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Talk Shop Anytime

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TECHNICAL

IN EVERY ISSUE

VIDEO

AN INSIDE LOOK AT QUALITY-BUILT, PURE ENERGY STARTERS AND ALTERNATORS

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THE VEHICLE INSPECTION PROCESS REPAIR SHOPS SHOULD IMPLEMENT

The amount of miles put on a vehicle before you get to see it again is growing, sometimes up to 7,000! That means you need to be on your game when you have a chance to perform an inspection.

John Burkhauser, the director of training at BOLT ON TECHNOLOGY, has cultivated ideas from hundreds of shops nationwide and believes they are quite easy to adapt to your shop. Doing inspections one way, the right way, every time is crucial.

This expert article is full of great tips to ensure you are using the right technician for this process as well as new ways to use technology like voice-to-text features.

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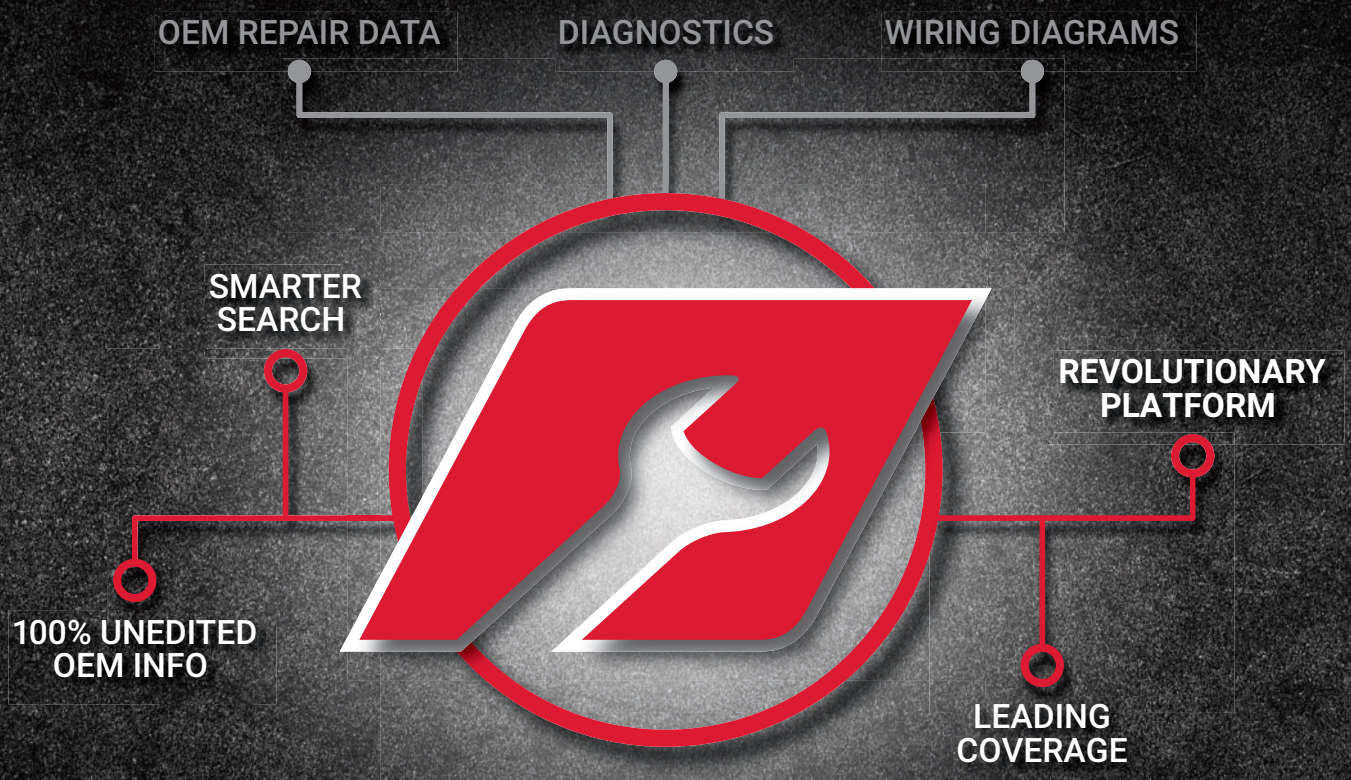

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RESEARCH

MILES DRIVEN PLUNGES IN MARCH AMID COVID-19 PANDEMIC

MOTOR AGE WIRE REPORTS //

"Market Insights with Mike" is a new series presented by the Auto Care Association's Director of Market Intelligence, Mike Chung, that is dedicated to analyzing market-influencing trends as they happen and their potential effects on your business and the auto care industry.

With millions of Americans working from home due to office and school closures, many in the industry are wondering about vehicle miles travelled (VMT) statistics — and rightly so! VMT statistics are correlated with the health of the aftermarket industry, and this makes intuitive sense — the more miles driven, the more that maintenance, repair, and replacement of vehicles will be required.

But what about the past few weeks, since COVID-19 has whipsawed the economy? In my local neighborhood, there is certainly less traffic, but what about the entire nation? Transportation data provider INRIX reports that overall daily national traffic volume for consum-

>> MILES CONTINUES ON PAGE 6

BREAKING NEWS

AID

SMALL BUSINESSES URGED TO APPLY FOR LOAN ASSISTANCE

During an Automotive Service Association (ASA) Media Briefing last month, Ray Fisher, President and Executive Director of ASA, and Bob Redding, ASA's Washington, D.C. representative, were joined by U.S. Representative Buddy Carter (R-Ga.) to discuss what mechanical and collision repair shops can do during the COVID-19 pandemic to help alleviate financial stress.

Congressman Carter repeatedly urged small businesses to apply for an Economic Injury Disaster Loan (EIDL) via the U.S. Small Business Administration (SBA) as soon as possible. In response to the COVID-19 pandemic, small business owners in all U.S. states, Washington D.C., and territories are eligible to apply for an Economic Injury Disaster Loan advance of up to $10,000. The

>> LOAN CONTINUES ON PAGE 6

TRENDING

MITCHELL 1 LAUNCHES MANAGER SE TRAINING

Mitchell 1 launched a new webinar series titled, "Master Your Mitchell 1 Shop Management Software" that offers seven courses on popular topics from its Shop Management Workshop.

MOTORAGE.COM/SEWEB

EXTEND ASE CERTIFICATIONS REMOTELY

The new ASE renewal app allows automotive professionals to extend their certification expiration dates by one year without setting a foot in a test center.

MOTORAGE.COM/ASEAPP

RAYBESTOS OFFERS FREE ONLINE TRAINING

The Raybestos website offers training resources that repair professionals can access free of charge, including videos to expand the knowledge needed to perform the textbook brake job.

MOTORAGE.COM/ONLINE

ADAS WEBINAR NOW OFFERED ON DEMAND FROM AUTEL

Autel recently sponsored "Addressing ADAS calibration for service and body shops," a live webinar featuring Autel's George Lesniak, that is now available on demand.

MOTORAGE.COM/ADASNOW

THE NETWORK EXPANDS ONLINE TRAINING

The Automotive Distribution Network is partnering with BBB Industries, LLC and ZF SACHS to provide additional live professional training on new automotive technology.

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>> **MILES** CONTINUED FROM PAGE 4

ers, local fleets and long-haul trucks was down 38 percent for March 21-27, relative to Feb. 22-28.

Based on anonymous speed/location data reported in real-time from all road types for more than 100 million trips per day in the United States, INRIX found that relative to typical daily travel (Friday 2/22):

- Nationally, personal travel dropped by 38 percent to 48 percent during the work week.
- Long haul truck travel showed its first signs of decline by Thursday 3/26, down 20 percent on Friday 3/27.
- Local area commercial travel declined steadily throughout the week, reaching 16 percent on Friday 3/27.
- San Francisco and Detroit's personal travel have both dropped by nearly two-thirds overall.
- Michigan had the largest statewide decrease in personal (56 percent) and long-haul truck (41 percent) travel.

The week of 3/21-3/27 saw further reductions in vehicular travel than the week of 3/14-3/20, both relative to the week of 2/22-2/28.

Personal vehicle travel was down 42 percent the week of 3/21 compared to 20 percent the week of 3/14. Local fleets were also down 14 percent the week of 3/21, compared to 5 percent the week of 3/14.

Metropolitan areas with the highest reductions for Friday 3/27 (relative to Friday 2/22) include Detroit (down 62 percent), San Francisco (down 54 percent), Seattle (down 52 percent), and New York City (down 48 percent). Note that San Francisco was the first major city to "shelter-in-place").

How long the decrease in VMT will persist is uncertain, particularly in the face of lower gas prices, the upcoming summer driving season, and aversion to flying given social distancing. What we have seen historically, though, is that aftermarket spend is sustained as automobile owners keep their vehicles longer. This may be even more pronounced given temporary shutdowns of motor vehicle factories.

>> **LOAN** CONTINUED FROM PAGE 4

loan advance will provide economic relief to businesses that are currently experiencing a temporary loss of revenue. Funds will be made available within three days of a successful application, and this loan advance will not have to be repaid. You can learn more about and apply for the loan from the SBA website.

The panel also discussed the Paycheck Protection Program, which was enacted under the CARES Act to help small businesses cover their near-term operating expenses during the COVID-19 pandemic and provide a strong incentive for employers to retain their employees. Fisher and Redding urged shops to reach out to their local lender or banker to learn more about the program.

If shops encounter issues with either of these two programs over the coming weeks, Fisher encourages members to contact ASA for help and guidance. He commented, "We want to help however we can. That's what the association is for. If you're having issues, please reach out."

Fisher noted that many shops across the country have never relied on federal programs for their businesses and that now is not the time to turn them down. He shared, "We're a proud group of people. So much has been thrown at us these past 40 years in terms of vehicle technology and safety requirements. But this situation is beyond everyone's control. Be humble and take advantage of the federal programs and utilize all resources available to you. This will pass in time, but we have to act now and as a community."

TECHFORCE ANNOUNCES 2020 FUTURETECHS ROCK GRAND PRIZE WINNER

TechForce Foundation announced the 2020 FutureTechs Rock Awards Grand Prize Winner is Griffin Howland, a senior in high school attending Pickens County Career and Technology College, in Liberty, SC. As a nonprofit dedicated to helping student techs achieve their professional dreams, TechForce created this prestigious award to honor our student community and recognize those who have a promising future and will shape the transportation industry.

Griffin's nominator stated, "Griffin is extremely motivated to be the best at every task that is put in front of him. Griffin also has great soft skills and character traits that allow him to remain calm and focused even during adversity. I truly believe that it is the sum total of these skills and traits that will propel him into a bright future. He is already proficient in SMAW, GTAW, GMAW, and FCAW welding processes with multiple materials, as well as OSHA 10 Certified. His drive and motivation is unmatched and is evidenced by his commitment to school even when school has been cancelled. Griffin is constantly trying to polish his skills outside of the classroom through various welding projects." Keep reading at MotorAge.com/Griffin.

ONLINE SALES

AFTERMARKET HAS UNPRECEDENTED SURGE IN ONLINE SALES

WIRE REPORTS //

The aftermarket is having a surge in online sales, with a sales spike the week of April 12-18, according to Hedges & Company data. This surge appears to be continuing into the week of April 19. This shows parts and accessories sales continue to grow online, accelerated by the coronavirus shutdown and stay-at-home orders across North America.

The arrival of tax refunds and the Federal government's stimulus payments are also helping drive online sales. Stimulus payments reached consumers last week and amounted to approximately $155 billion.

Hedges & Company, a digital marketing agency serving the automotive aftermarket, OEM parts and powersports industries, analyzed 7.7 million online user sessions and online purchases from parts and accessory websites in the US and Canada. The analysis included retailer websites and manufacturers selling direct to consumer (DTC). In the analysis, the company gave online sales from the week of March 1 an index of 100, before wide-spread shutdowns were in place. The week of April 12-18 had an index of 140, or a 40 percent overall increase in online sales of parts and accessories from six weeks earlier.

Hedges & Company broke down the analysis into OEM replacement, truck and off-road, and performance racing. Here are the comparisons of the week of April 12-18 to the week of March 1-7:

- Overall aftermarket eCommerce sales: Index of 140.3 vs. 100 the week of March 1-7.
- OEM replacement parts sales: Index of 125.4 vs. 100, the first positive week after sales declines in earlier weeks.
- Truck and off-road parts sales: Index of 157.2 vs. 100.
- Performance/racing parts sales: Index of 148.9 vs. 100, showing surprisingly strong demand considering many motorsports events are cancelled.

Another factor contributing to the surge in online sales appears to be a migration of buyers from Amazon. The retail giant cut back on promotion and advertising for automotive parts and accessories to focus on products related to the coronavirus crisis, such as disinfecting wipes, sprays and other health items. This may have sent consumers searching for other buying opportunities and contributed to online sales growth.

How to increase labor hours and keep customers happy

Don't make the mistake of not asking customers for their business

Are you looking for a solution that will increase your gross profit margin? If so, you're reading the right article. Let's listen to ATI Performance Coach Don Walter explain how to do it. The answer may be very simple and right under your nose. It only requires having some basic processes in place for this to work. I'm not talking about increasing car count, gross profit or trying to save yourself into a profit. I'm talking about increasing your labor hour per invoice.

When I'm coaching shop owners around the country, a common question I'll ask is: How is business this week? One of my members who was really struggling answered: "We are slow; I need more cars." When I looked at his key performance indicators (KPIs) report for his shop, it told a very different story. His shop saw 60 cars that week, but had a low average repair order, low gross profit margins and low labor hours per invoice. He thought he needed more cars, but he didn't. He actually didn't have a car count problem at all; he had a labor hour problem.

After studying hundreds of shops with similar problems and looking at their three-year average, I found that their labor hour per invoice only varied by .20 per hour. I examined their invoices and realized that they were leaving approximately .5 to 1.5 labor hours of recommendations off every invoice. These were simple services that never made it to their invoices. What's worse is that most of these services could have been done by an entry-level tech, which would have easily increased their gross profit margin.

NEXT TIME YOU THINK YOU HAVE A CAR COUNT PROBLEM, AUDIT YOUR INVOICES. IT MAY BE THAT YOUR LABOR HOUR PER INVOICE IS TOO LOW.

How, you ask? It's simple math. Let's say your labor rate is $100 an hour. If you were able to sell an additional .5 hour per invoice that would be an additional $50. Considering best practices, you would also sell $50 in parts for an additional $100. So, if your shop averages 50 cars a week, that's $5,000 more each week in sales and $250,000 each year. The WOW factor here is that we didn't add more cars or gross profit. When doing this math with my 20 group, I discovered they were collectively leaving about $4 million on the table. My second 20 group was leaving about $3.4 million on the table. So, in total, both groups had $7.4 million of missed recommendations.

If you're asking yourself how this can be done in your shop, the answer is simple. First, you need a good courtesy check process. It starts with your service advisors understanding your customers' buying personality and the type of drivers they are. Second, your service advisors need to get the mileage off their vehicles, check their repair history and review their vehicles' maintenance schedule. Third, make sure that your service advisors are presenting their service recommendations along with your customers' requests. Fifth, make sure that all your service advisors are recommending these services consistently across the board by downloading ATI's Courtesy Checks Consistency Guide. To be sure this is happening, I recommend that you perform daily invoice audits to find missing or inconsistent recommendations. You can use the findings from this audit for training and coaching your staff.

So how are these missed services addressed? Here's an example: a vehicle comes into your shop that has 91,000 miles on it. Your tech does a great courtesy check and has some great recommendations, but left the transmission service off the ticket. Your service advi-

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sor, after checking the history and scheduled maintenances, notices that the tech didn't recommend it. Could you still sell it? The answer is YES. You could just ask the customer if the transmission fluid had ever been exchanged. And, follow up that question by telling them that your records do not show that the service has been done and that the manufacturer is recommending it. If your customer approves, there's .9 hours of labor.

Another way to increase your labor hour per invoice is to cross sell. For example, if you're servicing an air conditioning system, you could sell a cabin air filter with that service and check if the antifreeze needs servicing. There's .5 and .9 = 1.4 additional labor hours.

One mistake made by far too many salespeople is not cross selling — neglecting the related or maintenance sale. Your presentation, product knowledge, understanding of customer needs, etc. could be perfect, but if you don't ask your customer for their business, your success rate will be marginal at best. Your customers are there to make a purchase. You know that, they know that, and they know that you know that. Despite this common knowledge, you might be surprised by how many people are never asked for their business. They go home to "think" about the purchase only to go to a local competitor to make the purchase. The reality is that the customer probably would have purchased your product had you simply asked for the sale.

Below are some ideas of how this can be accomplished.

1. Know your customers' buying habits. You should always request your first-time customers' service records and should ask them about their service histories verbally as well. This information can be extremely helpful during any sales process, especially when it comes to selling maintenance. Great doctors are always interested in a patient's medical history, just as great service advisors are always interested in a customer's service history. This information not only indicates which maintenance services are due but will give you valuable insights into your customers' buying habits as well.

2. Have the right tools available. People believe what they see, so whenever possible, you should get your customers visually involved. At ATI we are big supporters of complete vehicle inspections, proper documentation and visually showing your customers what was discovered. Since third-party documentation is usually viewed as a credible source, you should use your customers' owner's manuals, their service records, printouts that show industry recommendations, maintenance brochures, repair orders that show the high cost of repairs, failed components and fluid samples.

3. Make sure your employees understand why timely maintenance is so important. Have all your employees conduct the ATI Smell Test then compare your answers to find a common recommendation. For those of you who are not familiar with the ATI Smell Test, create a document with all your services listed on it. Hand it out to all your internal customers and have them independently fill in what time and mileage intervals each service should be performed. Then have a shop meeting to discuss and agree upon the interval standards for your shop. Does your shop have a policy and procedure of when we recommend certain services?

4. Prepare an estimate that will sell. When presenting your estimate to your customer, always start first with their initial concern that they came in for. Next address any safety items and then present any maintenance recommendations.

