



10 OPERATIONS

THE TOP-3 THINGS KILLING YOUR PRODUCTIVITY...
AND THE WAYS TOP OPERATORS SOLVE THEM

ARE YOU DOCUMENTING YOUR REPAIRS?

Whether you're a service writer, technician, or owner, the words we all dread to hear are, 'Ever since you,' or, 'I'm still having the same problem.'

14 ALL IN A DIAGNOSTIC-DAY'S WORK

We've seen many different faults cause some strange symptoms over the years. But just when you think you've seen it all, you find out you haven't.

22 MACS 2023 MOBILE A/C UPDATE

Air conditioning systems are evolving into thermal management systems to serve as heat pumps for EVs, and the EPA continues its HFC phasedown, creating R-134a supply shortages.

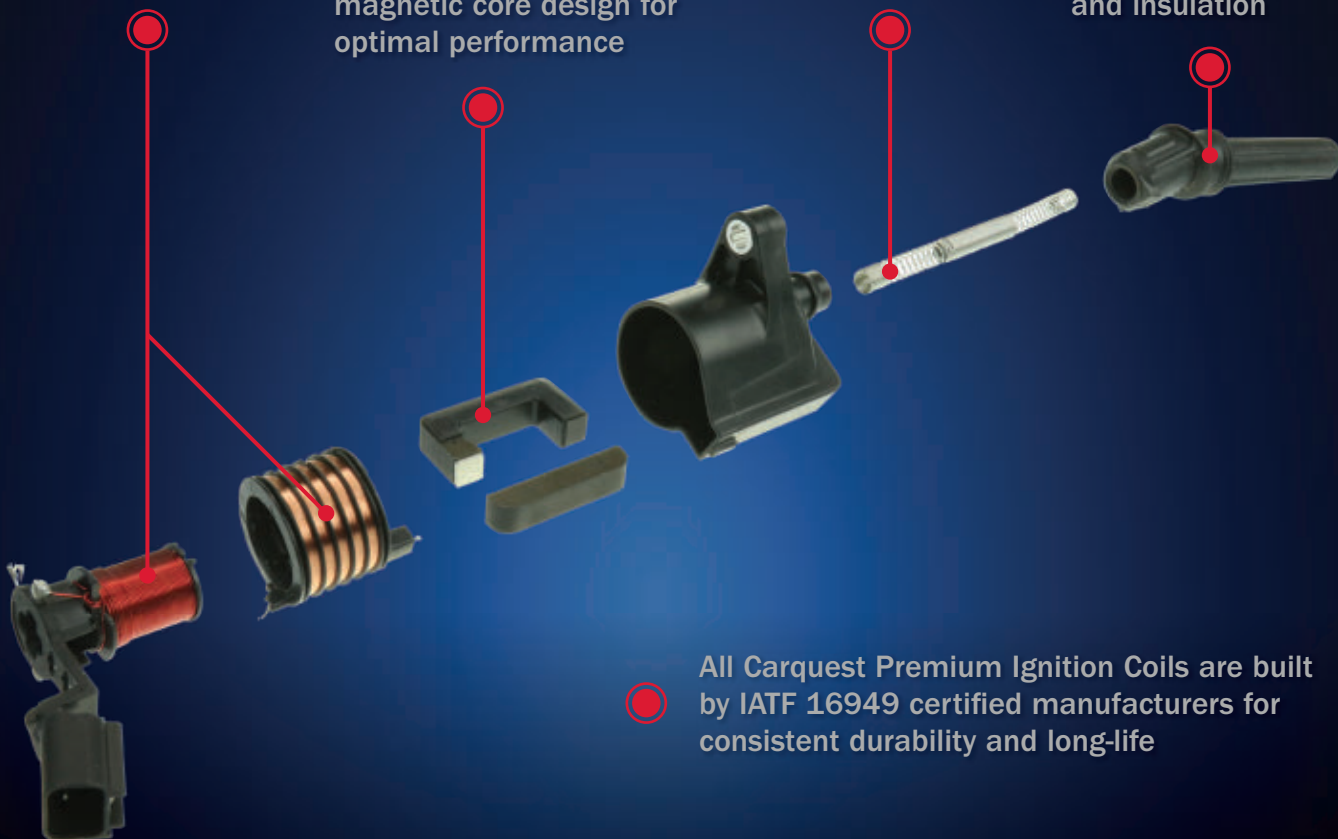


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OPERATIONS

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DAVID ROGERS

TECHNICAL

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JERRY "G" TRUGLIA

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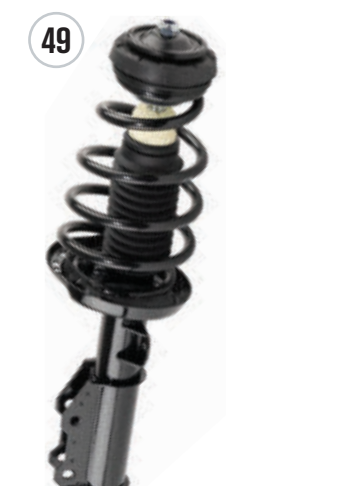
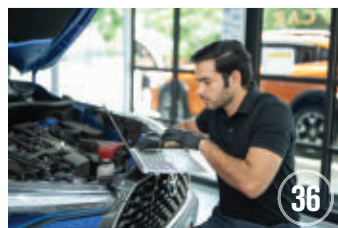
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In this video, Mike Berg (aka Flat Rate Master) talks about some new tools he's recently added to his collection.

Berg is the shop foreman at Anthem Automotive in Atlanta. Throughout his career, he's always tried to position himself as a mentor in the shop.



WEB EXCLUSIVES

MASTERING VEHICLE DIAGNOSTICS PT3 - EVALUATING ENGINE MECHANICAL CONDITION FROM THE DRIVER'S SEAT

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RECOGNITION

AUTO CARE ASSOCIATION AND ASE ANNOUNCE 2023 WORLD CLASS TECHNICIANS



The Auto Care Association has announced the latest recipients of the World Class Technician Award in partnership with the National Institute for Automotive Service Excellence (ASE). The two organizations provide this annual recognition to professional technicians who have attained ASE certification in 22 specific areas during the previous calendar year.

There are an estimated 887,000 technicians in the United States, with approximately 250,000 holding ASE certification. As of now, there are 2,224 technicians who have earned the respected status of “World Class Technician” since its inception more than 30 years ago.

The class of 2023 World Class Technicians is listed below:

Anthony H. Caputa – Arnold, Mo.
 Arlen Parker Hart – Athens, Ga.
 Bobby Leatherman – Stony Point, N.C.
 Bradley Kilwy – Plano, Texas
 Brian Ward – Denton, N.C.
 Bryan Jensen – Apple Valley, Calif.
 Craig Wilkins – Fillmore, Calif.
 Dale Collins – Orange Park, Fla.
 Daniel Hammond – Indianapolis, Ind.
 Daniel Indovina – Centennial, Conn.
 David Yentema – Macedon, N.Y.
 Don Verville – Cape Coral, Fla.
 Gordon Marr – Yorba Linda, Calif.
 Gregg Brinlee – Detroit, Mich.
 Gregory Pheasant – Sparks, Nev.
 James Moody – Heber Springs, Ark.
 Jarod Johnson – Lubbock, Texas
 Jason Kirby – Groveland, Fla.
 Jeff Autery – St. Louis, Mo.
 Joel A. Pritchard – Warren, Mich.
 John Lewins – Nashville, Tenn.
 John Vaccarello – Detroit, Mich.
 Jon Ewing – Detroit, Mich.
 Jordan Ellis – Corpus Christi, Texas
 Luke Plant – Edmond, Okla.

Marcus Buchholz – Detroit, Mich.
 Mario Monsivais – Houston, Texas
 Matt York – Canton, Ga.
 Michael Gavrielides – Winterville, Ga.
 Nathaniel A. Dillard – Brookwood, Ala.
 Paul Bostel – Apple Valley, Minn.
 Paul French – Dallas, Pa.
 Robert Bridges – Omaha, Neb.
 Rodney Prince – Henderson, Nev.
 Roger Abbey – Rochester, N.Y.
 Russell Andrew Ringling – Warrenton, Va.
 Ryan Woods – Old Bridge, N.J.
 Sam Mott – Reno, Nev.
 Shawn Williams – Ladson, S.C.
 Thomas Kepler – Curtice, Ohio
 Tyler Grahl – Newport, Tenn.
 Victor Hasstedt – Hollister, Calif.
 William P. Link – Virginia Beach, Va.
 William Pickham – Bensonville, Ill.

The Auto Care Association surveyed this year’s ASE World Class Technician award recipients to learn about their career journeys, what motivated them to pursue the goal of ASE World Class Technician and what achieving this status means to them in their own words.

“To become ASE World Class meant becoming a top person in my field of work. I strive every day to gain more knowledge in every aspect of the automotive field. I adopt the philosophy of ‘If you’re going to do something, you might as well be great at it!’ and World Class status is another step in becoming great at what I want to do.” – Joel A. Pritchard, General Motors, Warren, Mich.


“This is an honor to be named a world-class technician. Every day, I strive to be better, learn more and always move in a forward direction. This indus-

try can be challenging at times with the constant growth of new technology, and systems training is a must. I pride myself in constantly furthering my education in the field and adapting to these new advancements to be the best at what I do.” – Gregory Pheasant, A Master Mechanic, Sparks, Nev.

“World Class (and ASE) status is a valuable confirmation tool I use to audit my knowledge of current customer products. It shows my customers and employer that I am keeping my knowledge current and that my skill is of the highest quality and value to our customers.” – Bradley Kilwy – Toyota Motor North America, Plano, Texas

“World Class certification is important to me because of the exclusivity of achieving it. I set the goal for myself years ago, when I first read about it and take great pride in reaching that goal. I currently hold a total of 29 ASE certifications, a feat I display proudly.” – Don Verville, Kia of Cape Coral, Cape Coral, Fla.

For more information about World Class Technician certification qualifications, timing and recognition, go to bit.ly/3TKRLIF.

For more information about ASE and service professional certification, visit ase.com 



For help in preparing for ASE certification, go to passthease.com. Motor Age Training’s library of books, practice tests, and video resources is edited by ASE Master Technicians with years of experience in repair processes. Each product is designed to help you prepare for and pass your ASE certification exam – guaranteed.

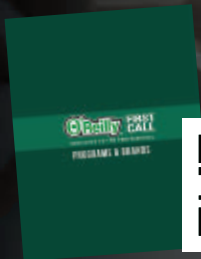


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REPAIRIFY AND AUTEL FORM EXCLUSIVE PARTNERSHIP

Repairify, Inc. and Autel U.S. announced an exclusive long-term collaboration agreement for the delivery of Repairify's patented global OEM remote solutions for diagnostics, calibrations, and programming through Autel's remote capable products across North America.

As part of the agreement, Repairify will integrate its patented global remote diagnostic, calibration, and programming solutions as a new service offering into a revised version of Autel's Remote Expert platform.

Both will jointly manage the platform that will now offer customers the choice of using the certified and warrantied OEM remote solutions from Repairify, along with the independent Remote Experts (vetted for their experience) who are already serving the platform.

"We are excited to enter into this collaboration with Repairify," said Autel U.S. CEO Chloe Hung. "Autel developed the Remote Expert platform to provide our users remote access to specialized and experienced module programmers and diagnosticians. We are very proud that its success drew the attention of a company of such quality and

industry success as Repairify. We are confident that this partnership will benefit both companies and, most importantly, be of immense value to our users."

Autel's Remote Expert is designed to offer customers onsite aftermarket scanning and access to remote OEM tools supported by experienced professionals. It is available through the Autel MaxiSYS Ultra, Ultra EV, MS919, MS909, and MS909 EV diagnostics tablets.

Remote Expert will also be expanded into Autel's ADAS calibration systems.

By combining the Repairify remote services solutions program with the Autel Remote Expert Platform, automotive repair professionals will have a seamless experience that delivers fast, accurate, certified, and safe vehicle repairs with the choice of aftermarket or OEM tool support.

"Repairify is honored to embark on this partnership and to broaden the reach of our solutions through the new and existing Autel network of customers," said Cris Hollingsworth, president of Repairify Global Holdings. *ZZ*

RIGHT TO REPAIR

TESLA FACING TWO RIGHT TO REPAIR CLASS LAWSUITS

Two lawsuits were filed the week of March 13 in San Francisco federal court. In both class action suits, Tesla is being sued over claims that it has "designed its electric vehicles, warranties and repair policies to discourage owners and lessees from using independent shops outside of Tesla's control," reported Reuters.

The proposed class in both cases would include anyone who has paid Tesla for repairs or parts since March 2019.

It has been noted that Tesla defense counsel has not yet made an appearance in the cases.

