new cars as it once was, where it is present OBD II regulations say it must be monitored. A typical testing procedure simply has to determine that the system is indeed capable of injecting air. To do this, the management software first determines that the HEGO has reached operating temperature, then reads its signal to make sure it indicates the lean signal air injection causes.

The fuel monitor is one of the most important in OBD II, so it's fortunate that it's also one of the easiest to understand. The diagnostic software simply keeps track of the dynamic adjustments in fuel calibrations known as long-term and short-term fuel trim. If these exceed certain specifications in the same direction—in other words, both making lean corrections or both making rich corrections—it identifies a problem, such as faulty fuel pressure, clogged injectors, a vacuum leak, etc., and the fuel system fails its test.

Traditional self-diagnostics

Finally, there's the comprehensive component monitor, which looks at emissions-related factors that aren't tested by previously-mentioned specific monitors. Many of these are checked in the same way as they have been by the car companies' proprietary self-diagnostics since the early '80s. This monitoring is continuous, so no enabling criteria are needed.

First, there's the integrity of the electrical circuits that are involved in the emissions control system, both for sensors, such as those for coolant and intake air temperature, and actuators, such as the idle air control motor or the canister purge solenoid. Is there an open, or is there a short to ground or battery voltage? If so, a code is set and the MIL is illuminated.

Second, there's input rationality. In other words, do the signals from the sensors make sense when compared to other inputs and PROM information. If, for example, the engine has been running for half an hour, yet the coolant temperature sensor is sending a signal that represents a below-zero reading, there's obviously a discrepancy, so a code is set and the MIL is turned on.

Finally, there's functionality. Are the PCM's commands being carried out? For instance, when the IAC motor is told to go to a specific position, does the rpm signal match? No? Then it's time to set a code and warn the driver with the MIL.

We'd better expend some space explaining the OBD II DTCs. These follow SAE standard J2012, which requires a five-character alphanumeric code. The first character is called the prefix letter, and it may be a "P" for powertrain, a "B" for body, or a "C" for chassis. Only "P" codes are OBD II-related because they have an effect on the vehicle's emissions.

If the second character is a zero, it tells you the DTC is a standardized SAE code. If it were a one, it would be a trouble code that is part of the car maker's proprietary diagnostics, and to interpret it you would need that company's factory information.

The third character of a "powertrain" DTC indicates the system the trouble is in. The numeral 1 stands for fuel and air metering, 2 the fuel injector circuit, 3 the ignition system or misfire, 4 auxiliary emission controls, 5 vehicle speed control and idle control system, 6 computer output circuits, 7 and 8 the transmission.

The fourth and fifth characters identify the specific trouble the system has detected.

Put out the light and clear the code

Before you buy a generic scan tool for Global OBD II, make sure you know exactly what it'll work on.

(Continued on page 18)

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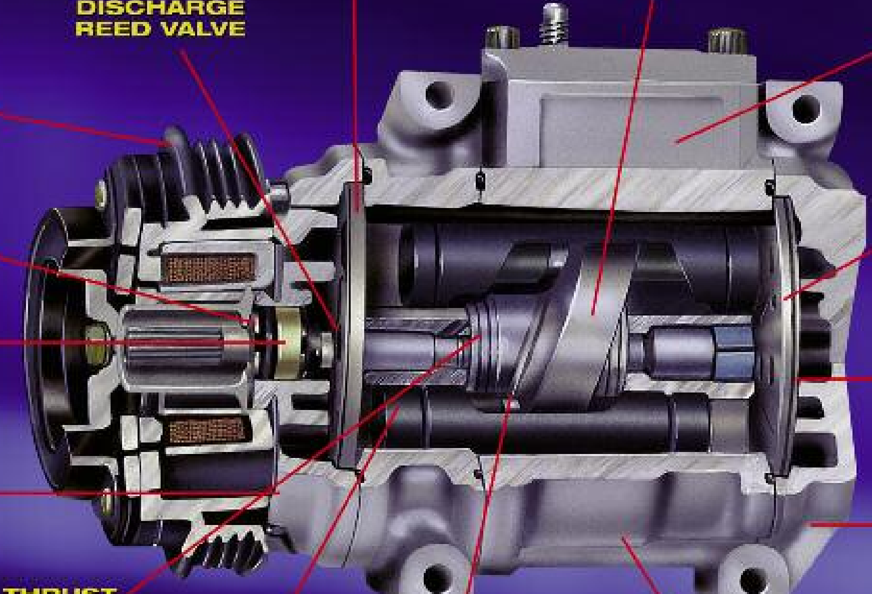