5. Use an assumptive close technique. Instead of asking your customers if they would like you to perform the recommended maintenance services, you could say, "All that I'll need is your go-ahead, and we'll get started on it right away." Assumptive closes send a strong message that there is no logical reason for your customers to decline the services that were recommended.

6. Schedule the next appointment. There is no better time to schedule the next appointment than at the time of car delivery. Your customers are standing in front of you, they feel comfortable with you, and it's easy for them to say yes. If your customers leave without making an appointment, then they're going to be fair game for all your competitors. In addition, taking good care of your customers' vehicles is a process, not an event, so it stands to reason that you'll need to see them again to perform the services that will be due at that time, to complete a periodic safety inspection, etc.

So, the next time you think you have a car count problem, audit your invoices before you spend money or time on marketing or other actions to increase gross profit. It may be that your labor hour per invoice is too low and that you're leaving money on the table. You can correct this by implementing or improving your courtesy checks process and remembering to cross sell related services and items. To ensure courtesy checks are being performed consistently, download ATI's Courtesy Checks Consistency Guide by going to *www.ationlinetraining.com/2020-05* for a limited time.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 130 full-time associates train and coach more than 1,700 shop owners every week across North America to drive profits and dreams home to their families. Our 32 full-time Certified Performance coaches have helped our members earn over ONE BILLION DOLLARS in return on their coaching investment since ATI was founded. This month's article was written with the help of ATI Performance Coach Don Walter.
chubby@autotraining.net

HAVE YOU SEEN THIS MAN?

Terry Keller hasn't been inside his shop to manage it for 20 years.

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Can you handle the biggest decision in your career?

You must choose between being a technician or being a shop owner

Many shop owners in the country have reached the fork in the road that is forcing them to make an important decision, yet, it seems 80 percent of them are stunned and want to ignore, or not acknowledge, this most important time in their life due to the new business realities.

"Who do I want to be — a full-time competent technician or a full-time business entrepreneur?"

The realities of the many complexities of our business are here front and center, driving rapidly toward you, and a lifetime decision must be made.

Consider the following realities:

- The independent sector of the automotive afterrmarket and service industry has a crisis of profitability, retailer attitude and public perception. Most shops have bought themselves a job, and do not enjoy a financially rewarding lifestyle reflecting the risk, liability and responsibility of this type of business. Most shops are running their business based on price. The owner does not really understand the financial ramifications to their bottom line with their day-to-day pricing decisions; this business policy attracts price conscious "customers" rather than the quality service "clients." The shop is working hard, not smart.

- Outlets across the country are closing, yet, the number of vehicles on the road has, and is, increasing significantly and must be serviced. So is the shop missing potential opportunities?

- Technology has increased substantially to the point where more equipment is needed and must be serviced/replaced more frequently than years ago, such as ongoing software upgrades. The vehicle has moved to a full software platform.

- Margins on all hard goods are decreasing and will continue to decrease significantly over the coming years with Pacific Rim influences, yet, it is imperative that a shops total gross profit comes in at 70 percent (labor included) to keep a shop prosperous and provide management with a professional income.

HOW DO YOU DEAL WITH ALL THESE ISSUES PROFESSIONALLY AND BE INVOLVED WITH THE VEHICLE AT THE SAME TIME? YOU CAN'T.

These three issues alone are forcing small one-, two- and three-bay shops to realize that if they are going to stay in this business, serve their clients professionally and be financially successful, they must grow. By "grow" I mean to a minimum of six-, but preferably to eight-bay operations if another 10 to 15 years are left in the owners' working life.

- With an ongoing shortage of competent people in our industry, the day of the division between the boss and employee has ended. Wages will continue to rise significantly. To be able to manage this, employees must be brought into the picture of the business operation and clearly understand how the business works and how it is going to grow and prosper.

-The banks have curtailed financing significantly to our industry, as we have been classified as people who do not understand the financial and business management criteria that is required today to be risk/credit worthy. Assets don't mean much in today's economy, as profitability and cash flow are everything in answering, "Can you pay your debts?"

- Taxes, whether business taxes, income taxes, employee payroll taxes and other levies are a true requirement to be met on a shop's cash demand.

- Stress is more prevalent in today's industry than ever before. Stress on employees to keep learning the new technology, on the owner to keep the business afloat and on the home life as the state of our industry and economy affects the shop owner's attitude and disposition.

The obvious question is, "How do you deal with all these issues properly, professionally and be involved with the vehicle at the same time?" The answer? You can't. Today is a world of "specialization," which means that you learn and become very proficient in the one field in which your interest truly lies. Do I want to be a competent technician and work on vehicles all day, or do I want to be a successful business entrepreneur and learn how to run my business?

If you choose to be a competent technician, then truly focus on that profession. Consider: "How can I do this and run my business successfully, meeting the financial expectations I have for myself and family coupled with my responsibility to my employees?" It is time to hook up with an entrepreneur, because, as a competent technician, you will make more money than you thought you could and without the business financial risk/

concerns playing on your mind. The shortage of competent people is everywhere and your skills are needed badly. Wages for competent technicians have an exciting future, providing they are working in a business where management has the skill/knowledge to run and manage the business.

If you choose the path of business entrepreneur, then the owner must mentally prepare for change to the point where he/she develops a flexible mindset so that change becomes a permanent state of mind.

Business management training now becomes the top priority and an ongoing development for the owner. A professional/successful service business is very rewarding, but is an extremely complicated business to run today. However, nowhere in high school did anyone learn about shop business management. No one was taught revenue, gross profit measurement and the mix of both in a shop business and how they work. Nor did they learn about balance sheets/income statements, how to calculate accounts receivable profitability and manage the A/R properly, inventory management, shop productivity measurement and management, shop staff relationship management, shop business relationship management and how all these factors interact to affect the net profit of the shop. These are all new skills that must be learned by everyone owning and running an shop business today. As in technical training, it is an ongoing process of learning and should be revisited in a classroom a minimum of six times a year.

It is time to make the decision that is best for you! They say you can live a life of fullfilment if you only have the courage to let go of the past and listen to your heart.

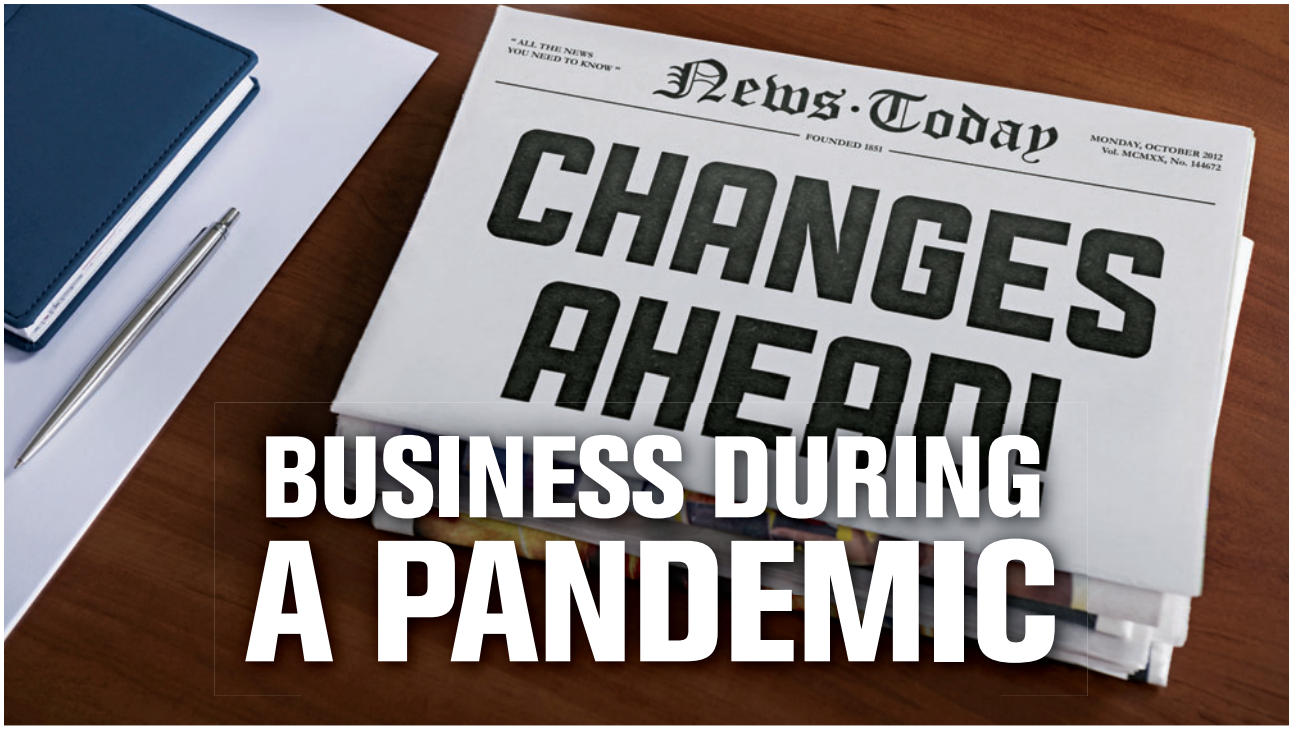
Who are you — an entrepreneur or an employee? Only you can answer this question honestly. Your financial security is at stake here.

Once your decision is made, act upon it without reservations. Move forward with a positive attitude. You have to expect things of yourself before you can go out and actually do them. Be proud of your decision because both choices have a great deal to contribute to the lifeblood of our industry.

Be focussed to be the very best you can be. Most importantly though, don't cheat yourself. Give yourself the time required to learn to be the best. Don't say you don't have the time when you can find the one week to go fishing, or the 10 days for hunting. Just schedule it. Pretend you're in the hospital, and you just can't make it into work. Realize too, that it is not just an "overnight" visit to be the best. It is a process of learning and experiencing for both career paths to be successful.

In summary I will leave you to ponder this: The road to success is not a straight one. There is a curve called "failure," a loop that is called "confusion," speed bumps that are called "friends," red lights called "enemies," caution lights called "family," and you will have flats called "jobs" — BUT — if you have a spare called "determination," an engine called "perseverance," insurance called "faith" and a driver called "enthusiasm," you will make it to a place called "success." MM

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



BUSINESS DURING A PANDEMIC

Industry leaders worry of difficult days ahead following COVID-19 outbreak

TIM SRAMCIK // Contributing Editor

On the last day of 2019, authorities informed the World Health Organization's (WHO) China office of pneumonia cases in Wuhan City with an unknown cause. A week later, China identified a new coronavirus (COVID-19) as the source of the outbreak and reported its first death. Within a month, multiple countries reported outbreaks; WHO Director-General Tedros Adhanom Ghebreyesus declared a public health emergency of international concern, and the U.S. declared a domestic national emergency.

Fallout from the outbreak then sped up considerably as the international infection and death rate grew. Within weeks, the WHO changed its declaration to a pandemic. In the U.S., many states have shut down schools, ordered bars and restaurants to offer only takeout or delivery services, closed gyms, theaters, sports venues and salons, and limited social gatherings sizes (some to 10-person limits). Businesses, typically retailers, have cut hours or voluntary closed their doors. Americans have panicked, emptying store shelves of food essentials, cleaning products and toilet paper, while unemployment claims have spiked as thousands of workers are locked out of their jobs and millions more worry about their future in a world of quarantines and social distancing.

Such is life in early 2020. With a recent government plan anticipating the pandemic could continue for 18 months, small businesses are bracing themselves for a grim future and the prospect of a severe recession. This includes auto repairers. While the industry is in the early stages of dealing with this crisis, some shops already have taken significant steps to protect their employees, customers and business futures and begun laying out a plan for difficult days ahead.

Impacts on the national level and front lines

The COVID-19 pandemic already has hit the repair industry nationally and regionally in areas likely to have ripple effects, namely education and training. The 17th Annual TST (Technical Service Training) Tech Training Big Event, which offers seminars from some of the best-known trainers in the industry, has been moved from March 21 to August 15. The Automotive Training Expo (ATE) has rescheduled from March 16-18 to July 31-August 2.

"We had one thousand people signed up to come to the show," says Jeff Lovell, President/Executive Director of Automotive Service Association (ASA) Northwest, which sponsors ATE.

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Lovell says his organization also has had to cancel seven chapter meetings this month. The postponement and cancellations are the results of restrictions put on group sizes to help prevent the spread of COVID-19.

G. Jerry Truglia, a New York shop owner, founding member of TST and owner of Automotive Technician Training Services (ATTS) reports he's had to cancel all of his training sessions for the same reason (New York doesn't allow groups of 10 or more in one place at a time, and Truglia notes that shops don't want to risk having their techs around others). Truglia says other trainers such as NAPA, Carquest and Christian Brothers have done the same.

"The cream of the crop of the industry isn't able to come out for training," says Truglia. "These are people who are in search of information to help their businesses, and they're being cut off from it."

Along with the flow of information, shop business also is seeing cuts. Truglia, whose Mahopac, New York shop sits 40 miles from New York City, says business is "definitely down." Further, he's heard of some shops that have closed down. Lovell says he's heard from ASA members who are seeing substantially less business, with others being unaffected.

Lovell suspects the dip in work is a combination of customers staying home so as not to risk exposure to the virus and those affected by or worried by financial issues created by the outbreak. He says urban shops could see greater business declines since customers have better access to alternative transportation while suburban businesses could see fewer disruptions, for now, since these customers rely more on their vehicles for travel.

Meanwhile, on the collision repair side, shops haven't seen any noticeable drop in work. Trace Coccimiglio, owner of Valet Auto Body in Draper Utah, says work typically slows a bit this time of year. However, looking at the highway that runs near his shop, Coccimiglio says he sees far less traffic and believes this will translate into a decline of work in the coming weeks.

Lovell sees a long-term drop in business lasting at least 4-6 month and probably lingering into 2021. Already, he's witnessed the fallout in other service jobs. Lovell knows of multiple workers in the hospitality industry who have been furloughed. A hotel ASA Northwest does business with just furloughed six employees. On March 19, Bank of America warned investors that the country was now in a deep recession. The financial giant expects the economy to shrink by 12 percent alone in the second quarter of this year with significant losses in employment and wealth.

That's very bad news for any small business, especially those in automotive repair where profit margins can be slim and many shops are "hanging on by a string," according to Truglia. Grim days aren't simply coming. They're already here.

Cleaning up the industry

With the health of the industry and its people at risk, the obvious question is: How should repairers respond? Some have started by addressing the virus itself. Truglia regularly visits the Centers for Disease Control and Prevention (CDC) website (https://www.cdc.gov/) for guidance. He prints off CDC recommendations and shares them with staff.

He and his employees also have adopted a policy of using cleaning products to wipe down every handle in the shop — from the coffee pot, to office doors to car door — first thing in the morning and at the end of the day. "Viruses can be on any surface so we take extra precautions like wearing gloves, asking our people to sneeze into their sleeves and disinfect any areas of a vehicle they think may be contaminated," he says. "In auto repair you come into contact with all kinds of people. You have to keep this in mind when handling keys to consider what they may have come into contact with."

Lovell similarly recommends wiping down steering wheels, shifters and door handles when a vehicle enters a shop and again before it is handed back over to the owner. Coccimiglio has adopted similar cleaning practices. ASA Northwest suggests members stock up on gloves and sanitizers.

This attention to physical health needs to be accompanied by extra work on the financial health of a shop. Since the industry appears to be in the beginning stages of a steep downturn, Truglia recommends looking into state programs to help businesses affected by COVID-19.

On March 16, the national ASA signed on to a letter to the leadership of the U.S. House of Representatives — House Speaker Nancy Pelosi and House Minority Leader Kevin McCarthy — requesting COVID-19 disaster relief for small businesses and their employees where the core functions of the business cannot switch to remote operation.

"Most of the time we don't look toward the government for help but this is unprecedented," says Lovell.

Truglia and Coccimiglio are looking at ways to cut expenses. Coccimiglio says he'll put off replacing his paint booths. Should an economic downturn be serious enough, Truglia will use his staff to perform work like painting the shop instead of hiring outside help.

