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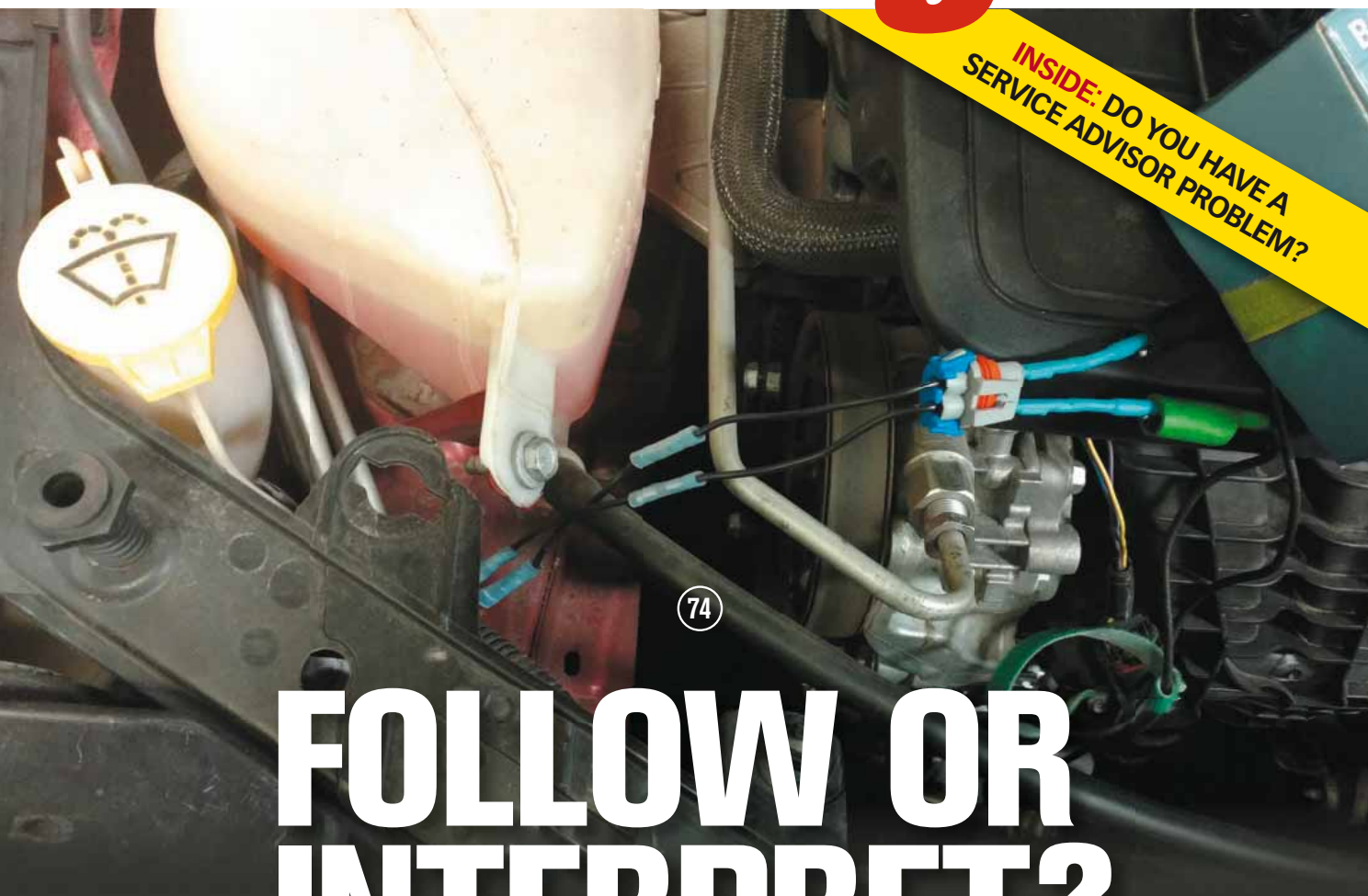

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Talk Shop Anytime

AUTOPRO WORKSHOP

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KIA QUALITY CONNECTION

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WHAT'S IN A WARRANTY?

While shops go to different lengths to offer warranties — and offer different lengths of warranties, too — Keith Katz and James Santistevan are going beyond that for their customers. These shop owners share their experiences with implementing warranties, serving customers and what other shops can learn on the latest NAPA AutoCare Center Podcast.

MOTORAGE.COM/WARRANTIES

LOOKING FOR A SILVER BULLET FOR REPAIRS?

Mitchell 1 and *Motor Age* partnered for a free whitepaper about asking the right questions, gathering complete information the first time, combating cost and working with educated customers. This is the guide you need in your shop to work smarter, not harder.

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INDUSTRY TRAINING

NACE AUTOMECHANIKA EVENT THRIVES IN CHICAGO

NACE Automechanika, the largest U.S. trade show dedicated to high-end technical and management-related training for automotive collision and service repair shops, returned to Chicago July 26-29, 2017. More than 360 leading suppliers displayed new automotive service and repair technologies, while connecting with nearly 8,000 attendees who took part in activities throughout Automotive Service and Collision Repair Week.

"NACE Automechanika succeeded in bringing buyers and sellers together on the show floor and in the training

>> NAMC CONTINUES ON PAGE 8

BREAKING NEWS

A/C EDUCATION

REGISTRATION OPEN FOR MACS 2018 TRAINING EVENT

A/Ccess is the theme of the MACS 2018 Training Event and Trade Show to be held Feb. 14-18, 2018 at the Caribe Royale Hotel and Convention Center. Attendees will gain A/Ccess to the mobile A/C and engine cooling service and repair information needed to make accurate diagnoses and reliable repairs; A/Ccess to the experts in the field who design and manufacture A/C systems, components, tools and equipment; and A/Ccess to network with other mobile professionals. In addition to blockbuster training classes, the MACS 2018 Training Event and Trade Show includes a trade show, a golf tournament and multiple networking opportunities.

A complete list of events for the MACS 2018 Training Event and Trade Show is available at www.macsw.org.

TRENDING

NARSA MOBILE HEAT TRANSFER PAVILION RETURNS TO AAPEX

The NARSA pavilion wil again feature everything heat exchange, including products, materials and supplies, and is focused on innovation, knowledge and opportunities.

MOTORAGE.COM/NARSA

BOSCH EXPANDS MULTIPLE PRODUCT LINES

Bosch added new parts coverage for a select 46 million vehicles in the U.S. and Canada needing replacement engine air filters, starters, alternators or brake pads.

MOTORAGE.COM/46MIL

CELEBRATE CAR CARE MONTH IN 5 MINUTES

The Car Care Council suggests five quick and easy ways to leverage Fall Car Care Month, the consumer education campaign to drive business to repair shops, in under five minutes.

MOTORAGE.COM/5TIPS

CARDONE CHALLENGES TECHS TO SHOW OFF THEIR SKILLS

For a chance to win $5,000, CARDONE invites all techs to share an original video featuring the installation of an under-the-hood or under-the-car automotive part.

MOTORAGE.COM/SKILLS

AFTERMARKET CHARITIES STILL SEEK HURRICANE AID

The automotive community continues to come together to donate to industry-backed charitable organizations in support of hurricane-stricken businesses.

MOTORAGE.COM/DONATE

Sensing the Future

Simple sensors are a common part of daily life. But advanced sensors are an increasingly important component of technological innovation.

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HELPING HANDS

Under-skin sensors that keep track of pets are common, but a Swedish start-up company is implanting sensors into its employees in the name of convenience. Biologically safe sensors the size of a rice grain can be quickly inserted near the thumb, using the same Near-Field Communication (NFC) technology in tap-to-pay credit cards to allow employees to open doors, operate computers and order their lunch with the wave of a hand.

GETTING BUZZY

Australian scientists are hoping to develop solutions to environmental threats to the global food supply with information from microsensors affixed to thousands of honeybees. The sensors record changes in honeybee behavior, helping to show the impact of pesticides and climate change on bee colonies. The information could be invaluable to stabilizing the population of insects that pollinate 70 percent of the world's crops.

TAILORED TECH

The dramatic rescue of 33 Chilean miners that captured the world's attention in 2010 was due in part to special harnesses fitted with biometric sensors. The sensors allowed doctors to monitor the miners' vital signs as they were pulled up from a half-mile below ground. Similar technology has since found its way into an athletic shirt that can measure heart and breathing rates during exercise.

NEW WAVE

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INNOVATION STARTS WITH THE ORIGINAL

>> NAMC CONTINUED FROM PAGE 6

rooms, where we provided four days of high-quality education to automotive service and collision repair professionals," said Jim Savas, vice president and general manager of UBM's Automotive group. "We also had very favorable responses from attendees who enjoyed the networking opportunities associated with several co-located events, including the Collision Industry Conference, the MSO Symposium and our new Business Outlook Conference."

The new alliance between NACE and Automechanika Chicago proved a successful one with a heightened support from the collision repair industry. Several industry groups held meetings and events during the week including AMi, I-CAR, CIC, CREF, Enterprise Rental Car, CCC Information Services, Inc., Allstate Insurance Company, the OE Roundtable and others.

"The industry needs and deserves a national show that is solely dedicated to advancing the collision and service repair industries. As evidenced by the tremendous support from industry associations and companies, NACE Automechanika is that source," said Dan Risley, president and executive director, ASA.

The NACE Automechanika show floor featured opportunities for testing equipment, learning about market trends and hearing from carmakers about what the future holds for vehicle service and repairs. The OE Coliseum included advanced information from General Motors, Toyota, BMW, Nissan and Fiat/Chrysler. These sessions greatly impacted attendees by providing up-to-date and current information on the latest trends in automotive repair processes. The new Scan-A-Palooza area featured diagnostic tool demonstrations and gave attendees important lessons in performing proper pre- and post-repair scans. Additional show-floor training from I-CAR gave collision repairers insight into new materials being used in vehicles and proper repair procedures.

THE INDUSTRY NEEDS AND DESERVES A NATIONAL SHOW THAT IS SOLELY DEDICATED TO ADVANCING THE COLLISION AND SERVICE REPAIR INDUSTRIES. AS EVIDENCED BY SUPPORT FROM [THE] INDUSTRY, NACE AUTOMECHANIKA IS THAT SOURCE – ASA'S RISLEY

"We go to a couple training classes a year in our town through local vendors, but we just figured this was the best way to learn from some of the top trainers in the field," said Joshua Dykes, a technician from Indiana who attended NACE Automechanika. "The training is the reason we chose to go to NACE Automechanika Chicago. We were learning from top trainers like Bernie Thompson. We have his tools here in the shop that we use on a daily basis. It was nice to meet the guy who invented the tools we use and ask him questions about them that you don't normally get to ask."

At A Glance: NACE Automechanika 2017

Exhibition space	108,000 sq. feet
Exhibitors	367
Exhibiting Countries	19
Pavilions	7
Attendees	7,700
Attendees' Countries	43

Highlights from the show floor included a showcase of products, services and interactive demonstrations from several exhibiting companies such as NAPA, Pro-Spot, Federal Mogul, Car-O-Liner, Tenneco and TTA Appraisal, among others. From diagnostic testing to new paint technology in the Spray Zone and welding techniques by key exhibitors, NACE Automechanika covered it all.

"We are pleased that so many leading companies chose NACE Automechanika as their platform to highlight the latest technologies and advancements in the automotive aftermarket," said Bridget Ferris, show director. "The support both domestically and internationally reinforces our vision of being the first choice for business encounters."

At the event this year, several organizations successfully raised money to support the automotive industry including the Collision Repair Education Foundation (CREF), which raised $22,500 for Kennedy-King College, one of seven City Colleges of Chicago. Giving back to the automotive community was also the focus of a scholarship program organized by the UBM Community Engagement Program in cooperation with the Automotive Management Institute (AMi), National Automotive Technicians Education Foundation (NATEF) and Technicians Service Training (TST). These groups provided roughly $13,000 in scholarships to professionals and students attending this year's event.

What's next at NACE Automechanika? Following a successful event this past July, NACE Automechanika will transition to an annual format, providing even more content to the automotive collision and service repair industries The 2018 edition of NACE Automechanika will take place Aug. 8-10, 2018, in Atlanta, home to Porsche Cars North America and Kia Motors. To stay up-to-date on news coming from the event, please visit: naceautomechanika.com.

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INNOVATION STARTS WITH THE ORIGINAL

ADDRESSING INDIFFERENCE

Panelists question if industry-wide licensure would dissolve apathy towards training

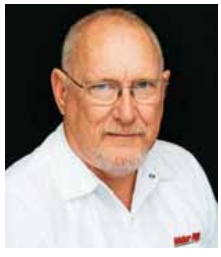
CHELSEA FREY //
Senior Associate Editor

For this year's roundtable, *Motor Age* gathered industry professionals to discuss the biggest challenges facing the service repair industry today, such as the widespread apathy towards training, ushering new talent into the industry and the self-inflicted devaluation of repair work — as well as one possible solution: industry-wide licensure.

Here are some of the highlights of this year's *Motor Age* Roundtable, which included various perspectives ranging from technicians to association executives (see sidebar "Who was at the Table?").

***Motor Age*: What developments did you see in training opportunities this year? How would you like to see the industry approach training in the next 1-5 years?**

Pete Meier: We've had some excellent training opportunities in Chicago with NACE Automechanika, but we're not the only organization providing great opportunities. I think there are more people coming out for training — not huge numbers — but overall there's an uptick in technicians that are getting the training they need. The resources are out there. The challenge is spreading the word so that techs know about them.



Pete Meier

Trish Serratore: There are two different training opportunities offered by the industry. First, there's training that's delivered to the service professionals. I worry that facilities aren't taking advantage of it as much as they could or should. They rely on one tech to take the training and teach everyone; they're afraid of fewer productive hours, and are worried the guy they train is going to leave. Secondly, there's training for our educators. We have to make sure that instructors are up to date so that they can provide relevant information to their students

We here at NATEF, AYES and ASE feel that there is currently and will be an increased instructor shortage. As current instructors retire or burn out and leave the teaching profession, those programs tend to close. We're here to take that on as a challenge to find individuals who are seeking to leave the technician ranks or service repair professional side and come into the educational community. We hold an instructor conference every year, and we have training sessions from our aftermarket, OE and educational partners to help build that platform of up-to-date instructors who can go back to their classrooms and provide the information that our up-and-

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Scot Manna: Being a shop owner and attendee of training as well as a training provider, training is not going in the direction it needs to go, and it's moving at a turtle's pace. There's a lot of apathy. The same people seem to be showing up to training. I train a lot of people who don't really need the training — they're pretty smart guys because they continuously attend training. The other 80 percent of service professionals out there can't seem to get it together.


Scot Manna

Matt Fanslow: Years ago, when electronic ignition, for example, came about we thought "all this new technology is coming; we're going to watch all these shops die because they're not keeping up." But that doesn't happen because there are a lot of resources out there that keep them going even without the training and tooling. Shops aren't making the money that they should be to be able to afford to send employees to training. There are many other industries where training is expected and will be on company time, on the company's dime. That doesn't happen often in our world.


Matt Fanslow

Pete: There are a lot of shops out there doing the right thing to meet the modern challenges. But there is also a lot of apathy. Maybe people are too comfortable doing what they've always done and don't want to grow any further. One of our strengths is also one of our weaknesses: the independent shop owner. They're the men and women who had that entrepreneurial spirit and the guts to lay it all on the line and start their own business, to take the risks. That same entrepreneurial spirit is put to the test when it comes to change — it wasn't their idea, so they don't want to do it. To create real change in our industry, we need to get that person to adopt to something across the board, to get everyone to agree to do things the same way in order to make our industry more attractive and better. Is it time for mandatory certification for shops and technicians?

Trish: Our industry battles between "We are a profession" and "We are simply a small business, and I'm going to run it however I want." Take the health care industry for example — whether you are a doctor or a nurse, there is a recognition that you are in the healthcare profession, and there is an expectation that you will come into the field with the proper training and credentials and that you will maintain that training throughout your career. If you practice medicine without a license, you will go to jail. Our industry has not yet committed to that acknowledgement. We don't always set expectations and demand credentials industry-wide. Until we do that, training is not going to be as effective, and certification is going to be voluntary.


Trish Serratore

Matt: If the trade was a unified front, together we could assign value to training and the work we do. Looking at the medical field example from the perspective of the consumer, if you think you have strep throat after researching symptoms, you're still going to the doctor and paying a professional to verify, diagnose and fix it. It's the same thing at an auto repair shop. Yeah, the customer can go online and research an issue with their vehicle and likely find out what's causing it. But you're paying a professional to verify it and make sure nothing else is wrong and to fix it. We have to come together and commit to the fact that there's value in that. But right now we're good at running ourselves and our competition into the ground.

WHO WAS AT THE TABLE?

Matt Fanslow is a diagnostic technician at Riverside Automotive.

Scot Manna is the owner of MB Automotive Inc. and a contract trainer for the State of Illinois Emission Program, WORLDPAC, and Autowares.

Pete Meier is the Director of Training for UBM Automotive Group and *Motor Age* Technical Editor.

Skip Potter is the former Executive Director of the National Automotive Service Task Force.

Trish Serratore is the Senior Vice President of ASE and President of NATEF/AYES.

***Motor Age*: Say you've been invited to speak to a classroom of teenagers about careers in the industry. What would be the key messages you would have for them?**

Skip Potter: There are two things I want to make teenagers aware of that go a long way to promote our industry, one being the career opportunities — just look at the lists on AutoCareCareers.org. It's a broad industry that can suit many different skills. The other message I'd share is the scholarships that are available. Pete Kornafel, who is the chairman of the Global Automotive Aftermarket Scholarship Committee, has been campaigning and creating awareness of the availability of automotive scholarships on automotivescholarships.org for years. If cost is going to be an issue to start in

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570,000 VIO

FPS11
Fuel Pressure Sensor
GM Pickups & MD Trucks (2010-06)
Hummer H1 (2006)
VIO Over 395,000

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Our HPI7 Diesel High Pressure Oil Pump is the product of an extensive remanufacturing process that includes a complete teardown of the pump, the addition of new critical components, leak checks, and thorough testing to ensure a superior, long lasting pump.

Fuel (Cont'd)

FICM3
Diesel Fuel Injection Control Module
Ford F Pickups & E Vans (2010-04)
VIO Over 590,000

100% NEW POWER SUPPLY

Upgraded, 100% new power supply prevents heat-related failure that can occur in competitors' units

FIDM2
Diesel Fuel Injector Driver Module
Ford F Pickups & E Vans (2003-99)

825,000 VIO

FTP5
Diesel Fuel Transfer Pump
Dodge Ram 2500 & 3500 (2002-98)
VIO Over 365,000

UPGRADED PUMP DESIGN

Upgraded design and flow characteristics delivers quick startups and more consistent fuel pressure at all operating temperatures.