According to one of the proposed class actions' plaintiffs lawyer, Matthew Ruan of Freed Kanner London and Millen, "damages could

total hundreds of millions of dollars."

Reuters reported that Tesla's alleged restraints on service and repair, according to the new lawsuits, caused "exorbitant wait times" for drivers who otherwise would have gone to an independent repair shop.

The lawsuits call for Tesla's repair services and parts monopoly to be "dismantled" and for the company to be ordered to make its repair manuals and diagnostic tools "available to individuals and independent repair shops at a reasonable cost," noted Reuters.

The two cases are Virginia Lambrix v Tesla Inc, U.S. District Court, Northern District of California, No. 3:23-cv-01145; and Robert Orendian v. Tesla, No. 3:23-cv-01157. *ZZ*

STUDENT ACHIEVEMENT

TECHFORCE ANNOUNCES GRAND PRIZE WINNER IN NATIONAL STUDENT AWARDS

TechForce Foundation has announced Taeler Coverdale, a collision student at the Universal Technical Institute in Houston, Texas, as the grand prize winner of its 2023 FutureTechs Rock Awards.

More than 4,000 TechForce followers voted in this year's awards. The student with the most votes was Coverdale, earning her the grand prize from among ten contenders who were all category winners.

"Role models like Taeler show students that there is a place for them in technician careers," said TechForce Executive Director Jennifer Maher. "As we all know, young people are so much more likely to pursue a career if they see people like them succeeding in it. Women account for less than 3 percent of transportation techs, and so welcoming women into the trade is critical to addressing the ongoing technician shortage. TechForce is proud to celebrate Taeler

and the new generation of women joining the industry."

As the grand prize winner, Coverdale will receive a \$1,000 TechForce scholarship and \$4,000 in prizes from TechForce and sponsors including Advance Auto Parts, AutoZone, Cengage Learning, CRC Industries, Mighty Auto Parts, New Ford Tech, Nissan, Snap-on Industrial, Volvo and WD-40 Company.

Through the FutureTechs Rock Awards, TechForce and its partners have awarded 50 transportation technician students with over \$67,000 in prizes and scholarships since 2019. The Awards are made possible because of generous donations from people and companies that believe everyone should have a chance to succeed.

Learn more about the 2023 grand prize and category winners at TechForce.org/FTR23Winners. *ZZ*



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The top-3 things killing your productivity... and the ways top operators solve them

BY DAVID ROGERS // Contributing Editor

We've all had those customers. They hold onto an old vehicle long past when it's time to replace it. Whether it's nostalgia, stubbornness, or something else keeping them from trading in their clunker, you know it would make more financial sense to upgrade. But they're unwilling to budge. That customer can certainly see the warning signs – flashing alerts on the dashboard, new sounds and smells, unexpected clunks and shimmies – but they choose to continue to live with the problem.

Of course, shop owners do the same thing to their operations, where the warning signs are every bit as obvious, and the solution just as straightforward. With one big difference, of course.

On his or her vehicle, your customer has a dashboard arrayed with flashing lights and audible alarms to call attention to ongoing problems. He or she cannot help but know that systems are breaking down and urgent problems are imminent. But when it comes to the shop, operators are at two disadvantages. First and most obviously, many shops do not have an array of lights, warnings and systems to detect problems and alert them.

But some do, is the thing, and yet these shops often suffer from the same production problems that plague shops without advanced warning systems. This is because the much bigger problem is that our industry chooses to live in the shadows.

Productivity is about so much more than benchmarks or systems or tools, which is why my goal in this article is simple: I want to pull back the curtain and let in the light. Even great operations can suffer from several problems, and you can't begin to truly excel as an operation unless you're willing to address them.

So first, let's take a moment and talk about some of the most common causes of productivity problems in shops, and then look at the larger picture, and how our industry can find real, sustainable productivity that enriches our communities and fulfills our employees.

Productivity killer #1: broken communication

Communication is everything. In day-to-day operations, communication breakdowns can lead to incorrect parts being ordered, vehicle comebacks, or even bays sitting idle longer than they should. It's the difference between advising the customer at 11:00 a.m. versus 1:00 p.m., which in turn is the difference between work being approved and completed today versus tomorrow.

But communication breakdowns also hurt morale, destroy relationships with loyal customers, and let employees drift out of our shops and even out of our industry because they don't feel heard.

The goal in every decision you make as an owner should be to make sure the outcome is equally beneficial for the customer, the shop, and the employees. If any side of this "management triangle" is shorter, then the triangle is out of balance and unstable.

Have you communicated this way of thinking to your team? The more they understand that everything that goes on in your organization is seeking to protect and grow everyone involved – their community, their coworkers, their career – the better they can live out this mission in everything they do. It's the first step in fixing broken communication in every facet of your business.

Productivity killer #2: The owner (or manager, or any ONE person) as the secret ingredient

The owner or manager often feels this most acutely in their lack of time. Maybe it's because the team needs their work checked, needs constant judgment calls to be made and directives given, or the owner/manager needs to constantly retrain the team on processes and systems. No matter the specific problems draining your time and passion, the root is the same: one person becomes the secret sauce, and without their direct involvement day to day, things will go off the rails.

Repair shops need clearly documented processes and procedures. The larger your operation, the more critical of a problem. It's okay to admit you don't have all the answers, though! Every shop struggles with getting the right policies and procedures that adhere to the management triangle. Even when you establish the right ones, it usually leads to growth that renders your old policies and procedures outdated and useless. It's a constant struggle, and successful shops are never done. Is there one person who has become the secret to your organization's success? When your operation can only grow as far as the owner or manager personally can take it, not only is the team deprived of the chance to help grow something they believe in, that "secret sauce" owner or manager is deprived of the success and freedom they want and need!



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Productivity killer #3: settling for mediocre

There is a theme through the first two points: the most successful operations are never comfortable with how things are. Fixing communication breakdowns means constantly improving how our teams work together and serve our customers. Getting the owner out of the role of “secret sauce” means finding resources that lead to far more growth than one person can do on their own.

Top operators never settle. They never look around their operations with a sense of contentment and say, “We’re pretty good... we don’t need to change anything right now.”

This is the opposite of what our industry encourages.

The constant message from industry voices is, “You’re fine!” It’s on display in every 20 Group meeting where a shop owner pretends he or she is doing better than he or she is to impress the other group members. It’s evident in every coaching session where the focus is on cheerleading instead of hard choices. It’s highlighted every time an owner convinces himself or herself that copying everyone else is doing is well enough.

The end results of this industry trend are a crippling technician shortage, a tarnished reputation in popular culture, and dwindling trust in the community. Will you choose to be comfortable and pretend everything is perfect? Or will you choose the path that enables everyone and every location in your organization to grow and prosper?

Think about what productivity means: getting more done during a time period than you used to be able to. So often, that number gets distorted in our industry. Truly! It does not matter how quickly your technicians can clock in and out of jobs in search of some infinitesimal gains to some productivity benchmark if everything else in the shop is slowing down the team, making everyone miserable, and keeping your organization mired in mediocrity.

That’s because productivity isn’t just about more money in the bank or more free time for the owner. It’s also about creating a team who truly feels valued and who wants you to win because it helps them win, too!

Here’s what I mean.

Tools are important. Systems are important. Processes are absolutely important. But behind tools and systems and processes is a living, breathing person who deeply needs to understand their purpose, who needs to believe in something, and who needs somebody to reinforce their confidence in their skills and their workplace.

If you want your team to produce well beyond the minimum – if you want the very definition of increased productivity, in other words, – then stop managing at the wrong end. They don’t need better tools or more micromanagement of their work, they need to understand how and why what they’re doing matters. Give them a purpose, a way to see the direct results of their hard work. Create an environment where the lives of everyone are enriched and emboldened!

Yes, at some point, tools and systems and software can increase productivity. But nothing can have so great an impact on an organization as pay plans that reward your team for growing your shop ethically and sustainably, and a culture that stands for protecting and lifting up the people in the shop and the neighbors in the community.

But it really does start with you. You have to stop accepting the comforting lie that everything is okay the way it is. You have to want to make things better for your team and your customers and your business more than you want things to be easy for you.

When you do, you give everyone on your team the motivation to win. You create a more ethical business, and you strengthen your whole community because you value your customer, your employees, and your business equally instead of giving first priority to your comfort.

There’s no easy button to what I’ve discussed here today. The solution to productivity problems is about so much more than a software subscription or training class.

Because the truth is you can’t do it yourself. You need systems and processes that are replicable and duplicable in every location. If it’s up to you to go location to location, desk to desk, bay to bay... you’re the secret sauce. You will never grow beyond your own herculean efforts. That’s not necessary, though. Sacrificing everything isn’t a required part of success.

Instead, you need only decide today to stop accepting things as they are. Will you build a team and culture that rewards productivity and excellence? Will you resolve to build a business that outlasts you and enriches your community? Are you ready to finally build the business and the team you’ve always wanted?

You know how much your customer’s life will improve when they stop living with their problems. Even if their next steps involve test drives and financing and other hurdles, they are actively working now to improve their situation.

So, in shop ownership: the biggest and most important step is the very first one, once you resolve to stop making your shop and your family and your team and your community live with the same old problems. The light is shining into dark corners. Now... what will you do? *TL*



DAVID ROGERS is president of Auto Profit Masters, Shop4D, and the award-winning Automated Marketing Group, and the COO of Keller Bros.

Auto Repair in Littleton, Colo. Together, these companies form an ecosystem of success for shop owners, offering proven, sustainable solutions for maximizing efficiency and growth, growing customer bases, and creating a culture of excellence. With nearly half a century of experience in the automotive industry (and they’re still growing exponentially), Auto Profit Masters and Automated Marketing Group have the tools and resources to help set your shop apart from your competition and elevate your business to the next level.

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ALL IN A DIAGNOSTIC-DAY'S WORK

WE'VE SEEN MANY DIFFERENT FAULTS CAUSE SOME STRANGE SYMPTOMS OVER THE YEARS. BUT JUST WHEN YOU THINK YOU'VE SEEN IT ALL, YOU FIND OUT YOU HAVEN'T.

JERRY "G" TRUGLIA // Contributing Editor

I'll begin this article with a simple problem that could have been harder to diagnose and repair if I did not use my diagnostic game plan.

Sometimes it's easy to get off track and take the backhoe out when the shovel will do the job. I have seen many techs go down the wrong path and start with an advanced diagnostic procedure that sends them in circles.

Remember that old saying, KISS (keep it simple, stupid)? No, I am not saying anyone is stupid, so please don't take it the wrong way.

But sometimes after taking a class or reading an article with an advanced procedure that found a problem, we decide to use that approach first. After all, it's normal to want to take out your new diagnostic equipment and use it to

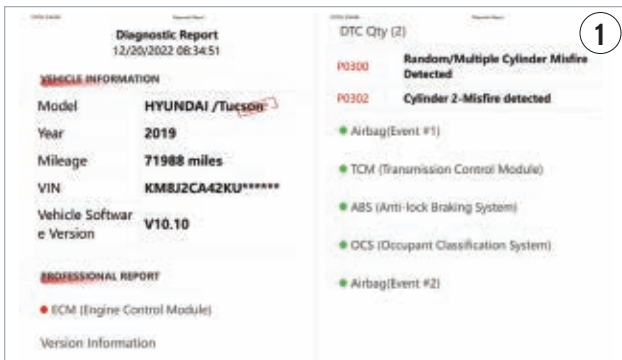
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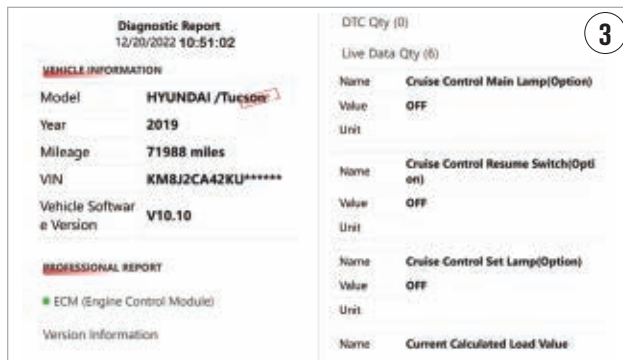


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INITIAL DTC SCAN indicates a misfire fault is present.



AFTER REPLACEMENT OF the faulty spark plug, another scan for DTCs reveals the misfire has been repaired.



COMBUSTION GASES are passing through the spark plug and leaving soot-like evidence behind on the insulator.

find the problem. But going down that path may send you the wrong way, only to find out later that a basic test would have found the problem.

When you read through this first vehicle case study you may think, “He must be kidding. This problem would have been a piece of cake to diagnose.” But as you read through it and see that the test procedures initially used did not uncover the issue, you will then understand that many times, basic testing procedures are all that are required to uncover the problem.