Cutting expenses alone won't compensate for a serious downturn in business. Lovell and Truglia say shops need to be more proactive. In the current climate, they suggest repairers leverage services, for example towing to and from a shop, to reduce a customer's risk of exposure. Digital solutions, such as letting customers sign electronically online to authorize a repair, also are

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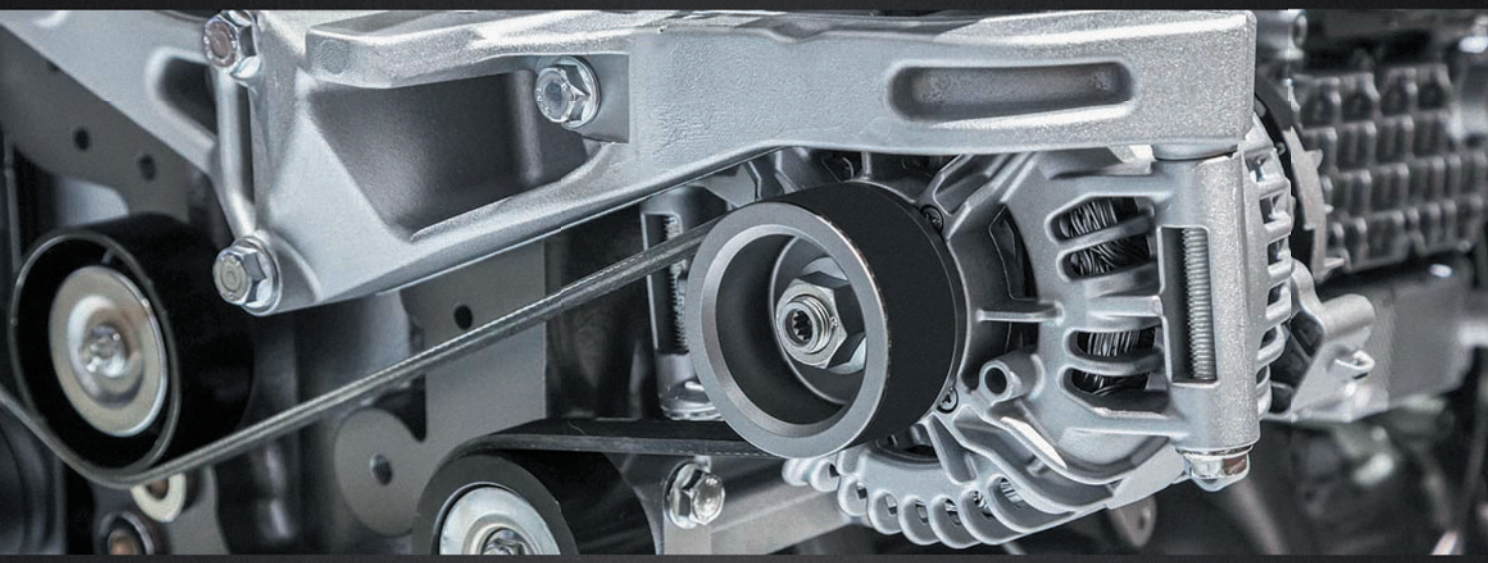

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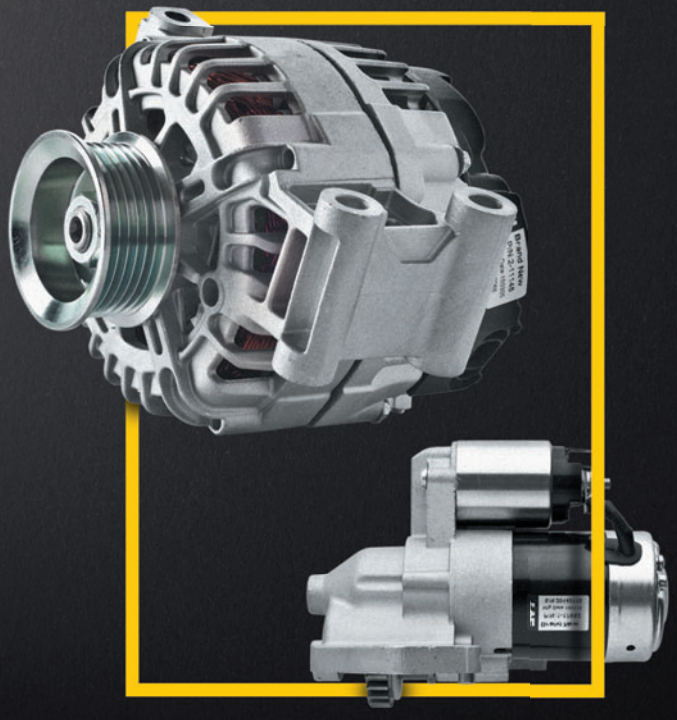

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attractive. Both men say shops should advertise these efforts, letting customers know they are aware of their concerns with COVID-19 and are ready with solutions to make repairs safer and more convenient and that ensure a vehicle is returned in sanitized condition.

Some shops are taking just such an approach. Yates Service Inc., an Alexandria, Va., company that owns both mechanical and collision repair businesses, just launched Complimentary White Glove Vehicle Pickup & Delivery Service at its locations for customer vehicles needing repairs, maintenance and detailing services. Its collision business also started offering online auto body repair estimating so customers can send damage photos to Yates Collision using mobile device instead of venturing to the shop.

Star Auto Authority started a "Disinfectant Detailing" promotion with the shop offering to do its "part in helping fight the COVID-19" with 20 percent off all detailing services. The promotion touts the shop's convenient pickup and delivery services and includes messaging referencing the CDC and noting how detailers wear protective gloves and spend "extra time cleaning all interior surfaces touched by hands."

Truglia suggests repairers "clean up their act" with clean and sanitized customer waiting areas and restrooms to help qualm fears of customers, especially the elderly, one of the groups most at risk from COVID-19. "Elderly customers are your best customers," he adds. "They understand their cars and know they need cared for."

Long-term prognosis

While efforts to meet the COVID-19 outbreak head on are encouraged, so are traditional efforts to remain competitive and run a high-quality operation. Coccimiglio says shops need to follow OEM repair procedures and continue building their brand by working on their online presence and protecting their reputation with good work. "Remember that every customer represents potential future business," he says. "Don't take them for granted."

Lovell says shops should reach out to customers every way they can and offer as many services as they can handle. "Have your service advisors call up customers and let them know you're looking out for them," he adds. Further, he says organizations like ASA are important resources for help and mentorship, now and at any other time.

Even with these efforts, a serious or long-term recession could force shops to make difficult decisions, namely letting go of staff if there isn't enough work to maintain their employment. "We do all we can for our employees, and you always want to treat your employees well, but there is a point where you can go no further without hurting your business," says Truglia.

Coccimiglio says if an economic downturn is serious enough, his business will have to choose between keeping staff while doing lower volume or letting staff go and rehiring later as the economy rebounds. Letting staff go while hoping to rehire later is a risky prospect with technicians already in short supply.

The likelihood of taking such drastic measures seems to be growing with each passing day as the U.S. struggles to handle an expanding crisis. Healthcare providers say necessary products are in short supply with no relief in sight and warn the U.S. healthcare system is increasingly at risk to be overwhelmed. The stock market continues to be depressed. In late March, California Gov. Gavin Newsom issued a statewide order for all residents to "stay at home" until further notice amid the coronavirus outbreak. That's 40 million Americans being asked to park their vehicles and not leave their homes.

While repairers can still conduct business, it's impossible to perform work when it isn't being brought to a shop. Since much of the country follows California's example, repairers nationwide probably can expect to see business to fall off as motorists simply stay home or lose their ability to pay for work.

Still, with the industry's gloomy prospects, Lovell and Truglia say there's room for optimism if repairers gain some perspective. Lovell notes that as bad as 2008 was, some shops still fared well since consumers were forced to hold onto older vehicles that would require repairs and maintenance. "A lot of shops learned their lesson from that time and know to maintain a rainy-day fund," he says.

Truglia notes, "We've been through really tough times before with 9/11 and some of the storms we've had."

"We'll get through it," he adds.

Indeed, some repairers have moved beyond worrying about their own businesses and turned to humanitarian efforts. Finish Pros, with multiple locations in Metro Atlanta, is donating N95 masks to local nursing homes and hospitals. "Because we are a body shop, we have several cases of masks on hand at all times, so we decided to donate them to hospitals and other facilities that we think would need them," says Joe Rizzo, Principal. Finish Pros hopes their act will inspire others to do the same.

As the industry heads into unchartered and what looks to be frightening territory in the months ahead, working together and feeling less isolated could be an important part of the prescription for renewed good health.

TIM SRAMCIK has written for *ABRN* and sister publications *Motor Age* and *Aftermarket Business World* for more than a decade.
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President signs third COVID-19 stimulus package

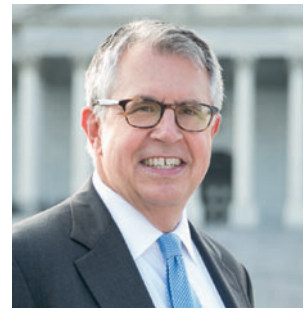
New PPP popular with automotive repairers

Last month we discussed the first two COVID-19 stimulus bills passed by Congress and signed by the President, the Coronavirus Preparedness and Response Supplemental Appropriations Act of 2020 and the Families First Coronavirus Response Act. Important for auto repairers is the third stimulus package, the Coronavirus Aid, Relief and Economic Security Act (CARES Act) that the President signed into law in late March.

There are several programs and incentives included in this third package for small businesses; by far the most popular in the auto repair community is the new Paycheck Protection Program (PPP). This $350 billion program for small businesses with 500 employees or fewer can provide up to eight weeks of cash-flow assistance through a 100 percent federally guaranteed loan to employers who maintain their payroll during the COVID-19 emergency. According to the U.S. Senate Small Business Committee, "if the employer maintains its payroll, then the portion of the loan used for covered payroll costs, interest on mortgage obligations, rent and utilities would be forgiven." Congress gave the Small Business Administration (SBA) the flexibility for a loan term of up to 10 years. SBA opted to cap the term at 2 years.

In addition, Congress enhanced the Economic Injury Disaster Loan (EIDL) program and shops can apply for both the EIDL and PPP programs as long as they are used for different purposes. EIDLs are low-interest loans of up to $2 million that are available to pay for expenses that could have been met had the disaster not occurred, including payroll and other operating expense. The CARES Act also provides businesses applying for EIDL expedited access to capital through an Emergency Grant, an advance of $10,000 within three days to maintain payroll, provide paid sick leave and to service other debt obligations.

The Automotive Service Association (ASA) has been very concerned that automotive repair facilities would, in some cases, be determined to be nonessential.



However, the U.S. Department of Homeland Security's (DHS) Cybersecurity and Infrastructure Security Agency (CISA) recommended that state and local governments include "Automotive repair and maintenance facilities" as Essential Critical Infrastructure Workforce within the Transportation Industry.

The SBA's programs require governors to obtain an Economic Injury Disaster Loan Declaration. ASA and a coalition of aftermarket associations, in a letter to the National Governors Association, noted:

"The crisis isn't two months away. It's here. Many of these businesses are already down by 40 percent to 75 percent. Their operating margins cannot sustain such losses. When they fail, millions of employees become unemployed with no other source of available income while thousands of business owners declare bankruptcy. In the meantime, they suffer daily with excessive emotional stress from loss of income and shortages of critical services such as affordable health care and child care.

We urge you to urge your members to take immediate action to obtain an Economic Injury Disaster Loan Declaration for their states so that suffering small businesses can have access to Small Business Administration disaster support."

So, what's next? The $350 billion allocated for the PPP program will not be sufficient for this first-come first-serve small business program. Congress is now preparing a $250 billion influx of funds to keep the PPP program moving forward. Despite some differences, Congress is expected to approve this additional funding soon. Finally, both republicans and democrats are discussing a fourth stimulus package that will be considered when Congress returns to Washington.

ROBERT REDDING is the Automotive Service Association's Washington, D.C. representative. He has served as a member of several federal and state advisory committees involved in the automotive industry. *rlredding@reddingfirm.com*

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Deadlines extended for ASE accredited programs

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With many programs unable to complete their renewal applications and compliance reviews due to the difficult times we are facing, ASE has extended its deadlines for accredited programs.

Programs with accreditation renewal deadlines from March 1, 2020 to December 1, 2020 will have six months added to their expiration dates. Programs with compliance reviews due from March 1, 2020 to December 1, 2020 will also have six months added to their due date.

"The health and safety of students, school staff, evaluation teams and industry partners is our first concern during this unprecedented time," said Mike Coley, president, ASE Education Foundation. "While virtual instruction may be taking place this spring in some places, many programs are unable to provide hands-on lab instruction. Other activities, such as advisory committee meetings, are being delayed or cancelled. Therefore, we felt it was only appropriate to extend expiration and due dates."

ASE is also allowing any applications or compliance reviews that were submitted prior to March 1, 2020, but were not yet completed due to no on-site evaluation, program improvement needed, pending instructor ASE certifications and other factors to remain active through December 31, 2020.

"The staff and board of directors of the ASE Education Foundation appreciate the hard work of administrators, instructors, advisory committee members and evaluation teams who continue the important mission of educating the next generation of service technicians for our industry, especially in these challenging times," said Coley. "We want everyone to stay safe and well, follow the guidance of the CDC and health authorities, and know that we are here to support you as you continue that mission."

For more information about the deadline extensions for ASE accredited programs, visit www.aseeducationfoundation.org/coronavirus.

CTI, WTI LAUNCH ONLINE WEBINAR-BASED TRAINING PROGRAMS

In an effort to further support automotive professionals during this time of uncertainty, Carquest Technical Institute and Worldpac Training Institute (CTI+WTI) have launched two new online webinar-based training programs to provide advanced-level technical and business management training courses. At rollout, access to training content is free and open to any individual working in the aftermarket

World Professional Automotive Community and Virtual Classroom programs are training solutions developed by Worldpac and Carquest, part of the Advance Auto Parts enterprise serving the aftermarket. Courses will feature training led by instructors from CTI+WTI, guest industry leaders and automotive systems experts from OE and premium aftermarket suppliers and manufacturers.

Beginning last month, World Professional Automotive Community courses are held weekdays at 5 p.m. Pacific time (8 p.m. Eastern time). Technical classes will be featured on Mondays, Wednesdays and Fridays, with management focused classes on Tuesdays and Thursdays. Virtual Classroom programs, including in-depth programs that build on the CTI+WTI Career Pathways training model.

To see a full list of complimentary training available from Advance by CTI+WTI, visit www.worldpac.com/training/classes/online or www.ctionline.com.

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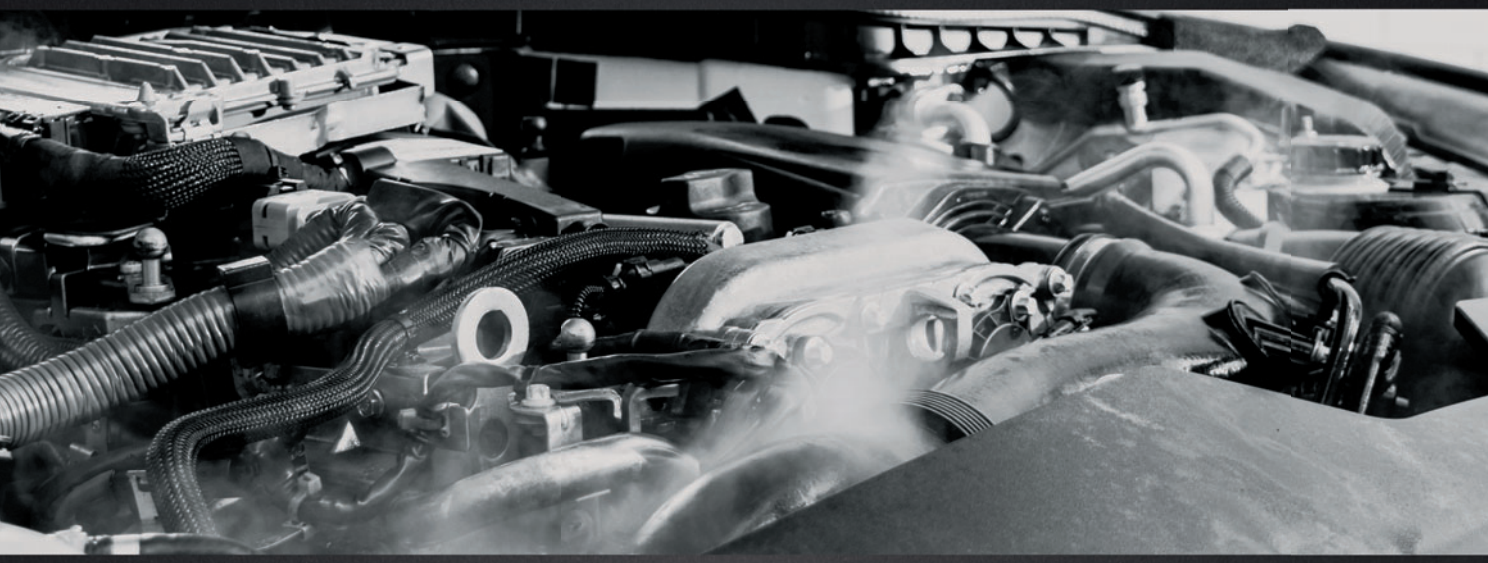

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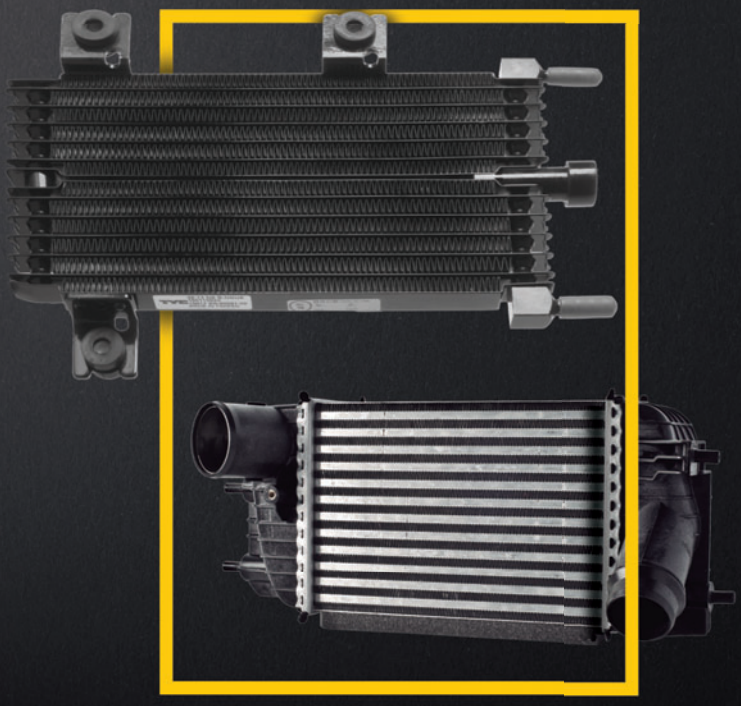

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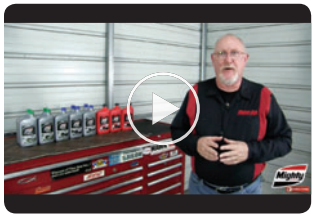


The top 2 causes of premature engine wear

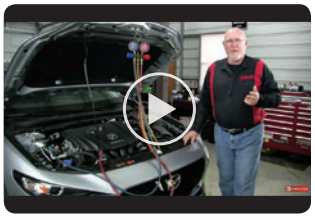
MOTORAGE.COM/EngineWear

Surviving your financial struggles

MOTORAGE.COM/Finances

Automotive instructors move to online training

MOTORAGE.COM/TrainOnline



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2007 Pontiac Grand Prix, 3.8L V-6, Automatic Transmission

MILEAGE:
148,992

PROBLEM:
The customer reported that the ABS light was on. The brakes seemed to operate normally.

DETAILS:
Using his scan tool, the tech pulled DTC C0035 (Left-front wheel speed sensor circuit issue). First, he checked the left-front wheel speed sensor (WSS) resistance at the sensor. It was within specifications (800-1600 ohms). Next, he checked the WSS resistance at the ABS control module and the circuit was open. Moving to where the WSS wiring harness passed over the suspension, he found the problem. A previous repair had been made and was not done correctly.