GP113
Diesel Glow Plug
Ford F Pickups & E Vans (2010-04)

825,000 VIO

GPH104
Diesel Glow Plug Wiring Harness
Ford F Pickups & Excursion (2007-05)
VIO Over 530,000

PROVEN DURABILITY

High-quality harness connectors withstand extreme engine temperatures

OPH3
Diesel High Pressure Oil Pump Hose
Ford F Pickups & E Vans (2003-00)
VIO Over 620,000

PROVEN QUALITY

Anti-corrosive steel material and precision-bent oil lines ensure longevity and ease of installation

HPI7
Diesel Injection High Pressure Oil Pump
Ford F Pickups, E Vans, & Excursion (2009-05)
International Trucks (2008-04)
VIO Over 600,000

PROVEN RELIABILITY

Product of extensive remanufacturing process at our TS16949, ISO9001, and ISO14001 certified facility

► Diesel Fuel Injectors - NEW

Our exclusive, new diesel fuel injectors are manufactured in the U.S.A. at a TS16949-certified facility using OE-production design, development, engineering, and manufacturing processes. They also undergo extensive dynamometer, hot gas test stand, and diesel emissions testing to ensure superior performance and durability.

Fuel (Cont'd)

OCK1
Diesel Oil Cooler Kit
Ford F Pickups & E-Vans (2010-03)
International Trucks (2012-02)
Workhorse Custom Chassis W42 (2009-05)

960,000 VIO

SK138
Fuel Injector Installation Kit
Ford F Pickups (2017-11)

970,000 VIO

PR444
Fuel Pressure Regulator
GM Pickups & MD Trucks (2012-06)
Hummer H1 (2006)
VIO Over 380,000

PROVEN RELIABILITY

Precision engineered for proper fuel delivery and engine performance

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FJ738NX
Fuel Injector - New
Ford F Pickups & E-Vans (2003-99)
International Trucks (2002-99)
VIO Over 868,000

EXCLUSIVE, 100% NEW

Undergoes extensive dynamometer and diesel emissions testing to ensure proper performance

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FJ928NX
Fuel Injector - New
Ford F Pickups & E-Vans (2010-04)
International Trucks (2009-04)
VIO Over 850,000

EXCLUSIVE, 100% NEW

Undergoes extensive dynamometer and diesel emissions testing to ensure proper performance

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FJ1009
Fuel Injector - Reman
Dodge Ram 2500 & 3500 (2010-07)
Ram 2500 & 3500 (2012-11)
VIO Over 370,000

PROVEN RELIABILITY

Remanufactured at our certified facility to ensure quality

FJ1226
Fuel Injector - Reman
Chevrolet Silverado 2500 & 3500 HD (2016-11)
GMC Sierra 2500 & 3500 HD (2016-11)
VIO Over 580,000

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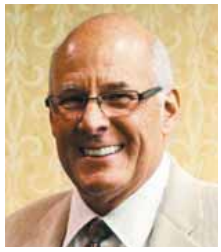
Skip Potter

our industry, these scholarships can help. One application works for multiple scholarships. I would want teenagers to know about those two websites.

Matt: I struggle with this. Part of me feels there's a lot of good about doing this for a living. Instant gratification is the No. 1 reason — you're either right or wrong. That rush of solving a problem and helping customers is a great aspect of this career. On the flip side, it's hard to tell bright students to go into this trade when the salary is not great. You can do something else much easier and in a much nicer environment. You will probably have a retirement if you have an office job — but not in our industry. In this trade, once you start aging, your body starts breaking down, your production decreases and so does your paycheck. We need to fix the compensation package to make it more competitive with other trades.

Scot: We are one of the only industries that penalizes employees when they get older. The smartest and the brightest techs who do the most difficult diagnostic work aren't getting compensated properly. Tech Y, who's putting on struts, brake calipers and rotors, is running at 150 percent. Tech Z, who's finding a spread terminal in a fuse box in the trunk of a car that makes an intermittent no-start once every week, is not being properly compensated for that work. Those are the people we're looking for, but he's seeing Tech Y in the next bay slamming parts on a car, and the owner is happy as can be because he has a 50 percent margin on the parts. Tech Z is viewed as a necessary evil to take care of the weird problems that come in. It all wraps around money and compensation if we're trying to get new talent and new techs in.

Pete: If you're going to fix the conversation strictly on being a technician, then I'm very torn. There are so many skilled labor positions open in other industries that pay better with better benefit packages. However, there are many opportunities and careers within our industry, whether it's working as a service advisor, shop owner or sales manager or with aftermarket companies and OEMs.

Skip: On a similar note, I think if businesses would get involved more with their community colleges and votech institutions and take advantage of programs like AYES and follow Trish's guidelines on things like mentorship and internships, we would convert many more of the kids graduating from these programs into our industry. There are good programs out there that go unnoticed and unused. We need to make them more successful by banning together and letting the industry know they exist.

***Motor Age*: What would you say is the biggest challenge facing the industry, and how do you foresee addressing it?**

Scot: My biggest issue as a shop owner today is parts. The whole parts industry is a mess; the distribution model is a mess. It's mind-boggling that a consumer can buy oil at Walmart for cheaper than I can as a professional installer. The defect rate is still a problem. In the last 10-15 years, I've seen it a lot where if a repeat customer comes in with an issue, most of the time all you have to do is look in the system to see what was installed the last time they visited, and it's usually an issue with that part. My use of dealer parts has increased year by year. I know the aftermarket means well, but it's difficult to stand behind it as an installer. There's so much price pressure that drives the price down. I often can't buy parts I want because the local vendors don't have it on their shelves — what's on their shelves is the cheaper options.

Pete: This goes back to the idea of standardization. A lot of the OEMs are leery about how their products are getting fixed — not only in the aftermarket, but in their dealerships as well. It's impacting their brand loyalty. In the collision repair side, if the car isn't the same after a repair as it was when they bought it, they don't fault the collision repair shop — they fault the brand and model. With a lot of the OEMs now, if a dealer doesn't have someone in their shop who has been factory trained to do XYZ, that dealer isn't going to get paid by the manufacturer for the repair. That to me is the edge of what I wouldn't mind seeing in the future.

Matt: If I set up the adaptive cruise after a car's been fixed in an auto body shop and the client rear-ends somebody on the highway, they're going to need to follow that back. If it gets back to me, how do I prove that I knew what I was doing setting up that system? Maybe stuff like that will start driving licensure. But if we flipped the switch and did something like that, we'd probably break the industry. I think ASE naturally should be the bar.

Scot: To close, I'll share a few experiences I've had recently. Again, everything rolls back to apathy. I've been in business for 35 years, so I know a lot of trainers and instructors from many colleges. I've never had an instructor at any of these institutions ask me, "Can I spend a day or week at your shop in the summer to see what's going on?" It never happened — in 30 years. They are no more willing to give up their time to better themselves in their profession than what we're asking of our technicians who are getting paid less and are not getting pensions. I can't figure out why guys are so unmotivated to do their jobs, so to speak. It's hard to move the boulder in any direction. And it is a boulder.

CHELSEA FREY is the Senior Associate Editor for *Motor Age* and for its sister publication, *ABRN*, in the collision repair segment.
chelsea.frey@ubm.com

CULTURE CONVERSATIONS

Encourage discussions about long-term operations improvements for continued success

JEFF PEEVY // Contributing Editor

One thing that stood out to me as we worked with shops in past studies on the impact of training was the quality of the conversations, or should I say lack of quality, between management and staff. In many instances there was a gap in those conversations. For one, they were not necessarily ongoing. By this I mean a topic was not carried on over time and developed. The gap I refer to was the lack of discussion about improving the operational efficiency and profitability of the business and the application of learning.

Most conversations were focused on the current or next repair order. It was short-sighted and focused on the present or very near future as it related to a vehicle being repaired. From there the conversations tended to jump to personal topics related to family or hobbies. What rarely happened was an open discussion about the topic of making things better for the business, driven by the understanding that improved operations and profitability could or should mean better working conditions, more income and stability for all.

For many years, my team and I identified a management approach within our industry; we referred to it as an Industrial-Age Management Mindset. This management philosophy is simply a remnant from our country's success as an industrial world power beginning in WW1. It has impacted and influenced our management style ever since and though it may have served us well for many years as an industrial world power, today it doesn't. This management approach sees employees simply as workers who use their strength of back and hands to accomplish a task. They are not seen or engaged as thinkers who can improve the business and operation they work in. Unfortunately, many repair businesses work under this approach. Even worse, they do not realize it and seem unaware that there is a more informed approach and mindset that could radically improve

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their operation. To make the shift to engaging employees at a cognitive level, it requires a willingness to be more open about the business's operation and the challenges it faces that are often seen as management issues.

To make these ongoing conversations happen, they must be encouraged. To make them productive, learning and sharing knowledge must be expected. Within the context of a business culture, learning on purpose and with purpose drives business success. A business culture that does this will reap the benefits from the one single thing that sustains a competitive advantage: learning.

Make sure the conversations within your business are not just focused on the present situation. Encourage deeper, longer-term discussions about operational improvements. Establish the value of different perspectives. Let it be understood not every idea will be implemented or even acted on, but considered. Discuss the power of collective perspectives and how they ultimately ensure accurate operational actions.

Look for things that may interfere with learning and sharing knowledge. This could include apologizing for sending an employee to a training class or an ego-driven environment that silently says, "Admitting you learned something is an admittance you did not know something you should have known." Openly encourage learning and make it understood it is expected. When sending someone to a training opportunity, set the learning expectation upfront and explain that a discussion on what was learned will take place afterward. Tie accountability to the need to constantly be learning, to ensure every action, as an individual in a role and as a business operation, is a knowledgeable one.

The success of your business is based on its ability to learn and have ongoing, meaningful conversations. That means every employee should be learning constantly and on purpose and collectively sharing with one another. That is the one element that catapults a business ahead of its local competitors for the long term, every time. The American philosopher, Eric Hoffer was quoted as saying, "In times of change, learners inherit the earth while the learned find themselves beautifully equipped to deal with a world that no longer exists."

JEFF PEEVY is the president of the Automotive Management Institute. Jeff has been involved in industry training and education for more than 20 years. *jpeevy@amionline.org*

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Three symptoms of a service advisor problem

Unhappy customers will most likely not complain, but they also may not return

It's easy to look back and see it, and it's easy to give the advice. But the sad fact is, most people don't look beneath the surface until it's too late," said Wendelin Van Draanen.

I have the greatest respect for anyone engaged in selling service at the front counter. It can be the most exciting and frustrating position in the shop. I started my career decades ago teaching service advisors, and I have watched thousands of advisors perform it live in the shop. The interesting thing to me is that in the classroom we all do fairly well and the performance is much easier; however, the front counter reminds me of Vietnam because the customers are firing back at you. We all know to keep cool, show we care and build relationships while we try to teach consumers the value of maintaining their investment. The challenge is that under fire it doesn't always turn out the way we want it and the longer that happens the worse the average repair order becomes. What's worse is service advisors can't see what they're doing wrong because they are under fire and reacting.

This is why they need an immediate supervisor or a shop owner who understands not only the sales process, but also sales management. We have been teaching a sales management course to shop owners for decades, and today we are going to share three symptoms to look for and what to do about it! Let's listen to ATI Coach Eric Twiggs explain to a shop owner how to begin being a sales manager of your front counter folks. Eric's story began with this:

Greg and I were struggling to figure out why his car count wasn't improving. He had 10 five-star Google reviews. When I Googled all the primary automotive search terms for his area, I found him on the first page and in the top spot.

His website was so strong that I would send the link to my other clients as an example of what to do. Steve, his service advisor, had been with him for seven years and had forgotten more about the automotive business than the average person knew.

IF YOU HAVE SEVERAL CUSTOMERS VOICING THE SAME CONCERN, YOU HAVE A MUCH BIGGER PROBLEM BREWING BENEATH THE SURFACE.

"So how is Steve performing?" I asked. "Eric, Steve isn't the problem. He's my most dependable employee!" In an effort to trust but verify, I decided to have one of my fellow coaches call the shop posing as a customer in need of brake service.

Not inviting the customer to the shop

To my surprise, Steve made no attempt to get the caller's name and phone number or to invite him to the shop. I personally reviewed the results of the mystery call with Steve and he confirmed that he understood and committed to do better.

The only change to the business was Greg taking over at the counter. In the following weeks, I had two different coaches conduct two additional phone shops, and the results were the same. No attempts were made to invite the caller to the location.

Business declined to the point where Greg had to lay Steve off and take over the service writer duties himself. It took eight weeks to find a qualified replacement. During this time span, the sales and car count trends took an interesting turn — for the better!

When Steve was writing service, the shop averaged $14,000 per week in sales with 35 cars. Greg averaged $19,000 per week with 40 cars.

Here's what I learned from this experience: Consistently bad phone shops is a symptom of a service advisor problem. You may be thinking: "Eric, you're being too hard on Steve. Failing multiple phone shops isn't a big problem."

Well, consider the following math: Let's assume that by focusing more on the phones you only acquired two additional customers per day who normally wouldn't have come in.

Over five days, that's 10 customers. If you have a $400 average repair order, that's an additional $4,000 per week in revenue. (10 x $400=$4,000)

By not answering the phones correctly, your writer would be costing you $208,000 in potential sales over 52 weeks! ($4,000 x 52=$208,000) Therefore, I live by the following motto: If car count drops, do a phone shop.

I am often asked the following question: "Why should I do a phone shop if I don't think I have a service advisor problem?" If this is your question, consider the following findings:

Over the past 10 years, ATI Trainer

Randy Somers has phone shopped more than 1,800 service writers during his Service Advisor Part 1 class. Out of 1,800 calls, only 72 of the advisors offered the customer an appointment to visit the shop. This math works out to only 4 percent of the service advisors in North America answering the phones correctly.

The trend is an indication that you may have a bigger problem than you realize.

Failing multiple shops isn't the only symptom. Keep reading to learn about two more symptoms of a bad service advisor.

Common complaints

During the eight weeks that Greg covered the counter, he had a total of 13 customers mention how they were glad to see Steve gone! Several of these patrons commented that if Steve was still employed, they wouldn't have come back.

Greg was surprised because he had only heard three customer complaints about Steve in the past six months. All three mentioned that Steve was very short with them and came across as being rude. Greg didn't realize that these common complaints were just the tip of the iceberg.

A 2014 retail industry study concluded that 96 percent of unhappy customers will never complain. The study also found that 91 percent of these patrons will never return.

To make matters worse, they will tell up to 15 of their friends about their experience. If you have several customers voicing the same concern, you have a much bigger problem brewing beneath the surface.

Pay close attention to those common complaints you receive about your writer. The following quote is attributed to noted author Jack Rosenblum: "If one person tells you you're a horse, they are crazy. If three people tell you you're a horse, there's conspiracy afoot. If 10 people tell you you're a horse, it's time to buy a saddle."

If multiple people who don't know each other share the same opinion, it's just the tip of the iceberg, and the second symptom of a service advisor problem.

Blaming "they"

A few weeks ago, I was speaking with a service advisor named Jim who was in town attending class. He told me that his shop was struggling to stay afloat. When I asked Jim about using the parts matrix, he said, "They think we're too expensive."

When I suggested offering every customer an exit appointment, he responded: "They don't like to schedule in advance." I asked him about making follow-up calls to which he replied: "They think it's too pushy." The Twiggs translation for the word "they" is "I." "They" is the signal of a limiting belief and a symptom of a service advisor problem.

He was really saying, "I think we're too expensive;" "I don't like to schedule in advance;" and "I think making follow-up calls is being pushy."

It's important to get these issues out on the table, because you don't feel accountable for your results until you become responsible for your "reasons."

I've discovered that 80 percent of a struggling shop leader's issues are due to mindset, with only 20 percent resulting from skill set. In other words, how you think drives what you do.

Simply addressing skill set doesn't solve the problem. The key is to address their mindset by asking them to explain how your request is good for the car, the customer and the company.

This level of dialogue will give you the opportunity to address any limiting beliefs that are causing problems below the surface.

Conclusion

So, there you have it. Consistently bad phone shops, common complaints and blaming "they" are the three symptoms of a service advisor problem.

If you address these issues head-on, making the top shop list will only be the tip of your success iceberg. You will have more profit and happy customers beneath the surface than you would ever imagine. If you would like to try your hand at being a sales manager simply download our Service Writer Assessment Checklist for a limited time by going to *www.ationlinetraining.com/2017-10*.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 115 associates train and coach more than 1,400 shop owners every week across North America to drive profits and dreams home to their families. This month's article was written with the help of Coach Eric Twiggs. *chubby@autotraining.net*

Do you have a problem with staff turnover?

If so, the problem most likely lies with shop management, not your staff

Everyone acknowledges the shortage of competent technicians, and staff in general, in this industry, but it becomes really scary when a service provider's shop can't keep the staff it does find. When a shop can't keep good people, it not only affects the shop's general attitude — it affects the profitability, too.

Constant personnel "replacement" is not personnel "management."

Too much personnel replacement is not good for business. It creates a situation where too much time by the shop owner is used in a perceived negative process, rather than spending time working on the positive processes of the business that builds a client base and profitability. If the business is not moving forward, then the fact is that it is stagnant or moving backwards.

Consider the following:

• In many cases, it is not the staff that is the problem; it is "shop management" that is the problem.

• If an employee would leave a shop for a $2 or $3 per hour raise, then the employee does not "see" a future with the current shop that would allow him/her to earn in excess of the amount offered, to enjoy a career. The employee sees the current situation as a job. The owner does not seem to believe in, or have the skill to, create positive employee business relationships.

• Due to a shortage of competent people, it must be recognized that dealing with staff members today must change substantially compared to the 10-years mentality.

• It must be recognized that you can buy a man's time, you can buy his physical presence at a given place and you can even buy a measured number of his skilled muscular motions per hour. But, you cannot buy enthusiasm today, you cannot buy initiative today, you cannot buy loyalty today and you cannot buy devotion to the business today. You must earn these.

AN EMPLOYEE-CENTERED MANAGEMENT PHILOSOPHY MAKES SOUND BUSINESS SENSE. TO SUCCEED, A SHOP HAS TO CARE PASSIONATELY ABOUT ITS BUSINESS AND COMPASSIONATELY ABOUT ITS PEOPLE.

• Employers today must learn to be supportive and willing to take responsibility of their employees' long-term well being. The employer, in essence, is stating, "You are not easily replaced; therefore, I am interested in you and your future and how working with and being part of this company can meet, or exceed, your personal goals. Let's talk."

• In the past, you would hear people saying, "Wouldn't it be great to work for company X or company Y?" You don't hear that anymore because we are now in an age known for "lean and mean management," which has created a psychological atmosphere within the marketplace where the prevailing perception among employees is that there are not too many companies out there that VALUE their people.

• As much effort must be made to nurture your employees as you do servicing your clients. This is a role management must be willing to "get their head around," because if it doesn't, what are the long-term financial consequences to the business?

• An employee-centerd management philosophy makes sound business sense. Any corporation in our industry that wants to succeed today has to care passionately about its business and compassionately about its people because businesses that fail to understand and act on this will probably fail.

• The only sustainable competitive advantage in business today is people. The competition can copy your technology and latest feature, but they can't copy the skills, knowledge, judgement and creativity of your committed workforce. People are the edge today.

• There is a new "social contract" being made today where companies are asking employees to change, to be innovative and creative. Employees, in return, are then stating, "Well, in that case, let me try to do it, rather than you watching over my shoulder trying to clone me like you, because I am not you. Yes, I will make mistakes, because no one, including you, is perfect, but I will learn through my mistakes and become a much better employee and person for it. When you display and support confidence in me, in the long run, I will not let you down. Also, for my concerted effort and dedication to

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the task requested, it is only fair that I am properly compensated."