Misfiring Hyundai

Our first problem was a 2019 Hyundai Tucson 2.0L with 71,988 miles. It came in with a complaint of the check engine light illuminated, running rough, and lack of power. Keeping in mind that a diagnostic game plan (including speaking to the vehicle owner, visual inspection, a full scan of all computer systems, and repair information lookup) is the best step forward. In this case, after speaking to the vehicle owner I took his Tucson for a short test drive, followed by a full system scan to see what caused the MIL to illuminate. I uncovered P0300 and P0302 DTCs (**Figure 1**). Using my best tools first (my brain, eyes, ears, nose, and hands) to check everything from the data stream, Mode \$06, relative compression, fuel, and ignition, I came up empty-handed for anything that could’ve caused the misfire DTCs.

scope, or ignition tester. Could it be a COP coil failure that is common on many engines?

I tried the easiest thing first (the coil swap) by switching a coil from a non-misfiring cylinder to cylinder number 2 without any change in the data. I remembered that the vehicle owner told me the engine had a catastrophic failure at 34,433 miles and the engine and other auxiliary parts were changed under a Hyundai recall.

The problem was due to a faulty spark plug that was allowing compression gases to leak out of the cylinder. This is indicated by the brown stains on the plug (**Figure 2**). It was this loss of cylinder charge that was causing misfires, but they were not detectable in the misfire data, mode \$06, or primary/secondary ignition analysis.

In my opinion, by changing the spark plugs I confirmed that they were the cause of the misfires. The manufacturer of NGK plugs states corona stains is normal and caused by oil or dirt particles along with static electricity. My conclusion was that two of the four spark plugs that I removed (with brown stains) were leaking compression and causing intermittent misfires and the associated DTCs.

After removing all the plugs and installing a new set of (OEM-recommended) NGK spark plugs, I performed a computer rescan of the vehicle that resulted in no DTCs (**Figure 3**). The Hyundai was fixed and running great again, and the root-cause problem was solved.



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The stalling, dying Chevy

The next vehicle up is a 2004 Chevy Monte Carlo with a 3.8L supercharged engine, and 20,536 miles indicated. This vehicle was the owner's pride and joy that he only took out on nice days. He complained that the engine died while driving and then wouldn't restart right away. The owner showed us receipts from two different GM dealers that diagnosed and changed the complete exhaust system (including the catalytic converters), spark plugs, MAF sensor, fuel injectors, PCM, and more.

After compiling the information from the owner, we started our diagnosis and found that the fuel system was not up to specifications. The fuel pump current-ramping waveform was all over the place and at about 4 amps when it should have been 6 amps (**Figure 4**).

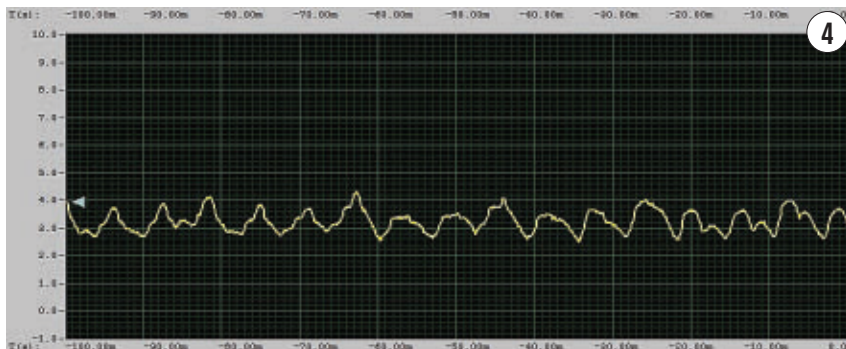
We followed the current-ramping test by checking pressure and flow. The pressure was within specification, but the flow was about .3 of a gallon per minute when it should have been at a minimum of .5 gallon per minute. Using the MAC Tools FST2000 fuel system tester, here is an example of good fuel volume (**Figure 5**). Flow is the key to proper fuel delivery to the engine, especially on a supercharged performance engine.

We replaced the fuel pump with an OEM pump and re-tested the system. It now passes the current ramping, pressure, and most importantly volume tests. After running the engine for hours and getting it hot, we drove the vehicle and noticed that the engine delivered more power and had no DTCs or problems.

We called the owner and told him the vehicle was repaired and ready for pickup. The owner stated he did not want the vehicle back until we were 100% sure that the engine would not stall again. In a way, we were lucky that he lost confidence in the vehicle's reliability, providing us more time to confirm that the Monte was fixed.

We were confident that we solved the problem and thought that the customer was a bit strange for insisting we keep the vehicle. But then again, after two GM dealers supposedly repaired the vehicle, it still resulted in him getting stuck; we understood his paranoia.

We called the owner to inform him we had driven over 600 miles without encountering any issues. I voiced my concern about driving his collectible vehicle and putting more mileage on it (along with the increased risk of something getting damaged). He didn't care about any of that and wanted it driven at least 2000 miles before he would pick it up.



THIS CURRENT WAVEFORM of the fuel pump is at least 30 percent lower than expected, providing evidence of a circuit fault.

THIS FUEL VOLUME TESTER offers more information than just a pressure gauge alone. Maintaining the proper pressure with adequate flow is what is required of a fuel delivery system.



Thinking this new customer was out of his mind, I tried my best to convince him otherwise, but he stated once again he lost faith in the vehicle. Although I felt a bit uncomfortable driving his vehicle for so many miles, I gave in and told him we would continue to drive it to reinstate his confidence back in the Monte Carlo.

The day finally came when we completed over 2000 miles road test (without stalling). We called the customer requesting he come in to confirm the distance we had traveled before paying the invoice. The test drive went well, and he was very happy. He paid the bill and took off. Months went by without a call from the vehicle owner. Bill and I were confident that the vehicle was fixed and thought that we would not hear any complaints from him again.

Later that year, the owner contacted us to inform us it happened again. He was stuck about a mile away from his house. I assured him we would come right out to diagnose the cause of the stall/no-start.

We brought a scan tool, lab scope, fuel gauges, vacuum gauges, and a propane-enrichment tool to diagnose the engine issue. When we arrived at the location, the engine was nearly at operating temperature and did not start. This seemed like a different issue than during our previous encounter (since the engine was not as hot as it was during the original complaint).

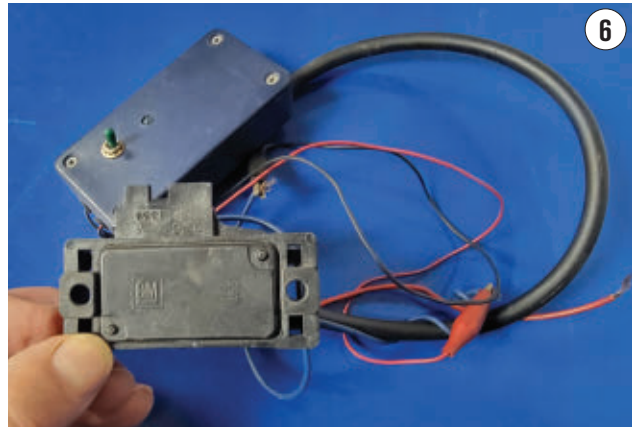
After checking for codes, none were found. We looked at data PIDs, spark, and fuel. All appeared to be normal. There are only four things that run an engine, as we all know: air, compression, spark, and fuel. Since this engine had all of them present, our next step was to disconnect the engine sensors (one at a time) to see if maybe a 5-volt reference was being pulled down.

Starting with the easiest sensor first (the MAF sensor), followed by other sensors (except for the crankshaft position sensor and camshaft position sensor, since the engine needs them to provide spark and fuel) we were down to unplugging the hardest sensor to access, the MAP sensor. It was buried way in the back of the engine.

Once I disconnected the sensor, Bill cranked the engine over and it started right up. As soon as I plugged the wires back into the sensor the engine died and would not start.

Since we had to drive the vehicle back to the shop, I had to leave the wires to the MAP sensor disconnected.

The owner called for a ride and requested that we call him with the diagnosis. When I got the vehicle back to the shop, I parked it outside and tended to other work that we had scheduled. Later in the day, I plugged the wire harness connector back into the MAP sensor) and cranked it over, resulting in the engine starting right up (Figure 6).



THIS INTERNALLY MALFUNCTIONING MAP SENSOR prevented the engine from starting.

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I ran the vehicle outside until the engine died and would not restart. I unplugged the MAP sensor and once again, the engine would restart. Since this happened like clockwork, I realized that the MAP sensor had a problem that was temperature-related.

I called the GM dealer and ordered a new MAP sensor, since the customer only wanted dealer parts installed. In the meantime, I conducted a brief experiment. I removed the sensor and placed it in our shop freezer for a bit. Once the sensor cooled, I connected it to the engine and the engine started. I went over to my toolbox and took out my old MAC Tools CT901 carburetor choke tester (Figure 7). It uses shop-air to function and allows for one side of the tool to output cold air while the other side dispenses hot air. Using it allowed me to duplicate the problem. The engine died and would not start until it reached a certain temperature. The problem was the MAP sensor had an internal issue that I could now prove to the owner.

I installed the new sensor and the engine started right up and stayed running, confirming my diagnosis. The vehicle owner was once again able to enjoy driving his Monte Carlo with confidence.

No-charging Toyota

2009 Toyota Camry 2.4 L with 120,561 miles on it came into the shop with a complaint of a slow-cranking engine, dash light illuminated, and dim headlights. We connected our Midtronics tester to perform the battery and alternator output test. The battery failed the test, so we could not properly test the alternator until we could correct the battery issue.

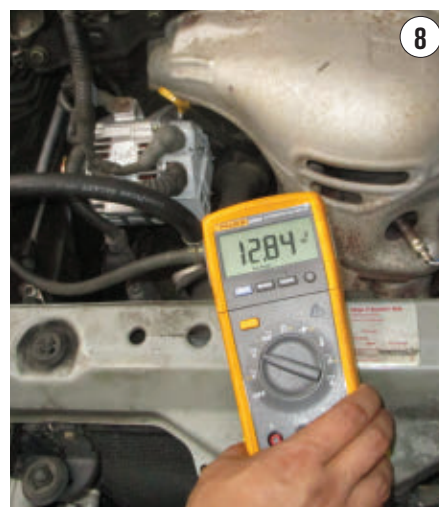
The next step was to connect our Associated smart battery charger to get the battery backup to specification, making sure it was good before retesting the alternator. The battery passed the test, so we moved on to rechecking the charging system, confirming a bad alternator. Since the alternator was not able to output a proper voltage there was no doubt it had to be replaced.

We ordered a replacement alternator, installed it, and rechecked the charging system which once again was not outputting a proper charging voltage (Figure 8). Bill called the parts store to get another alternator and installed the replacement, only to come up with the same results.

At this point, Bill used Identifix and “RTFI” (read the friggin’ information) to find this issue can occur on high-



THIS OLD CHOKE TESTER (FOR CARBURETOR TUNING) was used to chill /heat the suspect MAP sensor, proving the fault was temperature related.



THE REPLACEMENT OF THE ALTERNATOR

did not repair the charging system fault. Everyone makes mistakes, so never forget to reference service information during diagnostics so you understand system strategy.



THIS COKED-UP THROTTLE VALVE prevented the engine from idling properly and was the root cause of the charging system fault.


mileage Toyota vehicles. The problem can be caused by the engine not idling properly (our vehicle had no such problem) preventing the alternator from charging as designed.

Identifix had a diagnostic procedure listed to perform a voltage drop on the white sensing terminal wire, followed by checking the voltage level (On our sick Camry, the voltage was only at 11.6 volts). The next step was to run a jumper wire between the battery and the white wire at the alternator, then rechecking to see if the alternator will output proper voltage. This made no difference.

The information went on to state that a dirty throttle body could cause the issue as well. Bill removed the throttle body boot and found a dirty throttle body (**Figure 9**). He cleaned it and then performed an idle relearn.

The idle system is controlled by the ETCS (electronic throttle control system). It detects the accelerator pedal position as the APP sensor signal is sent to the PCM. The system will then control the throttle valve opening angle and monitor its position via the TPS (Throttle position sensor) signal. This is why after cleaning the throttle body, it is important to perform a throttle relearn. The next step was to recheck the alternator output, making sure the system was

working as designed. Out of curiosity (and since it is an easy alternator to remove), Bill removed the new alternator and reinstalled the original alternator. The results confirmed it was defective because there was still no voltage output. However, even though the original alternator was faulty, neither of the replacement alternators would have functioned, anyway. Bill and I had learned a lesson because we did not realize what we didn't know. Thanks to Identifix we now knew (we should have read the service information first).

I hope this information helps you diagnose vehicles more easily. I would love to hear your comments; please email me at gt@attstraining.com. 