CONFIRMED REPAIR:
The tech repaired the wiring by soldering the connection and using heat-shrink to protect the connection. He also installed a new plastic harness guide on the suspension to properly route the wires. The problem was permanently fixed!

This tech tip and others come from ALLDATA Tech-Assist, a diagnostics hotline of ASE-certified Master Technicians.

Learn more at at ALLDATA.com.

TRAINING EVENTS

JULY 14-17
ASE Instructor Training Conference
Embassy Suites
Frisco, Texas

JULY 19-23
2020 NACAT Annual Conference & Expo
Cincinnati Mariott at RiverCenter
Covington, Kentucky

JULY 20-25
TIVA Summer Conference 2020
Omni Bay Front Corpus Christi
Corpus Christi, Texas

JULY 31- AUGUST 2
ATE 2020
DoubleTree by Hilton SeaTac Hotel
Seattle, Washington

AUGUST 15
TST 2020 Big Event
Westchester Marriott
Tarrytown, New York

AUGUST 24-25
2020 ASA Annual Business Meeting
Hurst Conference Center
Hurst, Texas

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1

A HEAVY-DUTY A/C PROBLEM

DIAGNOSING AN A/C FAULT IS THE SAME NO MATTER WHAT VEHICLE THE SYSTEM IS ATTACHED TO, RIGHT? WELL...

MICHAEL EILBRACHT // Contributing Editor

Air conditioning has been around for a long time. I have been working on heavy-duty air conditioning systems for quite some time myself, and to be honest, one certain aspect of these systems has changed dramatically: the electrical controls to the system. When I first started in this field 20-plus years ago, the controls were not as electronically savvy as they are now. I have seen quite a few changes over the years, and in my opinion, sometimes these changes do not help as much as we think they do. I have seen the simple systems with just wire, fuse, thermostat, switches and a clutch to having a system with pressure transducers, stepper motors and an electronically controlled thermostat. So with this new savvy technology, of course, the general public and some techs think that these systems are easier to diagnose because of the software that can communicate with the computer and give you data.

Well, I have news for you! On today's modern electronic systems, if you don't have an oscilloscope and a good understanding of electronics and electrical fundamentals, you are going to be lost. Not only that, you need to understand how the system works before you start testing. In this case study, I am going to show you why a DSO is needed and why it is so important to understand system operation and proper specifications.

A bus with a 1606 — clutch overload

This bus came in with a complaint of erratic air conditioning operation and is equipped with a TK3 System. I hooked

PHOTOS: MICHAEL EILBRACHT

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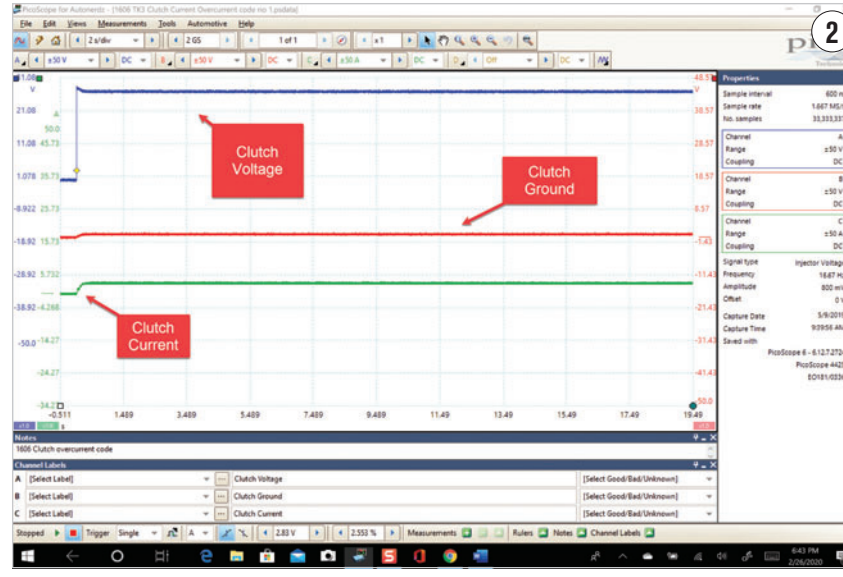
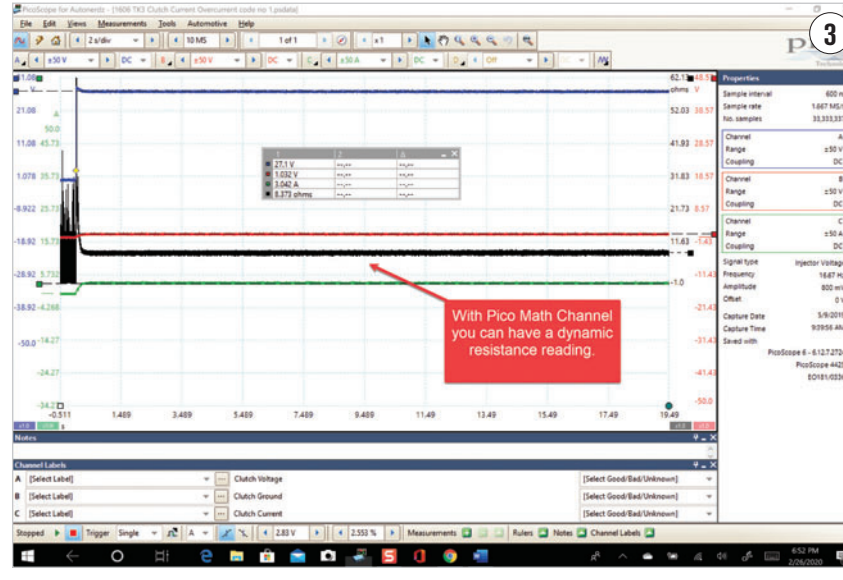
up the laptop to check codes and found a Clutch Output Short code as indicated on the TK3 Clutch Output Short Picture. The code set criteria states that if the current exceeds 3.75 amps, there will be a three-second delay before the alarm, and if it goes over 6 amps there will be no delay in the alarm. So after seeing this, I looked at the corrective action box on the troubleshooting manual and it gives you the basic things to check — wiring, clutch and also to verify the current measured at the clutch reads the same as it does at the computer.

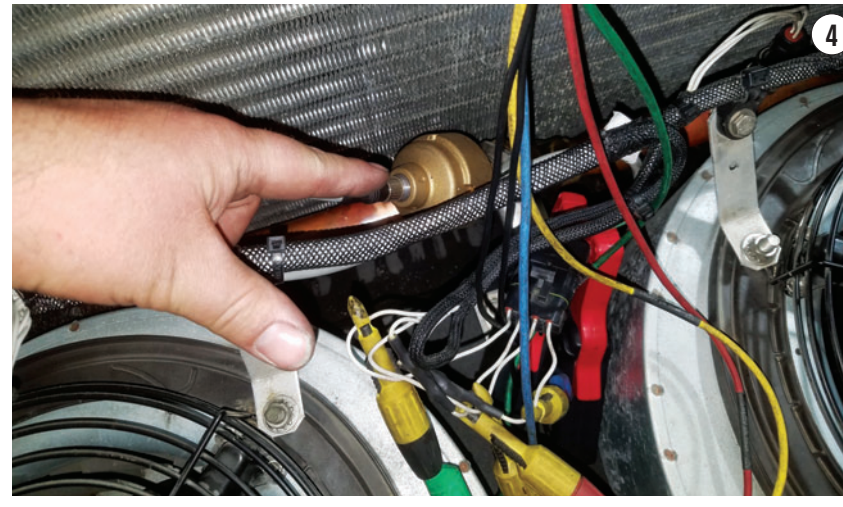
I did all these checks and one spec stuck out as an alarm to me at that time. My clutch current looks too high to me on the software. I hooked up my DSO (Digital Storage Oscilloscope) to the clutch power and ground, and put a current clamp around the feed wire (**Figure 1**).

I turned on the A/C and had my scope set up for a single trigger (so I didn't have to worry about missing any data, as I was at the front of the bus almost 40 feet away). As you can see by my first markup, I had good battery voltage, good ground, but the current was showing excessive on the scope as well as the software (**Figure 2**). Also, I looked at my math channel and the resistance showed it being lower than what I was expecting, which was around 11 to 12 ohms (**Figure 3**). After this, I got out my ohm meter to test the coil resistance; the resistance on the meter showed close to the same as it did on the Pico Math Channel. I was convinced the clutch coil was shorted.

Before we move on, did you notice that the clutch current had a dip midway up the ramp and then went back to normal? What you are seeing is the mechanical movement of the clutch. I decided to ask my buddies at Autonerdz why this happens. It all has to do with Lenz Law. Now I am not going







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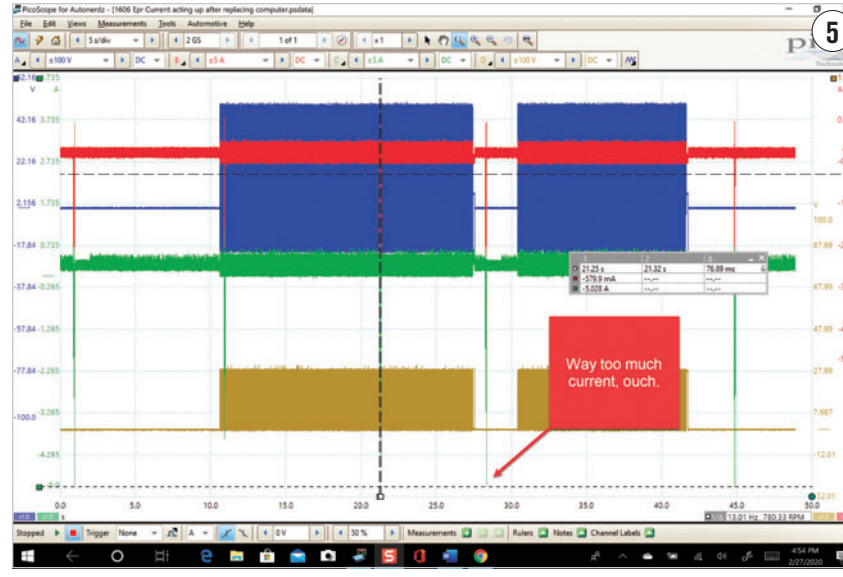
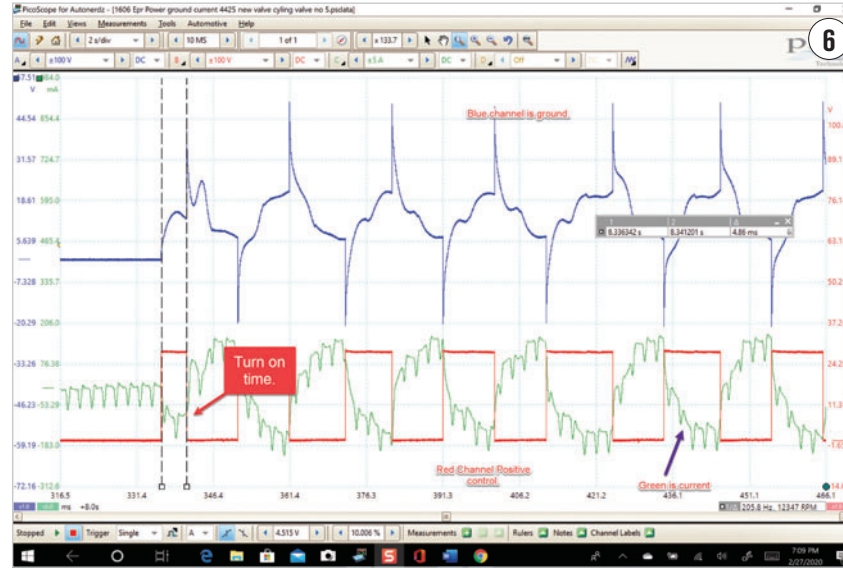
to go too deep into the theory on this, but after talking to quite a few Autonerdz members — Ian Crane, Spencer Decordre and the one and only Autonerdz team of Tom Roberts, Brian and Sean — it all comes down to this — what you are seeing are magnetic fields that are working against each other at the moment of armature movement. Since the armature moves as the clutch is applied, it momentarily changes the direction of current flow because of the magnetic fields working against each other between the clutch coil and the armature.





Moving on now

So now back to the problem at hand. I went to my parts guy, ordered a new coil and that was it, right? Nope, if anyone has met me they know that a lot of the stuff I share with everyone is not always cut and dry. Here is the rest of the story. I went on vacation for a week and when I came back, I heard that the new coil was installed, but the bus was back once again for intermittent A/C.

I pretty much felt like the koala bear from all those Facebook posts showing the koala with its mouth hanging out with script on the picture saying, "The look on your face when a vehicle you worked on previously is back in the stall." Face it, everyone, I'm human just like everybody else and I make mistakes. However, I learn from my mistakes. So with that being said, I decided to check the resistance of this new coil, and it was the same. I then started looking at the service manuals, and I pulled out one for a 2011 model and one for a 2016 model. Well, due to my laziness here, I'll admit it, I neglected to notice in the service manual that the coil specs had changed from 2011 to 2016. The bus I was working on had a resistance spec of 7.1 ohms at 100 degrees F and at the lowest temp of 50 degrees F, it is at 6.6 ohms. On the older models for that specific compressor and coil setup the resistance is 12 ohms at 100 degrees F and 11.2 ohms at 50 Degrees F. So I was an ohm off, but the new one matched the old one. So, I crossed that off the list as a problem.

After that, I hooked up to check codes, and it did not have any codes. Oh, great! After seeing that, I drew on some prior experience with this system, to be honest, to isolate this issue. I hope this information will help everyone out from having the headaches I had when I first started working on these systems. I decided to go to the electronic EPR valve.

I bet you're asking, "Mike, what is an EEPR valve?" What this valve does is control the backpressure in the evaporator for more efficient cooling. So if this valve is malfunctioning, it can cause the backpressure in the evaporator to either go low or high causing intermittent cooling problems.

The troubleshooting tree for this is

nonexistent. All that the Thermo King manuals tell me is that it is a two-phase stepper motor that uses one phase to go one direction and the other phase in the opposite direction. The operation of this valve is a little vague, to be honest, but by using the scope we can have a better idea of how this controller actually turns on the valve. So, to see if I have any activity on the EEPR valve, I take two low-amp clamps and put one clamp on each leg and use the TK Software to make the valve turn on and off. There is no activity whatsoever.

I then checked the output voltage of the valve at the computer on all four wires (**Figure 4**), and I had no voltage. After this, I checked all powers and grounds to the module and they passed. So what has happened here is the computer has failed. I then proceeded to check the EEPR Valve for shorts with a DVOM thinking the valve took it out, but I saw no shorts to ground on the valve. I cannot give a spec, unfortunately, because the TK Manual does not provide a resistance spec for the valve. So at this point after verifying the wires to the valve were not shorted to ground, I concluded that the board just failed open.

Another win for the Pico!

I ordered a new computer for this unit and got it installed the next week. Before I connected the EEPR valve, though, I left the valve disconnected to see how all the legs worked with the circuit open. All legs showed it being pulsed with a positive pulse width modulation at 28 Volts. Also, the computer did not log a code while I did the test. So for this controller, it has not been programmed into the software to notice a fault. The only way you are going to know to go this route is with prior experience (or as a reader, just learning it from me). Now here is where the fun begins and yet proves beyond a shadow of a doubt that a scope is needed now in the HD industry to fix these problems. I hooked up both current clamps with one clamp on each leg again and then also looked at a power and ground on one leg as well. As you can see, the current is spiking over 3 amps (**Figure 5**)! That will definitely take out a computer for this system.

I could not see this issue with the DVOM, because that is a static test and the valve is cold. After the circuit heats up, you can see it fail and with the scope, you can catch it in the act. Also look at the period of time the fault happens, 76.89 ms. Good luck ladies and gents trying to see that on a DVOM. Even with min/max, you're cutting it close. So what took out the computer was the valve. It was intermittently shorting to ground internally and damaged the computer. I then installed a new valve and saved the new computer and then did another capture. On the good capture, I was showing 246 milliamps peak to peak on this valve when I cycled it with the computer, and I had the 24 Volt pulse width and a ground showing voltage as well, but it is different. On my ground, I am seeing the voltage rise on the turn-on of the valve and then when it turns off the voltage tapers off. Also notice that every time voltage is taken away or applied, it shows a spike in voltage (**Figure 6**). This has to do with the magnetic fields of both field coils working against each other, plus after making some more measurements of the harness I found 150 ohms on each ground leg. So the resistors are being used as current-limiting devices for the valve. That explains the elevated ground voltage. On my known good valve, I have 468 milliamps. This vehicle was fixed. I hope everyone enjoyed that; it just goes to show that the software does not tell you everything, and it can lie to you. Using a scope now is more important than ever.

MICHAEL EILBRACHT is a transit bus technician for the Champaign and Urbana Mass Transit District in Urbana, Ill., and is the owner of Mje Diagnostics, a heavy-duty mobile diagnostic and training business. He is also an ASE Certified Master Transit Bus Technician and also holds an Advanced L2 Certification.

ADVANCED COOLING SYSTEM TECHNOLOGIES

LEARN THE TECHNOLOGIES MANUFACTURERS ARE UTILIZING TO REDUCE WASTE AND MAXIMIZE FUEL ECONOMY THAT WILL CERTAINLY COMPLICATE COOLING SYSTEM REPAIR

DAVE MACHOLZ // Contributing Editor

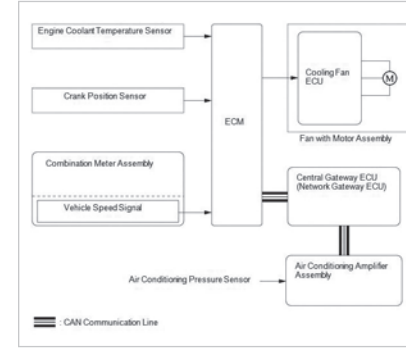
Advances in engine cooling technology and thermal management have brought a variety of small yet noticeable changes to the modern automobile. These changes are being made to address the performance, emissions and fuel economy of the internal combustion engine. Along with any new technology comes a learning curve and the potential for new service and parts sales.