All these are key points, and there is no doubt there are service providers who will either agree with them, or argue it is still the employees' fault anyway because "they just don't want to work." At this point, with statements like that, one must make an assessment as to whether this shop owner is willing to change the way he/she thinks. People are willing to work when they have something positive to be motivated about that creates the desire to work. A good starting point for management is to have a respect for the employee as an individual, and a respect for the skills that they have worked so hard to achieve. The next hint is to display pride in your team and each member, openly in front of the customer/client. If you are not proud of your team and each member in your shop, it doesn't say much for management's ability; after all, who hired them, who trained them and who pays them?

Today everyone must be willing to understand that personnel management is not a "one-time meeting," but rather a nurturing process that requires ongoing discussion and understanding of points of view from both sides over a longer period of time. The overall benefits to the business and its bottom line are enormous. This is truly the expression of "entrepreneurship" where the management of the shop is leading the business, and the employees have a strong desire to follow.

As this sample problem has shown, if the owner is not prepared to change, then one must accept that the shop will not grow, and will actually experience serious financial difficulties, if it is not already there. Entrepreneurs must devote their time to the progression of their business because they realize that their shop will be one of the few that will be here in five years, coupled with a "team" standing alongside them.

Take the time to learn about your employees. Express and show your concern for their future, and I believe you will be amazed at the positive response you will get from the better technicians/staff in the marketplace.

BOB GREENWOOD, AMAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), which provides business management resources for the automotive aftermarket. Bob has more than 36 years of business management experience and is one of 150 worldwide AMi-approved instructors.
greenwood@aaec.ca

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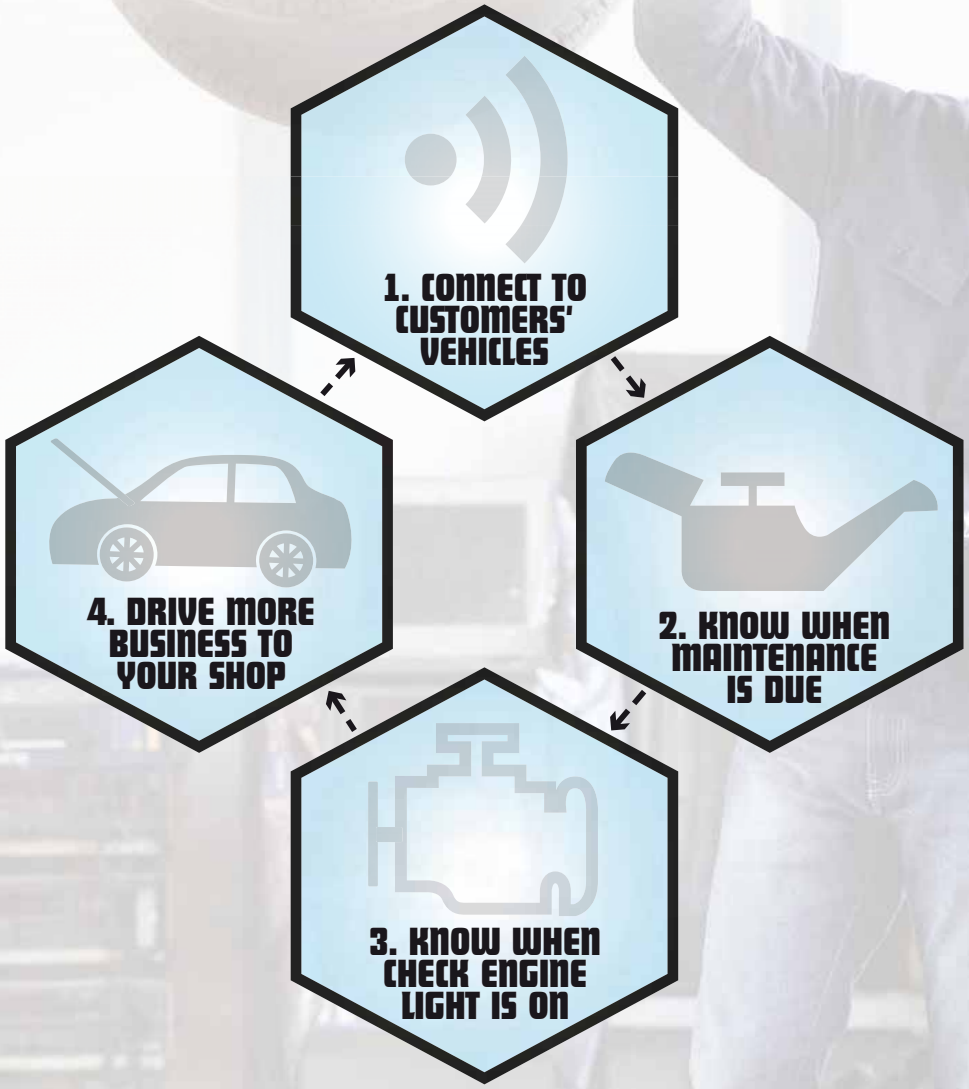

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From aerospace to a career in automotive, one shop owner's electrical experience crosses industry lines

ROBERT BRAVENDER // Contributing Editor

Perhaps nothing better parallels the paradigm shift in automotive repair from the mechanical to the electrical than the career of G. William Fay. Owner of Bill's Auto Garage in Queen Creek, Ariz., Fay started his career in the aerospace sector "as a technician soldering circuit boards" but now specializes in automotive diagnostics and drivability.

After serving for six years in the Marine Corps' Communications-Electronics division, this Los Angeles native returned home to the private sector to help build fuel control systems for Pratt & Whitney 4000-series jet engines, but by 1990 the aerospace industry was drying up in southern California.

"I found myself with no job — but at the dawn of the computerized car age," comments Fay. "I was in the unique position that I understood the electronics better than most mechanics did," particularly when it came to diagnostics.

"I knew how to run a lab scope in 1986," Fay recalls. "It wasn't even really a diagnostic tool in automotive technology yet; people were using the big Sun tuning machines, watching primary and secondary ignition wave forms. But that didn't do a lot for an '88 Buick 3.8 that had a bad crank sensor in it, or a magnet falling off a cam sensor, or a distributor-less ignition system that wasn't working correctly.

"I think the whole industry was completely unprepared for the computerization of cars at that time," believes Fay. "That was pre-OBDII, so none of the scan equipment was standardized; everybody had their own plug, their own diagnostic DTCs, their own way of doing anything. In the Marine Corps and aerospace industry, I learned to work with a lot of things that didn't necessarily have any kind of commonality."

As it turned out, Fay's brother had recently bought a small shop in Rosita — coincidently called Bill's Auto Garage — and he needed help. "With a lot of electronics experience and minimal mechanical experience, I went to every type of school I could," Fay reports. "Getting that place off the ground was tough, so I worked for GM dealerships in the day and wrenched at our place at night, training, training, training with anything I could get my hands on, learning everything I could."

Fay and his brother ran the shop together for about 9 years before his sibling decided to make a go of it on his own. After buying him out, Fay ran the shop alone until 2003, when he himself decided on a change of pace and place. Selling the business in Los Angeles, Fay moved his family east to a semi-rural area on the outskirts of Phoenix.

BILL'S AUTO GARAGE
Queen Creek, Ariz. // www.billsautogarage.com

G. William Fay Owner	**4** No. of employees
1 No. of shops	**1,000** Total square footage of shops
13 Years in business	**2** No. of bays

Amidst bucolic cows and dairy farms, Fay just took it easy for the first two years. "I stayed at home and played house dad," he recounts. "But then somebody asked, 'hey, what are all those tools in your garage? Do you know how to fix cars?' I started doing jobs on the side for friends and neighbors, and in less than a year I started having tow trucks show up at my house with drop offs. I thought no, no, no, this can't happen here."

Initially not wanting to go back into business for himself, Fay went to work fulltime at a dealership. But about eight years into that, his son, with ambitions, talent and training of his own, asked Fay if they could go independent, and in 2014 they opened a new Bill's Auto Garage.

"We just have a teeny-tiny shop, so we have to make decisions about what we do and don't do," says Fay. "I try to stay away from

PHOTO: BILL'S AUTO GARAGE

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the heavy line work — pulling engines, rebuilding transmissions, that sort of thing — I try to focus more on the diagnostic, emissions repair and drivability issues; I don't have the racks to tear down engines any more.

"But while it's a small 'mom & pop' repair, I do a lot of work for other shops in the area," Fay continues. "Diagnostics, programing, modular installation; I have 14 scan tools, a gas analyzer, lab scopes. (Out here) not a lot of people have good diagnostic equipment or techs to run them, so they send that work to me."

There's a saying about auto repair: in the old days it took a few minutes to diagnose a problem, a few hours to fix; today it takes a few hours to diagnose, a few minutes to fix. "I can't agree more," laughs Fay. "The first thing I do is a health check of the vehicle — full module scans, looking for any TSBs, recalls — before I pick up a tool. That's your first hour — and I do tier diagnostic rates.

"I'm very upfront about my diagnostic costs," Fay acknowledges. "I don't ever do it for free, but you get a value for it. One of the hardest things in our industry is to sell 'thinking' time, because the customer doesn't see a tangible item being installed, fixed or repaired. You have to take the time to talk to the customer; otherwise you load up the parts shotgun and start firing at the car."

And despite starting over in a new state, business has flourished. "I opened the shop three years ago and business has doubled every year," Fay happily reports. "I belong to an organization called BNI, Business Networking International, and I've been with them for almost seven years now. They're the largest international networking group in the world, very structured. It's referral marketing. You've got to pay to play and they aren't cheap, but I'd say they've thrown me $100,000 worth of gross sales every year."

As for expansion? "I think I'm going to leave that up to my son," he muses. "We turned $500-600,000 gross last year. My costs are low and my profits high; I make enough money and that's as hard as I want to work. My shop's two blocks away from my house, my commute is three minutes every morning; I've got it set up pretty good."

ROBERT BRAVENDER graduated from the University of Memphis with a bachelor's degree in film and video production. He has edited magazines and produced shows for numerous channels, including "Motorhead Garage" with longtime how-to guys Sam Memmolo and Dave Bowman.
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7 tips to deliver extraordinary service to your customers

KEEP YOUR CURRENT CUSTOMERS COMING BACK AND GET NEW ONES IN THE DOOR

BOB COOPER //Contributing Editor

Most shop owners will pump money into their marketing campaigns when they are looking to increase car counts. This can help bring new customers to the shop, which is important, but the value of your new customers diminishes if you're unable to keep them coming back. There is no greater key to your success than your ability to create a memorable customer experience that shows your customers you genuinely care about them, so here are 7 tips to help you deliver extraordinary service and keep your customers coming back to your shop for years to come.

#1. Always under-promise and over-deliver. If you apply this principle to your business, you can often exceed your customers' expectations. For example, when your competitors are asked how long it will take to do a minor service, they will typically tell the customer something like, "It will take about an hour." Unfortunately, they have now set an expectation in the customer's mind. What they should have done was ask the customer how soon he needed the vehicle. If the customer were to then respond by saying, "I need it by noon," (and it's 9 a.m.), your service advisor now has three hours to complete a one hour job, and can pleasantly surprise the customer by getting it done before noon. Always under promise, and then look for every opportunity to over deliver.

#2. Make sure that all of your employees follow the Marriott Rule — any time a customer comes within 20 feet of any employee, the employee should smile and make eye contact. If the customer comes within 10 feet of an employee, Marriott employees are asked to smile and give a salutation like, "Good morning!" Ask your employees to not only smile and give a salutation, but to also ask the customer, "Have you been helped yet?" Discuss this at your next employee meeting and watch employee morale and customer satisfaction go up!

#3. Empower your service advisors so they can put out small fires before they turn into more serious issues. Implement a policy similar to the one used at the Ritz Carlton, where they empower all employees with a predetermined budget that they can use for customer satisfaction. Set aside a small budget that your service advisors can use to resolve customer complaints on the spot, and long before you have to get involved. To reward employees who provide exemplary customer service and do not exhaust this budget, give them a portion of the unused money!

#4. Be very careful with using the word "free." Most people view something that's free as being of little or no value. What you should do is tell your customers that the service is "no charge." This will send a strong message that there's a value to the service, but you are setting the cost aside for them.

#5. Make a habit of always asking your customers, "Is there anything else that I can help you with?" It's a question you should ask throughout the entire customer experience. Ask after your customers have authorized your recommended services, at car delivery, and when you have completed your customer follow-up calls. It shows your customers you genuinely care about them and that you embrace every opportunity to help in any way possible.

#6. Always follow through on what you say you are going to do. If you give an estimate, then we understand it to be just that: An estimate. But if you tell a customer that a repair won't run over $500, and later on it does, then you should pick up the difference. Not only is it the ethical thing to do, but that customer will sing your song for years to come, because people always enjoy dealing with people who make promises and then deliver.

#7. Never forget: It's what you do after the sale that counts. Follow-up thank you calls that are genuine and from your heart are priceless.

BOB COOPER is the president of Elite, a company that offers coaching and training from the industry's top shop owners.
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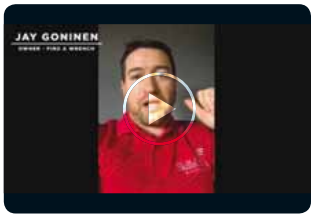

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FORD E-450 MISFIRES — BUT NOT UNDER A LOAD

UNDER THE LOAD, THE MISFIRE COUNTS WENT TO ZERO OR WERE VERY MINIMAL – THE OPPOSITE OF WHAT YOU WOULD EXPECT

VEHICLE: 2011 Ford E-450, V10-6.8L, Automatic Transmission
MILEAGE: 54,006
PROBLEM: The engine in this van had been replaced by another shop and the MIL was on. They had replaced the spark plugs and installed new coils but the misfires continued.
DETAILS: When the customer brought it to the new shop, the tech retrieved DTCs P0300, P0301 and P0307. A static compression test revealed no mechanical problems.

With a scan tool connected, the tech checked the misfire counts and noticed that the misfire counts increased between 1500-2000 rpm in park or neutral and in 4th and 5th gear between 1500-2000 rpm. Under load, the misfire counts went to zero or were very minimal — the opposite of what you would expect.
CONFIRMED REPAIR: The technician performed a Misfire Monitor Neutral Profile Correction Relearn procedure and the problem was cured.
SYSTEM STRATEGY: For the misfire detection system to function correctly, any mechanical inaccuracies in the crankshaft position (CKP) sensor must be learned by the PCM. Neutral profile correction learning should be accomplished using a scan tool any time the PCM, CKP sensor or the crankshaft pulse wheel is replaced, or when major engine repairs have been completed.

To determine if the neutral profile learning has been completed, check the MP_LRN parameter identification (PID) using the scan tool. The PID should read YES if the neutral profile learning has been completed. If the PID reads NO, complete the neutral profile learning prior to diagnosing any misfire DTCs.

This tech tip and others come from ALLDATA Tech-Assist, a diagnostic hotline of ASE-Certified Master Technicians. Whatever technicians need — from creating alternative diagnostic strategies to providing step-by-step repair assistance — the Tech-Assist Team can deliver. Learn more at ALLDATA.com.

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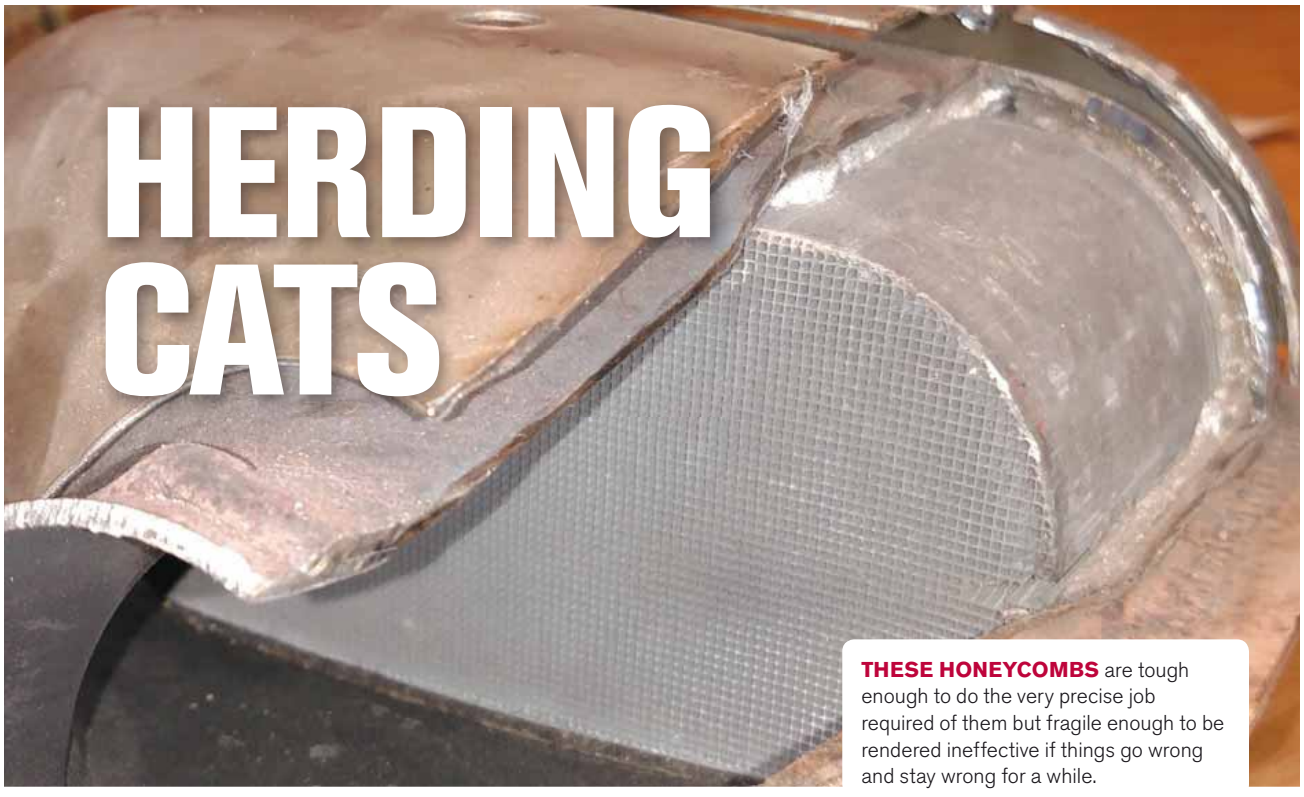

THESE HONEYCOMBS are tough enough to do the very precise job required of them but fragile enough to be rendered ineffective if things go wrong and stay wrong for a while.

WORKING THROUGH CATALYTIC CONVERTER CHALLENGES AND ISSUES

RICHARD MCCUISTIAN //
Contributing Editor

The catalytic converter was introduced nearly 50 years ago because of EPA-ordered cuts in emissions, and in response to those orders, auto industry execs said the EPA's targets could never be met. But thanks to old-fashioned American ingenuity, they were. What the EPA conceives, our engineers always achieve. Fuel-cell engineer Jonathan Frost once said: "When the U.S. introduced clean air legislation in the 1970s, many engineers said that cleaning up emissions from cars was impossible, but the legislation was passed anyway and new technology was invented in the form of the catalytic converter."