CYLINDER BLOCK & FRONT/REAR HOUSING
Cleaned, inspected and brought to O.E. specifications, or replaced with new components if necessary, to insure proper fit.

DISCHARGE REED VALVE
Inspected, cleaned, and polished, or replaced by new components as necessary, to insure compressor performs as "new."

STEEL GASKET
Replaced 100% with new components to insure compressor performs as "new."

O-RINGS & SEALS
Replaced 100% with O-Rings compatible with both R12 & R134a refrigerant to achieve O.E. performance and maximum service life regardless of which refrigerant is utilized.

OIL
Replaced 100% with R134a compatible oil to insure long service life.

PISTON
Inspected and cleaned, or replaced by new if Teflon surface is damaged, to insure compressor performs as "new."

SHAFT & SWASH PLATE
Cleaned, polished, and inspected, or replaced with new components if necessary, to insure compressor performs as "new."

SHAFT KEYS
Replaced 100% with new components to insure new OEM spec. tolerances.

SHOES
Inspected for deterioration and cleaned to eliminate contaminants, or replaced by new components. Gauged and sized for noise reduction.

SNAP RINGS
Replaced 100% with new components to insure compressor performs as "new."

SUCTION REED VALVE
Inspected, cleaned, and polished, or replaced by new components, to insure compressor performs as "new."

THRUST BEARING
Inspected for deterioration and cleaned to eliminate contaminants, or replaced by new components if necessary.

VALVE PLATES
Inspected, cleaned, and polished, or replaced by new components, to insure compressor performs as "new."

DENSO

 (Continued from page 15)

After you've fixed the problem, you're still not done until you've cleared the code and made the MIL go out, which is easily done with your scan tool by selecting the "Clear Info" command. Otherwise, it will take 40 warm-up cycles for the system to automatically clear.

What about just disconnecting the battery or pulling the computer's fuse to erase the memory, the way it's been done for years? Well, believe it or not, some computers can retain their memory for months without battery power, so this just isn't practical anymore.

Finally . . .

Let's face it: It's not so easy to fix cars anymore. Sure, the skills you might have learned in the past will make it possible for you to replace a water pump, take care of a steering or suspension problem, bolt on a new alternator or starter, reline the brakes, or do many other jobs. But when it comes to a problem that involves driveability, performance, or emissions, it's a whole new world of complexity and sophistication.

But the technician hasn't been entirely forgotten in all this upheaval. One of the main goals of OBD II was to simplify diagnosis of the systems that are part of electronic engine management. The more you work with OBD II cars and your scan tool, the more you'll learn about putting this system to work for you where it counts: Helping your customers with efficient, accurate diagnosis.

In future issues of TECHDRIVE, we'll cover some very specific ways in which those clever engineers at BMW have actually put the OBD II concept into practice. Even though one of the basic reasons it exists is to give the aftermarket a generic diagnostic system, there's a certain amount of leeway in the regulations on how each carmaker can best achieve that goal given its particular engines, EFI, emissions controls, etc.