The internal combustion engine is a truly amazing machine. However, its ability to convert gasoline into usable energy is not very efficient. Historically, only around 20 percent of the energy created in the combustion process was converted to usable work needed to propel the vehicle. The large majority of this wasted energy was lost in the form of heat. Managing this heat issue is essential and has become a priority of all manufacturers. Heat is lost energy that when minimized can greatly help with reducing fuel consumption and minimizing emissions. According to the engineers at Massachusetts Institute of Technology (MIT), heat transfer leads to loss of volumetric efficiency and overall performance loss. Additionally, excess heat creates complications in regard to engine knock. An inability to heat the engine quickly during startup can also lead to fuel mixture considerations that affect consumption and emissions.

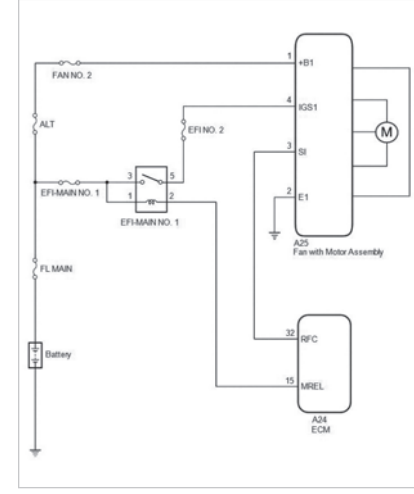
So, the question this poses for technicians is why is thermal efficiency an issue now when it hasn't been for the last 100 years? The answer is both complex and simple. If you control temperature, you can better control fuel economy and emissions. This becomes increasingly important as engines are being downsized. Historically, the larger an engine's displacement was the less thermal efficiency mattered. Given the current climate of downsizing, thermal management is key.

Manufacturers across the automotive world are addressing thermal management in a variety of ways, including the utilization of electric water pumps, advanced fan control strategies, coolant flow control and other engine technologies aimed at improving thermal efficiency. In some cases, manufacturers are claiming to have reached 35-40 percent efficiency with the implementation of these new technologies.

Electric Water Pumps – Electric



COOLING SYSTEMS CONSISTING of a duty-cycle controlled fan such as on the 2020 Camry are becoming the standard.



ON MANY VEHICLES the fan assembly includes integrated electronic control functionality.

PHOTOS: TOYOTA TIS

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water pumps are a technology that we have seen for quite some time. Initially, electric pumps would be seen in production on hybrid electric vehicles. The beauty of these pumps is that they do not require a belt drive from the engine. The belt drive from the engine essentially meant that any time the engine turned, so did the pump, and the rpm of the pump was matched to the rpm of the engine. An electric pump can be turned on and off, allowing the engine control module strategy to be set in such a way to prevent coolant flow during start up, allowing the engine to warm up quickly and therefore minimizing emissions and fuel consumption. Decoupling of the water pump from the engine also reduces the parasitic engine loss and therefore lowers fuel consumption.

Duty-Cycled Cooling Fans – Most traditional cooling fan circuits work to provide either an "on" or "off" state of operation that is determined by ECM strategy based on inputs such as coolant temperature and A/C demand or pressure. In some cases, half speed operation of the fans is achieved through the use of a five-pin relay or other configuration to power the two fans in series so that they operate at half of their functional capacity. When attempting to maintain a set operating temperature, this strategy worked well. However, when attempting to control temperature precisely, some manufacturers have moved to a duty-cycle-controlled fan. This style of fan control really serves two purposes: to provide precise temperature control and to minimize the current required to operate the fan, both of which help to achieve better overall efficiency.

Duty-cycle-controlled fans are operated by the engine control module or cooling fan module that provides a duty cycled signal to turn the fan. Duty cycling can be thought of as the percentage of on-time per cycle at a given frequency. For example, at high temperatures, the duty cycle may be 100 percent, meaning full-speed operation of the fan or fans. To achieve half-speed operation, a duty-cycled control of 50 percent would be utilized.

The overall benefit of utilizing duty-cycle-controlled fans is that multiple speeds of the fan can be achieved for a variety of cooling and thermal management scenarios.

Active Grille Shutters – Many manufacturers are furthering fuel efficiency through the use of active grill shutters. This technology enables a shutter assembly placed in front of the radiator to close at startup or other times during operation. The shutter system has two purposes, one being for cooling system function and the other to improve the aerodynamics of the vehicle to reduce fuel consumption.

PHOTO: OPUS IVS

A MAP-CONTROLLED THERMOSTAT allows for precise control of engine temperature.

Coolant Flow Control – Many manufacturers have continued the use of traditional engine driven water pumps but have moved to a coolant control valve or series of valves to rapidly warm up or to precisely control the flow of coolant in a more refined manner than that of a traditional thermostat.

These devices in their simpler forms

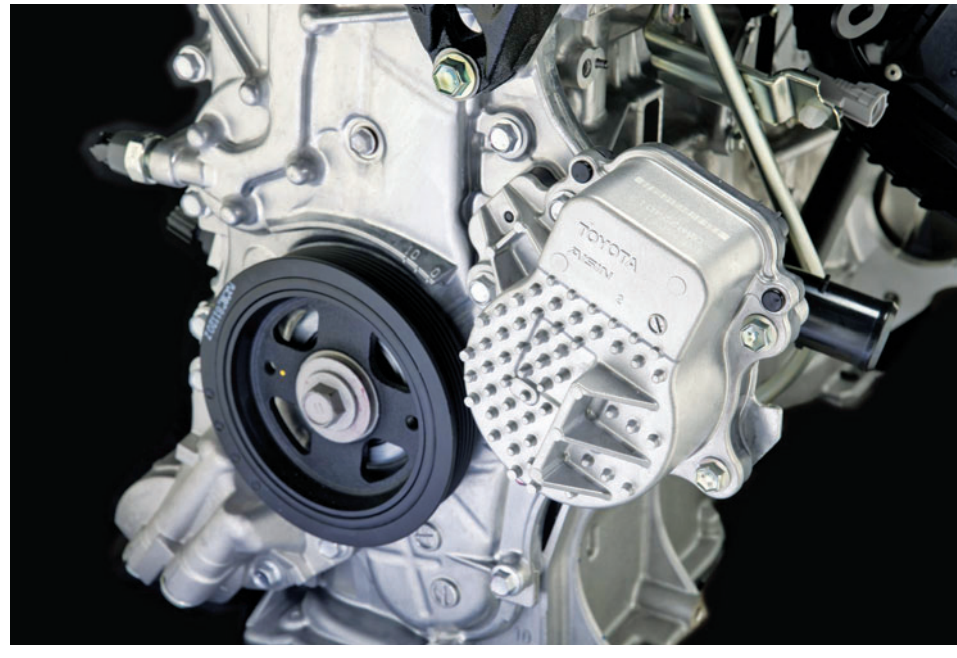

PHOTO: TOYOTA MEDIA

ELECTRIC WATER PUMPS allow thermal management strategies to be precisely controlled.

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are not so different than the heater core bypass valves that many manufacturers have used for years. They simply block the flow of coolant to certain parts of the cooling and heating system during varying engine conditions such as start up to more precisely control temperature.

In more advanced configurations, coolant flow control valves are a more centralized form of coolant flow control, which utilize a multi-position valve configuration allowing a single flow control valve the ability to distribute coolant based on thermal management strategy.

Electric Thermostats – An electric thermostat allows for precise control of engine temperature that is not dependent on engine temperature to function. Traditionally speaking, wax pellet-style thermostats relied on a specific engine temperature to open and once the temperature was reached, stayed open. The benefit of the electric/electronic thermostat, also referred to as a map-controlled thermostat, is the ability to more precisely control engine temperature at a wide range of operation criteria.

DESCRIPTION

The flow shutting valve (for heater control) used for the variable cooling system is a magnet type valve that is closed when the engine is warming up to prevent coolant from flowing through the heater passage which reduces engine warm up time.

DTC NO.	DETECTION ITEM	DTC DETECTION CONDITION	TROUBLE AREA	MIL	MEMORY	NOTE
P268111	Engine Coolant Bypass Valve Circuit Short to Ground	All of the following conditions are met (1 trip detection logic). • An open signal is being sent from the ECM to the flow shutting valve (for heater control). • Current operating state and target operating state differ for 3 seconds or more continuously.	• Open or short in flow shutting valve (for heater control) (water by-pass hose assembly) circuit • Flow shutting valve (for heater control) (water by-pass hose assembly) • ECM	Does not come on	DTC stored	• SAE Code: P2682 • DTC for Mexico Models: Applies
P268115	Engine Coolant Bypass Valve Circuit Short to Battery or Open	All of the following conditions are met (1 trip detection logic). • A close signal is being sent from the ECM to the flow shutting valve (for heater control). • Current operating state and target operating state differ for 3 seconds or more continuously.	• Open or short in flow shutting valve (for heater control) (water by-pass hose assembly) circuit • Flow shutting valve (for heater control) (water by-pass hose assembly) • ECM	Does not come on	DTC stored	• SAE Code: P2683 • DTC for Mexico Models: Applies

Related Data List

DTC NO.	DATA LIST
P268111 P268115	Coolant Temperature Coolant Water Route Switching Valve

PHOTO: TOYOTA TIS

COOLING SYSTEM diagnostic trouble codes are the new normal.

Most designs of this style thermostat contain a coolant sensor and a heater element allowing the thermostat to be opened on demand.

Diagnosing cooling concerns

Diagnosing cooling system concerns has come a long way. I remember a story my grandfather used to tell — he had a two-bay repair shop down the street from Long Island's Islip Speedway. His gas attendant was often the one who was diagnosing cooling system concerns. Every time a full-service customer came in for gas, he would pop the hood, check belt tension and give

GRILL SHUTTERS such as those used on the 2020MY Prius are utilized to control fuel consumption.

the fan a wiggle to see if there was any play in the water pump. A quick visual inspection for coolant leaks as well as an inspection of the cooling hoses and they had an overall picture of cooling system health. Needless to say, today's systems will require a bit more effort, tools and resources.

Diagnosing cooling concerns on these new vehicle technologies will require the technician to have access to several key diagnostic resources including service information, a scan and a scope. The variations across manufacturer platforms will require the technician to gather critical information on system operation and overall function. This may require the ability to access factory service information, which is readily available on a subscription basis. At times, when these technologies fail, they will be accompanied by diagnostic trouble codes (DTCs). The ability to retrieve the codes and further test these systems through bi-directional controls or active tests will also require the use of a scan tool that supports such functions.

A case study in thermal management – 2020 Toyota Camry

The 2020 Toyota Camry is Toyota's most recent example of engine technology with a focus on thermal management. When researching newer vehicles, access to factory service information such as Toyota's Technical Information System (TIS) comes in very handy. The New Car Features document within TIS reveals a rather interesting diagram of the cooling system of the 2020 Camry. The diagram of the system seems very complex with multiple hoses, connections and various integrated parts. This is not the cooling system of old with simply an upper and lower radiator hose, some heater hoses and the like.

The 2020 Camry utilizes an electric water pump and service information indicates the purpose is for reducing engine warm-up time and reducing cooling loss. This would seem to indicate they slow the pump in order to keep the engine temperature at the desired temperature without over cooling. An electric thermostat is also utilized to help in this regard.

Several coolant shut valves, which are electronically-controlled solenoid-style valves that are able to stop coolant flow, are utilized to block coolant flow through the heater core and through the transmission fluid warmer, allowing the system to prioritize warming and cooling through each of these components. Additionally, these can block coolant flow to the heater core, allowing the engine to warm-up quickly.

An ECM, duty cycle controlled fan is also utilized to further enhance thermal management.

Outlook

While there is no single technology here that is very complex, it is clear that the approach to thermal management is the enhancement of the components we are all familiar with to achieve the overall end-goal of thermal efficiency at levels that were not possible with older cooling system technologies. How this begins to affect the aftermarket is yet to be seen. However, early indications are as with any part or system, we will see an opportunity for diagnostics and repair with these systems.

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

AUTOZONE OFFERS TIPS FOR KEEPING EMPLOYEES, CUSTOMERS SAFE IN PANDEMIC

As an essential provider of goods and services, you supply a critical service to "the motoring public." Whether it's people getting to critical doctor's appointments or to the grocery store for their kids, your ability to operate your business and repair vehicles is a matter of public safety and welfare. AutoZone is committed to supporting you. The following are some tips and best practices that can help prevent the spread of COVID-19 at your shop.

Wear Gloves - Protects hands from shared surfaces like computers, tools or equipment, and discourages face touching

"On-Hand" Sanitizer - Make sure you have hand-sanitizer at each work station and throughout the front of the shop.

Keep a good supply of soap at each wash station.

No Visitors - Vendors and non-employees should not be allowed in the shop in order to reduce contact and exposure

Pick-Up & Drop-Off Spot - Designate a location for parts and deliveries to be dropped off or picked up. Also, consider labeling this location with signage to direct staff and reps accordingly.

Limit Crowds - From work schedules to lunch breaks, try to make sure that personnel are not scheduled at the same time to help physical distancing

If you have more than one location, eliminate employees traveling to other offices. Keep reading at **MotorAge.com/safe**.

MACS 2020 MOBILE A/C UPDATE

REGULATORY UPDATES, EMISSIONS TAMPERING, ELECTRIC COMPRESSOR CONCEPTS AND MORE TACKLED AT THIS YEAR'S EVENT

STEVE SCHAEBER // Contributing Editor

MACS 2020 is in the history books, destined to go down as one of the most memorable events in the Society's history. This year we were at the Gaylord Opryland Resort in Nashville, which played out as the most enjoyed venue we've been to in recent years. Besides our trade show (where you could see the latest in recovery machine technology, line splicing kits, lubricants and scan tools) were classes where many of the industry's top A/C trainers and engineering professionals gave presentations ranging from product design updates and OEM-specific service methods to in-depth component lectures on compressors and thermal expansion valves. We even had a session on SL-MAC (secondary loop mobile air conditioning) systems that use R-152a with a refrigerant-to-glycol heat exchanger!

For those of you who couldn't join us this year, let's review some of what took place at MACS 2020.

Technician certification

You're probably already aware that U.S. federal law requires certification for technicians who work on mobile air conditioning systems. Many of us have had our "MACS Card" for decades, primarily because we needed it to purchase R-12 back in the day. But when we transitioned to R-134a, the Environmental Protection Agency (EPA) didn't require certification to purchase it, that is, until 2018. Now we need our "609 Card" to buy all MVAC (motor vehicle air conditioning) refrigerants.

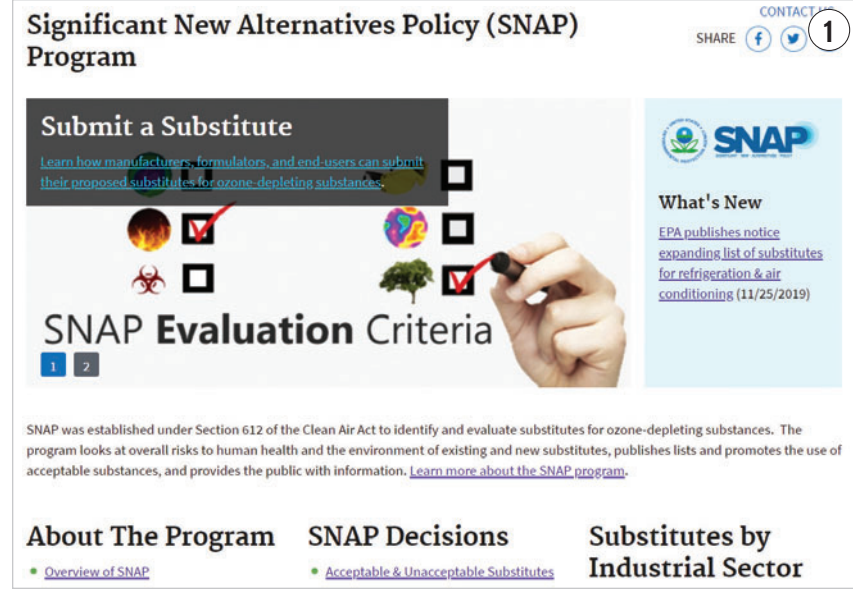

PHOTO: US EPA

MVAC END USES ARE UNIQUE in that they operate in a wide variety of ambient conditions (sunload, shade, idling in traffic with little air movement, traveling down the highway with lots of ram air, etc…), variety of refrigerants, the likelihood of accidents, and the location of system components (evaporator inside the passenger compartment). Because of this, all refrigerants approved for use in MVACs have use conditions which can be found on EPA's SNAP list.

We often think about "Section 609" of the Clean Air Act (CAA) as being the one that affects technicians in the shop, considering that's the official name for the "MACS Card" you likely have in your wallet. But there are really three different sections that we should know about because they relate to motor vehicle air conditioning.

The first is Section 608, which although it primarily covers rules relating to stationary refrigeration (like the window units and central air conditioning used in your house or office), it also prohibits intentionally venting refrigerants. Also, it spells out the sales restrictions, which limit refrigerant purchases to certified technicians only. There is, of course, the controversial exemption for DIY use, which allows sales of R-134a and R-1234yf in small cans (less than two pounds), as long as they incorporate a self-sealing valve (you've probably seen these new cans and their associated adapters at a big box store near

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you). Section 608 also requires refrigerant to be recovered before disposal.

Being the primary MVAC rule, Section 609 is what officially requires technicians to be properly trained and certified in the use of approved refrigerant handling equipment. It says we have to use recovery-only or recovery/recycling machines when servicing MVAC systems. However, most shops have machines that can recover, recycle AND recharge.

Section 612 is probably less known, but it's just as important. It's the one that covers EPA's Significant New Alternatives Policy (SNAP) program, under which EPA approves and lists the refrigerants allowed for certain end uses and sectors of industry (**Figure 1**). It's what allows us to use R-134a as a replacement for R-12 and it also DOESN'T allow us to retrofit an R-134a system with R-1234yf. It spells out all of the use conditions for the various refrigerants, including uses beyond air conditioning (such as foam blowing applications for house insulation, for example).