In 1972, Ford President Lee Iacocca said that "if the EPA does not suspend the catalytic converter rule, it will cause Ford to shut down." He was obviously wrong, but at the time, the prevailing wisdom was that the catalytic converter was a near-impossible concept, overly expensive and inefficient, pegged as an idea that would never, ever work.

The 1970 mandate that auto manufacturers would be required to reduce harmful emissions by 90 percent by the 1975 model year drove Engelhard Industries and Corning Glass to propose the device that would later become the catalytic converter. A "catalyst" foists chemical changes on other elements while resisting any change in itself. The catalytic converter adds the necessary oxygen molecules to CO and HC (the exhaust from rich mixtures), to change those harmful elements into CO_2, which is the same thing we breathe out. The exhaust gases flow from the combustion chambers through the catalytic converter's core, which is a block of ceramic material honeycombed with tiny lengthwise channels, designed to force every cubic millimeter of the gasses into contact with the catalyst material, and that's where the necessary changes take place.

Lab work finally proved that a catalytic converter would work, but mass-producing them became a new and even more difficult hurdle. Engineers would have to take an abrasive clay mixture and force it through a shaped die at high speed to create the complexities of structure we see in cat-cons today. This process is called "extrusion" and at the time it was very commonly used for creating things like metal pipes and hollow noodles, but nothing anywhere near this complex had ever been attempted. It was a daunting task.

But that wasn't all. Once that soft block of honeycombed clay emerged from the die, it first had to be cut to the proper length and then heated simulta-

PHOTOS: RICHARD MCCUISTIAN

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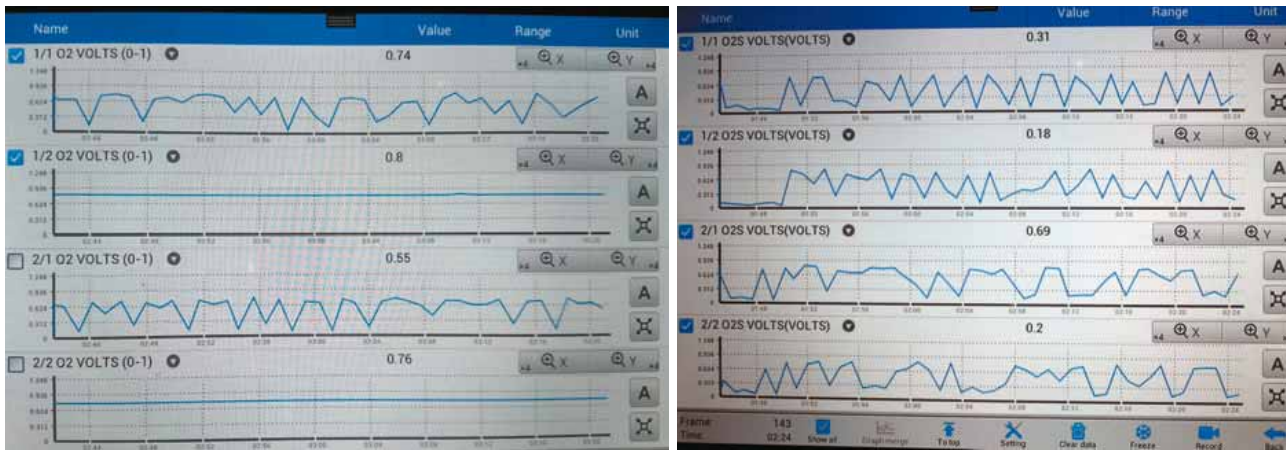

THE CONTRAST BETWEEN a pair of good catalysts (left) and a bad one are easy to spot using the PIDs. If the rear O_2s mirror the front ones this completely (right), the cats are no longer cats.

neously inside and out until it was totally firm. And all this had to be done without distorting those tiny channels or causing the clay to crack. Then they had to find a way to coat all the channels with a layer of very fine platinum particles so that the platinum wouldn't simply fall off after repeated (and vast) temperature swings. Under normal conditions, a catalytic converter races from ambient temperature to 800° F in 30 seconds, and the temperature of the gases can climb as high as 2,000 degrees. The catalysts on the vehicles I've datastreamed lately will normally float between 1000 and 1700°F while driving. In early development, on nearly every prototype, thermal expansion ruined the guts of the converter after just a few drive cycles.

But then it was discovered that samples of clay from one mine in Georgia showed much better heat resistance. This clay turned out to consist of microscopic needle-like units aligned in such a way as to withstand the thermal expansion, and that was the key to making a cat that would last. The cats were off and running, and it has since become our job as technicians to herd them.

Front and rear

Nowadays we're accustomed to seeing the "light off" cat(s) mounted very near the exhaust manifold(s) to take advantage of the natural heat still present as the exhaust has just made its exit from the combustion event — this front cat is the one sandwiched between the front and rear O_2 sensors, and the oxygen that is stored in this converter is extracted from the NO_X that is created during the combustion process, leaving N_2, which, to quote Bernie Thompson, is the cylinder's "working fluid." Combustion heats the nitrogen so that it expands against the head of the piston, pushing it down and spinning the crank around. The oxygen extracted from NO_X in the front cat

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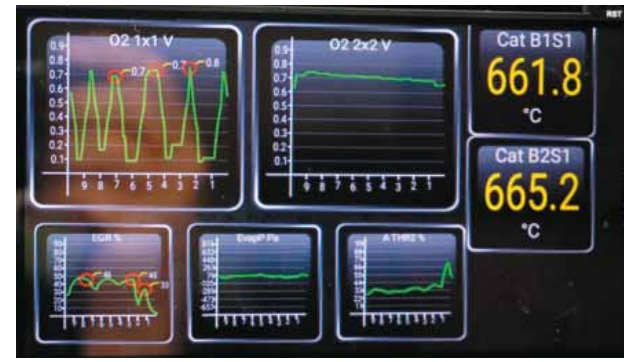
is used in the rear cat to handle CO and HC, converting them to harmless CO_2, oxygen and water vapor, which is also created during combustion.

The aft-cat O_2 sensor monitors oxygen storage and that sensor's signal should switch much more sluggishly than the front O_2, but if the rear O_2 begins to register a problem, the PCM will do what it must with the fuel trim to keep the rear O_2 (and the cat) happy, so be ready for that in case you ever see it happening.

So, what damages the cat? Well, engine misfires (caused by no spark or low compression) can lead to overheating and potential meltdown of the substrate. It can be contaminated by silicone sealants (or liquid spray), coolant leaks into the combustion chamber that coat the strata, excessive oil steam blow by that is picked up and processed by the PCV system and sent out the exhaust, high sulfur fuel, and rich fuel mixtures forming carbon deposits. Any of these elements (and some others, like leaded fuel) can quickly coat the catalytic substrate, preventing it from working effectively. Catalysts sometimes just wear out. The brick may break loose inside the shell and dance around in there or chunks may break off the engine side of the cat and rattle around, preventing good exhaust flow. Overheating can also cause cats to break up into dusty, abrasive particles that find their way through the EGR system and into the combustion chamber, a scenario that is an engine killer of the first magnitude. And there are times I've seen the vermiculite blanket around the outside of the brick shed material that will clog enough of the passages that exhaust backpressure rises and the engine begins to lose power because it can't breathe.



THIS DISPLAY SHOWS HEALTHY CAT ACTIVITY, but also healthy cat temperatures (Celsius). I have set the Android radio I have in my 2006 Explorer to display these parameters during normal driving. The diagram shows which gasses are handled by the converters. The front one is the "light off" cat.

The codes and the protective PCM

Just about everybody has seen the P0420 and 430 codes flagged because the rear O_2 is reflecting poor oxygen storage, but that doesn't always mean the cat is bad. The honeycomb will sometimes be coated with one element or another that might well be burned off when the rest of the system is repaired to work right. With that in mind, other DTCs should be carefully considered before condemnation of the cat. Hydrocarbon soot initially cools the cat and makes the O_2 sensors sluggish, (skewing the mixture even more) and the soot coating prevents the precious metal substrate from doing its job.

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Problems maintaining fuel control can prevent a catalytic converter from working at all. The cat needs a very precise mix of feed gasses to "light off," and the range expressed in Lambda is very narrow indeed — 1.005-0.995.

One of the first times I encountered PCM cat protection was in the late '90s when I was working on a Windstar that had all the EGR ports clogged except number four. When EGR was flowing, that one cylinder was getting it all, which created a somewhat mysterious misfire in warm off-idle mode. When I started working on that one, I noticed that when I cracked the throttle, it would begin a very steady misfire on four, and as I was doing my troubleshooting, I noticed that when the misfire was under way, the number four injector would stop clicking, which led me to believe there was a problem in that area. Not knowing that the PCM strategy was shutting the injector down to protect the cat, I did some circuit tracing before I realized that disabling the EGR did away with the skipping, and that's when I found the reason for the misfire. Ford's instructors had, at that point, never told me about that strategy in training, but maybe I missed it while I was grabbing a cup of coffee.

WHENEVER YOU SEE other codes displayed that can have an effect on the efficiency of the cat(s), go after those codes first, then complete a couple of drive cycles to see if the cats will clean up their act and start working right.

If the rear sensor picks up on a consistently dreadful imbalance at the cat's exit stream and reports it to the PCM, the box might realize that the front O_2 is unreliable and fuel trim strategy might be modified based on the rear O_2 feedback to protect the cat. This will vary from platform to platform, but the PCM's concern about the cat's health is very real.

Once again, all other codes related to air/fuel should be addressed first. MAF, IAT, ECT, rich/lean codes and fuel trim issues would be the focus, along with a careful consideration of the EVAP system and even the condition of the engine oil, both of which can be the source of excessive HC.

After dealing with the other pertinent codes, make sure you've recorded them, erase them, and then start the engine. Hold it at about 2500 to light off the cat, all the while watching front and rear O_2 sensors. With a front O_2 switching rapidly and a rear O_2 trace a lot less active, the converter should be OK. But if the rear O_2 sensor is mimicking the front one on a

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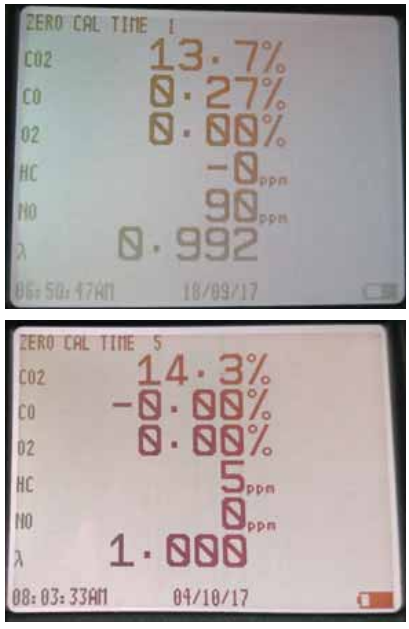
system that is otherwise healthy, the converter is probably ready for the scrap pile, but it'd be wise to dump the codes and complete a drive cycle to see if the converter monitor will flag a problem with the cat before you make your final decision. And there are other considerations.

If the only code is a cat efficiency code, check out the freeze-frame data. If the fuel trim was high when the code was set, it might indicate unmetered air, unreliable MAF readings, or a skewed BARO reading from a speed-density MAP sensor; the fuel pulse will be wrong, and that'll create a genuine lean condition. The PCM will respond to the O_2 sensor(s) lean reporting by dumping extra fuel into the intake to bring things back into balance. If this is happening on just one bank, it's not likely to be MAF or MAP related and more likely to be something only affecting that bank.

If the fuel trim is double-digit negative, it typically indicates extra unmetered fuel is finding its way into the chambers and the ECM is compensating by subtracting pulse time. This can be fuel injector pressure regulator related, either because the regulator diaphragm is leaking or because it isn't regulating the pressure at all — shoving 100+ psi of fuel through the nozzles. I've seen that more than a few times. And cam timing errors can cause fuel trim anomalies too, so watch out for that.



IT'S GOOD TO HAVE an exhaust gas analyzer on hand. Notice that the display on the top is showing some CO and NOx, along with a 0.992 Lambda reading – there was a problem with this vehicle. The other display shows plenty of CO_2 (good), no CO, HC, or NOx, and a perfectly balanced Lambda reading.

Visuals and audibles

A cat that is dented or rattling is obviously in need of replacement, because the brick usually can't take that kind of thing without suffering damage. A discolored converter ("blued and hued," like some gun parts) is also suspect, because it must get blistering hot to change color that way. It's also a good idea to get eyes on the front of the brick with a borescope or whatever method you can. If it has clogged combs, is breaking up, or is obviously contaminated, it'll need replacing, but first you need to find the source of any contamination. You need to find the cause before you attack the effect. Temperature and backpressure tests are a good idea, too. It should be hotter at the outlet than at the inlet, and you shouldn't have more than about a pound of pressure in front of the cat — a good one won't even have that much. Keep in mind that the temperature test only tells you whether or not the conditions are right for the cat to light. It alone does not mean the cat is no good.

Another common cause of P0420/0430 DTCs are leaky exhaust systems. Even pinhole leaks can suck enough oxygen in to cause a problem. Use your smoke machine to locate the presence of leaks, especially any upstream from the cat and within a foot or two of the backside of the cat.

Then there are those converters that look just fine on the outside but have been gutted by somebody for one reason or another. Back in the 1980s when I was working at a large Ford dealer, some of the mechanics would buy a brand-new truck and immediately have the exhaust system totally re-done — doing away with the cats in the process. For the life of me I've never been able to understand why somebody would do that to a new vehicle.

WHENEVER THESE SHENANIGANS have taken place (for whatever reason), there'll be MIL lights and contraband, poisonous gasses galore. The 2003 Wrangler got a $400 bolt on replacement set. It had been purchased used by a doctor who wanted this "mod" reversed.

The overarching point is that not every catalyst efficiency code necessarily condemns the cat, although there are many times when that is the case, particularly if everything else is as it should be.

If you're replacing the cat with anything other than an OEM, make sure you get one that meets the application, and not a "universal" — not all cats are created equal. Back in the 1990s we diagnosed a dead one at the dealer and let the customer talk us into having a replacement put on at a local muffler shop. The replacement converter threw efficiency codes on the first drive cycle. Today, even using one that "looks" right may lead to repeat codes.

RICHARD MCCUISTIAN is an ASE-certified Master Auto Technician and was a professional mechanic for more than 25 years. Richard is now an auto mechanics instructor at LBW Community College/MacArthur Campus in Opp, Ala.
rwm19@mail.com

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SOLVING YOUR CUSTOMER'S EVAP PROBLEMS

THE SMALLER THE LEAK, THE TOUGHER THE CHALLENGE

G. JERRY TRUGLIA // Contributing Editor

EVAP problems are still among the top 10 codes in the country and tend to be, for us technicians, a pain in the butt when we have to diagnosis them — especially with a 0.020" leak. One of the problems that EVAP DTCs present is that the systems are not the same on every vehicle or for that matter not even the same on one OE's complete vehicle line up. For example, let's look at Toyota — one EVAP system is not used on all of their vehicles, but rather different variations, sometimes from model to model and year to year. It's always a good idea to make sure that you look at system description in your service information system before diving into the problem.

It's increasingly common in the industry to use Identifix or ProDemand to look up a common issue and then change the component that the system identifies as causing the most problems. I am not saying that in many cases they are incorrect, but in a good number of EVAP problems you just may be changing a component that is not going to prevent the MIL from coming back on. EVAP problems have a tendency of coming back and haunting you. Remember that most vehicles from 2001 and newer — when the EVAP leak standard started dropping from 0.040" to 0.020" leak — have leaks that are much harder to find. A good first step is to identify the system type — is it vacuum (the most common that you will find in many cases and used by most OEs), pressure (such as the LDP system used mostly on European vehicles and for a while on Chrysler vehicles) or NVLD (Natural Vacuum Leak Detection) that has been used by almost every OE on newer vehicles that use a 0.020 standard?

Now that we reviewed what we should look for in an EVAP system, the next step is to build your game plan that includes the information from your SI source along with a good smoke machine and/or a CO_2 system tester. After retrieving the DTCs then reading the system description, you're ready to hook up either a smoke machine or a CO_2 tester to locate the leak. Smoke machines work well if you know their limitations; if you have a leak in the charcoal canister or in the fuel tank, smoke is going to be very hard to find. Since most smoke is a

hydrocarbon base, it's going to be tough to find a leaking canister or a small hole in a gas tank. The reason that these two problem areas leave you empty handed in most cases when using smoke is because the charcoal canister's job is to trap hydrocarbon vapors, and when using a smoke machine that is exactly what it is doing. I am not saying that the smoke machine is a useless tool — far from it. In fact, it is very helpful in finding many leaks on a vehicle, and in my shop, we use it all the time. When it comes to EVAP problems, we hook up our Smoke Wizard machine that we have been using for years to check for leaks. We always have CO_2 connected to the smoke machine on EVAP issues for two reasons: 1) air pressure is not safe to use since air, fuel and spark will make one hell of a problem; and 2) not every EVAP problem, especially when we have an 0.020 leak, is going to be easy to locate. So if that's the case, we can easily switch from checking for smoke that works great if there is a broken line or a bad EVAP solenoid, to using our gas analyzer, or better yet using the ATS Bulls-Eye CO_2 detector. The CO_2 method is amazing since the CO_2 molecule is very small and heavier than air, so it drops down. Using CO_2 makes the problem of finding a small leak in the system easier.

Capless Ford

Our first case study is on a 2010 Ford F-150 that has a capless filler neck. The vehicle came in with P0461 (Fuel Level Sensor Circuit Range/Performance) and P1450 (Unable to Bleed Up Bleed Fuel Tank Vacuum) DTCs. The code descriptions did

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not exactly provide me with a detailed description of the problem but rather a general checklist of just about everything else, almost a process of elimination. When you drill down in the DTC chart and read the possible causes, you find components that may be causing the problem, such as solenoids, hoses and the pressure sensor. You may then discover that there is a possible problem in the capless filler neck.

In reading through the service information, Ford recommends the use of their special tool to be used in the capless filler neck and to remove any debris so the filler neck can be tested properly. Ford recommends installing and removing the tool at least five times so any debris around the flap door can be dislodged before using a smoke machine to test. The problem for most shops is that most likely they do not have the special tool. But don't worry, a capless vehicle comes with a special funnel (Figure 1) that you can use along with duct tape to test the system. So, there is no need to purchase a special tool if you don't want to, just use the funnel that comes with the vehicle or you can purchase one from a parts store.


2

Your next step is to place the duct tape on the top of the funnel opening and insert a small hole in the duct tape area so you can insert the hose end of a smoke machine or CO_2 tester. On this Ford F-150, the problem was not found from inserting smoke with CO_2 from the filler neck down since the neck flaps were the problem causing the DTCs. What we did discover from the test was that the filler neck to the tank was not leaking due to rust or a break that is so common on many vehicles in our area. When we smoked the system from the engine side, we did not come up with any leaks due to the fuel level in the vehicle. We had the owner return when the fuel level was very low so we could re-smoke the system.