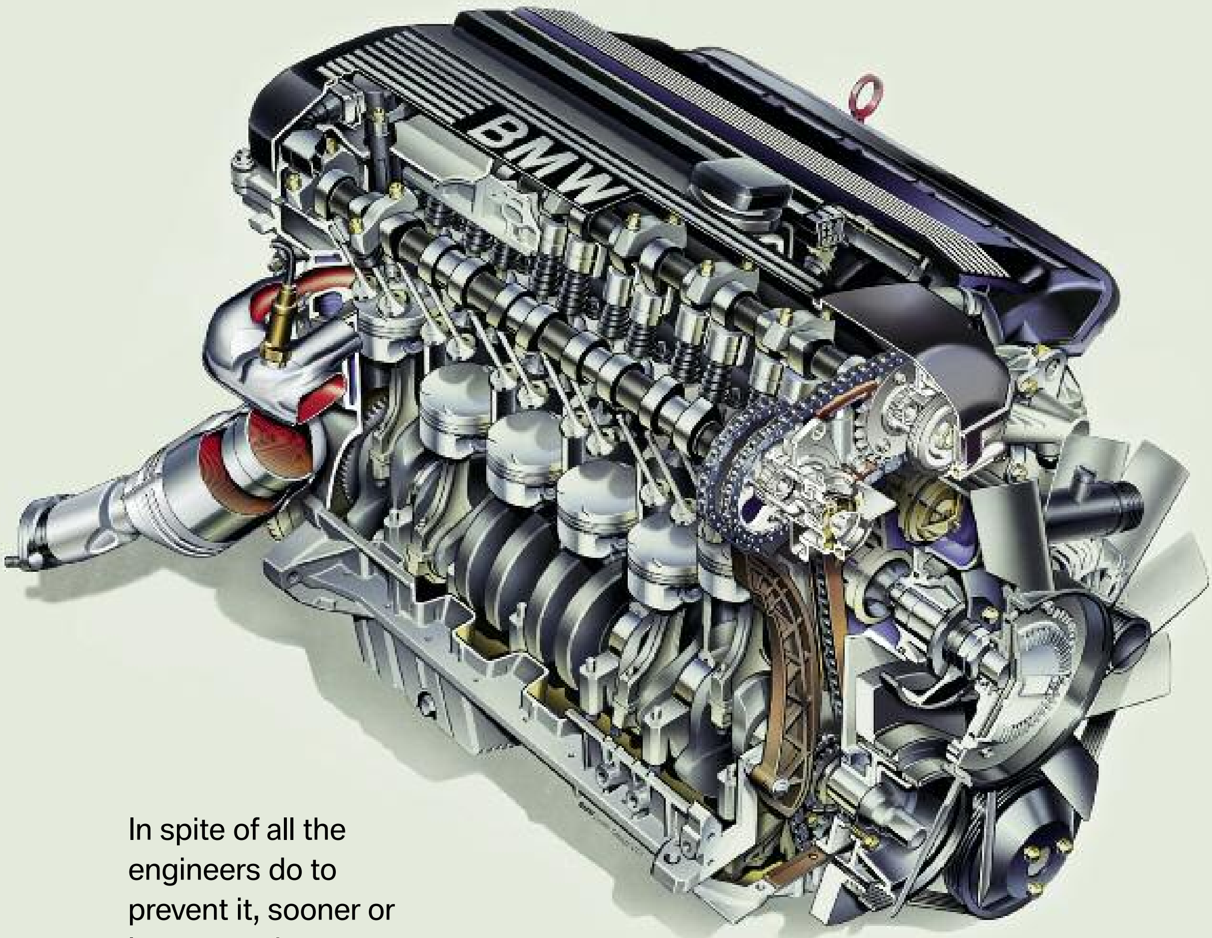
False Air

We fondly remember our first encounter with this situation. A 7 Series BMW 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. Sure, 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 V8 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.



In spite of all the engineers do to prevent it, sooner or later even the most highly-evolved engine will seep oil somewhere.