JERRY "G" TRUGLIA, is an automotive instructor and author whose work with the U.S. Environmental Protection Agency, Society of Automotive Engineers, National Automotive Service Task Force, Council of Advanced Automotive Trainers, *Motor Age* and *Motor Age Training*, *PTEEN*, and the not-for-profit Technicians Service Training has made him nationally recognized in the automotive repair industry. G. is an ASE World Class Triple Master Technician Auto, Truck & School Bus, L1, L3, F1, A9, X1 C1.

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MACS™ 2023 MOBILE A/C UPDATE

AIR CONDITIONING SYSTEMS ARE EVOLVING INTO THERMAL MANAGEMENT SYSTEMS TO SERVE AS HEAT PUMPS FOR EVS, AND THE EPA CONTINUES ITS HFC PHASEDOWN, CREATING R-134A SUPPLY SHORTAGES.

BY STEVE SCHAEBER // Contributing Editor



It's been about three years since the last "full-sized" annual **MACS event** took place (that was in Nashville, in February 2020). And now that COVID-19 is mostly in the rear-view mirror, things at our 2023 Training Event and Trade Show did finally seem to be getting back to normal.

MACS 2023 took place at Nashville's Gaylord Opryland Resort, where we had 31 speakers teaching 41 hours of mobile A/C classes over three days. This year we focused more on A/C for the EV market, as many OEMs indicated many more EV models being offered in the coming years.

Now, I know what you must be thinking; we've heard all this before, "The EVs are coming, the EVs are coming." And we have the same thoughts. But when you investigate the data, there are clear lines that can be drawn along the path to the ever-increasing numbers of EVs on the road.

Reading into the data

Each year at the MACS event, we get an update from the industry's two largest data suppliers, Experian and IHS Markit (now a part of S&P Global), and each one told a similar story with

graphs and charts to back them up. In 2020, hybrids made up around 3.4 percent of new registrations, which increased two years later to 7.4 percent. Pure EV registrations made up 1.8 percent in 2020, which increased to 3.1 percent in 2021 and 5.6 percent in 2022. That's a 49.4 percent increase in just 1 year!

Sure, those numbers are still small in comparison to the overall market, but they indicate... they're coming!

So, why do we care about EVs in the mobile A/C space? Because "air conditioning systems" are developing into "thermal management systems."

Traditionally (up until Nissan integrated a heat pump system into the 2013 Leaf to increase driving range during the winter months), the sole reason for air conditioning systems in light-duty vehicles was to provide passenger comfort. But as the industry transitions to electrified vehicles, the "air conditioning" side of the system will have to do double-duty. Besides cooling the passengers, it will also have to cool the battery and power electronics, too.

But batteries don't just like to be cool in the summer, they also like to be warm in the winter (just like people) and a heat pump system is ideal for doing this double-duty job.

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Refrigerant update

One of the presentations we saw was the annual update from the US EPA. There's always a lot for them to report, but this most recent one was packed with new regulations and proposals, thanks to the US AIM Act, which took effect in December 2020.

Officially known as the American Innovation and Manufacturing Act, AIM gives the EPA new authority to regulate the refrigerants we use in mobile A/C systems while also directing the EPA to issue new rules that restrict the use of Hydrofluorocarbons (HFCs).

What does this mean to aftermarket service and repair shops? A lot! As we reported last year, probably the biggest change we've seen so far is in the supply and price of refrigerant. You may remember that AIM directs EPA to phase down the production and consumption of HFCs across the American economy, and for us, that means less R-134a is going to be available. This alone is one of the biggest drivers in the price increase we've seen, but it's not over yet.

The next phasedown step

This chart shows the HFC phasedown schedule, which began at the end of 2021 (**Figure 1**). For the years 2022 and 2023, there was a 10 percent reduction in HFCs, which again is what drove the initial shortage and subsequent price spikes in refrigerant. Going forward, there is another stepdown which takes place in 2024. This will reduce HFCs by a further 30 percent (or a total reduction of 40 percent).

What's that going to do to price and supply? We can only speculate that we're going to see a similar reaction in the market as we saw in 2021. Distributors, jobber shops, wholesalers, and retailers are likely to be cautious with their sales to

preserve availability, while also being super price conscious, as fluctuations are likely to occur. If things go the same way as they did last time, price and supply issues should settle out somewhat by summer 2024, but leading up to that the waters may be choppy.



AIM Act overview

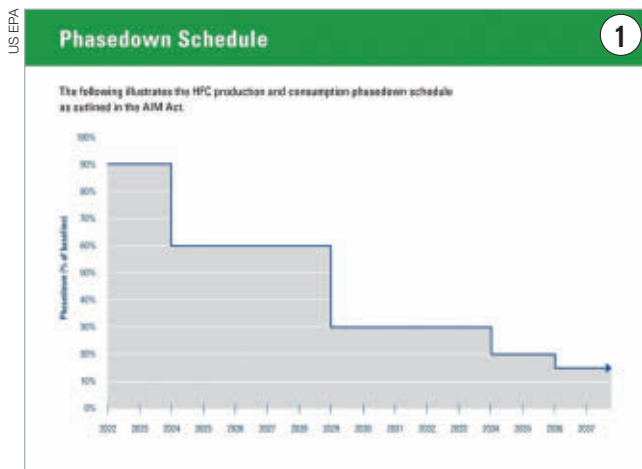
The goal of the AIM Act is to phase down HFC production and consumption by 85 percent (by the year 2036). Within the category, 18 HFCs are listed as regulated substances (R-134a is just one of them). AIM authorizes EPA to address HFCs through an allowance allocation and trading program. It also facilitates sector-based transitions to next-generation technologies (in our case, R-1234yf) through restrictions on HFCs. Passenger cars and light trucks have pretty much all converted over to "yf" during the last 10 years. The rest of the mobile A/C industry is still using HFCs, but that is likely to change soon.

The EPA proposes a GWP limit for five MVAC subsectors

The mobile air conditioning industry has only seen R-1234yf refrigerant being used in passenger vehicles and light-duty trucks. And although MACS has reported on other subsectors which have been granted permission to use "yf" (such as medium-duty trucks, complete heavy-duty vans, and certain agricultural and construction equipment), to date, we have only seen R-134a being used in these systems. But when this new EPA rule takes effect, we're likely to see these vehicles switch over to using R-1234yf.

The U.S. EPA issued a new notice of proposed rulemaking (NPRM) on December 7, 2022, which proposes to limit the global warming potential (GWP) of refrigerants used in newly manufactured vehicles in five subsectors of motor vehicle air conditioning (MVAC). These include:

- Light-duty passenger vehicles
- Medium-duty passenger vehicles
- Heavy-duty pickup trucks Complete heavy-duty vans



SHOWN IS THE EPA PHASEDOWN SCHEDULE for HFCs.

The first reduction of 10 percent has already taken place (2021 and 2022), with the second step just a few months away. In 2024, we'll see a 40 percent reduction, which is cause for concern with the price and supply of R-134a refrigerant.



2

IN THE U.S., PASSENGER CARS (like this 2022 Ford Mach-E) and light trucks have already switched away from R-134a and are now using R-1234yf (with only a few exceptions).

HEAVY-DUTY PICKUP TRUCKS like this 2018 Ford F-350 are allowed to use R-1234yf but are still being filled with R-134a. When this new rule takes effect, they're likely to use only "yf."

- Nonroad vehicles (agricultural and construction equipment)

The proposed GWP limit is 150, which is the same limit imposed by European regulators (and by the Kigali amendment).



3

What does this mean for each subsector?

On the light duty side, it means the EPA is requiring car makers to continue using a low-GWP refrigerant in their MVAC systems (**Figure 2**). Almost every passenger car and light truck being sold in the US today (with only a very few exceptions) has already switched away from R-134a and is now

using R-1234yf. For those last holdouts, they'll be required to switch away from HFCs by the 2025 model year (which for some, means early 2024). For the remaining subsectors, it's going to force a change.

Medium-duty passenger vehicles, heavy-duty pickup trucks, and complete heavy-duty vans, (according to the EPA) are considered to be limited types of heavy duty vehicles (**Fig-**

"News that techs can use."

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VOL. CLXX... No. 1,211

MONDAY, March 13th, 2023

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THE TORQUE IS OUT THERE



Saturday Morning March 11th at Crazy Tom's Auto Repair photo courtesy of Dale Pepparoni

"Take us to your torque converter!"

Shocker! Aliens eat auto parts.

LUFKIN, TX -- An alien spacecraft arrived at "Crazy Tom" Vierlington's Auto Repair Shop in Lufkin last Thursday insisting they wanted to eat an entire 2012 Buick. "I told them Martians what they could do with that idea," Crazy Tom protested. After some tense negotiations, the aliens agreed on a hubcap from a '98 Pontiac, and an ETE remanufactured 6R80 transmission, which they consumed on the spot. "Them Martians know their transmissions, ETE's are by far the best," Tom exclaimed. For his "end," Mr. Vierlington received a jar of guava jelly and a certificate for a free alien probe. (Story continues page 12)

It's Alive!

Following torque converter transplant, transmission becomes undead, sings show tunes.

MILWAUKEE, WI -- Mad Scientist and grave robber, Dr. Noah Rickunstein, was stunned when a dead transmission "core" he'd recently dug up came back to life and started singing It's a Hard Knock Life. "It was unreal, said Dr. Rickunstein, that transmission was kaput, but after a bit of reman magic, the thing won't stop! Three years, unlimited miles, that 6L80 keeps humming along. It's like new, only better." (Story continues page 38)

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STEVE SCHAEFER



INCOMPLETE HEAVY-DUTY VANS are not yet approved for yf, but if they're built "complete" from the factory (like this 2020 RAM 3500 ProMaster), they are allowed to use it. However, they are all still using R-134a.

THE EPA FINALIZED A RULE IN 2021 allowing the use of R-1234yf in certain agricultural equipment (like this Massey Ferguson WR9840 windrower). While they still use R-134a, when this rule takes effect, they, too, are likely to switch to "yf."

5



ures 3 and 4). EPA previously allowed the use of "yf" in these vehicle types, but so far none are using it.

The reason is cost. Most of these vehicles are vocational, meaning they're used for work. This makes them very cost-sensitive because like all things that go into "making something," cost matters. Cost matters to the company buying something to be used in the product or service they provide, and cost matters to the customer and the end-user, who ultimately purchases said product or service.

Also, there has not been a driving force making the manufacturers change.

For LD vehicles, the EPA tried to require OEMs to switch away from R-134a (a few years ago), and while their plan didn't work out, it wasn't the driving force, anyway; CAFE credits were. There are no such credits outside of light-duty, so there has been no reason to switch (until now).

It's a similar situation regarding non-road vehicles, such as agricultural and construction equipment (**Figure 5**). This category is also broken down into a few types, which include:

- Agricultural tractors greater than 40 HP
- Self-propelled agricultural machinery
- Compact equipment
- Construction, forestry, and mining equipment
- Commercial utility vehicles (UTVs)

Just as with the "limited types of HD vehicles", OEMs have also been allowed to use "yf" in these systems for some time now but have yet to do so. There has been no requirement, no

credits, and of course, like always... cost matters.

It's important to note that the EPA does not require the use of any specific refrigerant. All they're saying is that beginning with the 2026 model year, OEMs will no longer be allowed to use a refrigerant with a GWP of more than 150.

And in case you were wondering, the proposed rule includes vehicles being manufactured in the U.S. exclusively for export, along with electric vehicles. This includes light-, medium- and heavy-duty hybrids, plug-in hybrid electric vehicles, fully electric vehicles, and fuel cell vehicles.

Also please note, that there has not yet been a proposal to limit the use of HFCs in other types of HD vehicles, such as class 4-8 trucks, buses, school buses, and specialty vehicles. We do know, however, that a submission for the Significant New Alternatives Policy (SNAP) program is being worked on at the moment to evaluate possible substitute refrigerants

for these vehicles. <https://www.epa.gov/snap/substitutes-refrigerant-and-air-conditioning>

What are the benefits of this proposed rule?

The EPA estimates that the proposed rule (if finalized as written), would result in significant reduction of greenhouse gas GHG emissions while providing savings to American consumers and industry through energy efficiency gains and lower-cost alternatives. The proposal would result in cumula-

tive GHG emissions reductions ranging from 134 to 903 million metric tons of carbon dioxide equivalent (MMTCO₂e) through 2050. The EPA estimates that the cumulative net benefits of this proposed action are between \$13.1 billion to \$56.3 billion from 2025 through 2050. These numbers are for the entire HFC marketplace and are not just limited to MVAC. Thanks for reading!

Want to learn more about this proposed rule? Here's a link to it on EPA's website:

<https://www.epa.gov/climate-hfcs-reduction/technology-transitions>

For more information about MACS, please visit our website:

<https://macsmobileairclimate.org/>



WITH THE 2024 HFC PHASEDOWN calling for another 30 percent reduction in HFC production, speculation of price hikes and supply of R-134a are in discussion.