By smoking the vehicle with a low fuel level, we were able to see a small amount of smoke and a large amount of CO_2 escaping from the filler neck. We explained our findings to the F-150 owner and provided him with an estimate that he declined. The F-150 owner thought that it was too much money to spend for a problem that did not affect his driving. What we found was that periodically when the owner fueled his vehicle up, the filler neck flaps would sometimes work as designed and the MIL would go off. My experience on other vehicles with capless filler necks that had a similar issue was better after we installed a new neck. The vehicle owners of the


3

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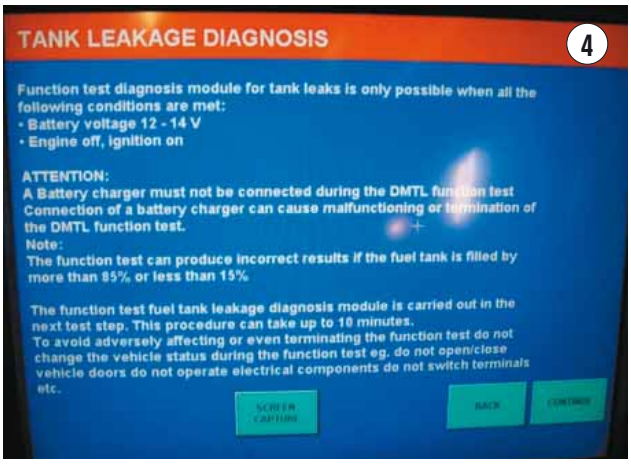
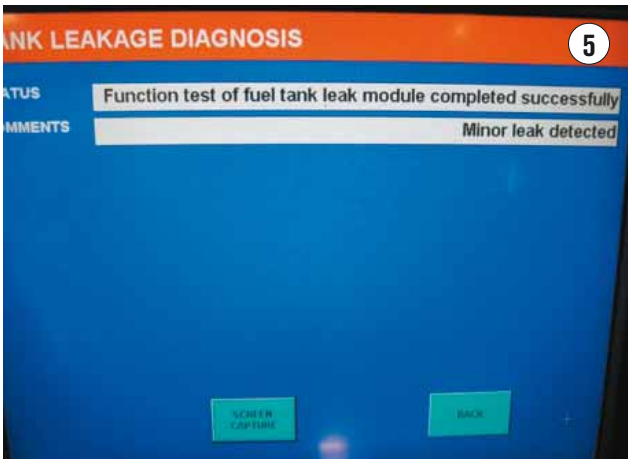




capless system that had the replacement necks no longer experienced an illuminated MIL.

Nissan EVAP issues

This case study is about a good customer of ours who has a 2003 Nissan Altima that came in with the complaint of the MIL illuminated. As usual, we questioned the vehicle owner on when she first noticed the check engine light illuminate — was it after getting fuel, was the gas level low, what was the temperature at the time, etc. We looked at the most obvious — the gas cap — to make sure it was installed properly, followed by a good visual under the hood to see if anything was obvious. Next, we connected our scan tool and found a P0442 EVAP Control System Small Leak Detected. This EVAP system is the basic vacuum system I explained earlier, which uses the engine's vacuum and a purge valve that is normally closed, not allowing any vacuum or EVAP vapors to pass through it, along with a canister vent valve that is left open until they are both commanded by the PCM. Once commanded by the PCM for system EVAP testing, the purge valve is duty-cycled open to allow a suction while the vent is still open. When the PCM has pulsed the purge valve enough, it first closes the vent followed by closing the purge valve. This action has trapped a vacuum that we can test for decay (vacuum loss) to determine in a set amount of time if the system has a large or small leak.

The problem with this type of system is that a leak can be confused with any pressure change from the vacuum leaking out to a clog in the system due to insects or debris blocking the vent line or valve. Understanding the system, we thought that it would be really easy to find the problem using our Smoke Wizard along with CO_2. As we started to flow smoke with CO_2, we noticed that there was in fact a small leak coming from the rear of the vehicle where the charcoal canister, vacuum cut-off valve, vacuum bypass valve, pressure sensor and vent valve are located.

The DTC can be caused by a list of 20 different problems from the gas cap to foreign matter caught in the EVAP canister to a leaking component. In our case, the EVAP system's canister vent valve could no longer provide a complete seal and needed to be replaced. You may be thinking, "Big deal, that's easy; just change the vent valve." If you have not worked on one of these Nissan Altimas, you are sadly mistaken, as this system requires that the rear subframe (Figure 2) be dropped to replace the valve properly. I have read that some Nissan techs remove the gas tank

instead so they do not encounter problems with the frame rail studs that can break. We have done a few of these and have seen the rust and the potential problem, so we spray the studs with penetrating oil and have the owner come back at least two times so that we can respray the studs before performing the subframe removal. Now that the subframe is out of the way, we can easily get into the EVAP area and replace the valve and in this case replace a few vacuum lines as well.

Since the vehicle owner understood the time and labor cost of the job, they took our suggestion and thought it was a good idea to replace the complete EVAP assembly. Our Nissan dealer confirmed that the valve is usually sold as an assembly and that is how their service department performs the repair on these vehicles. I guess if you look at the age of the vehicle and the labor involved to replace the valve, it's a better bang for the buck to replace all the EVAP components. We all understand that in an older vehicle, sometimes you replace one part and then another seems to go not that long after you repaired the vehicle.

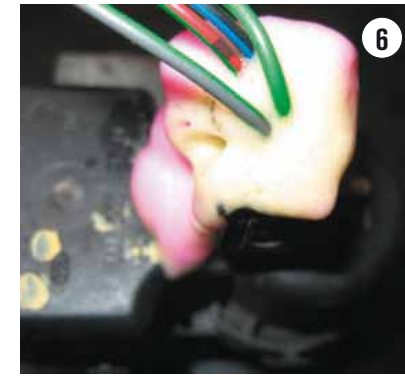
Remember that a vehicle owner does not know the difference in codes when the check engine light illuminates; he or she just knows the light was on and they paid you to turn it off. It is sometimes difficult to explain to the vehicle owner that the check engine light can illuminate for many different problems. In my shop, we always print out scan tool reports and provide pictures to the owner and save digital copies on our computer. If the owner of this Nissan only wants the vent valve replaced, we would have documented the complete repair with pictures and noted on the invoice that the other components may fail and illuminate the MIL light for possibly the same DTC P0442. If this happened, we would have to charge them the complete amount of labor for the job again. Lucky for us, this customer understood and agreed to perform the complete repair, making it unlikely that they would come back with an EVAP leak from that area. We tested the EVAP system for leaks with our Smoke Wizard (Figure 3) to make sure, before we reinstalled the subframe, that the vehicle would pass an 0.020 leak check. Now that we were confident that the vehicle's EVAP system was repaired, we returned the vehicle to the owner and moved on to the next job.

2006 BMW 320I P0456 small leak

Sometime European EVAP systems put a scare into a technician who is not familiar with these vehicles. Sometimes it's easier than you think. In the case of the BMW that came into our shop with a small EVAP leak, knowing how to proceed in your diagnostics is a very important step. For instance, on a BMW we have to find out if the system uses an LDP (Leak Detection Pump)/DMTL (Diagnostic Module Tank Leakage) or an NVLD (Natural Vacuum Leak Detection).

Once you find out what system it uses, you then can plan your course of attack. In our problem BMW, it uses the DMTL system, so we are first going to perform a scan tool test (Figure 4) using the EVAP leak test. Step 1 is to make sure that the fuel tank is 15 percent to 85 percent filled, followed by making sure the battery voltage is good. In most cases it's better to place a battery maintainer on the vehicle to prevent the battery from draining down since these vehicles can suck the battery down quickly and the test can take more than 10 minutes to perform.

After you completed the following checks, you're ready to move on to test the system right through the scan tool. The first test performed IDs the large leak test that must pass to perform the small leak test that in this case we know we have. After the large leak, the scan tool will come up with a screen that confirms it failed the small leak test (Figure 5). I connected the EVAP tool test hose to the canister as per BMW directions and used the BullsEye leak detector to locate the leaking area. What we found really amazed me, since it seemed that CO_2 was leaking right out of the wire harness. I confirmed the leak by using the BullsEye foam (Figure 6) that turned yellow. We replaced the part and retested the system using the scan tool small leak test that no longer failed.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While I was researching some service information on another BMW EVAP system I was working on, I found a service bulletin stating that the BMW sensors can possible have a sealing problem that can cause an EVAP leak. Finding and repairing this BMW was not that hard of a job. Just try reading up on the system that you're working on and know the capabilities of your scan tool, and you're on your way to a successful EVAP repair.

G. JERRY TRUGLIA, ASE World Class Triple Master Technician Auto, Truck & School Bus, L1, L3, F1, A9, X1 C1, is president of Technicians Service Training and a nationally recognized trainer/author. He founded TST to bring affordable training to fellow techs and owners.
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UNDERSTANDING DIESEL DPF SERVICE AND REPAIR

PROPER SERVICING OF DIESEL PARTICULATE FILTERS WILL PROLONG SERVICE LIFE AND HELP YOUR CUSTOMERS AVOID PROBLEMS

TRACY MARTIN // Contributing Editor

The primary products of combustion produced by automobiles and light trucks, whether powered by either gasoline or diesel engines, are carbon dioxide, water and nitrogen. As we all know, it's the other gases that create a problem. Unlike gasoline-fueled engines, a diesel engine's power is controlled by the fuel supply instead of throttling the amount of air entering the engine. This causes diesel engines to produce a different array of pollutants than spark-ignited, gasoline-fueled engines. One example is carbon monoxide (CO) emissions. Because diesel engines burn their fuel in excess oxygen, even at full load, their CO production is considerably lower than gasoline engines.

However the lean-burning nature of diesel engines comes at a price, and the high combustion temperatures result in significant production of nitrogen oxides (NOx). In fact, NOx from gasoline engines have decreased 96 percent through the use of catalytic converters, but diesel engines still produce 20 times more NOx if left untreated. Some OEMs reduce their diesel NOx emissions through a method called Selective Catalytic Reduction, or SCR. This process involves injecting urea into the exhaust gases. It reacts with the hot gases and releases ammonia that helps the catalytic converter turn the NOx into nitrogen and water.

The other major exhaust component that separates diesel from gas engines are the particles of soot or particulate matter. The black-colored soot from a diesel engine contains carbon compounds that are formed because of fuel that is not fully atomized, combined with low temperatures within the combustion process. Cylinder walls and large droplets of fuel are relatively cool when compared to the rest of the combustion chamber and carbon deposits (soot) are formed in these areas because of the rich air/fuel mixture and lack of oxygen. To keep particulate matter from being blown out of the tail pipe, modern diesel-powered cars and light trucks use a diesel particulate filter (DPF) to capture and intermittently burn them off. Trapping soot particles is important because of their small size, which can be inhaled and cause serious medical problems for humans.

DPF filtration

Diesel particulate filters can capture around 90 percent of particulate matter and because of the environment they operate in, have to be mechanically and thermally durable. Because there is limited space to locate a DPF in a vehicle, their physical size can only be so large and depending on engine operating conditions they can quickly accumulate a considerable volume of soot.

If a DPF collects too much soot, it restricts exhaust flow drastically, affecting engine performance. DPF systems have to provide a way of removing the particulates from the filter to restore its capacity and lower exhaust backpressure. This process is known as filter regeneration and usually takes place continuously as the vehicle is driven. Typically regeneration is triggered when the backpressure in the DPF reaches a predetermined level and the vehicle is operated for a time period long enough to burn off the particulates. Initiated by the vehicle's PCM, continuous regeneration should be "invisible" to the driver.

THIS DPF FILTER from a Ford 6.4L Powerstroke engine needs to be replaced around 80,000 miles. Once the filter becomes 90 percent plugged it can't be regenerated by driving or undergoing a forced regeneration using a scan tool. Replacement cost is around $1,700.

DPFs use thermal regeneration where the collected soot particulates are oxidized or burned. The DPF is heated and oxygen/nitrogen (air) is added, causing the soot to burn and transforming it to carbon dioxide or CO_2. The DPF must reach a high enough temperature (1100˚Fahrenheit) to oxidize the particles and on some systems

PHOTOS: TRACY MARTIN

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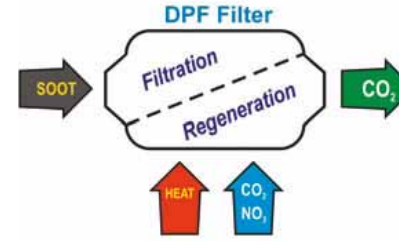
the source of heat is the exhaust gas. This type of filter is known as a passive filter and regenerates continuously during normal operation of the engine. Passive DPFs use a catalyst, which lowers the soot oxidation temperature to a level that can be reached by using the engine's exhaust gas alone. Passive systems may also use fuel additives that allow the soot to be burned off at lower exhaust temperatures.

Another method for burning off soot is called active regeneration. The "active" process heats the DPF using additional fuel. During the process, exhaust temperatures can be increased by late cycle injection of increased fuel quantities or injection and combustion of fuel in the exhaust system. Exhaust gas combustion consists of fuel burned in a fuel burner or burned in an oxidation catalyst. Another method is the use of electric heating by placing a heating element upstream of the filter substrate or using electrically conductive filter media that acts as both heater and filter. Whatever method is used, regeneration is performed periodically as determined by the vehicle's on-board computer.

In addition to passive and active filter regeneration, there is a third type called passive-active or quasi-active. These systems use a catalyst that allows regeneration at lower temperatures and/or shortens the regeneration time period. For example, a passenger car would regenerate passively during sustained freeway driving but use active regeneration during city driving. Having the ability to perform DPF regeneration under both sets of driving conditions results in fewer incomplete regeneration attempts and presumably



THIS DIAGRAMS SHOWS how a passive DPF filter operates. Heat from the engine's exhaust combined with air burns off the particulate matter collected in the filter by transforming it to CO_2.

less flashing DPF dash lights warning the driver of impending DPF failure.

Unfortunately, if a car or truck is operated only for short driving periods, the automatic regeneration process does not complete. The PCM will turn on the DPF warning light, letting the driver know that a regeneration is required. The vehicle owner's manual provides the steps that need to be taken to regenerate the filter. Here is a generic guide to get the vehicle's PCM to go through a regeneration cycle. Warm the engine to operating temperature and drive it for 15 minutes at a constant speed on the freeway, keeping the engine RPM above 2000. These conditions should initiate a regeneration cycle. Adding DPF cleaning additives may help in the regeneration process. These additives include a fuel born catalyst (FBC) that doesn't raise the temperature of the exhaust, but instead lowers the temperature at which the soot blocking the DPF will burn off. True DPF cleaners are more expensive than traditional fuel additive injection cleaners, so read the container label to ensure that it contains an FBC. If in doubt about how to initiate a DPF drive cycle, or adding non-factory chemicals to the fuel tank, consult the owner's manual or service information.

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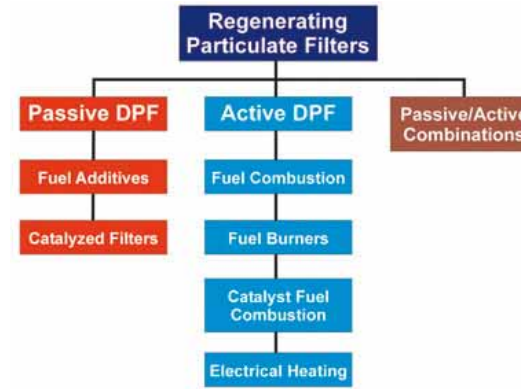
may be required when a vehicle is not driven at a high enough speed to allow automatic active or passive regeneration, especially if the driver ignores the DPF light. When the DPF differential pressure sensor detects a significant blockage in the DPF and automatic regeneration is not initiated, a manual regeneration is required. There are two modes of manual regeneration that can be initiated by a scan tool: static and dynamic. Static regeneration takes place with the vehicle stationary, and dynamic regeneration requires the vehicle to be driven. Some auto manufacturers disable static regeneration due to the high temperatures created at the DPF. The combination of a do-it-yourselfer at the controls of a scan tool, and the high exhaust temperatures present during regeneration have undoubtedly resulted in OEMs being burned on warranty issues with "cooked" DPFs and melted engine components.

As long as the DPF is not severely blocked (over 90 percent soot capacity), a scan tool can initiate a regeneration. Scan tool data could include DPF pressure sensor voltage, soot accumulation as a percentage, distance since last regeneration and distance since last DPF replacement. In addition, a successful DPF regeneration can only be achieved if all the exhaust and engine management system components are in good working order. If this is not the case, the PCM will disable manual regeneration and set a "failed or unsuccessful regeneration" message on the scan tool display. The reasons for this message can include: DPF over 90 percent of capacity (requires DPF replacement); fuel level under 25 percent (usually a minimum of 20 liters in the tank is required); oil qualify degraded/diluted (on vehicles with oil quality monitors); any DTCs set (glow plug circuit, DPFE sensor, exhaust temp sensors, O_2 sensors) and DPF service life reached (DPF needs to be replaced). Replacement intervals can be as low as 75,000 miles on some vehicles.



THERE ARE THREE TYPES OF DPF SYSTEMS: Passive, which operates all the time as the vehicle is driven; active regeneration is initiated by the vehicle's PCM under the right conditions; and passive/active uses a combination of both systems to burn off soot.

P2463, Diesel Particulate Filter Restriction — soot

With the DPF warning light turned on, the vehicle is probably suffering lack of power symptoms and may have a DPF-related trouble code. If the PCM detects exhaust back pressure levels over a programmed limit, a P2463 could be stored in memory and the check engine lamp may be illuminated. Because a DPF restriction could lead to engine or fuel system damage, this code should be considered severe. According to SCM Hotline Diagnostics (www.autohotlineusa.com – 800-847-9454) symptoms of a P2463 code may include: other DPF-related codes, excessive black smoke from the exhaust, difficulty in maintaining desired RPM levels, lack of power and increased en-

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gine temperature or overheated DPF components. Other possible causes can include a bad DPF pressure sensor, low urea level (tank is empty), problems with the DPF injection system and faulty exhaust pressure sensor.

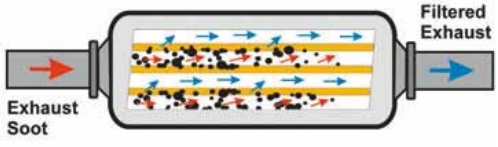
DPF service

Diesel cars and light trucks with DPF systems were introduced in 2009 and the first ones are now eight years old and have a corresponding number of miles on them. On some of these vehicles, DPF filters that have in excess of 80,000 miles can become clogged with ash. Ash is a by-product of the diesel combustion process with its main ingredients being calcium from engine oil and sulfur from diesel fuel. However, unlike soot, the ash plugging up filters cannot be burned off by a regeneration process or by adding chemical cleaners to the fuel tank.

When a vehicle's DPF warning light comes on, it's generally about 45 percent blocked and the normal regeneration (passive or active) should burn off the particulates and turn off the DPF light. If the vehicle owner ignores the DPF light, a forced regeneration using a scan tool will work up to around 60 percent blockage depending on the specific vehicle. Because of ash accumulation, a high-mileage DPF that is blocked by 90 percent can only be repaired using two options: cleaning with special equipment or replacement.