Seek the Leak: Engine Oil

You can't stop the bleeding if you can't find the wound

Contained in its proper place, oil does wonderful things. Elsewhere, it's a mess. Not only does it make for a disgraceful view when you open the hood, it can contaminate belts and soften hoses. But it's a dissolving driveway, a stained and slippery garage floor, black tracks on the new rug, and maybe high oil consumption that'll finally bring that motorist to you for relief.

That doesn't mean you should wait to be asked. Whenever you've got a car in for any service, look for evidence of excessive leakage. It's a rare vehicle that isn't seeping liquid lube from one seam or another, so there's plenty of work to be done, lots of money to be made, and a large number of customers to be pleased.

If you're a long-time reader of automotive service magazines, you've probably noticed that the topic of thwarting leaks comes up over and over. While modern highly-engineered gaskets made of space-age materials (when was the last time you saw cork?) and advanced sealing techniques such as carefully-machined O-ring grooves have reduced the number of leakage problems that find their way into your bays, the job of keeping hot oil inside an assembly as complex as an engine is so incredibly difficult that failures are bound to occur.

An aside is appropriate here: Many years ago, a vice president of one of the major gasket manufacturers told us something interesting: The company's engineers decided to find out exactly what would happen if they pulled out all the stops and meticulously assembled an engine with special gaskets, chemicals, and seals so that nary a sniff of oil would seep through to the outside, then used it in the real world. At first, it seemed pretty good, but after a while everything on that powerplant, and even the castings themselves, started to rust to the point that it got out of hand and actually caused problems, besides just looking like a horrible lump of iron oxide under the hood. So, they concluded that a certain amount of seepage was a good thing. That, of course, is much less so today with aluminum blocks, heads and intake manifolds. But who says light alloys don't corrode, and there are still all those steel parts bolted to the castings. Of course, this is no justification for allowing a leak to exist, just a surprising anecdote.

Time to talk

Whether you're doing this work by request, or trying to sell it, a little time spent chatting with your patron now will go a long way toward his satisfaction with your performance later. Explain that, unless the source of the leak is obvious, it often takes serious diagnosis to pinpoint it.

A case in point is the BMW M60 or M62 V8. An oil (or coolant) leak can develop in the valley due to a head gasket sealing problem. Unfortunately, the liquid lube tends to migrate toward the back of the engine and exits at the weep holes in the rear of the block. From there, it'll flow down to the engine/transmission seam, and there's a good chance you'll mistake it for a rear crankshaft seal leak, which would be a big blow to your reputation. So, whenever you see seepage or drips under the bellhousing of one of these V8s, remove the center sound-absorbing engine cover and look around before you jump to any unfortunate conclusions.

We'll get to the various oil leak detection methods, both traditional and modern, shortly, but we want to make the point here that the confused, buffeting flow of air through an engine compartment and the way oil can travel along unsuspected paths once it's escaped from the crankcase can fool you into making a monumental mistake. You might perform a big, expensive resealing operation only to have the same leak present after you're done, which is the kind of comeback that hurts both your credibility and your schedule, besides giving you a self-confidence crisis.

After you're very sure you've zeroed in on a leak, the repair itself may be as simple and inexpensive as replacing a cam cover gasket, a sending unit, or, as on certain BMW 7-Series cars, retorquing the oil plug in the filter housing. Or, it might be as involved as pulling the engine to install a new rear main seal.

Now would be a good time to insist that the man REALLY look at that disgustingly grimy powerplant, and suggest a thorough cleaning by whatever means you prefer, which will make finding the leak easier while actually improving the resale value of the car.

An old trick is to clean the engine, spray likely areas with aerosol foot powder, then watch for oil tracks.

Looksee

The first logical diagnostic step is a careful visual exam under a strong light. And bring your experience of various models to bear. When you're presented with a specimen that seems to be losing oil through every possible joint and seal, suspect elevated crankcase pressure from a clogged PCV system. A ring problem that results in more blowby than the PCV can handle is another possibility, as is frequent overheating that dries out gaskets and fries seals.