You can read all about these rules and regulations, along with the full text of the U.S. Clean Air Act (and subsequent amendments) on EPA's www.epa.gov/mvac website. Or do a Google search for "Just the facts for MVACS."

The never-ending court case(s)

In November 2016, EPA issued a final rule that extended refrigerant management regulations to include HFCs (R-134a) and HFOs (R-1234yf). Before that, they only covered ODSs (ozone-depleting substances). In our case, that meant CFCs like R-12. Since then EPA has received comments (and has been sued in court), and they are now in the process of writing new rules, which may roll back some of those requirements.

Certain provisions are still in place that apply to MVACs, such as the 2018 sales restriction that limits the sale of most refrigerants to 608 and 609 technicians. Distributors and wholesalers of containers larger than two pounds are still required to keep sales records and make sure that people who are buying refrigerant are certified and approved to purchase those refrigerants.

What about that upcoming ban on R-134a?

Back in 2015, EPA made a final rule that changed the listing status for R-134a from acceptable to unacceptable in new passenger vehicles and light trucks beginning with the 2021 model year. That rule did not say that R-134a would be banned altogether, just that it could not be used in new vehicle production. R-134a is still allowed (and will continue to be allowed) to service the existing vehicle fleet for many years to come.

But on the next day, EPA was sued in court by two refrigerant companies, who said EPA does not have the authority to regulate HFCs (like R-134a), but only ODSs like R-12. Their reasoning goes back to the original text of the CAA amendments from 1990, which gave EPA their authority to regulate MVAC in the first place. The case went back and forth in federal court, eventually ending up at the supreme court. They agreed that EPA had overstepped its bounds, and the rule was thrown out.

As a result, EPA issued a guidance document in 2018 that said they would not apply that part of the rule (as per the court's decision), but again they were sued in court over the guidance. EPA since held stakeholder meetings about this, where senior MVAC industry members said that regardless of what happens in court, the refrigerant changeover is going to take place.

And by MACS last count, we figure that more than 80 percent of MY2020 vehicles use R-1234yf refrigerant.

But after five years these cases aren't over yet, as we're still waiting for the D.C. Circuit Court to render its decision on the guidance document. So, while we're still technically in limbo, and we think it too will be thrown out, we have to reserve our final report until we hear from the court and EPA (which we're hoping for later this year).

WHILE NOT CURRENTLY ON EPA'S APPROVED LIST, dual-refrigerant R/R/R machines like Snap-on's PolarTek Dual can legally be used with both R-134a and R-1234yf. And once EPA's next rule becomes final, this and other J3030 machines will be added.

Regulatory update

EPA has put together a draft proposed rule (to incorporate by reference) three SAE Standards into the regulations: J2843, J2851 and J3030. It's been in development for almost 10 years, dating back to 2011 when J2843 (the SAE Standard for R-1234yf R/R/R, or recovery / recycle/recharge machines) was first published. This rule will require technicians to use equipment certified to one of these SAE Standards, in addition to the ones already on the books.

Here's the way it works. Current regulations say we have to use R/R/R equipment during service, and EPA specifies which ones by referencing the respective SAE Standards in their rules. Right now we officially have to use J1990

machines for R-12 and J2210 or J2788 machines for R-134a. (You can check your machine in your shop to see which standard it meets by reading the information label, likely on the back cover.) Once this new rule goes into effect later this year, we will also be required to use J2843 machines for servicing R-1234yf vehicles, and J2851 machines to recover contaminated refrigerant. And if we want a machine that can work with both R-134a and R-1234yf, we can use a J3030 machine for that (**Figure 2**).

Once they officially publish the proposed rule (which should happen by April 2020), there will be an opportunity for the public to make comments, which will be addressed in the final rule, due out this summer. And once that final rule is published in the Federal Register, EPA can then add equipment that is certified for R-1234yf to the list on their website.

Emissions tampering

We're not talking about exhaust pipes here, but rather tampering with an A/C system. There are lots of rules about this, but the main point is that changing out a low GWP (global warming potential) refrigerant with a high GWP refrigerant is not allowed and would be considered tampering with an emissions-related component under Title II of the CAA.

The rationale is that since EPA gives OEs an emissions credit towards their CAFE ratings for using a low-GWP refrigerant, if you were to, for example, remove R-1234yf from a system and replace it with R-134a, that would be tampering with emissions (because R-134a is more damaging to the atmosphere than yf).

So the main takeaway is that EPA does not want people mixing refrigerants, nor removing yf and replacing it with R-134a.

Electric compressor concepts

It may not seem like it, but we've been using ECs (electric compressors) in automotive A/C systems for more than 20 years now. One manufacturer, Sanden, began selling their earliest models back in 1997, which they had in development since 1992. So, we've already got a long history with their operation and service.

In the beginning, there were only certain applications for ECs, primarily with Honda's Insight and Toyota's Prius. As those models began to take off and sales increased, so did sales of ECs for both OE and aftermarket replacement use. But EVs (electric vehicles) are growing in popularity today, and ECs are being demanded more. Over 2.5 million have been sold for electric cars to OEs like Audi, BMW, Daimler, Geely, Honda, JLR, Porsche, PSA, Volvo, VW and also for HD truck applications as well. They're being used for parking cooling in Daimler, Iveco, MAN, Scania, and Volvo Trucks among others, which we'll explore in a bit.

Since then there have been many evolutions of these compressors, which continue to be adapted to meet customer needs. In this case, the customer is the vehicle OEs. The first ECs did not integrate inverters into the compressor housing (as many do today), but rather used a separate module (**Figure 3**). You've probably seen them on 2005-2007 Honda Accord and 2006-2011 Honda Civic Hybrids with that heavy orange cable running down to the compressor.

Around 2009 they started integrating the power inverter into the compressor housing so there would be only one "module" that needs to be replaced if a problem arises. Those early models were quite big, and over time they were redesigned to be smaller. Still, they're somewhat bulkier since their electronics are built-in. For example, the large, flat surface on Chrysler's Pacifica hybrid compressor contains the inverter and takes up about the same width as the main body.

Compressor manufacturers are always looking for ways to improve performance and reduce costs. Today's electric compressors operate with 5v/12v controls and around 430v for the motor. In the future, there are plans for 48v and also high-tension compressors that work off of 800 volts!

Many design parameters need to be taken into consider-

ation for electric compressors. First of all, they need to have similar performance as can be achieved with a standard mechanical compressor. Tests have shown that a 33cc EC is equivalent (more or less) to a 150cc piston compressor. You might think that's not possible, or maybe that it's just some marketing hype, but it's actually due to EC efficiency. A major advantage is that it can run at speeds independent from the engine speed.

In the case of mechanical compressors, the most difficult situation is at idle. As you can imagine, the compressor during that time is running at a slower speed and so there is slower, lower refrigerant flows through the condenser and other system components. But since ECs can run at speeds independent from the engine, it can be ramped up or down as needed to keep up with performance requirements.

Then there's noise levels. Electric cars are very quiet, so every noise is very noticeable. EC manufacturers have to consider not only idle noise but also vibration and suction pulsation (which is key for reducing noise within the vehicle cabin).

PHOTO: RANSHU

THE 2005 HONDA ACCORD HYBRID was the first US Honda fitted with an "electric" compressor. But don't let the clutch fool you! This unique compressor can be driven by a belt on one side of the scroll and by an electric motor on the other side (referred to as a "combo compressor"). It's a Sanden HBC175, which displaces 75cc on the belt-driven side and 15cc on the electric side.

Most ECs are placed on the engine inside the engine compartment. So they must fit in the same approximate space as their predecessor piston compressors did. That's because ECs are still noisy and make vibrations, but when mounted on an engine, this is absorbed and dissipated by engine mounts.

ECs also have to communicate with the vehicle systems, so many have integrated LIN/CAN. They also have to be used for battery thermal management and can be used for heat pump systems also (like what's been used on certain models of Toyota's Prius Prime since 2017).

ECs for parking cooling in HD trucks

Parking cooling brings in a whole new set of parameters that must be met. Cooling conditions must be matched with the parking requirements.

Before all of the no-idle laws went into effect, truckers pulling over to sleep for a few hours would just leave the engine running so they could have A/C. But many no-idle laws limit idle times to around 5 minutes, and many truck PCMs will shut the engine down after that time has elapsed.

To get around these laws (and save money at the same time), some trucks use no-idle HVAC systems for driver comfort. They include diesel-fired electric heaters to warm cabins during the winter, and electric powered A/C systems during summer.

Usually, they are only used during the night, so you don't have the additional heat load caused by the sun, hot pavements and reflection from nearby vehicles. And even though it is sometimes still hot out, you generally have cooler temperatures at night than you do during the day. This is good for the system because the performance output needed is lower at night than during the day. This helps the system to be capable of operating all night long on batteries so the engine does not need to run and waste fuel and pollute the atmosphere. This helps fleets and truck operators meet no-idle regulations. This also helps because even the best batteries on the market still have a limited life, which is reduced with prolonged charge/discharge cycles. These systems also have to be compact to fit in the size requirements and space considerations of the vehicle.

Current view on the A/C industry in Europe

Back in 2006, the EU (European Union) nations developed a regulation that said they need to decrease the import of R-134a because they want a more green environment. It said that beginning in 2011, car manufacturers could not use a refrigerant with a GWP of more than 150. This knocked out R-134a from the choices, leaving (basically) only R-152a, R-1234yf, and R-744 (CO2). By now we know that almost every OE has gone down the yf road. But although they first said 2011 would be the cutoff, there were many delays, and it didn't become mandatory until the 2017 model year.

In the meantime, however, those import regulations took effect on 1 January 2015, which said that refrigerant importers would need to limit the gross amount of refrigerant being imported into the EU. This is done by reducing the amount imported each year (based on 2014 import levels) until the year 2030, which would need to be at one-fifth of 2014 sales.

This sounds great; if you slowly step down the amount allowed to be imported, eventually there will be much less imports, and therefore, less of the harmful gas being used, and then less emissions, which is good for the environment, right?

Well, the timing of the whole thing could have been better.

The phasedown scheme started in 2015, but the use restriction did not start until 2017. So you had a few years there where R-134a vehicles were still being manufactured at the same production levels, but there was less gas allowed to be imported. So eventually the system came into an imbalance, to where there was not enough refrigerant available (particularly in the southern European countries) to meet the demand.

What happened next is that shops began searching online for "R-134a replacements" and they ended up buying HCs, propane, and other flammables like R-152a (sometimes being disguised in cylinders as R-134a with fake markings and counterfeit company logos printed on them). As you can imagine, this is still causing major headaches across the continent. Reports of major service issues for companies that make aftermarket parts have been widespread (particularly concerning warranty coverage issues), as well as those who make OE and replacement components and those who service the vehicle fleet.

Off-highway use of R-1234yf

It's been a few years since R-1234yf started showing up in passenger cars and light trucks, but we haven't seen it being used in anything else. Reasons for this are regulation (there is no current U.S. mandate for low-GWP refrigerants), incentive (there are no carbon credits for HD use) and permission (EPA has not yet approved its use beyond Class 3). But a group of off-highway equipment manufacturers and their Tier1 suppliers (represented by AEM, the Association of Equipment Manufacturers) have been working towards getting it approved.

And if their SNAP application is accepted by EPA, R-1234yf refrigerant may soon be allowed for use in newly manufactured off-highway work machines.

Given the higher cost of yf and lack of requirements, you might wonder why companies would want to switch. But there are a few reasons, the first having to do with the F-Gas quota system in Europe. It's a complicated scheme (based on 2015 usage) designed to limit the amount of high-GWP refrigerant being imported and used in EU member states. For example, in 2016 and 2017 they only allowed 93%, and for 2018 the amount was reduced to 63%. The gradual phase-down will reach 21% of 2015 sales by 2030. This makes R-134a more expensive and harder to get in Europe.

Also, these manufacturers are not country-specific, as most of them build machines for sale around the world. This not only applies to U.S. companies manufacturing products here in the U.S. for export to other countries but includes those who build off-highway machines for U.S. import. R-134a is costly and hard to get in some regions, and if allowed by EPA it would be much simpler to use yf. Likewise, U.S. manufacturers exporting to certain countries that ban HFCs must ship their machines empty and complete the A/C charging with yf upon arrival (since they can't legally do this stateside).

The first step towards the SNAP approval process took place in early May, with several AEM and MACS members attending a meeting at EPA Headquarters. Led by AEM (who represents segments of the off-highway industry including agriculture, construction, forestry, mining, and utility equipment) the group reviewed the risk assessment they had been working on over the last nine months for the first machine configuration, which was agricultural tractors over forty horsepower. Other machine types (each of which requires separate SNAP applications) include:

- Agricultural tractors (under forty horsepower)
- Self-propelled agricultural machinery
- Compact, utility and turf equipment
- Construction and forestry equipment
- Compact construction equipment
- Mining equipment

Essentially, they are asking EPA for the option to use either R-134a or R-1234yf as the industry sees fit for a certain application, expecting that more people will be using low-GWP refrigerants in the future. They have also conducted a risk assessment focused on any potential hazards to the operator, which includes items like cabin size, charge amounts, high-pressure cutoff switches, pressure relief valve location, evaporator, and seal testing, etc.

At this point, we're waiting to hear from EPA about further application requirements that may need to be completed. If there are none and EPA says the application is complete, then yf will be allowed after a 90-day waiting period. Official approval won't come until EPA publishes their next rule (which we expect later this year) and is likely to include certain use restrictions similar to those used on passenger cars. EPA will also prohibit retrofitting with R-1234yf, primarily due to R-134a evaporators not being certified for use with an A2L refrigerant.

Note: We've also learned that activities in Europe have begun for Class 8 trucks to receive what the EU calls "Type Approval" for using yf in those vehicles. Right now, they're still using R-134a in over-the-road trucks like we are in the U.S., and to date, there has been no SNAP application for Class 4 through 8 vehicles. When that happens, we'll keep you posted.

STEVE SCHAEBER is the Manager of Service Training for the Mobile Air Conditioning Society (MACS) Worldwide and Technical Editor of ACTION™ Magazine. *steve@macsw.org*

THE VARIABLES OF VARIABLE DISPLACEMENT A/C COMPRESSORS

IT'S A MUST TO KNOW MORE ABOUT HOW THEY WORK AND HOW TO DIAGNOSE THEM

DAVE HOBBS // Contributing Editor

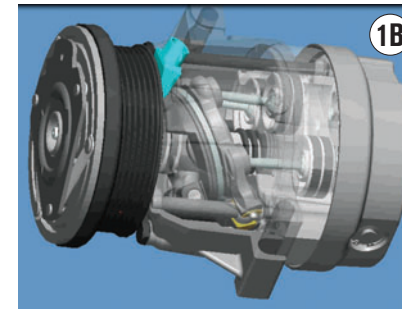
April showers bring May flowers and along with flowers, some weather-related variables such as heat, humidity and pollen! For many drivers that means getting their vehicles' A/C working to perfection is not an option . . . it's a MUST! With so many newer vehicles today using variable displacement A/C compressors it's also a MUST that we know more about how they work and how to diagnose them.

Why vary compressor displacement?

When I was a much younger technician, I recall an A/C component called a POA (Pilot Operated Absolute) valve that prevented the evaporator's outlet pressure from getting too low. We all know that when evaporator pressures get too low, the evaporator's temperature then becomes too low, causing condensation on the evaporator fins to ice up. An iced-up evaporator won't allow air to flow across its fins and that causes the passenger compartment to warm up. The POA valve was mainly a GM thing with a few Fords using them as well. Other OEMs did (back then) what they still do today — combine an expansion valve with an evaporator temp switch that shuts the compressor clutch relay off when the evaporator becomes too cold. Engineers at GM amid the fuel economy crisis days (1970s) concluded that if cycling the compressor worked to keep the evaporator from freezing up, then why not go for a simpler (and cheaper) version of the expansion valve (the fixed orifice tube) and cycle the compressor more often to maintain evaporator pressures within the perfect range of cold but not too cold. This increased fuel economy on all but the hottest days when the compressor would run nearly full time.

The rise and fall of CCOT

The old GM CCOT (Cycling Clutch Orifice Tube) systems born out of increased fuel economy requirements did a good job in saving fuel while keeping evaporators from icing up on less than sweltering days. There were less than desirable side effects, however. You may recall that distinct feel of engine load changes when the clutches for those old R6 and R4 GM compressors cycled. As engine displacement (and power) continued to decrease to address increased fuel economy requirements, that "feel" of the compressor cycling between either 100 percent displacement (clutch on) and 0 percent displacement (clutch off) became more noticeable. This led to the idea of a gradual compressor displacement change via a movable wobble plate that provided for the compressor's piston strokes to gradually increase and decrease to be less noticeable to the driver. More importantly,



PHOTOS: DELPHI TECHNOLOGIES

THIS DELPHI V5 (VARIABLE DISPLACEMENT – 5 CYLINDER) COMPRESSOR'S WOBBLE PLATE (1A) is connected to the 5 pistons. As the drive belt via the engaged compressor clutch turns the shaft, the angle the shaft rotates at is controlled by the pressure valve (1C). The controlled movement of the flexible wobble plate is guided along a rod with a brass bushing (1B). When lubrication problems occur as a result of improper oil balancing (when a new compressor is installed) or a large leak that causes oil loss this bushing's brass particles end up circulating within the A/C system. If you see brass in a screen or filter — it came from the compressor which has either failed or is nearing failure.

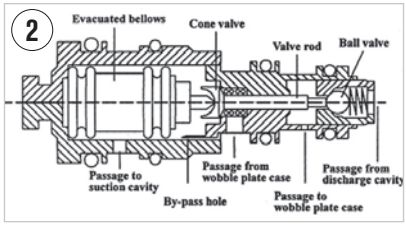


PHOTO: DELPHI TECHNOLOGIES

IN REDUCED STROKE POSITION, the bellows extends causing the ball valve to open. The suction orifice closes, discharge gasses flow to the compressor's crankcase and the compressor de-strokes. In full stroke mode, the bellows compress allowing the ball valve to seat. The suction orifice opens allowing compressor crankcase gas to flow to suction, resulting in the compressor going to full stroke.