STEVE SCHAEBER is the Manager of Service Training for the Mobile Air Conditioning Society (MACS) Worldwide and Technical Editor of ACTION Magazine. Schaeber has worked as a technician, manager, instructor and author in automotive, HD trucks, off-road, packaging & education since 1989. He holds two Auto Tech degrees from Penn College, is a PA Safety & Emissions Inspector & Instructor, is ASE Master certified, and is also a MACS Section 609 Certified exam proctor. You can reach Steve at: sschaeber@macsmobileairclimate.org

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NAVIGATING REPAIR INFORMATION: IT'S FOR MORE THAN JUST R&R

EVERY TECHNICIAN NEEDS THREE THINGS
FOR ACCURATE, EFFICIENT DIAGNOSIS AND REPAIRS.

BY BRANDON STECKLER // Contributing Editor

**GOOD
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**FUNDAMENTAL
KNOWLEDGE**

**PROPER
TOOLS**

1

THE LEGS OF THE STOOL
KEEP IT UPRIGHT, just like proper tooling, an understanding of the basics and adequate repair information keeps a technician working successfully.

Many of you will roll your eyes, as I have said this repeatedly. Every technician needs a fundamental understanding of how things work: the appropriate and capable tooling to evaluate the components and the systems they make up, and last (but certainly not least), access to accurate repair information.

Like a three-legged stool, all three legs are necessary to be present if that stool is going to hold us upright. Well, imagine that same stool representing a day in the life of a technician. Then picture the legs of the stool representing the three variables mentioned above. If any one of the legs (the variables) is missing, it's likely we will take a fall (**Figure 1**).

Most of my articles indeed revolve around the functionality of the system components and the tools and techniques to evaluate them, but today we will focus on the third variable, repair information. Repair information serves to be much more than just remove & reinstall instructions. It can and does

offer a lot more:

- Torque specifications
- Programming/adaptation requirements
- Diagnostic flow charts/system description
- Wiring diagrams
- Component locations/Exploded views

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- Connector views
- Expected values
- Examples of known-good oscilloscope waveforms

Each one of these specific areas serves a purpose and aids in my diagnostic approach. We will discuss the significance of each of them below.

Torque specifications

As simple to reference as it may seem, many technicians do not take the time to read instructions for proper disassembly and reassembly/installation of the components they are attempting to fix. Certain repairs are not as critical as others, but all fasteners are assigned a torque specification for a reason. Leaving a component's fasteners too tight or too loose can have some devastating effects.

Understand that the torque applied to the fasteners is not the end goal. The torque we apply with our wrenches or ratchets/sockets creates the desired clamping force. This clamping force is the critical component. The applied torque (to the fastener head) simply infers how much clamping force will be produced. Something as simple as applying a film of oil to the threads of a bolt will allow more of a clamping force for the same amount of applied input torque. This can cause components to deform and be permanently damaged, leading to oil leaks and such. This of course could cause damage to engine internal components, for instance (Figure 2).

Programming and adaptation requirements

With the advancement in technology over the last 5-10 years, along with the capabilities we have been afforded in the aftermarket via the implementation of the Massachusetts Right to Repair Act (although it's far from perfect), we have access to OEM-level software and tooling. However, we do not necessarily have the same capabilities.

For instance, Ford Motor Company currently uses two forms of software platforms. IDS (Intelligent Diagnostic Software) was designed for dealership technicians and supports the full functionality of diagnostic coverage and programming for all its vehicles. The other system, known as FJDS (Ford J2534 diagnostic Suite), is a flexible diagnostic suite designed to work with J2534 devices and exists to satisfy the R2R mandates, a less expensive option (Figures 3+4).

Not taking the time to read and understand what the tools exist to provide could leave you in one heck of a predicament. For instance, a common scenario would be accepting a job for a replacement of a restraint control module (RCM). Having the less-expensive FJDS available would certainly allow you to perform that job successfully. However, it's the post-flash routine that must occur to get the vehicle back on the road safely. Unfortunately, the FJDS can't do that post-flash routine. Unless you are equipped with IDS or something else capable, you are stuck. Ac-



FORD IDS LAUNCH SCREEN



FORD FJDS LAUNCH SCREEN

cessing proper repair information will alert you to what it takes to do the job in its entirety and correctly the first time.

Diagnostic flow charts

I once heard a fellow instructor describe diagnostic flowcharts as being good for one thing: toilet paper. As funny as that is, I can't say that I agree (well, not entirely). However, I do believe I know what he was referring to.

Many technicians will follow a flowchart step-by-step. They do so somewhat blindly (as in, not understanding the steps, simply following orders). You have likely been disappointed with the results on occasion. Many times, you find yourself at the bottom of the chart with no resolution to the symptom in sight. This is a very common occurrence.

Those charts were written to help guide a technician to repair most situations on most of the vehicles (under factory warranty) 70 percent of the time. The engineers cannot think of every possible failure scenario. I have a solution, though.

Follow the flowcharts and understand what each step is trying to determine. Combine that with information about system description and operation. The flowcharts offer great supple-

2

PROPER TORQUE is more critical in some jobs. Failure to follow torque specifications and tightening sequences can lead to a minor noise, a pesky fluid leak, or even catastrophic failures.



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5

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Terminal side of male terminals

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Is there between 2.0-2.7 Ohms at room temperature?

YES- Go to Step 11

NO- Go to Step 23

ALTHOUGH NOT ALWAYS HELPFUL to lead a technician directly to a proper diagnosis, the flow chart does contain pertinent data like resistance specifications that can aid you in developing your own diagnostic game plan.

mental input as well (like resistance values). If you are using this strategy with the three-legged stool approach, you create your own flowcharts that are far more practical and with less wasted time than those typically found in the repair manual (Figure 5).

Wiring diagrams

The wiring diagrams provide the overall view of the system, and I advise you to reference one before beginning troubleshooting any system, component, or circuit. Each one of these systems (when compared to other vehicles) may produce a similar outcome, but how that goal is accomplished varies between vehicles. The wiring diagram will allow us to see all the players in the game, decide where to make our preliminary tests for analysis, and just as important, prevent us from spending unnecessary time testing areas or components of the circuit we don't need to be testing.

When possible, I like to divide and conquer a circuit. Picture a string of six light bulbs in series. One bad connection will leave the whole string inoperable. Testing for available voltage at bulb

6

A COMMON TECHNIQUE is to divide and conquer. Splitting a circuit means beginning testing in the middle. In essence, in one simple step, you are eliminating half the circuit which means no unnecessary testing.

#4 (about halfway through the string of bulbs) tells me the circuit fault is ahead of my test point (between bulbs 3-6) and not behind me (between bulbs 1-3). Continuing to split the circuit ahead of my current test location will be carried out until the fault is located (Figure 6).

Component location/Exploded views

To be used in tandem with the wiring diagrams are component locations and exploded views. Beginning first with the importance of component locations, being aware of where a component is will certainly help you to develop a logical diagnostic approach.

Considering the light bulb scenario in figure 6, the test itself is easy. However, I certainly would not be looking to split the circuit right down the middle if I had to disassemble the instrument panel to access it. I will be looking for an easier place to initially access it. If my logical testing guides me to then disassemble the dash, at least then I will have justification to do so.

Exploded views offer similar information, and for the same reason.

Being able to see exactly where a component is located offers a tremendous benefit for how we are going to access it for testing (keeping in mind, we are not looking to remove it/replace it, assuming I was looking to access a connector for testing.) However, that connector is located within the driver's seat beneath the cover. I don't wish to disassemble the seat entirely because I'm just testing a circuit. Exploded views can assist (Figure 7).

Connector views

There isn't much to say about connector views, as they don't come in handy as some of the other pieces of information. However, they are an absolute life-

7

Driver's Seat Assembly

THIS EXPLODED VIEW (or in this case, see-thru) offers insight to exact component locations. Knowing how to access a component will help you decide if it's the best place to test or if there may be an easier access point.

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saver when you find yourself in need. Some as simple as a two-way connector can be troublesome. As when someone rewires the connector terminals in a reversed fashion, inadvertently. This is especially true because some faults like this appear to defy logic.

This PCM connector view allowed me to see how the connector terminals were arranged. Terminal #3 is in red and represents the ignition supply voltage. Just beneath it, in purple, is the terminal that carries the control signal to an ignition coil (**Figure 8**).

Water ingress created a resistive short between the two terminals. This caused ignition voltage on the coil control circuit (anytime the key was on) and led to the coil melting down (**Figure 9**). Any easy find with the proper information available to you.

Expected Values

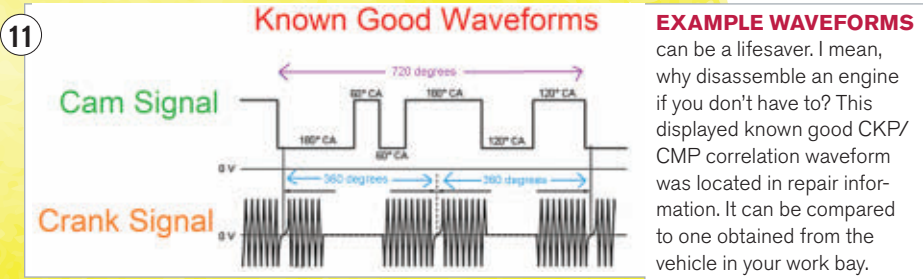
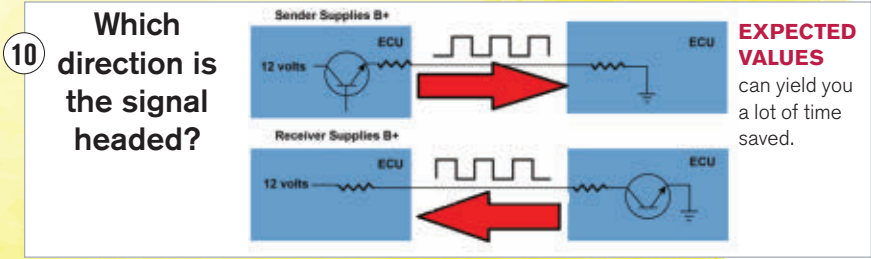
On occasion we will test a circuit and not know what it is we should expect to

Terminal	Color	Terminal Name	Description	Signal
1	Red	IGNITION VOLTAGE	Ignition supply voltage	Ignition voltage
2	Green	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
3	Purple	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
4	Blue	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
5	Black	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
6	White	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
7	Yellow	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
8	Orange	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
9	Light Blue	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
10	Dark Blue	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
11	Light Green	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
12	Dark Green	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
13	Light Purple	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
14	Dark Purple	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
15	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
16	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
17	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
18	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
19	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
20	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
21	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
22	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
23	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
24	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
25	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
26	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
27	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
28	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
29	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
30	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
31	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
32	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
33	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
34	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
35	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
36	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
37	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
38	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
39	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
40	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
41	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
42	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
43	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
44	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
45	Light Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
46	Dark Blue-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
47	Light Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
48	Dark Green-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
49	Light Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal
50	Dark Purple-Gray	IGNITION COIL COMMAND	Ignition coil control signal	Ignition coil control signal

CONNECTOR VIEWS AS DISPLAYED HERE can help see how the connector is configured. It was this picture that helped explain why I was measuring the voltage on a circuit that shouldn't have been energized.



WATER INGRESS created a resistive path for electricity to flow between a voltage terminal and the control circuit of an ignition coil.



see. For example, a communication circuit between two computers may offer a 0-5V square wave. However, suppose the communication circuit is faulty. Testing revealed the circuit is displaying a steady 200mV. The question is which of the two computers outputs the voltage and which manipulates it (**Figure 10**)?

This issue is difficult to determine but an expected values chart will identify the circuit, the state of the ignition key (on/off/run), and whether to test with the connector mated or removed. This becomes particularly handy in situations like the one above. Ultimately it will help determine which of the two computers is at fault. Otherwise, you would be forced to take your best guess.

Known-good oscilloscope waveforms

Many manufacturers such as Toyota have these lab scope captures within their repair information system. These captures that feature crankshaft position sensor signal/camshaft position sensor signal correlation can save a ton of time and often lead to a diagnosis of engine timing issues without ever having to disassemble the engine before repair. They're truly a game-changer (**Figure 11**).

Why this is so important is that vehicles are getting more complex as time passes and at some point, we are going to need to know what a normal capture looks like so we can recognize a faulty one when new see it. Often, we are the pioneers, meaning no such known-good capture exists in your circle of connections and you will have nothing to compare to. That capture by itself and with nothing to compare to is useless to you.