DPF cleaning requires the filter to be removed from the vehicle and placed in a cleaning oven where it is subjected to intense heat, pressure and chemicals to remove the blockage (ash and soot) from the filter. DPF filter cleaning is common for the heavy truck market and off-road construction vehicles, but almost non-existent for the automotive industry. The incentive for cleaning these heavy-duty filters is that it's less expensive to clean a plugged, high-mileage DPF than it is to spend $3,000 to replace it. The problem with cleaning DPF filters used on cars is that they are oftentimes a welded component of the exhaust system and do not fit the standard adapters used for large truck DPF filters. This may change in the future as more and more diesel cars and light trucks need replacement DPFs and cleaning may be an attractive option. DPF replacement is the only option that dealerships offer because they don't have cleaning equipment nor are they willing to offer a warranty on a DPF cleaning/repair.

Some DIYers have found an option to replacing a plugged DPF filter — cheat! With 2009 and later diesel cars and light trucks coming on the used market, owners of these vehicles are often faced with a $1,500-plus repair for a replacement DPF filter. Because many states only require a visual inspection for diesel vehicles, and a check to see if any emission-related OBDII codes are set, some owners entice their technician to cut a hole in the top of their DPF filter, remove the guts and weld it back shut. The DPF will look normal during a visual inspection and because there is nothing inside it to become clogged up, the DPF pressure differential sensor will never cause the PCM to set a code. Other more blatant DPF replacement components are offered on Amazon or eBay under names like DPF Delete Pipe, DPF Test Pipe and Off-road Competition DPF Pipe. These DPF replacements have literally nothing inside them to filter anything and are considerably less money than new DPF filters. This is such a problem in Europe that many countries are starting to add particulate detection to their emissions testing equipment and not just rely on OBDII DPF-related fault codes. Can the U.S. be far behind with this technology? Keep an eye toward California to lead the way in emission testing that detects if a diesel car or light truck really has a working DPF filter. MA



HOT EXHAUST GASES ENTER THE DPF and are allowed to pass through the filter. The filter media collects the soot, or particulates, and traps them. Periodically the filter has to be regenerated to burn off the soot and clean the filter media.

THE DPF DIFFERENTIAL PRESSURE SENSOR MEASURES the difference in pressure between the inlet and outlet of the filter. If it becomes too high, the PCM may flash the DPF warning light and initiate a regeneration process.

THIS DPF FILTER FITS A VOLKSWAGEN 2.5L TDI TURBO DIESEL. Owners should be aware that when the DPF light comes on they should drive their VW in such a manner as to allow the PCM to regenerate the filter. Ignore the light and it could cost upwards of $1,500 to replace the DPF.

TRACY MARTIN has covered the powersports industries since 1998. He is also the author of six Motorbooks Workshop Series books published by the Quarto Publishing Group and is a regular contributor for *Motor Age*.
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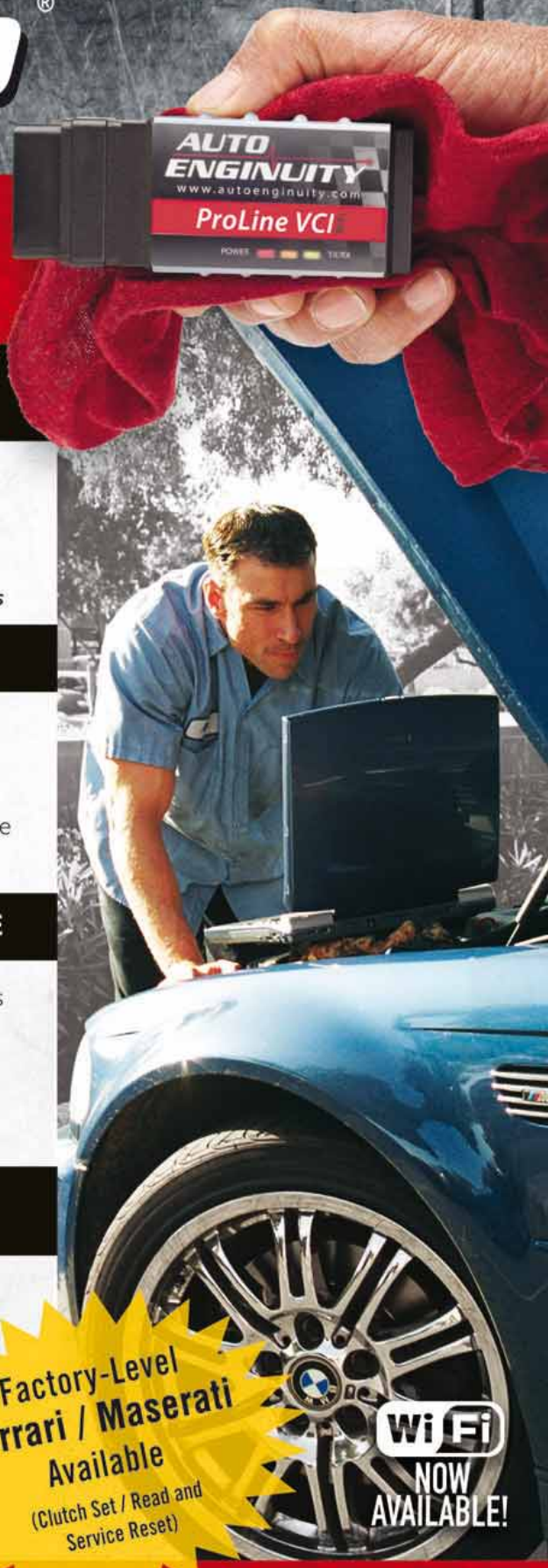

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WHO'S REALLY STEERING?

THE 2016 PRIUS introduced the use of a forward recognition camera that is used to keep the vehicle in its lane via the EPS system.

WITH ADVANCED ELECTRIC POWER STEERING TECHNOLOGIES, IT HAS BECOME CRITICAL TO UNDERSTAND THAT POWER STEERING IS NOT SIMPLY DRIVER OPERATED

DAVE MACHOLZ // Contributing Editor

Electric or electronic power steering (EPS) has been around now for over a decade. The technology is by no means new at this point and we have written a few times on this subject here at *Motor Age* over the course of the last few years. However, the emerging technologies that utilize the EPS system provide a new twist.

We are familiar at this point with technologies including electric-driven steering racks and columns, steering control units and various inputs including torque sensors, steering angle sensors and the like. The introduction of electric power steering occurred due to two major requirements: the first was the ability to have power assist on a vehicle without a belt-driven hydraulic steering pump, which began with the Toyota Prius and is now utilized across the EV/HEV market. The other purpose was the need to reduce parasitic engine load in the form of a belt-driven pump with the goal of improving fuel economy. Assist is only provided when driver input via the steering wheel deviates from a straight-ahead position. The steering angle sensor and torque sensor work together with the power steering ECU to determine the amount of assist needed. This "on-demand" style of steering assist minimizes electric consumption, which reduces the field current on the alternator and ultimately improves fuel economy. The overall feel of steering systems has greatly improved as a result. When driving these EPS steering vehicles, it is hard not to notice how the steering effort for the driver has been greatly reduced.

PHOTO: TOYOTA MEDIA

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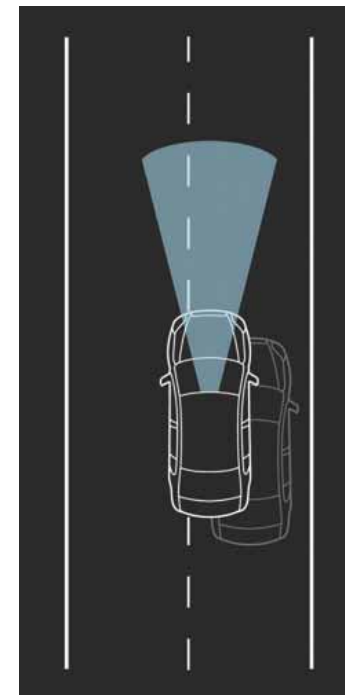
From driver assist to...?

In its basic implementation, the electric power steering system seems rather simple. The complexity increases due to the inputs to the steering ECU via the CAN communication network. Manufacturers utilize engine RPM via the engine control module, vehicle speed and braking data from the ABS/skid control ECU, as well as inputs from safety systems including forward recognition cameras. It is important to mention that the driver is no longer the sole input for steering and steering assist. Manufacturers have now begun to implement new strategies for utilizing the EPS system after years of researching driverless vehicle technologies. While we are not quite yet ready for driverless vehicles, we are beginning to see the foreshadowing, much of which ties into the EPS system. Safety systems such as ABS, stability control and cruise control systems are beginning to utilize the steering system to perform such tasks as steering correction to stabilize a skidding or rolling vehicle and other tasks like keeping a tired and dozing driver in their lane. Diagnosis of these systems will require a thorough understanding of electrical principles, multiplex communication systems as well as the use of aftermarket or factory tooling to retrieve DTCs and perform functions such as steering angle resets, diagnosis of communication issues and the calibration of advanced camera and radar systems. Access to factory service information and diagrams will be essential, which means that an ability to process complex system strategies and apply them to a well-planned diagnostic strategy will be paramount. Factory tooling is currently the only way to carry out ancillary services such as forward recognition camera adjustment/calibration, should one need to be performed in the event of a collision or when replacing related system parts such as a windshield.

SUBARU'S EYESIGHT SYSTEM is an example of how manufacturers are connecting technology to the EPS system to improve driver safety.

Lane Keep Assist, lane watch and lane departure warning systems are just a few of the proprietary names used for a safety system that utilizes a forward recognition camera and in some instances multiple cameras and/or sensors to maintain the vehicle's position within the lane while utilizing cruise control or whenever the lane departure system is activated during normal driving. This is done through the ability of the forward-facing camera to detect the painted reflective lane lines on the road. If a driver begins to fall asleep, the driver may drift in the lane. When the forward recognition camera and steering sensor corroborate that the driver is not intending to change lanes and is drifting, these systems will communicate with the steering ECU and correct the position within the lane.



PHOTOS: SUBARU MEDIA

SUBARU UTILIZES A FORWARD-FACING CAMERA to help keep the driver in their lane via the EPS system.

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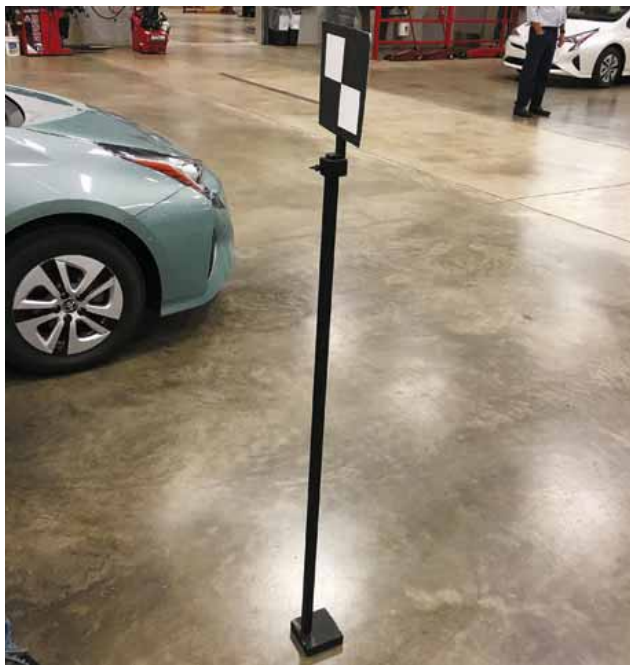

TOYOTA UTILIZES A SPECIAL SERVICE TOOL STAND and a target that can be printed from the service information to perform a calibration of the forward-facing camera.

An example

With the introduction of the 2016 Prius, Toyota introduced Toyota Safety Sense (TSS). TSS is now a standard feature across the Toyota product line and in most cases, includes lane departure warning with steering assist function. It is important to note that this type of technology is across just about every brand at this point. For our purposes, here we will look at Toyota's version of this technology. While attending a national instructor training event, I took part in a new-model 2016 Prius course that focused on this system and the diagnosis and calibration of the camera and millimeter radar system. This system is now making its way into the entire Toyota product lineup. While this system is specific to Toyota, it paints a picture of the complexities of the systems that relate to the EPS system.

At the heart of the system is a windshield-mounted camera with a complex latch and cover. The camera and its positioning within the windshield-mounted bracket require special attention during service after the replacement of related parts or in the case of a collision. Within Toyota service information, Toyota specifies the following considerations when working with the camera:

- When replacing the forward recognition camera, replace it with a new one.
- Do not touch the camera lens. If the camera lens has been touched, do not use the forward recognition camera.
- If the forward recognition camera has been struck or dropped, replace it with a new one.
- If the forward recognition camera is not properly installed, forward recognition camera optical axis learning cannot be performed properly. Make sure the forward recognition camera is installed securely.

PHOTOS: DAVE MACHOLZ

A PLUMB BOB is used to determine the center line of the vehicle.

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• Replace the forward recognition camera if there is any foreign matter on the camera lens.

• When replacing the windshield glass of a vehicle equipped with a forward recognition camera, make sure to use a Toyota genuine part. If a non-Toyota genuine part is used, the forward recognition camera may not be able to be installed due to a missing bracket. Also, the dynamic radar cruise control system, lane departure alert system, pre-collision system, forward recognition camera system or automatic high beam system may not operate properly due to a difference in the transmissivity or black ceramic border.

• If the forward recognition camera bracket is deformed or damaged, replace it together with the windshield glass.

• If there is any foreign matter on the area of the windshield glass in front of the forward recognition camera, clean the windshield glass before installing the forward recognition camera.

Once component replacement is carried out, a calibration of the system will need to be performed. This will require the use of a factory service tool (Techstream for Toyota/Lexus products). While aftermarket scan tool platforms are scrambling to make these services functional within their tools, the factory tool may still be required until that becomes a reality. In addition to the scan tool, a set of special service tools will be required to aim and adjust the camera. These tools provide a stand and, in some cases, a series of reflectors designed to be positioned at specific distances during the calibration process. To this point, there has been no standardization between manufacturers to aid the independent repair industry in providing this service to its customers. This means that a proprietary target and special service tool set may be required for each brand of vehicle you plan to service. The other complication is the lack of a standardized source for the distribution of these tools, requiring the independent shop to contact the respective manufacturers and purchase through different vendors. Add to this the extensive cost of these tools and you have a new service area that will cost quite a bit to get involved in.

If you plan on offering these calibration services to your customer base, you will need to address the space you have available in the shop to do it. Shops with limited square footage may be excluded as a large amount of flat, level, perfectly lit space will be necessary to carry out this procedure. Toyota requires an unobstructed, level area of 10' x 10' in front of the vehicle. This sole requirement prohibits many shops from performing this function. There are numerous considerations in regard to lighting location and potential shadows as well as images in the detection area of the camera that can all affect the ability to carry out a calibration. It is a good idea to have a very specific, dedicated area in your shop to perform this function. Consider visiting your local body shop and ask them if you can have some large pieces of scrap cardboard to

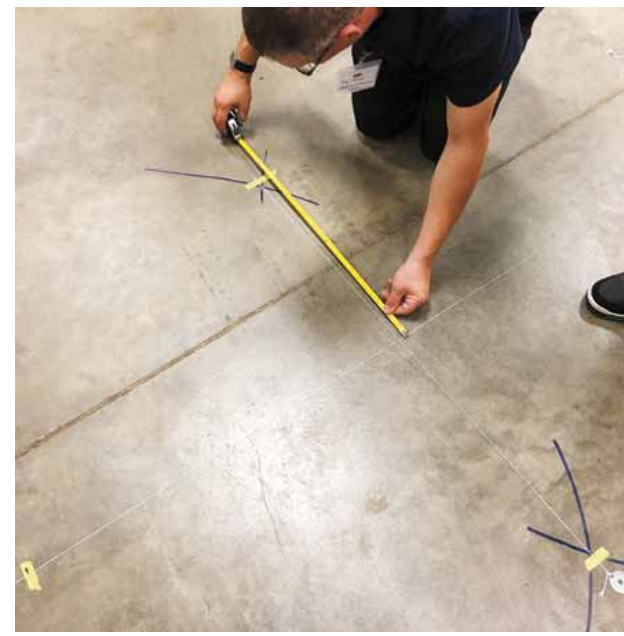

PHOTO: DAVE MACHOLZ

PETER PERNICE, AN INSTRUCTOR at Suffolk County Community College, measures to determine target placement.

place as a backdrop behind the target. A hood box (or a few of them) work well for this.

Once you have decided to take the plunge into these types of services, consider that the first time you perform one of these services there will be a considerable learning curve, so plan on spending a rather large amount of time setting up — a few hours at least the first time out.

To prepare, the tire pressure needs to be set to spec and the windshield will need to be cleaned. A target must be printed from the service information and will need to be measured and compared to the size specifications outlined. The target will then have to be positioned at precise locations determined by laying out a series of lines and performing several precise measurements. This begins with finding the center line of the vehicle with a plumb bob and following precise instructions from the service information. For this very reason, this is a job for a competent, process-oriented technician. Once the measurements have been made and target locations determined, the scan tool will be used to complete the process. All said and done, this took a group of seasoned techs and instructors an average of around two hours to complete the first time.

While not an impossible task, the idea of performing these calibrations may leave you feeling like this is just another tool to buy and another task to perform. While you may be correct in your thinking, you might consider this is the tip of the iceberg of where EPS and its related systems are headed.

PHOTO: DAVE MACHOLZ

SPECIFIC LOCATIONS NEED TO BE DETERMINED in order to perform the calibration of the forward camera.

Overall, diagnostics on EPS systems have become a bit more manageable with the availability of diagnostic trouble codes and live data. In some cases, a broader set of diagnostic information may be available. Toyota's vehicle control history data provides such insight by allowing the technician to view events as they happened with corresponding key cycles. Think of this as freeze frame data that is enhanced. The vehicle control history information began with the 2016 Prius, but is making its way across product lines, allowing a technician a new data set for diagnostics.

The EPS system will continue to evolve and with the anticipated push towards driverless vehicles, the systems that utilize EPS will continue to grow. As with any technology, read service information to understand the system you are working on, build a coherent plan and begin your diagnosis. Don't forget that a scientific approach to diagnosis includes taking data, performing tests to confirm and rule out hypotheses and using the entire process to come to a solid diagnosis.

DAVE MACHOLZ is an instructor for the Toyota T-TEN, Honda PACT and general automotive programs at Suffolk County Community College in Selden, N.Y. He is an ASE CMAT and L1 technician and holds a New York State teaching certification in vehicle repair.
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STATISTICAL DIAGNOSIS

ARE YOU BASING YOUR DIAGNOSTIC CONCLUSIONS ON STATISTICS OR DATA? MIGHT BE BEST TO CONSIDER BOTH.

PETE MEIER // Technical Editor

Recently, I heard two men I respect very much jokingly refer to technicians who were using a new diagnostic method I'd never heard of – Statistical Diagnostics.

It was a common practice in every shop I've worked in to lean on your fellow techs for opinions and advice when faced with a repair challenge. With the internet, the ability to interact with technicians from around the world was born — iATN (the International Automotive Technicians Network) is an example.

As an early subscriber to iATN, there are a few features that I found extremely helpful. One was the variety of forums I could access and learn from. There were, and are, some talented technicians there who don't mind helping those who truly want to grow. Another was the Tech Help feature that allowed me to share the steps I'd taken in case with others via email. I learned from the advice and help I received and eventually triumphed over problems. Better yet, I learned new skill sets that I could apply to the next one I ran into.