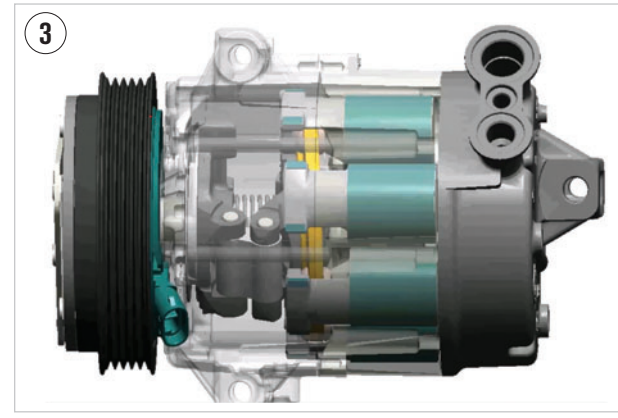
the compressor's variable displacement output combined with a varying expansion valve opening allowing for evaporator pressures to be maintained in the sweet spot between not too warm (passenger discomfort) and not too cold (evaporator freeze up).

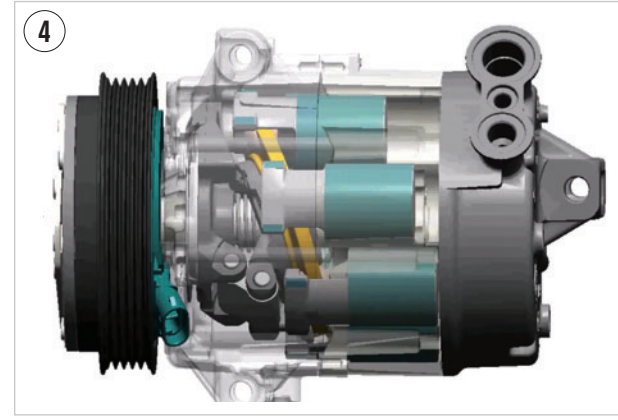
VDC (Variable Displacement Compressor) designs

Over the years both reciprocating piston designs and non-piston compressors designs (i.e. the scroll) were first adapted to variable displacement operation utilizing a manual self-balancing pressure control valve (**Figures 1A, 1B, 1C**). The control valve changed the sump (internal compressor pressure) as it reacted to low side pressure (**Figure 2**) to move the compressor from full displacement (full stroke) to low or no displacement (**Figures 3, 4**). The moving parts (besides the pistons) are the flex in the "wobble plate" attached to the compressor's shaft (**Figure 1A**) or the swash plate (**Figures 3, 4**) and the shaft itself.

Oil maladies – the compressor's No. 1 enemy

As with any mechanical component failure, insufficient oil quantity and/or quality are the main enemies. Adding too much refrigerant oil to the system can be almost as bad as having too little oil in the system. Too little oil is obvious — just like in an engine. Too much oil can be subtle. If several technicians have worked on the vehicle before you, they may have added too much oil. For example, just because a compressor comes shipped with X # of ounces of oil inside it doesn't mean all of that oil should remain in the compressor before installation. ALWAYS perform the OEM recommended oil "balancing" procedure on any new compressor you install. Basically, you drain the old compressor's oil from it and measure it. Unless the amount you drain is under 2-3 ounces (see OEM specs) you put that amount of the correct type of new refrigerant oil into the replacement compressor. Always spin the compressor





PHOTOS: DELPHI TECHNOLOGIES

NEWER VARIABLE DISPLACEMENT COMPRESSORS use a swash plate with a coupling joint. As the pressure in the sump (compressor case) increases this forces the swash plate (illustrated as the yellow component in these drawings) rearward (red arrow in Fig. 3) against spring pressure to de-stroke the compressor. When the sump pressure decreases an opposing spring pushes the swash plate forward again to increase the stroke of the compressor (red arrow in Fig. 4) Either a self-regulating valve or electrically controlled solenoid valve controls the sump pressures.

PHOTO: GLOBAL PARTS DISTRIBUTORS

THIS VDC (VARIABLE DISPLACEMENT COMPRESSOR) ELECTRONIC SOLENOID (Fig. 5) from a 2013 Chevy Malibu works in a compressor utilizing a conventional electro-magnetic clutch allowing for a full compressor shut off while the same model year Toyota Corolla's electronically controlled VDC does not use a clutch. Toyota along with a few other imported OEMs eliminate the need for a compressor clutch by using a 0-100 percent variable displacement solenoid duty cycle. Note the special break away front of the Toyota's drive pulley (Fig. 6) which allows for a faulty compressor to lock up w/o throwing the main accessory drive belt.

shaft by hand before running it with the engine. Too much oil, too much leak detection dye/sealants along with too high of a refrigerant charge will cause the system pressure to increase. Basic gas laws state the higher the pressure, the higher the temperature. This is even true of that cold stuff we call refrigerant. On the flip side of the excessive refrigerant and/or excessive oil charge coin is too low of refrigerant charge. Oil only moves with the refrigerant it was designed to work with. An insufficient refrigerant charge (or incorrect oil) will result in oil that's present in the system but not moving through the compressor as intended. This will, in turn, lead to premature compressor failure.

Electrically controlled pressure control valves

Similar in idea to those electric solenoids which control the flow of oil in an engine with variable valve timing, newer A/C compressors are using solenoids (**Figure 5**) to control compressor output. The solenoid takes the place of the older style self-regulating pressure control valve. As the evaporator temperature (and pressure) begin to drop (as the vehicle's interior cools down) the HVAC controls (monitoring A/C pressures) command the compressor's solenoid to move the swash plate to reduce the compressor's stroke (displacement). As with the self-regulating valve, the gradual displacement change is easier on the load changes applied to the engine. You probably began noticing this type of compressor appearing first on vehicles with smaller/lower powered engines. In more recent model years the electronically controlled variable displacement compressor is being used in all sizes vehicles and engines. Many German and Asian imports have even eliminated the compressor clutch, using a full movement to zero displacement via the computer-controlled VDCs electric solenoid to discontinue compressor operation when not required. In case of a compressor failure/lock up, the front of the compressor has a plate (**Figure 6**) with sheer pins that are designed to break away allowing the compressor's drive pulley to spin with a locked-up compressor. The idea is to prevent the serpentine belt from breaking/flying off.

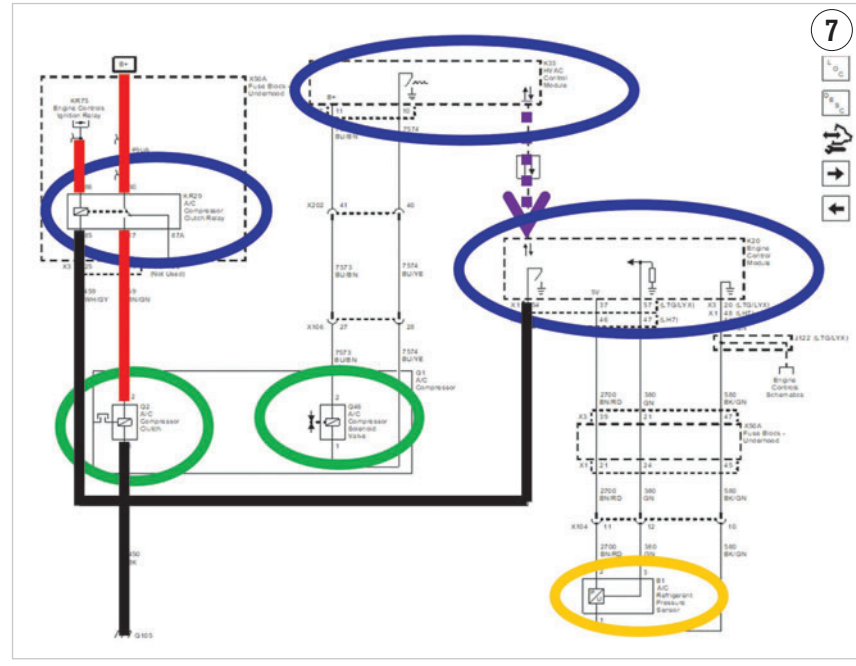


PHOTO: GENERAL MOTORS

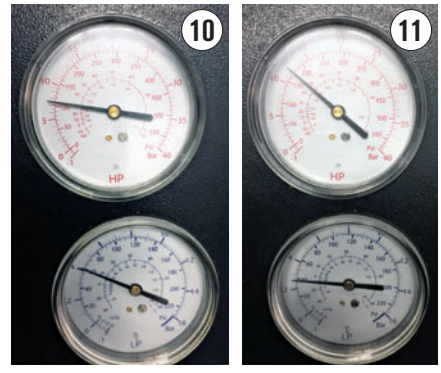
KNOWING HOW A VARIABLE DISPLACEMENT COMPRESSOR is electrically operated is an essential step in your diagnostic process. Even the most complex schematics can be simplified with colored high lighters. On this late model GM schematic we circled controlling devices (blue), sensing devices (yellow) and controlled devices (green). Red and black are used for main power and grounds and purple is used for a data bus circuit. Note the control circuit to apply the ground for the compressor clutch relay originates at the ECM while the control for the compressor's variable displacement solenoid comes from the HVAC control module.

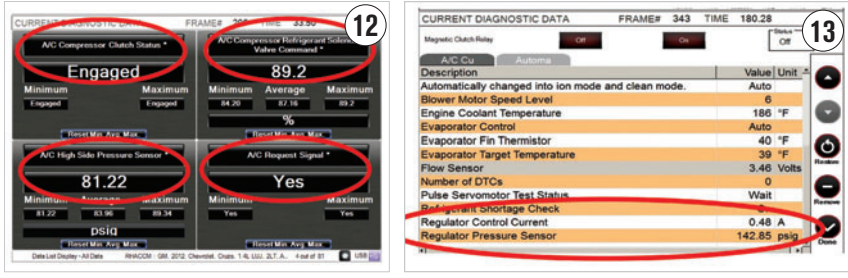
GETTING TO A VARIABLE DISPLACEMENT COMPRESSOR'S SOLENOID is not so easy on some applications. On the Ford Escape in Fig. 8 the solenoid is easily accessed from under the vehicle. Prior to attempting more elaborate diagnostics with a variable displacement compressor activation tool, always make sure the solenoid is neither shorted or open. This one (Fig. 9) reads within specs at 13.2 ohms. Most activation tools have a connector to place on the solenoid (allowing you to control it) and another connector to connect a dummy load (within the tool) to the vehicle's harness connector to prevent setting a false DTC for open circuit / low current draw.

VDC solenoid diagnostics

While diagnostics on variable displacement compressors using the self-regulating pressure control valves can be challenging, electric solenoids can be monitored with a scan tool. Always consult the vehicle's wiring diagram (**Figure 7**) to make sure you fully understand

UNDER MODERATE AMBIENT HEAT / HUMIDITY CONDITIONS many variable displacement compressors will have both high and low side pressures that might cause you to conclude that the system is low, or the compressor is not pumping sufficiently (Fig. 10). When the ambient temperatures / humidity (heat load) is much higher, your scan tool allows for ramping up the compressor's solenoid duty cycle or you utilize a specialized variable compressor displacement control tool, the pressure will go back to where you might expect them to be (Fig. 11) provided the solenoid is working correctly.





IN FIG. 12 THE HIGH SIDE PRESSURE is only around 80 psi with the compressor clutch engaged and the VDC (Variable Displacement Compressor) solenoid commanded to 89 percent. The pressure should be much higher IF the ambient temperature is warm — hot and the system is fully charged. If the answer to those last two questions are "yes" the solenoid may be stuck in the low stroke position. The clutch-less Toyota Corolla in Fig. 13 has around ½ amp current draw applied to the VDC's solenoid. High side is at 142 psi. This system appears to be working normal.

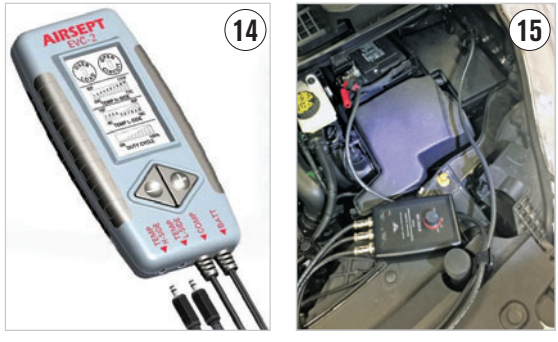


PHOTO: AIRSEPT

FOUR SEASONS, GDP AND AIRSEPT (FIG. 14) are some of the more popular variable displacement compressor solenoid activation tools available on the market. In addition to connecting to a power source and the compressor's displacement control solenoid (via universal alligator clip connections) to allow a linear variable control of the solenoid, the Airsept EVC-2 also has two temperature probes to connect to high and low side component tubing to allow for a quick check to see if the compressor's displacement is truly changing. The Techno Tools EVDC-100 (Fig. 15) is an OEM tool designed specifically for Ford and connects to the compressor's solenoid with a factory connector.

what component in the system controls the compressor's clutch (if used) and displacement control solenoid. There are differing opinions on what to do when you diagnose a faulty A/C VDC solenoid. Most will agree if the solenoid seems to be inoperative (full stroke/evaporator freeze up or low/no stroke and no cooling performance/low pressures) and the compressor has a LOT of miles on it, replace the compressor. No sense in trying to replace an old and ailing compressor's control solenoid only to see the compressor fail six months later. On the other hand, if the compressor is not an aged high mileage specimen, a replacement solenoid is available AND the solenoid is easily accessible (**Figure 8**), many techs are replacing only the solenoid and reporting profitable and successful A/C repairs that are quicker and less expensive for the customer. Always check the solenoid for a good connection and proper resistance (**Figure 9**) early on in your diagnostic process. If you're not experienced in monitoring high and low side pressures on variable displacement compressors you might misdiagnose a low system or other problem when the system is performing properly. For example, on a 72-degree F day with 50 percent humidity your RRR machine (or manifold gauge set) may read 60 psi on the low side and 100 psi on the high side. With a conventional fixed displacement compressor, you might rightfully assume a low charge or underperforming compressor. On a late model Ford Escape with electronically-controlled VDC this reading is normal. The proof is almost always flushed out in a performance test indicating whether or not the system is cooling but sometimes we're tempted to ignore the obvious "if it's not broke, don't fix it" rule and be led strictly by our gauge readings (**Figures 10, 11**). For this reason, it is imperative to combine scan tool DPID info (**Figures 12, 13**) along with scan tool bi-directional control of the VDC's solenoid to make the proper diagnosis. Some OEMs don't even allow their factory scan tool to control their VDC solenoids so you might consider purchasing a specialized tool (**Figures 14, 15**) to ramp up the solenoid's output to determine exactly what the root problem is. Knowing the variables with variable displacement A/C compressors will be the key to the proper diagnosis for this spring's A/C services.

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AN UNCERTAIN FUTURE?

COVID-19 CREATED A NEW "NORM" AND PREVENTED MANY OF OUR INDUSTRY'S BEST TRAINING EVENTS FROM TAKING PLACE. BUT DOES THAT MEAN TRAINING HAS TO COME TO A STANDSTILL?

PETE MEIER // Director of Training

I'm writing this at the end of April, and the coronavirus is still wreaking havoc across our country. I'm praying that, by the time you read this, things will have returned to a more normal state, but at the same time, with more cities requiring residents to "shelter in place" and the count of known COVID-19 cases still climbing, we may still be on the uphill side of battle.

Among the many victims of the pandemic were the numerous industry training events and expos that had to reschedule in light of travel restrictions and CDC guidelines. Among them was ASA Northwest's Automotive Training Expo (now scheduled for July 30 - August 1), the TST Big Event (rescheduled for August 15) and even our own inaugural Commitment To Training LIVE event scheduled for May 9 in Rosemont, Illinois (rescheduled for November 14, 2020. Visit the event's web page at https://events.motoragetraining.com/content/CTT-Rosemont.aspx for more information).

And, as of this writing, it is still unclear what will happen to the few events slated for the end of May. Even those taking place in June and July are in question.

The coronavirus pandemic also established new "norms" for us as a nation and as an industry. Our ability to interact directly with our customers changed — to digital interactions versus personal. Many of you began offering pick-up and delivery services to your customers or offered "hands free" drop offs at your shop followed up with mobile billing and payment options. We had to practice something new, something called "social distancing," to minimize the spread of this highly infectious virus. And when not in the shop, we were all "sheltering in place", staying at home binging on Netflix and ordering our meals through Uber Eats, Door Dash or GrubHub.

Many of you used the time wisely, investing some downtime hours to attend a variety of training opportunities online. Perhaps you reviewed a *Motor Age*/TST webcast that you had already subscribed to, or caught up on the episodes of The Trainer you haven't had a chance to view yet. With more than 100 episodes of The Trainer alone, there is certainly plenty of content available under the Motor Age Training brand to keep you busy!

In addition to the content that was already available to you, WORLDPAC and CTI began offering free training to the professional aftermarket under the WORLD Professional Automotive Community and Virtual Classroom banners, respectively. Courses feature training led by instructors from WTI and CTI, guest industry leaders and automotive systems experts from OE and premium aftermarket suppliers and manufacturers.

Courses are held weekdays at 5 p.m. Pacific time (8 p.m. Eastern time). Technical classes will be featured on Mondays, Wednesdays and Fridays, with management-focused classes on Tuesdays and Thursdays. Virtual Classroom programs, including in-depth programs that build on the CTI and WTI Career Pathways training model, debuted the week of April 6 and have been expanded since.

THE CORONAVIRUS PANDEMIC BROUGHT US yet another "new normal" — one that our industry met head on and learned from.

To see a full list of complimentary training available from Advance by CTI and WTI, visit worldpac.com/training/classes/online or ctionline.com.