If this data is published in repair information, there is a good chance of identifying a fault positively without having to first disassemble the engine. So, as you can see, repair information is not what it used to be. Take the time to understand what your repair information can do for you. Leveraging the power of accurate repair information can and will increase your accuracy and productivity in the work bay. *ZZ*

BRANDON STECKLER is the technical editor of *Motor Age* magazine. He holds multiple ASE certifications. He is an active instructor and provides telephone and live technical support, as well as private training, for technicians all across the world. bsteckler@endeavorb2b.com

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BY BRIAN HUNNICUTT // Contributing Editor

What was your diagnostic charge when the first computer was put in a mass-produced vehicle in 1981 because of fuel injection replacing carburetors? What is it now? How many computers were in a vehicle in 1981? How many are in a standard vehicle now?

There are places out there that will read the check engine codes for free, and there are customers who think you should not charge to check their vehicle. Some techs think that if you charge too much, you are ripping off the customer.

I always ask, who gets to define that? When is too much too much? Let me be clear; I never endorse stealing on any level. This is such an emotional topic, and people tend to overreact. Please

read this entire article before making up your mind.

Not all check engine lights are the same

You need different check engine diagnostic levels because not all check engine lights are created equal. Most shop owners and techs already know this, yet some businesses still insist on charging one price. It might make sense if check engines were all created equal to begin with, but that's not the case.

Picture a Cadillac that comes in with a check engine light. It takes five hours for a competent A tech to diagnose it. Since you have different diagnostic levels, you charge five hours to the customer — they buy our service, and we repair their car. They leave happy. Three weeks later, another Cadillac, like before, comes in with a

check engine light. You give it to the same tech, and it has the same code as the previous Cadillac. The tech jumps ahead, bypasses four hours of documentation he went through on the other Cadillac, and checks to see if it is the same problem. It is — so it only takes an hour to diagnose. In this case, we should still charge appropriately for the job.

Your techs are valuable but not perfect

Your techs are not perfect, and they don't have to be. So stop holding your A techs to such high standards when it comes to diagnostics. The fact that they are showing up ready to do the job is enough for them to be compensated — regardless of how simple you might consider the check engine diagnostic to be.

The auto repair industry is one of the

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only industries where the better techs get at their job, the less they are paid.

‘The accumulation of knowledge’

There is a concept called the ‘accumulation of knowledge’ that must be considered. Knowledge has value; to prove it, consider the university system in the United States. The average cost per year per student is around \$35,500. For a four-year degree, it costs \$142,000. Rarely do students have this kind of money, so they borrow it, or someone else pays for it because education in this country is considered valuable. How can they sell a four-year degree for that much money, and we can’t justify charging properly to diagnose someone’s car that we did not break, don’t drive, didn’t buy, and are not responsible for?

Find, get, and keep your best techs

We have been justifying free diagnostics to our A techs for a really long time, and it’s time we stop. We must start treating our best techs as such. If you want to find, get, and keep the best techs, then you must create a supportive and profitable environment for them to work in.

I have always respected what the techs could do. The best diagnostic tech I ever had wanted eight hours to diagnose a car; I laughed and let him know that I would not rip off my customers that way. At most, this vehicle would take him only two hours to diagnose, so I could graciously see myself selling three hours for him. He laughed and told me to give it to someone else.

I had three master techs at that time, so that is what I did. After six hours, the A tech I gave it to asked for guidance from the first one. With the first one pointing him in the right direction, it still took over eight hours to do it. I had to laugh at myself. From that moment on, I had no problem making people pay to have their vehicle diagnosed.

How you will charge and what you will charge is up to you for obvious reasons.

I will leave you with this: do you want to find, get, and keep the best techs? **Y**



BRIAN HUNNICUTT, CEC, PFP, has been in the automotive industry since 1978 and is an executive coach for the Automotive Training Institute (ATI). Often called in as a troubleshooter, Hunnicutt is an innovative thinker with a history of reviving failing stores, consistently breaking sales records and exceeding expectations. He helps auto shop owners effectively apply successful, practical methods and systems, rather than theoretical techniques. ATI’s 34 full-time, certified coaches have helped ATI’s members earn over \$2.5 billion in return on their coaching investment since ATI was founded.



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ARE YOU DOCUMENTING YOUR REPAIRS

WHETHER YOU'RE A SERVICE WRITER, TECHNICIAN, OR OWNER, THE WORDS WE ALL DREAD TO HEAR ARE, 'EVER SINCE YOU,' OR, 'I'M STILL HAVING THE SAME PROBLEM.'

BY CHRIS FARLEY // Contributing Editor

It's amazing how a customer can bring a vehicle in for one problem but be oblivious to others, such as:

- Brakes grinding
- Strut blown-out
- Engine fluids leaking and burning on the exhaust
- The Christmas tree of lights on the dash



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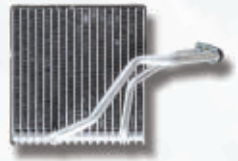
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RADIATORS



BLOWER ASSEMBLIES



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WINDOW REGULATORS



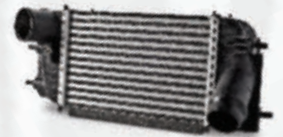
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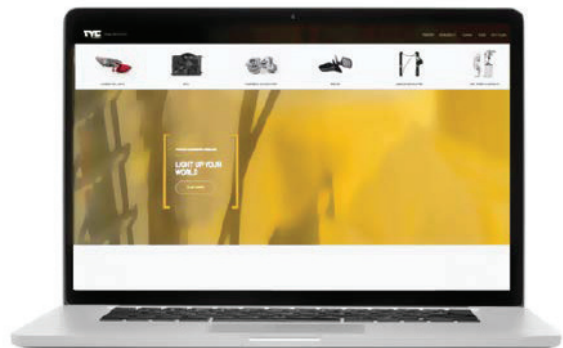
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But the minute you fix that “one problem,” suddenly these complaints appear. “My car was fine (except for the belt squeak) before I brought it in.”

I know not all customers are like this, but it only takes one! The best way I have found to counter this or protect against this is through documentation. There will still be a few random and completely out-of-the-blue situations that somehow get by, but these processes will help keep them to a minimum.

Digital inspections

Digital vehicle inspections (DVI’s) have been a huge advancement, not only as a selling tool but as a tool for documenting vehicle condition (both good and bad findings) for both the shop and customers. Not all shops have accepted and incorporated this tool into their shop, sometimes because of the perceived cost, and sometimes because they like to do things the way they always did.

As far as cost is concerned, the value of the report for both records and as a sales tool far exceeds the cost of any of these systems. Not to mention how this brings a new level of professionalism to your shop. You do not go to a doctor and have multiple tests performed without seeing results, scans, and reports, yet we want our customers to take our word that we ran tests and concluded that they need an engine (and the bill will be \$12,000). I am not saying all customers will require this, but a report of some type (showing the results of the test(s) performed) protects all parties involved.

We cannot forget that the technicians are the experts. The customer is bringing his or her vehicle to us for diagnosis, repairs, or maintenance. The customers may not like what we find, or they may not believe the risk in neglecting a prescribed repair, but if we do not document and present our findings to

the customer, then we are leaving ourselves at risk for a legal course of action if an accident were found to be related to the said repair. Without having some kind of record, it’s left to the “he said/she said” situation, and way too often, that does not end in our favor. Whether you choose a paper checklist (Figure 1) or a DVI report (Figure 2) the choice is yours, but documentation needs to be kept on file.

This is not an article on how to properly perform a vehicle inspection; there are plenty of resources out there for that. This is more of a reminder of certain steps that must be taken and things to look out for to help you get paid properly while looking out for your and your customers’ best interests.

A thorough inspection

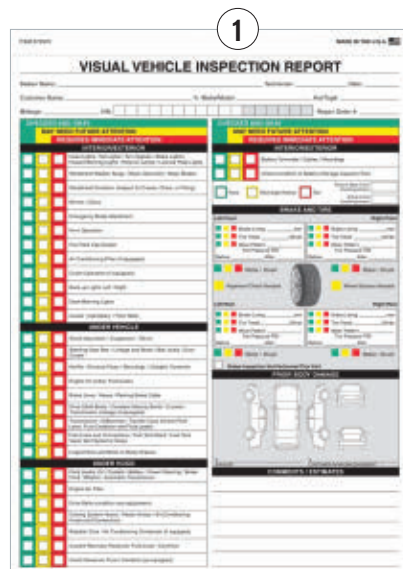
I will start with the mechanical side of the inspection. Depending on the initial reason the vehicle was brought in (if not a safety concern), I begin with a test drive, paying mind to the performance of:

- Suspension
- Brakes
- Driveability issues
- Suspicious noises.

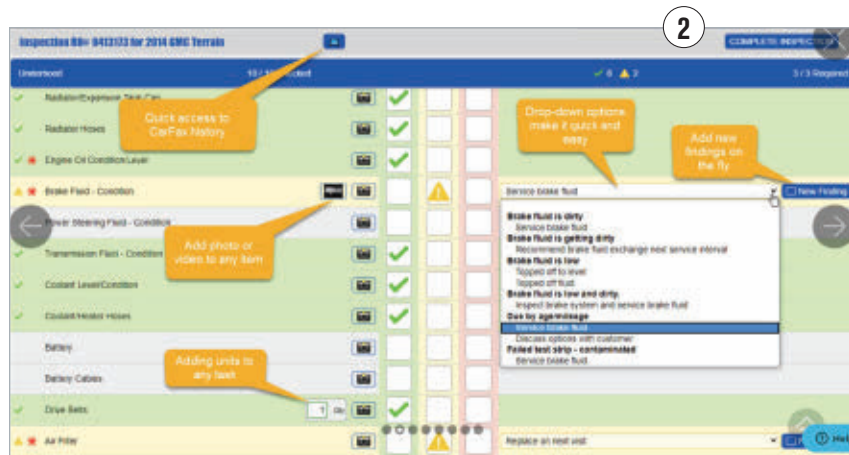
Once in the shop, a visual inspection of the entire vehicle (top and bottom) needs to be performed, noting any issues found along with photos of their

deficiencies. It is important to document the condition of all four wheels when checking brakes and suspension. Make note of any excessive rust or corrosion, which may require additional labor charges for removal and/or cleanup. All fluid leaks need to be noted. The car may be in for an oil/filter service, but if the transmission is leaking and the customer then sees fluid on the ground (after the oil service) you know what the first thought is going to be.

Always keep in mind that failed or worn components can cause other issues. For example, a leaking steering



AN EXAMPLE OF a traditional paper vehicle inspection.



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rack can starve a power steering pump of fluid and cause internal pump wear. Look at the whole picture and anticipate the potential repercussions. Although the customer gets to decide whether or not to perform the repair, it's our job to present the whole picture and educate them.

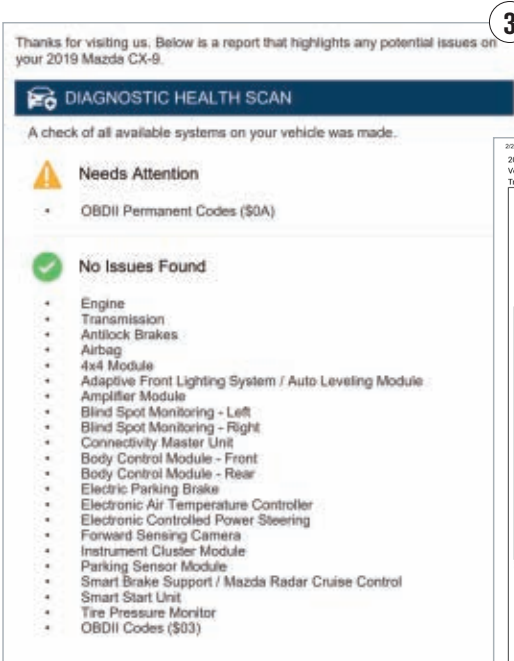
The pre-scan

I believe that every vehicle coming in for repairs or maintenance should get a full vehicle pre-scan. This can be added in as a charge with other inspections or done as a courtesy. This will enable you to make a better assessment of the vehicle, protecting you from a pending issue, or serving as a tool for selling needed diagnostic time or repairs.

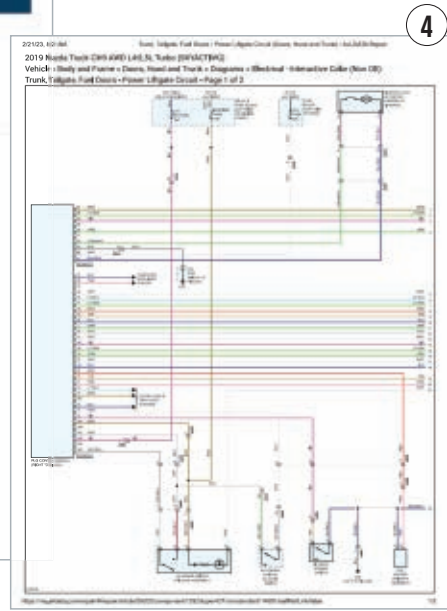
There will always be complaints about the cost of a capable scan tool and the time it takes to perform the pre-scan, but honestly, you can get a scan tool capable of performing this scan for a few hundred dollars and see a full return on investment in the first week (if not the first day) of implementing this procedure.