Newspapers and foot spray

Unfortunately, the convoluted airflow patterns through the engine compartment and under the car cause oil to spread in weird, inscrutable ways. So, when you confront a major leak, it wouldn't hurt to use the ancient trick of spreading newspapers under the engine while it's idling to find the drip. Of course, in many cases that won't tell you the actual source, just the general area.

There are better means of investigation. The traditional method is to clean the engine, go for a drive, then look carefully for spreading shiny spots. Another time-honored procedure is the use of aerosol foot powder, which works best with everything clean. Spray the white stuff over suspect areas and a leak will often become almost embarrassingly apparent.

Pump it up

If you're still not sure where the trouble lies, you can resort to low- or high- pressure testing. For the former, crank your air compressor regulator down to four or five psi, rig up a tight connection between your blow gun nozzle and the dipstick tube (a length of soft hose and two clamps will do it), pull the PCV valve, and plug its grommet. Tape the gun's trigger in the "on" position, then mix up some sudsy detergent and water and brush it over likely seams. Bubbles will tip you off. If there's a big hole somewhere, you'll hear it -- narrow down its location with a hose held to your ear. For high-pressure testing, set your compressor's psi to 80-100, remove the oil pressure sending unit, and screw in whatever adaptors are needed to tap into the oiling system. Use the soapy water and listen as above. This is especially useful for finding leaky casting plugs.

UV and you

Just an ounce of dye will do the trick no matter how much oil the crankcase contains.

But all those methods pale beside the champion: ultraviolet or "black" light detection. We were always impressed with how well this worked even decades ago when we used a wimpy 15 watt florescent tube, which required that the shop lights be off (that impedes the progress of other technicians and makes you an unpopular fellow) and the windows be shaded. Then we graduated to a succession of high-intensity lights and found contentment. They're so powerful ambient light doesn't really affect their use, although many makes come with yellow glasses that intensify the effect.

A little story will illustrate how powerful a quality modern UV light actually is. We had put a reman engine in an air-cooled tractor, and it left a pool of oil on the shop floor overnight. We looked and looked, but couldn't find anything wrong, so we gave it a dose of the dye intending to do the UV thing the next morning. An ex-mechanic neighbor stopped in for a visit and asked what that light on the bench was for. So, we turned it on to show him. Lo and behold, the hitherto invisible crack in the block was unmistakable even though the tractor was maybe ten feet away. Since then we've had automotive cases where we'd NEVER have found the problem at all with any other method.

The drill is simple. Pour an ounce of the proper fluorescent tracer dye (it won't hurt anything, and dissipates in 300 miles or so) into the crankcase, let the engine run, or, if the seepage is minimal, take it for a drive or ask the cutomer to come back the next day. Although cleaning the engine isn't really necessary, it's worthwhile if the grime is thick. Then, look around under the light. Use a shop mirror to take those ultraviolet rays where the light unit can't fit or be aimed. The offending area will jump out at you in bright yellow. It's the same principle as you might remember from the psychedelic 60's when a black light really made the colors of that Jefferson Airplane poster pop.

Patron pleaser

Other great aspects of tracer dye detection are sales and customer relations. You can point out exactly where a leak exists,

Nothing beats UV leak detection using the new generation of powerful and compact lights.

which will make it easy to explain the repair that'll be necessary to stem the flow. After the job is done, you can clean the engine (the dye can be washed off just like oil) and, under the light, verify that the seepage has stopped. You might even consider running a promotion on this service. A sign that says something like, "Leak Detection Special -- Keep Your Engine Clean, Save Oil, and Preserve Your Driveway," will appeal to your more fastidious customers and probably generate considerable business.

Let 'er bleed?

Now we come to a delicate question: How much leakage is too much? If the vehicle's an old heap that's not worth fixing, advise its owner to let it bleed and just keep checking the oil. On reasonably valuable cars, such as most BMWs, however, anything that allows more than a light film of oil to spread over and under the engine should be attended to. Drips and heavy accumulations of crud just don't go along with the image of a well-kept automobile. Also, a leak can only get worse. Fix it before the dam bursts.