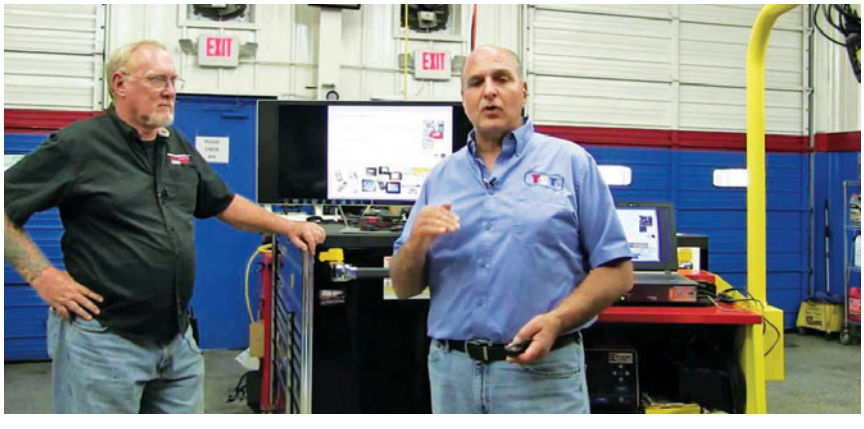
Another company that has made free training opportunities available is Dorman, in partnership with TST and featuring G. Jerry Truglia. Currently, the program has focused on mastering a variety of scan tools and diagnostic skills, incorporating real-world case studies experience by G and the technicians working out of his Mahopac facility. For additional information on these offerings, visit the TST web site at http://www.tstseminars.org.

Are you ready for another A/C season?

Since this is my May column, it's only fitting that I touch a bit on some best practices you should follow when servicing your customers' A/C concerns. First and foremost is making sure you are certified

PHOTOS: PETE MEIER

VISION WAS THE LAST "LIVE" TRAINING EVENT of the year so far with other popular events rescheduling for later in the year.



THE CORONAVIRUS PANDEMIC MAY HAVE SHUT DOWN "in person" training, but it isn't stopping us from doing all we can to provide you with alternative training solutions — with our biggest effort yet debuting in June!

under the EPA's Section 609 standards. Not only are you required to have this certification before performing any kind of repair or service to the refrigerant circuit, you are also required to present this certification when purchasing refrigerant in anything larger than the DIY 2# can. And even if you do have your certification, if it's more than five years old I encourage you to recertify. The new certification exam has a lot of great information on R1234yf and best practices.

However, certification has nothing to do with certifying you in the proper diagnosis and repair of A/C systems. The trend for some time has been in lowering both overall refrigerant charge and total oil charge — and that means that small variations in either has a much larger impact than before. Improperly charged systems won't cool as efficiently as they should and can also result in higher compressor head temperatures that could lead to premature compressor failure.

Last but not least, if you do have to replace a compressor that has failed internally, you MUST flush the rest of the system to remove any debris there and replace all components that cannot be flushed. Failure to do so could allow embedded debris to eventually find its way back to that new compressor and with the expected results.

A potential revenue opportunity that exists for each and every one of you is servicing hybrid air conditioning systems. Many hybrid models rely on the air conditioning to control the temperature of the High Voltage battery pack — making the a/c system a critical system that needs to function properly year 'round.

Servicing these A/C systems is not that much different from servicing any other, with one major exception. You should be aware that many hybrids use electric compressors powered by High Voltage from the HV system, so certainly a thorough understanding of safety is needed before attempting to replace one of these units.

If you are interested in learning more, it just so happens that we'll be hosting a live stream of a presentation on just this very topic on May 23! Many of you have been guests of our *Motor Age*/TST webinars in the past but due to travel restrictions currently in place, we won't be able to host this one "live" at the shop. However, both G. and I will be online with you for the debut of "Servicing Hybrid A/C —Tips For The Non-Hybrid Tech" to answer any questions you may have. MA

PETE MEIER is an ASE certified Master Technician with over 35 years of practical experience as a technician and educator, covering a wide variety of makes and models. He began writing for *Motor Age* as a contributor in 2006 and joined the magazine fulltime as Technical Editor in 2010. Pete believes in the mission of the magazine to "advance the automotive professional" and provides resources to working techs around the country through print, social media and YouTube.
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UNDIAGNOSABLE PROBLEMS?

HOW HAS DIAGNOSTICS CHANGED AND HOW MUST WE ADAPT?

MIKE REYNOLDS // Contributing Editor

As a technician, being ahead of technology is the best strategy. That being said, I was late to the game getting into hybrid diagnostics. I had attended a few of the hybrid training courses over the years, which covered safety, general function and operation. Aside from that, I never had much of an opportunity to perform any hybrid diagnostic work and never saw much value in learning hybrid diagnostics if I wasn't going to be able to apply the knowledge in the field.

When I made the transition to mobile technician, I was looking for a niche to market and associate myself to my clients that would associate my name with the latest and greatest technology. I wasn't sure if marketing myself as a hybrid specialist would be directly profitable, but I knew that many of my clients were hesitant to take hybrids into their shop because they were unfamiliar with this "new" technology. It seemed like a good idea to align my reputation with new technology, so I purchased a hybrid with a dead battery and decided to get my feet wet.

While fixing up that hybrid, it dawned on me how much diagnostics as we know it is rapidly changing. Code diagnostics for many of the hybrid systems in that vehicle included very little actual testing and a lot of, if you have this code, replace this component.

Manufacturers don't want their technicians going inside of batteries and other HV components. Most hybrid components are replaced as an assembly and as a result, most of the troubleshooting is done based on codes rather than intrusive, electrical testing.

I see that trend continuing not just with hybrids but with each new generation of vehicles.

Everything is a module

These days, just about everything in a vehicle is a module. Who would have thought we would be programming window switches! We are seeing fewer analog signals used on these vehicles. At the same time, these modules are even more capable of determining the cause of the fault using more advanced algorithms. Ten years ago we were handed a scan tool with a P0304 (or worse yet a P0300) code, and it was up to us to determine the cause of the fault. Nowadays an ECM can pinpoint that fault down to the ignition coil/circuit and set a P0354.

While this technology is typically great for us technicians, as it can streamline the process, sometimes I wonder if the technology on these vehicles will someday allow them to almost completely diagnose themselves. These days it seems much more common to look up a code and find a diagnostic procedure in service info that leads to component replacement rather than testing.

Like so many others in this industry, I have made a career out of stepping outside of the trouble tree diagnostics. I see my value in the industry as being able to take a symptom, learn proper operation, come up with a logical testing approach, and determine a root cause. I feel a little threatened by the

PHOTOS: MIKE REYNOLDS

thought of a computer doing this for me! Is this how cashiers felt when they heard about self-checkout?

I am confident that at least in my lifetime, there will always be concerns with vehicles that will require a mindful diagnostic approach, but that approach will have to adapt as rapidly as technology.

Undiagnosable?

But what really scares me about the future of diagnostics are what I like to call undiagnosable issues. What's an undiagnosable issue, you ask? An issue where no reasonable amount of service information or understanding of system operation will lead you to a logical diagnostic conclusion.

Let me explain using a 2018 Chevrolet Suburban (**Figure 1**) I recently worked on. I got called out to look at this truck because the rear window liftgate would not open. Typically, I would have assumed this was going to be an easy in-and-out diag, but this call came from a Chevrolet dealer collision shop. They have some pretty sharp techs, so I knew I was in for a challenge.

When I got to the truck, they explained that it had been hit in the rear, the tailgate had been replaced and everything had been swapped over. The first few things I check for with most collision vehicles with replacement doors and liftgates are grounds, connectors and mismatched harnesses. This shop is thorough, and I didn't find anything obvious right away. When checking operation, I found that the automatic liftgate itself worked properly; however, the glass would not open. When the button was pressed, the hazards flashed and the door chime would sound, but the glass would not open. I also noticed that the rear wiper would not turn on; however, the rear washers did work. There were no codes stored in any modules.

I have seen a liftgate control module fail after being hit in a collision as they are mounted to the liftgate. After checking the wiring diagram, I found that the liftgate window latch was controlled by the BCM rather than the liftgate module. The rear wiper motor was also controlled by the BCM, which led me to think we might be dealing with related issues.

The liftgate window operation is very simple. It does not automatically raise like the automatic liftgate. It only unlatches, allowing it to be raised to the "open" position by hand. There is a liftgate window unlatch window relay in the rear fuse block. The low side of the relay is always grounded and receives a B+ power from the BCM, which closes the high side of the relay, which allows power from the (always hot) fuse 11 to travel to the liftgate window latch and open the window. With my relay tester installed, I was able to verify the ground on the low side was OK and the power from fuse 11 to the high side was correct. When I applied power to the output of the relay, the window latch released the glass (**Figure 2**). This told me that I needed to focus on the B+ power from the BCM, which appeared absent when the window latch was commanded.

Wiper arm related to window operation?

With the glass released, it dawned on me how the wiper motor and window glass were related symptoms (**Figure 3**). The wiper motor and arm are mounted to the liftgate, and in the parked position the wiper does not contact the glass, which allows the glass to be opened independently. If the liftgate window was opened while the wiper arm was not in the parked position and contacting the glass, the arm of the wiper would hold the glass down on the liftgate and not allow it to open. I assumed that this means the BCM must see a signal from the park switch in the wiper motor to allow the window to open.

Furthermore, the BCM must know that the window is closed to operate the wiper motor so that the wiper arm would not turn on with the glass in the open position. To accomplish this the liftgate window latch has a switch that passes ground to the BCM when the window latch is unlatched.

With this information, I decided to first check that the window ajar switch was working correctly. Because I already had the Powerprobe connected at the window latch relay, I was able to latch and unlatch the window while watching the rear access open message display in the cluster (**Figure 4**). Although we knew they were functioning by the hazard flash and chime since I had the scan tool data up, I was able to verify that all of the window unlatch switches on the exterior and remote of the vehicle would switch to active when pressed (**Figure 5**).

With the liftgate closed, I was able to verify that the PID "Trunk Lid/Liftgate Window Unlatch Command" showed inactive when the switches were pressed, which told us that the BCM saw the request but was making the decision not to unlatch the window.

I decided to move on to the rear wiper motor, hoping to find an over-

looked blown fuse. The rear wiper motor on this vehicle communicates with the BCM on the LIN bus. It only has three wires: a power, ground and a LIN bus communication circuit. I verified healthy power coming from Fuse F16 in the rear fuse block as well as a healthy ground at the motor connector. Using our uScope, I verified that there is a healthy 0-12v LIN communication signal at the motor.

Next, I looked at the rear wiper data in the BCM hoping to find some direction. The only PIDs we have that pertain to the rear wiper motor are Rear Wiper Command and Rear Wiper Switch. I was able to verify that the rear wiper switch was operating correctly by monitoring that PID in the scan tool; however, we could not get the rear wiper command to switch from inactive, telling us that the BCM would not command the wiper on.

Digging a little deeper

I continued to do a little research on the description and operation of the wiper motor and liftgate window. Service information states:

"The Rear Wiper Motor is supplied with constant power and ground. After the BCM receives the signal from the Rear Wiper/Wash Switch it controls the Rear Wiper Motor operation via a serial data message to command the wiper to perform the requested function (Low Speed, Intermittent, Rear Washer or Off). The BCM does not control the parking of the Rear Wiper Motor; it is self-parking. When the BCM commands the motor off, the Rear Wiper Motor will park itself. The BCM monitors the liftgate ajar signal circuit, and the BCM will disable the function of the Rear Wiper Motor if the liftgate or lift gate glass is ajar or open."

This told me that the wiper park command is not controlled by the BCM, which made me think that the BCM might not need a confirmation of the park position of the motor.

The description and operation for the liftgate window states:

"The BCM monitors supplies a 12 V signal to the liftgate window unlatch switch so that when the switch is pressed, the voltage within the signal circuit is pulled low and in response, the BCM will detect the voltage drop and check the status of the door lock system. If the doors are locked, the BCM will ignore the request, if the All Doors Unlocked has been commanded, the BCM will recognize the request and command the liftgate window to release."

Wait a minute! I realized that I had never looked at the unlock status while I was testing the liftgate window latch function. I went back to verify that the door locks operated correctly, but the BCM would still not command the window with the door locks unlocked.

At this point, I had performed all of the testing I could think of, and I needed to try to determine what the root cause was. It seemed that we could have a BCM that is not operating the way it should, a failed park switch in the wiper motor, or a completely non-communicating wiper motor.

I was certain that GM wouldn't allow the window to be opened while the wiper was turned on, but since the only inhibit criteria listed was the door locks, I wasn't really sure if there was a park switch output from the wiper motor to the BCM, or if the BCM would just inhibit the window operation when the window command was turned on. For this to work, I assumed there would have to be a timer so that the window couldn't be unlatched immediately after the wiper command was turned off and yanked up before the wiper arm

returned to park. Because the description and operation explicitly said that the park function was not controlled by the BCM, it seemed unlikely to me that a park signal would be sent out of the wiper motor to the BCM. It also seemed to reason that if the BCM was supposed to monitor inputs from the wiper motor, then it would set a code if it was unable to communicate with it.

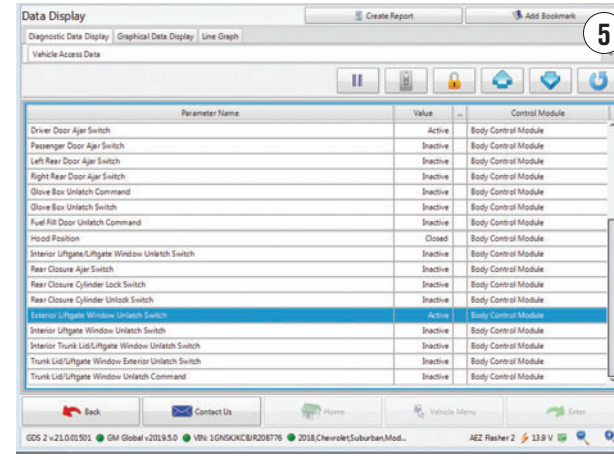
On the other hand, it would make sense that the wiper motor would send a park signal output and that because this truck was hit in the rear it was more likely to be the cause of the failure than the BCM under the dash. I visually inspected the motor and found no visible damage to the unit. I was also able to look at photos from the damage before repair, and all of the damage was to the lower section of the tailgate and bumper.

Doing even more research, I found this note in the troubleshooting information for the rear liftgate window:

Note: The M33 Liftgate Window Latch Assembly will be disabled if the body control module has detected that the M45 Rear Wiper Motor is Active, verify the function of the M45 Rear Wiper Motor before commanding the M33 Liftgate Window Latch Assembly. Refer to Rear Wiper System Malfunction.

This led me to believe that the decision for the BCM to inhibit the unlatch command would have been made based on whether or not the rear wiper was active and GDS2 showed the wiper command is inactive at all times.

I spent a lot of time researching every bit of info available because I couldn't misdiagnose a Chevy for the Chevy dealer collision shop. I explained to them that I wasn't 100 percent certain the issue was in the BCM, but I was feeling pretty confident that something may have shorted during the collision, causing this odd failure in the BCM and that even though the truck was hit in the rear, it had not set any codes for the wiper motor, and we had no indication of it failing. To sweeten the deal, the BCM was readily available and considerably less expensive than the wiper motor.



Learn from the mistakes

So…turns out I was wrong. A new BCM was installed and programmed and didn't fix the issue. The wiper motor was ordered and when it arrived and was installed, the shop was nice enough to let me come back and take some data from it. Unfortunately, everything looked the same aside from both the rear wiper and rear window latch commands would now switch to active when commanded on.

I did the best I could, but ended up manning the parts cannon in the long run. Even my "educated guess" of a shot missed the target, so I'm filing this one under "undiagnosable." Is it possible that someone could have diagnosed that vehicle properly? Absolutely. I'm sure GM engineering software has more useable data that might have told us if there was a wiper communication or park input issue. Or we could have used CAN hacking to try and interpret the messages and possibly compare them to known goods, but that hardly seems worth the effort compared to the cost of a BCM and programming.

So am I saying give up on diagnostics because soon it will either be impossible or handled by computers? Not at all. Technology is changing, and we are going to need to adapt as technicians now more than ever. Consider all of the new advanced driver assist components that, for the most part, cannot be tested using the traditional methods we have known for years. When a radar unit is not operating correctly you will need the ability to not only understand the fundamentals of how a radar system works, but also how the system operates and integrates with almost every other sensor and module on the vehicle. You may even have a code and a flowchart telling you where to go, but how many times have you been failed by a flowchart or trouble tree diagnostic procedure? It is inevitable that as the level of technology increases, the accuracy of flowchart diagnostics will decrease. The skills gap between technicians who are not capable of performing diagnostics outside the flowchart and ones who are is only getting wider and consequently, the need for technicians willing to adapt to the next level of challenges will continue to grow. And practical thinking, in addition to the knowledge already possessed by the skilled diagnostician will be a large part of our success as technicians going forward.

MIKE REYNOLDS is the owner of Mobile Automotive Service Solutions in Charleston, SC, and an automotive instructor at Trident Technical College. He is certified as an ASE Master Technician (A1-A9, X1) along with L1 and L3. *mike@masscharleston.com*

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AD INDEX

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SERVICE AND REPAIR OF HUB BEARINGS

THE ABILITY OF THE WHEELS TO ROTATE IS TAKEN SOMEWHAT FOR GRANTED, ISN'T IT? BUT THEY WOULDN'T ROTATE FOR LONG IF IT WEREN'T FOR THE SUPPORT — LITERALLY — OF A ROLLER-STYLE BEARING.

PETE MEIER // Director of Training

While tapered-style roller bearings may still be found on many passenger and light truck applications, by and large hub-style unified bearings have taken over. And when a customer pulls in with a steady "roar" emanating from the front wheels, the unified kits make the job almost a "bolt on" proposition.

Almost.

It's easy to rip the old hub assembly out and throw the new assembly in. But professionally servicing and replacing even the latest bearing designs requires a few extra steps to ensure the longevity of the replacement part.

Additionally, had certain preventative steps been taken, the old bearing assembly may have lasted considerably longer!

In this episode of The Trainer, I will walk you through the proper way to inspect the condition of a hub-style bearing and show you the extra steps to take when replacing one to ensure a professional job. MA

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