As far as the time it takes to perform the pre-scan, on most Asian and domestic models this can be accomplished in the time it takes to pull the car into the shop or to set the lift. Some of the Euro models can take longer, but you can usually bet there will be numerous codes stored in those vehicles (representing an opportunity for needed service, or at least a way to show those issues were there before the car arrived at the shop). This can also be performed by your service writer upon reception of the vehicle, and if there are codes found, some level of diagnostics can be sold before the work order is even written (and the pre-scan attached for the technician).

The mistakes I commonly see are



3 PRE-SCAN REVIEW of the list of modules; no power liftgate.



4 TAKE NOTICE OF THE DATA LINES coming out of the liftgate module. These indicate the computer communicates on a network and may be accessible with the scan tool.

on the electronic side. The most common scenario is a customer comes in with a warning light on and the tech performs a scan of only the module related to the warning light but suggests a repair or adjustment from that minimal amount of data. Just about all scan tools will perform a full vehicle scan on vehicles that allow it (depending on the year). There is no excuse not to scan the entire vehicle. Too often, a problem housed in one system will affect another seemingly unrelated system and illuminate a warning light. That said, you must know your scan tools' limitations and operation. I will explain this below.

Example case study: Mazda CX-9

The vehicle was at a body shop (post-repair) with a power liftgate that would not function. The vehicle had a new liftgate installed and I was told it would only open with the manual release the whole time the vehicle was being repaired.

It's possible something could have happened during the accident; maybe a wire was severed, or a component got damaged. However, I always begin with

a pre-scan (**Figure 3**). This is where knowing your scan tools' limitations and operation comes into play.

My scan didn't reveal any faults (no codes, just like the shop owner told me). However, knowing this is a power liftgate, I figured a module (computer) was likely managing its operation, yet it didn't show on the scan report. A quick look at a wiring diagram showed a module with CAN communication wires going to it (**Figure 4**).

Many scan tools out there (when they perform the full vehicle scan) test for all modules that could be present in the vehicle (as an option), and when they don't respond (when the scanner tries to communicate with them) the tool assumes the optional module isn't present and excludes that module from the list. Some scan tools will list modules that did not communicate at the bottom of the report (which will include all the optional modules that could have been installed).

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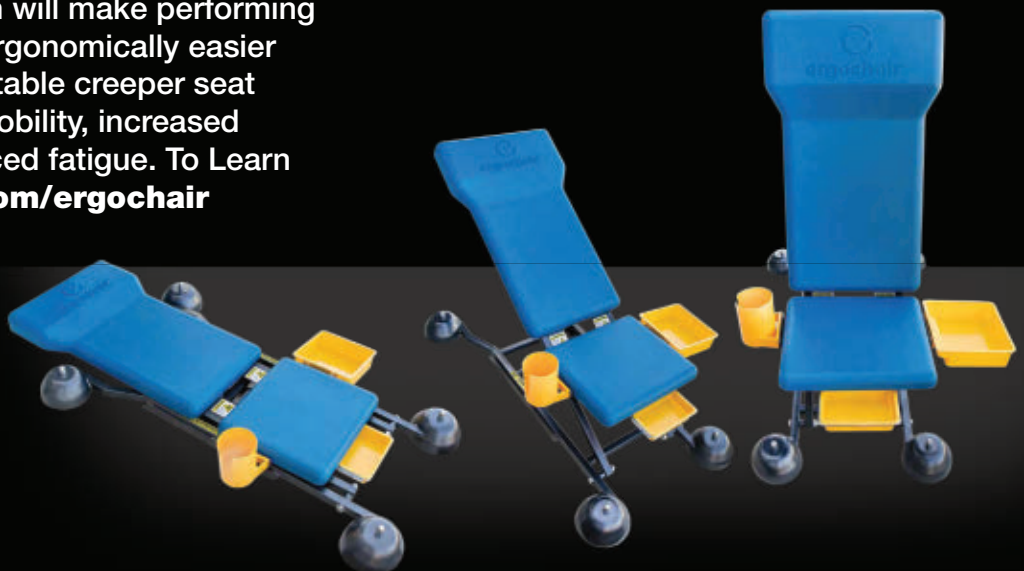
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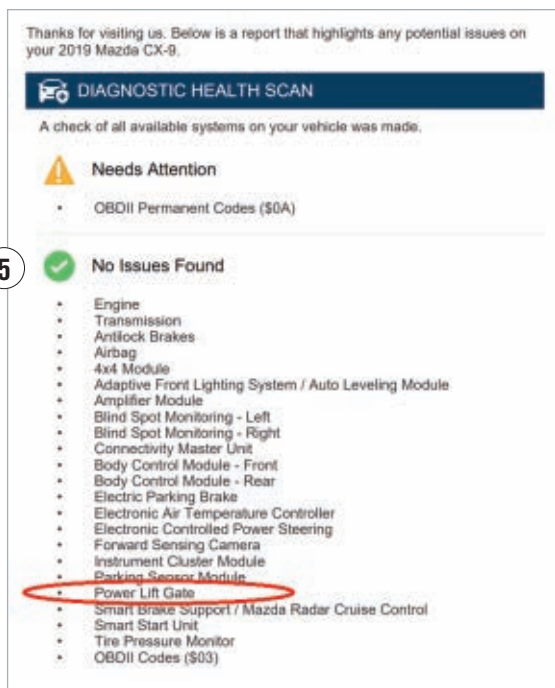
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I then asked to see the shop's pre-and post-scan of the vehicle (which was done with a different brand scan tool) but the liftgate module was missing from that post-scan as well. However, when reviewing the pre-scan (when the vehicle arrived) wouldn't you know, the liftgate module had responded, and with no codes stored. I made a decision to check the supply fuses (which tested "good") then started removing panels to gain access to the module for testing.

When I accessed the liftgate module, I performed a quick visual inspection of the connectors for proper fitment. One of the connectors was found to only be soft-set (not mated completely). I then verified that the liftgate functioned normally.

After reassembly and verifying proper operation, I performed a post-scan and verified the power liftgate module was showing on the list (Figure 5). In this instance, the shop's pre-scan saved me from wasting my diagnostic time (knowing it was communicating before disassembly, it most likely was a connection issue somewhere).



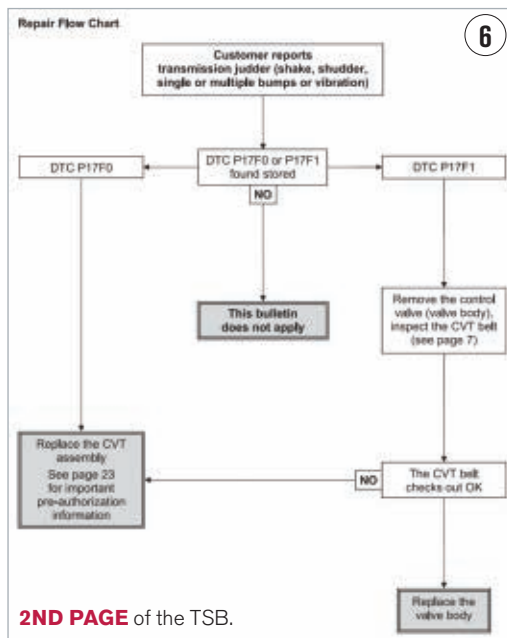
POST-SCAN: look who's back online!

Example case study: Nissan Altima

Suppose this vehicle was in for a routine transmission fluid exchange. You performed the requested service and maybe addressed a few more add-on maintenance items. You are feeling good until two days later when you receive a call that starts with those dreaded words "Ever since you..." The customer says, "The vehicle now has low power and sometimes jerks."

The car comes back, and you scan it, finding the infamous P17F0 for which there is a TSB from Nissan calling for the replacement of the CVT assembly (Figure 6).

Now, this becomes a tough conversation that tests your relationship with the customer. Whether this was a pre-existing condition, or it truly became noticeable after the service, if you had pre-scanned the vehicle you would have been able to better advise your customer of the situation.



shots of the "passed" test results, and the (now) "good" waveforms or readings, showing the improvements after the repairs. If repairs or recommendations ever come into question, these will save you. This is also a good time to create a library of those known good patterns for future use. All these files you save should be placed with the invoice or saved in the customer's files for future reference when needed.

With all this said and done, not only did you provide your customer with better service, but you also got paid for the whole repair. You showed your customer what needed to be repaired, you showed the customer the issues that were causing an extra labor charge, you let the customer know of the upcoming issues you found, and (most importantly) you covered your @\$\$ with documentation. **ZZ**

The importance of step-by-step documentation

One last suggestion is to carry out your documentation through the entire diagnosis and repair process. Some scan tools will automatically save your screenshots to the vehicle's folder (with the scans) but either way, take screenshots of the results of tests you are performing and/or waveforms you capture. Document all your findings and results that led to your recommendations.

When you are done with repairs, save screen-



CHRIS FARLEY is a 25+ year veteran of the industry and the owner and operator of Automedic LLC, a mobile programming & diagnostic

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'COOL' WHEN IT NEEDS TO BE

ELECTRIC WATER PUMPS HAVE CHANGED THE GAME OF THERMAL MANAGEMENT, BUT THEY REQUIRE ADDITIONAL DIAGNOSIS.

BY BRANDON STECKLER // Technical Editor



WELCOME BACK TO ANOTHER EDITION OF "THE DATA DOESN'T LIE," A REGULAR FEATURE IN WHICH I POSE A PUZZLING CASE STUDY, FOLLOWED BY THE ANSWERS TO THE PREVIOUS ISSUE'S PUZZLE.

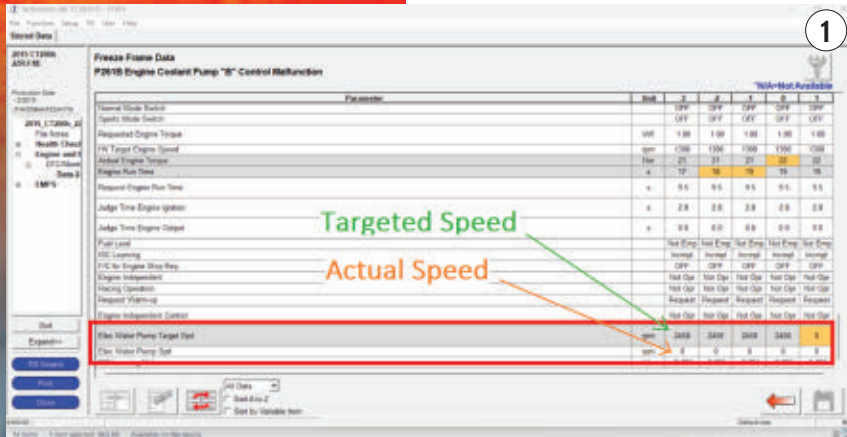
Keeping true to the theme of always trying to find the root-cause fault, and as efficiently as possible, this next interactive case study comes from a great friend of mine, Steve. He was issued a repair order for a 2015 Lexus CT200h with the complaint of the MIL being illuminated. He retrieved the vehicle from the lot, and it operated well under its own power. Steve scanned the PCM for DTCs and noted only one, a P261B "engine coolant pump-B control malfunction."

As with many of today's vehicles, this vehicle's water pump is driven electrically rather than by the accessory drive belt. This allows for more efficient engine thermal management.

For instance, by slowing pump speed, engine warmup time can be shortened. And increasing pump speed can provide better heat transfer under high engine loads.

Capitalizing on what the tools can provide

I've known this guy for a few years now, and he has a knack for extracting data from vehicles in a fashion in which he can make efficient diagnostic decisions without extensive disassembly or wasted time (time spent on unnecessary testing). True to form, Steve navigated the scan tool to view the freeze-frame data. This data can be of great value, as it is recorded at the time of the flagged DTC. Noted in the freeze-frame was the targeted vs. actual



FREEZE FRAME DATA offers insight to the nature of the documented fault and what may not be functioning as designed.

THE AMP PROBE DEMONSTRATES the work being performed in the circuit being measured. Since the current flow is the same anywhere in the series circuit, this measurement can be acquired at the most convenient location to save time and energy.

water pump speed (Figure 1). What should be obvious is that the apparent speed of the water pump is not what is being commanded. Still comfortably seated in the driver's seat, Steve then navigated the scan tool to allow bidirectional control of the electric coolant pump. Giving command to the pump, something very strange occurred. First, Steve noted two distinctions:

- When commanded to run, the water pump made an unusual sound.
- After commanding the pump on (for approximately ten seconds), then off, the pump couldn't be commanded on a second time.