Avoiding comebacks

We'd better conclude with a couple of important tips on avoiding a comeback whenever you do a leak repair:

• Proper torque on those fasteners really is important. When was the last time you had your torque wrenches calibrated? We do it at least once a year, but they take such a beating in a busy shop that it should probably be done more often than that. We've seen bolts broken because of a faulty T-wrench, which can escalate a simple job into a nightmare of extraction. Sure, an Easy-Out will probably work on a fresh assembly, but sometimes you can't get your drill in there, and how do you work this into the flat rate?

• Torque is dependent upon the condition of the threads, both in terms of cleanliness and lubrication -- the slipperier the interface between the bolt and the hole, the more the clamping force at the same torque reading. Unfortunately, there's no universal rule here, so you must look up the manufacturer's recommendations for that particular fastener. They may say, "clean and dry," or "clean and oiled," or "coat with thread sealant." A very scientific technician once proved to us through experiments that the condition and lubrication of the threads had a huge effect on bolt stretch and clamping force. If you don't follow this because you're too rushed to sit down at the computer or open a manual, you're risking either insufficient clamping, which can bring that leak right back at you, or, perhaps worse, a twisted-off bolt.

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Contact you local authorized BMW center for availability and ordering information.

Big Nuisance: Check Engine Light Illuminated, Faults Stored in DME/ECM Do To Poor Gas Cap Sealing (All models)

Information received from the field indicates that in a large number of cases the fuel filler cap is the primary cause for the illumination of the Check Engine Light due to the following:

- Insufficient sealing pressure because the fuel filler cap is not turned to the full stop.
- The retaining strap on fuel filler cap is caught between the filler pipe and the fuel filler cap.

This is such a common problem that in order to raise customers' awareness of the importance of a properly sealed fuel filler cap and the effect that it has on the illumination of the check engine light, BMW has produced a special brochure on the topic. The "Check Engine Light" brochure is currently part of the customer information delivered with each car.

So, look for it in the glove compartment and inform your customers about it to reduce nuisance MIL-on complaints.

Tappet Noise after Cold Start-Up (All engines with self-adjusting hydraulic tappets)

Engines equipped with hydraulic tappets may occasionally produce a rattling noise in the area of the valve train for a few seconds after initial cold start.

Engine start up and shut down present thermal changes, which require compensation. The duration of engine shut down, oil viscosity and ambient temperatures may combine to inhibit the self-adjusting action and audible valve lash may result.

The occasional occurrence of hydraulic tappet noise does not in itself indicate a mechanical fault and does not affect the service life of the engine.

If a tappet rattling noise continues for more than five seconds following a cold start, however, check the following:

- Engine oil level and viscosity
- Engine oil pressure warning lamp operation.

Should the tappet noise continue, allow the engine to idle or drive at slow speed (less than 2,000 RPM) for approximately 20 minutes. This will allow adequate time for the tappet self-adjusting action to be completed.

If the tappet noise continues, check the hydraulic tappets as follows:

- Stop the engine and remove the cylinder head cover.
- Press down on each hydraulic tappet with a wooden or plastic probe.
- If lash is clearly observed, the tappet has failed to self-adjust and must be replaced.

Engine Removal and Installation Tips (All models)

If repairs involving the removal and installation of the engine become necessary, the transmission must always be removed first as outlined in the repair manual.

Always support the engine and transmission using the appropriate special tools to avoid automatic transmission oil pump damage due to engine and transmission "sag" at the mating point (engine block to transmission bell housing) before the fastening bolts are removed.

Before reinstallation of the transmission, the dowel sleeves must be removed from the transmission bell housing and installed in the engine block as outlined in the repair manual.

Failure to follow the proper repair procedures will result in transmission damage due to engine/transmission misalignment.

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