Another valued feature is the Fix database hosted in iATN. This is the accumulated results of every Tech Help message ever sent or answered. Perhaps the problem I was facing had already been faced, and beaten, by another tech? If so, this was the first place to go see. As these data files grew (currently the Fix database alone has over 250,000 records and nearly 2 million related replies to search), pattern failures began to appear. These were the "silver bullets" many of us began to rely on in an effort to save diagnostic time.

ID1 AND 2 ARE THE FRONT TIRES, and ID3 is a rear. Notice the difference in the Low Threshold pressure PIDS; 26.1 and 26.82 for the front versus 28.64 for the rear. Why would the rear, with a lower cold pressure spec, have a higher threshold?

And there, my friends, is where I think the seeds of Statistical Diagnostics were planted – a growing online log of repair histories by year, make and model coupled with an uncertain method for being paid to accurately diagnose the problem.

Today's reality?

How do you get paid for your diagnostic time? How does your shop establish its diagnostic fees? That's been a big issue for many for a long time. When I was still full time in the bay, I would typically be credited no more than an hour for a "routine" diagnosis. Anything over that was on me unless I could successfully argue that the problem was not "routine."

And there were the times I spent more time figuring out a problem, only to finally find it and think that I should have found it much faster. It was a fault in my process that added to the clock. Is it fair to charge the customer for that?

But now we have a number of databases, some like iATN and Identifix, and others like Mitchell 1's SureTrack, that promise to reduce our diagnostic times to a more manageable level. You've heard many of our contributors, including yours truly, recommending that you do a search of related issues using these resources.

You've also heard us say that you should test and verify that the problem meets the criteria for the silver bullets you may have found checking those resources. And that's where the current

PHOTO: PETE MEIER

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trend starts drifting off to the left.

We used to call it "shotgunning" parts or firing the "parts cannon" to see what eventually fixed it. But there is one important difference in the Statistical Diagnostic method and shotgunning — the user relies on the statistical evidence at hand to decide what part gets replaced first. But without testing either component to verify the problem first.

Professional?

Is this a professional way to fix a car? Arguably, it's an efficient way. After all, if the fix works then the only time spent diagnosing was the time it took to look up the code or the symptom.

If the statistical fix doesn't fix the issue, then you're only out a few minutes plus the time installing the part and you can move on to the second most likely problem. Or, you could actually test something to see what the real cause is!

The use of the information as a resource to my diagnostic process is a legitimate one. I have, and do, use the statistical averages to help me make that final decision on whether or not to pull the trigger on an expensive part or repair. But to rely on it alone — especially if you are one of those few shops that lets the customer pay for your mistakes — then it's not only unprofessional, it's unethical, maybe even a tad illegal.

A TPMS tale

My wife owns a 2014 Scion tC that she is lovingly protective of. Her protective attitude bleeds over to her attitude towards her mechanic — me — whenever any little thing goes awry.

Today, it was the return of the TPMS warning light. The steady light had always pointed the finger at a punctured tire and I suspected nothing less this time. I used my Bartec USA tool to engage all four sensors to check the reported tire pressures and found them all to be well above the threshold that would turn on the light. Typically, TPMS warning indicators won't illuminate unless the tire has lost roughly 20 percent of its cold fill.

The tires were still a bit warm from her drive home. Let's get it in the air and inspect the tires more closely. I cleaned and marked a starting point on each and slowly rotated them by hand, looking for any signs of foreign objects that shouldn't be there. Nothing!

If the tires aren't low, then it must be a system problem. Let's check for codes. Nothing there either.

I let the car sit for a few hours and went back to check the pressures again. No real difference found, but the two front tires were a little low from the 33 psi specified on the sticker. I aired them all up, verified the pressures with both a digital tire gauge and the TPMS tool, and told my wife I'd do a little digging.

The next day

I started my research with a general search on Mitchell 1. There was no problem that even came close to mine, so the Statistical Diagnostic method wasn't going to be much help on this one!

On to research system operation. Like many systems, the TPMS sensors transmit their information to the TPMS receiver, which then sends the information to the TPMS control module. The TPMS module will send the command to the Instrument Cluster module to turn the TPMS light on (when a tire is low) or to flash the light (when a system error is detected).

I could see by the scan data that all sensors were reading the same as I had seen on the TPMS tool. There was, however, no PID for the command to turn the TPMS warning indicator on. I could, though, turn the light on or off at will using the bidirectional controls I had for the cluster. What did that tell me so far?

First, I didn't suspect data corruption or misreporting. No, the TPMS ECU was seeing the truth. The fact that I could control the light at the cluster told me that the cluster wasn't the culprit either. For some reason, the TPMS ECU was commanding the light on when it shouldn't be.

Taking a closer look at the data, I noticed the PIDS for each wheel called "Initial Threshold of Low Pressure". That had to be the number the ECU was looking for to command the light on, and while none of the measured pressures were below those numbers, I did notice that the PIDS associated with ID1 and ID2 were lower than the ones for ID3 and ID4. Then it dawned on me. Were the sensors on the scan tool representing the same locations as they were on the TPMS tool?

Comparing IDs from the scan tool and the TPMS tool, I could confirm that the current IDs were, indeed, the same. ID 1 and 2 were the two front wheels, and ID 3 and 4 were the two rear wheels. Cold tire pressures respectively are 33 psi and 30 psi. See where I'm going with this?

When the tires are rotated, the system needs to be reinitialized. That is, relearned as to what the right pressure for that new position is. As you can see, the lower thresholds for ID1 and 2 indicate that they were originally calibrated for the rear while ID3 and 4 were for the front. The failure limits were less than 10 percent of the cold tire pressure spec!

I looked up the relearn procedure and rechecked. Now the low pressure thresholds looked more reasonable – and the light was off.

And to think I almost pulled the trigger on the TPMS ECU?? MM

PETE MEIER is an ASE certified Master Technician and sponsoring member of iATN. He has over 35 years practical experience as a technician and educator, covering a wide variety of makes and models. His primary goal is to bring working techs the information they need.
pete.meier@ubm.com

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FOLLOW OR INTERPRET?

USING A WIRING DIAGRAM INCORRECTLY COULD COST YOU TIME AND MONEY

MIKE MILLER // Contributing Editor

We use wiring diagrams in many of our diagnostics, but if we are not careful, they can sometimes lead us to make decisions that are not accurate, which can lead to wasted diagnostic time, unnecessary parts costs for replacing parts that are not defective, and sometimes even missing a simple repair.

One area where I have noticed a wide skills gap when helping other technicians diagnose a problem is in the use of wiring diagrams — not reading them, but more importantly interpreting them. While there have been several very informative articles and training classes on the subject, the one that has had the greatest impact on improving my circuit diagnosis was a technique invented by Jorge Menchu of AESwave called Color Coding. His technique uses various colors to represent what types of signals to expect at certain points in a circuit and help narrow down where the problem is by seeing what is and isn't working as it is designed to. I point this out since the colors I used to highlight the circuits in this article are based off of this technique, and I also use this information to design/change my diagnostic plan. A color coding kit (AES# 02-WDCC) is available from AESwave.com.

But alas, even when using circuit wiring diagrams and having proper techniques, there are times when the provided information does not show the whole picture, which can cause inaccurate diagnostic summaries and wasted replacement of components.

When it isn't the bulb

How often when a vehicle comes in with a complaint of a bulb not working do we or the customer automatically just install a new one? In 95 percent of the vehicles that have this concern, bulb replacement fixes it, so for the most part it could be a valid first step. However, if it doesn't work, it can turn out to be a problem vehicle, especially if the wiring diagrams get a little complicated. This is what happened on a 2008 GMC Acadia SLT (Figure 1) that had 82,439 miles with the complaint of an inoperative RF turn signal. The technician who was originally assigned the repair order started with a replacement bulb, but found that this repair was not going to be that easy. Apparently, the bulb had already been replaced by either the customer or another shop, so their next step was to determine if there was correct voltage and ground supplied to the bulb. A quick check with a Digital Multimeter (DMM) showed no voltage. Looking at the wiring diagram for the exterior lighting, they determined that the Body Control Module (BCM) was at fault because in their thought process, that is what supplies the voltage to the turn signal and since the right rear turn signal was working, it must be getting the request from the Multifunction Switch. The tech checked the powers and grounds to the BCM and they were OK, so a new BCM was installed and set up. Obviously, if I'm writing about this vehicle, that didn't fix the concern.

Like most diagnostics, if I'm not sure how a system is designed to work, I do some research before testing. This is also the point at which I print out a wiring diagram and highlight what a correctly working circuit should look like. I find the same circuit also includes the

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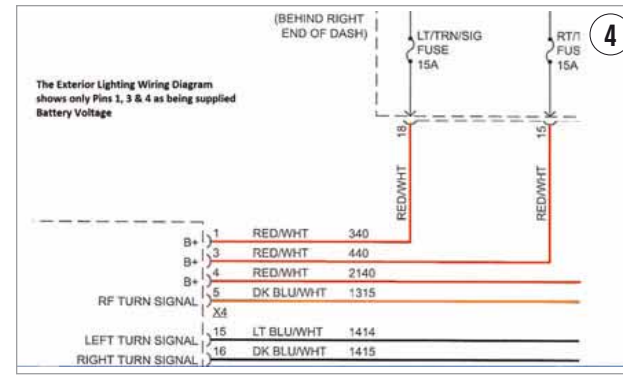
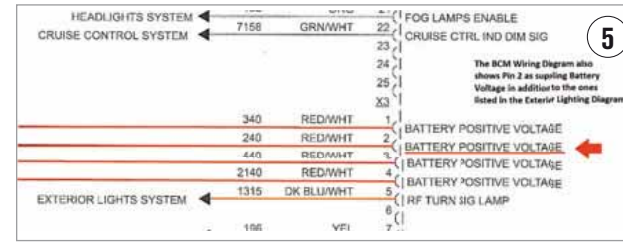
turn signal on the RF side-view mirror, and I noticed that it is not working either. However, the right rear turn signal is on a completely different circuit and is working as designed. I also gathered from the wiring diagram that the BCM (Connector 4 Pin 5 DK BLU/WHT wire) is what controls the circuit once the input from the turn signal switch is received (Connector 1 Pin 16 DK BLU/WHT wire). Since the BCM controls the turn signal circuit, it's a good idea to check for codes, and when I did I found a B2516 Passenger Compartment Dimming 2 Circuit. A quick look up of the code with a description of the circuit shows that this is related to the courtesy lighting circuit, which I notice is not working. This does not seem to have any effect on the exterior lighting circuit, so I decided to stay focused on the turn signal problem and keep that info in the back of my mind. Now I remove the RF turn signal bulb socket to start my voltage tests. I can see from the wiring diagram that the ground for the RF turn signal — in this case G102 — is a constant; it is the first signal I check with my LOADpro Voltmeter Leads to test the circuit under a load. Next we move on to the supplied voltage side of the circuit. Since the BCM is easily accessible by the driver-side kick panel, I perform my testing there.

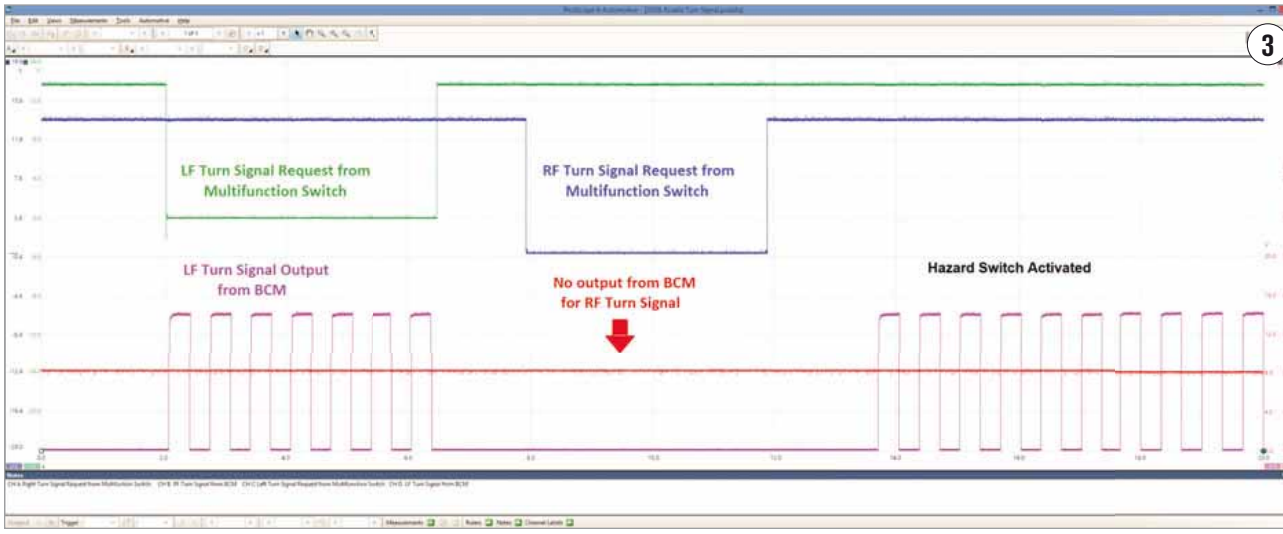




Known good — known bad?

When using a scope to diagnose a problem, it is a good idea to have a known good signal to compare a possibly defective signal to, so I also monitored the left front turn signal input and output (Connector 1 Pin 16 LT BLU/WHT and Connector 5 Pin 4 LT BLU/WHT, respectively), since I know this side is working as designed. As you can see (Figure 2), both inputs are working correctly but only the LF turn signal output is being generated by the BCM; nothing is happening on the RF turn signal output circuit. I also turn on the hazard flashers as another input source to the BCM and have the same result with an inoperative RF turn signal output. Next I use a Power Probe to apply battery voltage to the RF turn signal circuit at the BCM harness with the connector unplugged, and the directional bulb at the RF corner illuminates. This tells me that the circuit is intact and can handle the load when applied. Now I am starting to see why the previous tech suspected the BCM.

While looking at the wiring diagram for the exterior lighting circuit, I notice a few pins that are B+ supplies to the BCM, and one of the fuses is even labeled as the right turn signal. Something important to remember when testing voltage supplies and grounds to a module is to look at the actual module wiring diagram. While the exterior lighting wiring diagram shows some power supplies, it does not show the whole picture of the module itself (Figures 3, 4). I start with the grounds



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first. It looks like Pins 1 and 5 (Connector 3, both BLK/WHT) and Pin 9 (Connector 4 BLK) are the grounds, and all three test fine. Next I move on to verifying the voltage supply pins. I find that there are four pins, all RED/WHT wires numbers 1-4 that are supposed to have B+, but find that Pin 2 does not; it is an open circuit (Figure 5). Guess where the voltage supply comes from? Remember the code in the BCM for the courtesy circuit? The fuse that supplies B+ to this pin was open. After replacing the fuse, the RF turn signal worked.

I asked the other tech again to verify that he tested all the B+ supply circuits; he said yes and showed me the exterior lighting diagram and found it only lists Pins 1, 3 and 4 as B+. However, Pin 2 is not shown on the exterior lighting circuit. That is why it is important to use the actual module wiring diagram to check for B+ and ground. I do not understand why this power supply would affect only the RF turn signal, especially since there appeared to be a dedicated fuse for the right-side turn signal, but it does go to show that we must not get tunnel vision when performing something as simple as a lighting circuit diagnostic, as there may be a bigger picture.

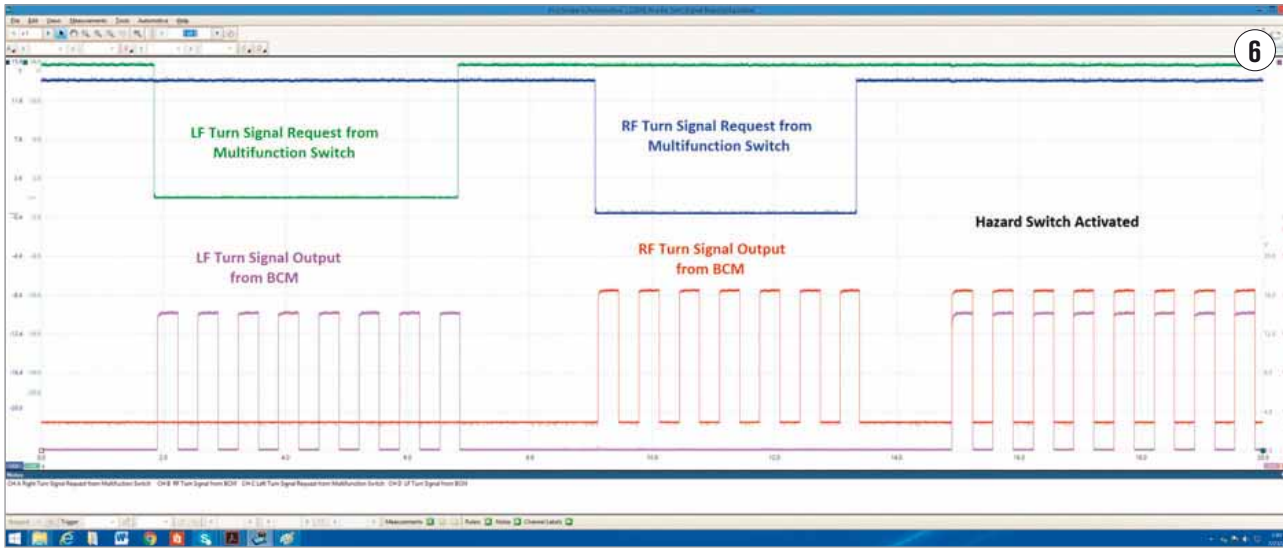
Not quite done

So the vehicle is fixed, right? Well, sort of. The RF turn signal is working (Figure 6), but the directional on the right side-view mirror is still inoperative. As stated before, the wiring diagram shows both the RF turn signal and passenger outside mirror are on the same circuit; in fact, the mirror is spliced to the same wire from the BCM before going through the Underhood Fuse Block, so it eliminates that part of the wiring automatically. Well, it looks like the best place to test is at the connector for the mirror itself so that we can see if the voltage signal is present and test the ground. After removing the door panel, the problem was pretty

easy to see: the mirror that was on the vehicle was incorrect for the application, the connector pins for the mirror side of the harness did not align to the pins in the original door harness, and there was a second mirror harness connector on the door that did not have anything plugged into it. Someone had just attached a side-view mirror that looked correct (on the outside) from a GM vehicle with different options. In hindsight I could have saved myself the trouble of removing the door panel by trying to move the mirror glass with the controls, as none of the functions of the mirror worked. Repairing the circuit for the RF turn signal restored the double-time flashing of the right turn signal indicator on the instrument cluster; the inoperative side-view mirror directional did not affect the rate of the flasher. I did not find out what caused the courtesy fuse to blow, but I don't know what happened to the original side-view mirror on the vehicle, either.