Gaining diagnostic direction

Both characteristics would prove to be noteworthy. This is what led to the test

he performed next to evaluate the condition of the pump. He implemented the lab scope and a current probe (Figure 2). Both these devices worked together to indicate pump operating speed, motor condition, and load on the motor (how much work is being performed). The best part is since this data doesn't have to be collected at the coolant pump, it can be acquired easily at the fuse box.

Referencing the capture of the suspect coolant pump, the information was acquired when the scan tool command was issued. The most notable characteristic was the seemingly low mechanical load on the pump (reflected by the low amplitude of current flow indicated by the amp probe trace).

Expecting approximately 10A, it's clear that something was not quite right, with the pump circuit drawing fewer than 4A (Figure 3). What Steve also noticed is that when the pump failed to operate under command from the scan tool, the coolant pump circuit current registered as zero. This led him to refer to a wiring diagram (Figure 4).

The data doesn't lie

With all the information in front of him, he was faced with deciding how to proceed. Here are some bullet points of what we know to be factual, and

I will ask all of you, diligent readers, for your input:

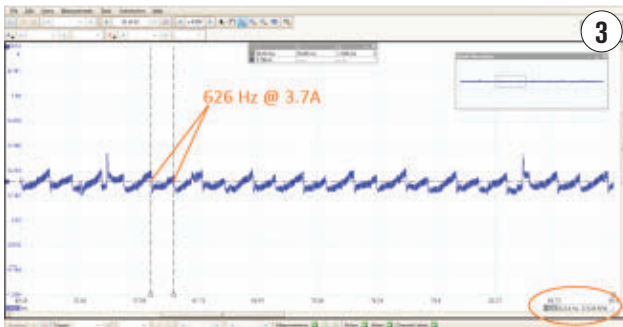
- Initially, the coolant pump functions under scan tool command. However, the coolant pump fails to function on a subsequent command attempt
- During circuit testing (while under scan tool command/no pump operation) voltage is not present at the output side/Terminal #5 of the W/P relay
- The front of the car looked particularly shiny

Putting the puzzle pieces of data together, the answer to both the following questions can be found in the wiring diagrams:

- Why might the coolant pump initially function under scan tool command but fail to function on a subsequent attempt?
- Where is the most logical location for the next test or correction?

Given this information, what would you recommend doing next?

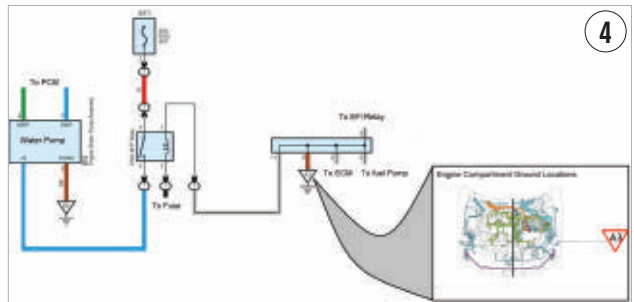
- Replace electric water pump



THE AMPERAGE CAPTURE of the water pump shows very low current flow (little work being performed). The vertical cursors are used to infer rotational speed. This data will be compared to a proper functioning water pump, after the repair is completed.

- Replace electric water pump relay
- Reprogram PCM to correct for faulty software
- Remove bumper for further testing, more unanswered questions

Be sure to read next month's *Motor Age* issue for the answer to this month's challenge and what was discovered!



THIS CROPPED/SIMPLIFIED WIRING DIAGRAM demonstrates commonalities between the water pump and the relay. This helped guide Steve to his next most logical test/location.



BRANDON STECKLER is the technical editor of *Motor Age* magazine. He holds multiple ASE certifications. He is an active instructor and provides telephone and live technical support, as well as private training, for technicians all across the world.

SOLVED: (March, 2023 *Motor Age*) 1994 Ford Ranger 2.3L, Stall unless alternator disabled

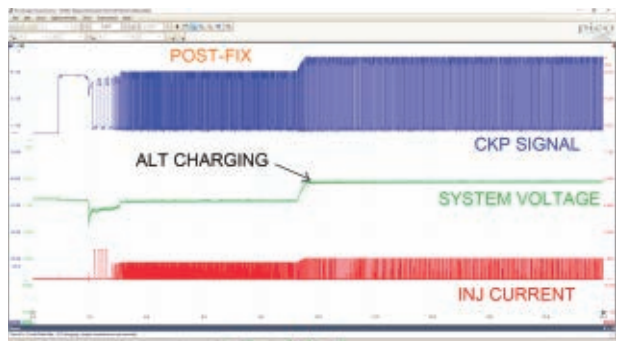
What would you recommend doing next, given the data bullet points in last month's challenge?

- 1) Replace PCM
- 2) Overlay new circuitry for fuel injectors
- 3) Replace ICM
- 4) Attempt to locate known-good scope captures in technician forums

For those of you who chose answer #4, congratulations! This is the most responsible approach. I will be the first to tell you that this was an extremely difficult conclusion to draw. In fact, I now have over eight weeks of research involved, down to the circuit board level of this Ranger's PCM!

I researched forums far and wide and found that the incoming PIP signal (between ICM and PCM) was indeed of lower amplitude on the suspect vehicle when compared to a known-good waveform. So, too, was the incoming CKP signal (from sensor to ICM). In fact, when referencing an "expected values" chart provided by service information, the amplitude of both those signals was lower by almost 5V.

The confusion sets in because (with that alternator disconnected) the engine runs and performs well under all operating conditions, even with the signals toggling between only 0-6.7V. While the alternator is connected/charging, the signals are of taller amplitude. They then attain amplitudes of approximately 0-7.5V (a 12-percent improvement) before the engine suddenly stalls. However, the known-good signals are of approximately 0-12V whether the alternator is connected or not.



THIS CAPTURE OF THE REPAIRED FORD RANGER shows the engine continued to run, even after the alternator began to charge, Proving the vehicle is now finally fixed.

My final decision was to replace the ICM. With the CKP sensor being of a pull-down circuit design (hall-effect sensor), the ICM is the source of the incoming CKP signal's reference voltage, and the sensor toggles the reference voltage to ground. Achieving only 7.5V of amplitude, the circuit was loaded internally to the existing aftermarket ICM. This is the only logical reason for replacing the ICM. I simply "hoped" it would fix the stalling symptom.

Although I'm still in pursuit of why the PCM stopped driving the fuel injectors (causing the stall), replacing the IMC fixed the CKP reference voltage, which corrected the outgoing PIP signal (ICM to PCM), and the vehicle functions as designed without stalling. If I can learn how this PCM's chip process the incoming PIP signal, I believe I will have the answer I seek. This information may or may not be possible to acquire but I will keep you posted!

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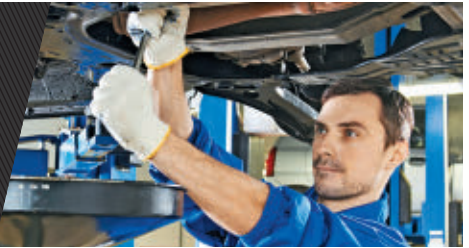
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MOTOR AGE THE TRAINER



THE TRAINER #136: DEALING WITH THE GATEKEEPER

IF YOU'RE A PROFESSIONAL TECHNICIAN, THEN ODDS ARE YOU'VE RUN UP AGAINST THE FCA, NOW STELLANTIS, SECURE GATEWAY MODULE. IF YOU WEREN'T SUCCESSFUL IN GETTING PAST IT, THEN YOU NEED TO WATCH THIS EDITION OF THE TRAINER!

PETE MEIER // Creative Director, Technical

In the summer of 2015, two hackers used the Uconnect feature on a 2015 Jeep Cherokee to remotely access the vehicle's CAN network. They were able to control vital vehicle functions in a way similar to what we do when executing bidirectional controls. And I don't mean just turning on the lights or changing a radio station – these hackers were able to kill the engine while the driver was motoring down the freeway at 70 mph from 10 miles away.

This highlighted a major weakness, not just in what is now Stellantis products, but one common to most major manufacturers. What enabled the access was the vehicle's connection to the internet via its connection to the cellular network. Almost immediately, Stellantis, or FCA at the time, issued a recall to address the issue but a more permanent fix was added in many 2018 models and all models in their line in 2019.

The addition was the Secure Gateway Module.

The Secure Gateway Module acts as a blocking device between the vehicle modules and the diagnostic link connector. The end result is that, without security access, the technician is no longer able to access the modules on the vehicle, with the exception of accessing DTCs and diagnostic data.

Any task that would require the technician to control action on the vehicle is



blocked. This includes clearing codes, the use of bidirectional controls, the ability to program or code modules, and the ability to perform functional tests.

Other manufacturers are also using secure gateway modules with more on the way. Some are passive, only requiring that the scan tool you use has the latest updates and is Wi-Fi-equipped. And others, like the FCA module, require third-party authorization for you to gain access.

In the case of Stellantis, the third party is an independent service called AutoAuth.com. This allows you to set up an account for your shop and to register, under the

base plan, up to five approved Wi-Fi-enabled scan tools for \$50 a year. Higher tier plans are available as well.

Many aftermarket scan tools are now FCA compliant and eligible for this service, including all of Autel's MaxiSYS tablets and its MX808 and TS608 service tablets. The primary requirement is that the tool be Wi-Fi compatible and its software must be up to date.

Once the service is in place, you'll be able to get past the security window and perform all the tasks you're used to performing. Scan the QR code to watch the video! [TZ](#)

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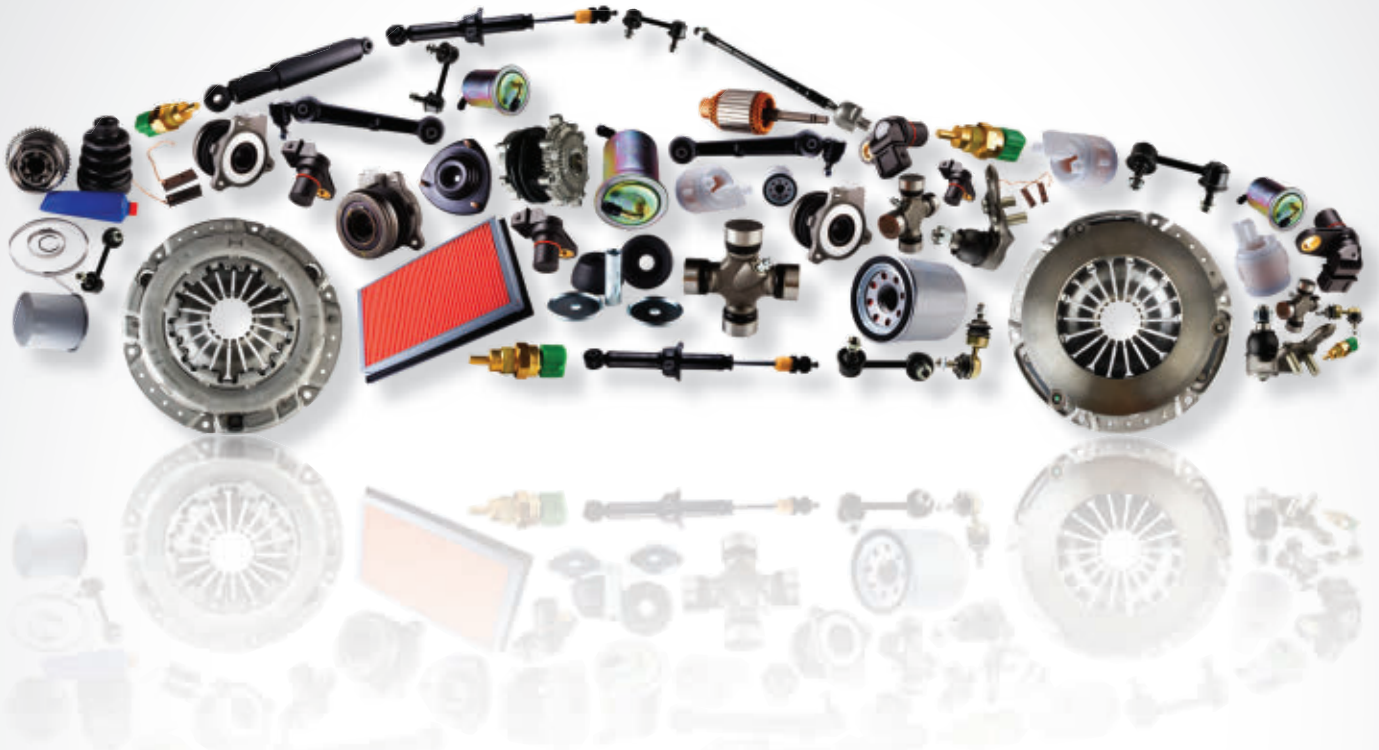
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