Another bulb in question

The next vehicle that was given to me was a 2008 Dodge Avenger with 112,976 miles and a 2.4L engine for a complaint of an inoperative right front low beam headlamp. A little background about this vehicle before it ended up in my bay: The customer has already tried replacing the bulb themself; however, when



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the vehicle arrived, there was no bulb to be found at the RF headlamp connector. In fact, there was a new connector already spliced in with butt connectors. The technician who got to look at the vehicle first also knew the customer had tried replacing the bulb, so they installed a voltmeter across the bulb connector and turned the headlamps on — 12V! They assumed that maybe the customer had purchased a defective bulb, but it was not found in the vehicle, and we didn't have another in stock to test. Since the bulbs are very easy to replace on this vehicle, he swapped the left front low beam bulb to the right side instead of ordering a new one, and he knew the left headlamp worked fine. Same problem: the bulb did not illuminate on the right side. He swapped it back to the left side and it again worked perfectly.

I can understand the confusion and frustration of the technician since he verified he had voltage and ground at the connector with the headlamp switched on, so why was the bulb not working? He pulled a wiring diagram for the headlamp circuit and saw that the RF low beam headlamp is a fairly simple circuit that has a constant ground and voltage is supplied by the Totally Integrated Power Module (TIPM). So he asked me for a second opinion before recommending a new module.

When looking at the wiring diagram, I like to start with the ground side of the circuit and highlight it. I noticed that ground is constant as he stated, but it is also shared by the right front high beam bulb and the right front fog lamp bulb, both of which are working normally, so it doesn't look like we have a problem with high resistance on the ground portion of the circuit. Another item I noticed is that the customer replaced the connector to the RF low beam headlamp with multiple butt connectors. Fortunately, they were not affecting the operation of the circuit.

8

Next I move on to the voltage supply side of the system. Again, as the technician stated, voltage is supplied to the RF low beam headlamp from the TIPM. So to verify my understanding of the circuit, I used a graphing multimeter and back probe Pins 1 and 2 of the RF low beam connector and wired in a headlamp bulb (Figure 7) that I also use to load test the circuit. When the headlamps' switch was turned on, my GMM showed no voltage. Upon unplugging my wired-in headlamp from connector, I had battery voltage again. Reconnecting the headlamp to the circuit I experienced the voltage dropping back to 0V (Figure 8).

It appears to be a defective driver in the Totally Integrated Power Module (TIPM), but let's not jump the gun until we verify the voltage and ground supplied to it first; we've already experienced that in our last case study. The TIPM is easy to access and had several connectors attached to the underside of the module. Using the actual TIPM wiring diagram and not the wiring diagram for the headlamp circuit, we find there is a larger B+ wire directly from the battery, which supplies voltage to the module and multiple grounds to check, again testing them under load since simple checking voltage it not going to reveal a problem — as we just witnessed with the headlamp circuit. All the voltage and ground circuits to the TIPM are fine, but just to be on the safe side, I simulate the work of the TIPM and supply voltage to Connector 5 Pin 3 WHT/TAN wire to verify the integrity of the rest of the circuit to the headlamp and my wired-in headlamp bulb illuminates brightly, proving the problem is with the RF low beam driver inside of the TIPM.

The customer approved the replacement of the TIPM but did not want to pay us to replace the headlamp bulb; they had the bulb at home and would install it themselves. With the new TIPM installed I still wanted to verify my repair so I attached my tester headlamp in place of the missing headlamp bulb and it worked great. At least by doing this I can be confident when the customer installs their new bulb it will work.

As I stated in the beginning, the repairs themselves were simple but using the correct wiring diagrams and techniques to understand how the circuits that operated them are designed to work is the key. Not doing so makes it easy to get misled if a solid understanding of the wiring diagrams is not in place.

MICHAEL MILLER lives and works in Las Vegas, NV. He is an ASE certified World Class Technician. He holds degrees in both Mechanical Engineering and Automotive Technology.
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EVAP TESTING TIPS

TACKLING EVAP DTCS CAN BE A CHALLENGE. WE'LL SHARE SOME TIPS TO MOVE THE SCALES MORE IN YOUR FAVOR.

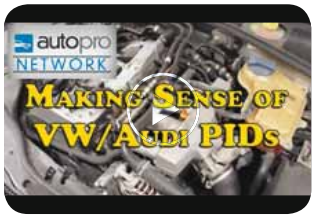
PETE MEIER // Technical Editor

The purpose of the Evaporative Emissions system, lovingly referred to as "EVAP" by many of us, is pretty straightforward — keep the fuel vapors locked up and out of the atmosphere.

Well, it sounds straightforward, but it can be a little overwhelming when it doesn't work as it was designed to. The first order of business is to understand what type of system the vehicle in question is equipped with. Even if you work on only one model line, you are still faced with variations on a theme, so it is always an important first step to identify what kind of detection strategy is in play. For example, using pressure to test a system that the ECM uses vacuum to test could lead you to miss the mark.

Handling EVAP DTCs related to component issues is also relatively straightforward. It's locating the source of the "small leak detected" that can cause you to pull your hair out. In this edition of the Trainer, we'll cover tips and techniques to help you quickly handle a variety of EVAP abnormalities, with a focus on finding those pesky leaks!

MORE FROM THE TRAINER!



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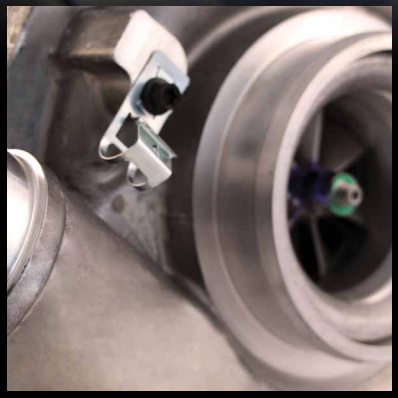
How Variable Valve Timing Systems Work

Tips for Diagnosing Turbochargers



When to Replace Mass Air Flow Sensors

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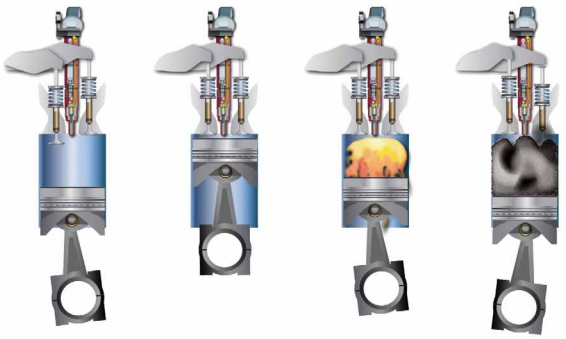
Ford 6.0L Diesel Injectors Explained

The Ford 6.0L Powerstroke engine uses Hydraulic Electronic Unit Injectors (HEUI). These injectors receive energy to open from engine lube oil that's pressurized by a gear-driven high-pressure pump.



How They Fire and Release

The PCM communicates to the fuel injection control module (FICM) that it's time to fire the injector. When that happens, an electrical signal is sent from the FICM to the electrical coils on the injector. The signal magnetizes one coil at a time, drawing the spool valve to the apply side to allow high-pressure oil to flow past the spool and push on the intensifier piston. The intensifier piston then travels down on the fuel plunger to deliver fuel to the nozzle area. The fuel achieves the "crack" pressure, lifting the pintle from its seat and delivering the fuel to the combustion chamber.

When the PCM decides that it's time to close the injector, an electrical signal is sent to the opposite magnetic coil on the injector to pull the spool valve in the opposite direction that it was previously pulled. The spool valve moves to the release side, allowing the contained high-pressure oil to flow past the spool and exit the vent port. The intensifier piston travels upward from spring pressure, allowing the fuel chamber to recharge with fuel for the next injection cycle.

What to Keep in Mind During Repairs

A faulty injector will cause the engine to smoke or run rough. You can identify the cylinder with the faulty injector by using a scan tool that's capable of performing a power balance test. For efficiency's sake, many technicians replace all of the injectors on a bank or even the entire engine at the same time. Here's what you need to know about this job:

Rail Sealing - A standpipe delivers high-pressure oil to the oil manifold. A common problem is that the seals warp under the heat and pressure, leading to a high-pressure oil leak that causes loss of injector control. Use updated plugs and standpipes when replacing injectors. Another common leak point is the ball tube in the high-pressure rail that connects the injector to the rail.

Injector Bolt - To avoid damaging the injector solenoids, use a long shank T40 (not a short shank T40) on the bolt that secures the injector hold-down bracket. When you loosen the injector clamp bolt, be careful not to drop the clamp and bolt into the engine. Before installation, remove oil and debris from the threaded injector clamp hole in the cylinder head. Otherwise, the injector may not be fully seated, which can lead to compression leakage in the fuel system.

Injector Seals - Make sure the compression seal on the injector tip comes out with the injector. Also, check for signs of fuel contamination at the injector fuel inlet screen. Any source of contamination must be located or the replacement injectors will fail. Use clean engine oil to lubricate any seals before installing the injector.

Installation - To install, assemble the clamp and bolt to the injector. Be careful to note the orientation notch. Once the engine is assembled, crank the engine over (without starting it) to bleed any air out of the high-pressure oil system. Don't forget to change the oil, oil filter, and fuel filters, and install an upgraded fuel pressure regulator.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Mass Air Flow Sensor FAQs

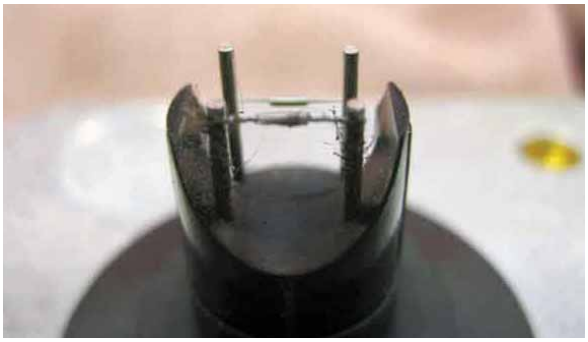
How does a mass air sensor work?

Modern mass air flow sensors use either a hot wire(s) or hot film element. The sensor's internal circuitry heats up the element to a specific temperature. As air flows past the element and cools it off, the sensor increases the current to the element to maintain the specified temperature. There is a direct correlation to the amount of current needed to maintain the element's temperature to the mass of airflow past it. It's important to note that the sensor's element is only a sample of a small part of the air stream. If the intake system has been modified or changed due to a failure, the element may not receive an adequate sample of incoming airstream, which may cause a measurement error to occur.

When do mass air flow sensors need to be replaced?

Road debris and other contaminants that get past the air filter can coat the mass airflow sensor's sensing element. The coating insulates the element, causing under-reporting of airflow off-idle and over-reporting of air at low air speeds.

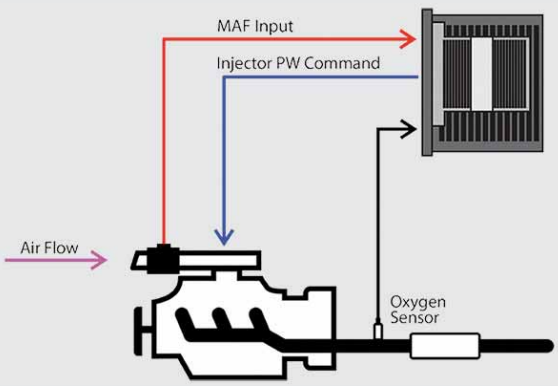
Cleaning a contaminated MAF may seem to bring the performance back, but it rarely brings it to 100% operation and accuracy. Plus, if the internal circuitry is damaged or shorted, the sensor needs to be replaced.



"In the past, I've replaced the MAF and the car ran worse. What should I do?"

There's nothing more demoralizing for a technician than making a diagnosis, replacing a part, and learning that it didn't cure the condition. If the technician isn't confident with their diagnosis, they often chase their tail by going in a different direction and replacing other components.

Enter Standard's new MAF program. Standard is the only supplier to offer 'OE or Better' quality in a full-line new MAF program. Plus, Standard® is the only aftermarket supplier with U.S. manufacturing. Each SMP-manufactured new MAF sensor is calibrated and tested to ensure 100% accuracy. No more installing a reman unit that has been cut apart and glued back together, and no more tapping it with the handle of a screwdriver and hoping that it works.



Steps to prolong MAF sensor lifespan

- Install OE-design air filters. Cheaper filters have designs that can alter airflow direction and skew readings.
- Make sure the air box seals properly and there are no obstructions
- No "performance" airflow devices in the air intake (like those tornado devices you've seen on infomercials). These devices disrupt the planar airflow required for accurate readings.

The New Benchmark for Mass Air Flow Sensor Accuracy

With onsite engineering, design, and test labs at our TS16949- and ISO14001-certified facility, Standard® and Intermotor® are able to produce MAF sensors that are 100% new and 100% airflow calibrated to precisely match the OE output and perform flawlessly under all operating conditions.

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Tips for Diagnosing Turbochargers

Vehicle manufacturers are adding turbochargers at a double-digit rate. Over the next five years, the turbo market is expected to grow to more than eight million turbocharged vehicles. As the number of turbocharged vehicles increases, more technicians will see vehicles with turbocharger issues in their shops. But there's already confusion in the field.

To help technicians diagnose turbocharger repairs, here are a few important diagnostic and repair tips to keep in mind. As a note upfront, most turbocharger diagnoses (aside from noise and low power issues) require scan data and an understanding of operation at the technician-level.

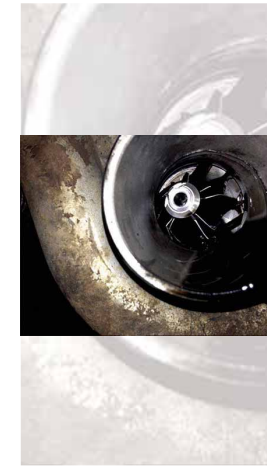
Common Trouble Codes

DTC: P0299 (Underboost)

Potential Issue: Wastegate stuck in open position or leak between compressor and throttle

DTC: P0234 (Overboost)

Potential Issue: Wastegate stuck in closed position, wastegate vent solenoid stuck in vent position, or leaking or disconnected control hoses



What Causes a Turbocharger to Malfunction?

Before we start, let's highlight what causes a turbocharger to malfunction in the first place. Symptoms of a malfunctioning turbocharger include loss of power, excess smoke, high fuel consumption, overheating, high exhaust temperature, and oil leaks from the turbocharger. But it's important to note that defects in other components can produce the same symptoms. Before wrongly attributing the issues to the turbocharger, remember that turbocharger performance can only be impaired by mechanical damage or blockage caused by debris.

Signs of a Damaged Turbocharger

If you hear whistling noises coming from the turbocharger, it's likely due to an air/gas leakage caused by pre-turbine exhaust gas or air/boost leaks. Your first course of action should be checking all of the joints. If the noise continues, check the turbo clearances and wheels for housing contact.

Turbocharger Tips

- Pre-lube the turbocharger by adding oil in the oil feed hole
- Verify the oil feed to the turbo
- Make sure the vehicle has the proper, clean oil
- Make sure there's a quality air filter
- Allow the turbo to cool after strenuous work

If the turbocharger rotor assembly has seized up or is difficult to rotate, the problem is likely tied to the degradation of the lubricating oil. When the oil degrades, it can lead to carbon buildup in the bearing housing interior. The carbon buildup will ultimately restrict rotation. Two other issues that can cause the rotor to seize up include insufficient or intermittent drop-in oil pressure and dirt in the lubricating oil. Another important detail to keep in mind is that a turbocharger has specific axial and radial rotor clearances. Sometimes, the clearances can be misdiagnosed as worn bearings. In reality, clearances that are out of specification may be associated with a lubricating oil issue. Check for insufficient oil, or oil contaminated with dirt or coolant.

To determine if the turbocharger has been damaged by foreign material, inspect the turbine wheel or impeller. You will clearly see any foreign material that has entered through the turbine or compressor housings. If the blades are damaged, the turbo is already destroyed. Look for metal that has come off the turbo in the intake tubes. Metal particles in this area may indicate a damaged engine.

Choose the Right Replacement

Once you've diagnosed your turbocharger and determined that you need a replacement unit, remember that Standard® and Intermotor® offer both 100% new and quality-remanufactured turbochargers for import and domestic applications.

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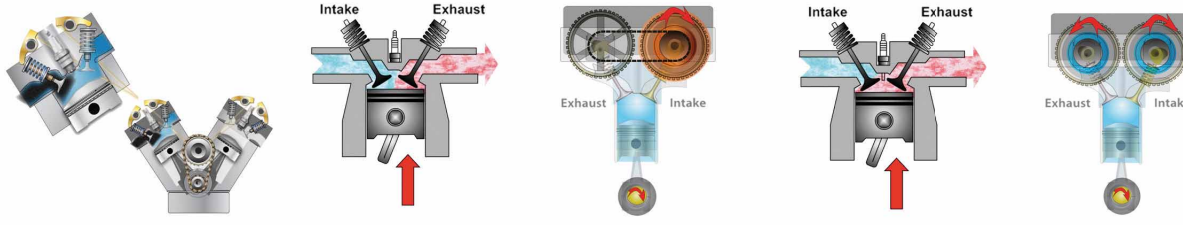
How Variable Valve Timing (VVT) Systems Work

Variable Valve Timing (VVT) or Variable Cam Timing (VCT) is common on most newer engines. It's responsible for increased performance and fuel economy on many engines, and for the elimination of many EGR valves.

Most systems are lube oil-activated, and they use a control solenoid as well as the camshaft sensor, crankshaft sensor, and PCM for control. Newer systems operate off rotational torque from the engine.

With a fixed camshaft, engineers have to balance between idle quality and performance on one side and low emission and fuel economy on the other. As a result, none of these goals are achieved completely. Variable valve timing allows the engine to obtain a smooth idle while achieving the rest of the goals. Modern VVT systems combined with technologies like electronic throttle control and direct fuel injection allow smaller engines to produce high horsepower and torque at lower RPM.



For increased performance, the exhaust cam is retarded a small amount to promote engine breathing. Higher engine speeds mean shorter valve open times and higher air velocity. The increased velocity pushes more exhaust out of the cylinder. The retarded exhaust valve timing increases Volumetric Efficiency. The exhaust valve is still open when the intake opens. Outgoing exhaust pulse creates a low-pressure zone behind the valve, which increases the pressure differential between the intake port and the combustion chamber. The result is better cylinder filling. Remember, this can't be done at idle due to low air speeds.

To provide an EGR function, the exhaust cam is fully retarded, which adds lots of valve overlap. As a result, the exhaust gas remains trapped in the cylinder. This ability allows a reduction in hardware and service issues from carbon. Opening the exhaust valve later retains more exhaust pressure in the cylinder, causing pushback to the intake charge and exhaust gas retention.

On some systems, the intake camshaft is advanced at part throttle and Wide Open Throttle (WOT). The placement opens the intake valve sooner and allows some exhaust gas into the intake stroke, which has an EGR effect. It also closes the intake valve sooner, which increases the compression stroke. On a cold engine, opening the intake valve sooner will also warm the intake charge and assist in reducing startup emissions.

Some newer systems utilize the best of both worlds; they control multiple cams independently of each other. In dual independent systems, the exhaust camshaft is retarded and the intake valve is advanced independent of each other. Doing so maximizes the EGR effect and further reduces pumping losses for maximum efficiency.

Tip: Have a vehicle that is setting VVT or VCT codes? Hear rattling sounds from your cam phaser? You may need a new VVT actuator or solenoid, and Standard® has you covered with a selection of VVT actuators and solenoids.

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