



PREPPING FOR WINTER

The colder it gets, the more important these simple checks are for your customers

12 **E-85: WHAT YOU DIDN'T REALIZE YOU NEEDED TO KNOW**

When one comes into your shop, you need to be ready to repair it

46 **A TWO-FOR-ONE REPAIR**

It's not every day a maintenance service inadvertently fixes a drivability problem

MORE TECHNICIANS CHOOSE DURALAST PARTS*

**"FAILURE IS NOT AN OPTION.
WE'VE GOT TO GET IT RIGHT THE FIRST
TIME AND EVERY TIME. I NEED MY
CUSTOMERS SAFE AND SATISFIED."**

DONNIE M. | TECHNICIAN | 24 YEARS OF EXPERIENCE

Duralast
PROVEN TOUGH™

*Duralast OE Quality Parts In Over 20 Categories.
Learn More At **DURALASTPARTS.COM***



* Source: Proprietary Consumer Study of Automotive Aftermarket Parts Conducted by The NPD Group, 2020.

©2020 AutoZone, Inc. All rights reserved. AutoZone, AutoZone & Design and Duralast are registered marks of AutoZone IP LLC or one of its affiliates.

OPERATIONS

PROFIT MOTIVE

6 **WHY YOU STINK AT SELLING MAINTENANCE TO WOMEN**

If your shop doesn't cater to female preferences, you are missing an opportunity

CHRIS "CHUBBY" FREDERICK // Contributing Editor

FINANCIAL FIGURES

10 **TIME TO REALLY FOCUS ON ATTENTION TO BUSINESS DETAIL**

Be sure not to fall into routines of the past to ensure future success

BOB GREENWOOD // Contributing Editor



26



36



46

TECHNICAL

12 **E85: WHAT YOU DIDN'T REALIZE YOU NEEDED TO KNOW**

When one comes into your shop, you need to be ready to repair it

SCOTT SHOTTON // Contributing Editor

20 **HELPING YOUR CUSTOMERS PREPARE FOR WINTER**

The colder it gets, the more important these simple checks can be

PETE MEIER // Director of Training

26 **DIESEL SCR SERVICE**

As diesel usage continues to grow, you need to prepare for these services

TRACY MARTIN // Contributing Editor

36 **A/C PERFORMANCE TESTING**

Learn the procedures that work nearly all the time

MARK DEKOSTER // Contributing Editor

46 **A TWO-FOR-ONE REPAIR**

It's not every day that I perform a maintenance service on a vehicle and inadvertently fix a drivability problem

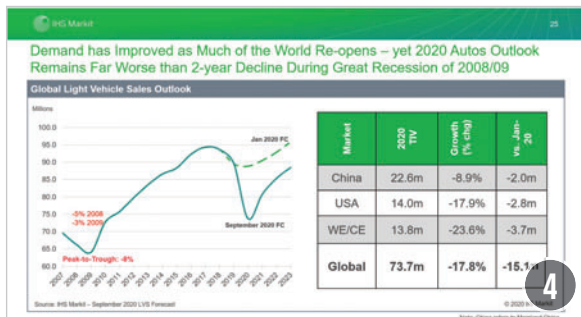
TIM JONES // Contributing Editor

64 **SPARK PLUG SERVICE THE PROFESSIONAL WAY**

Whether you're removing and installing the plugs during a diagnostic test or changing them as a routine maintenance service, there's still a "right" and "wrong" way to do it

PETE MEIER // Director of Training

IN EVERY ISSUE



4 INDUSTRY NEWS

INDUSTRY RESILIENCE SHOWN IN RECOVERY

KRISTA MCNAMARA // Editorial Director

INDUSTRY ORGANIZATIONS ANNOUNCE VIRTUAL TRAINING EVENT

52 TECH TIPS

62 AUTOMOTIVE PRODUCT GUIDE

63 MARKETPLACE

VIDEO TRAINING

WATCH AND WORK

Continental's "Watch and Work" series provides tips on how to correctly replace water pumps. Watch now:

MotorAge.com/WatchWater



WEB EXCLUSIVES // MOTORAGE.COM

HOW TO INSTALL LIFT SUPPORTS

In this video from ZF Aftermarket, learn how to determine if you have a lift support beginning to fail and how to find a replacement. Learn safety issues and other considerations for replacement, along with general instruction and tips to safely change your lift supports.

MOTORAGE.COM/LIFTSUPPORTS

HVAC DATA ANALYSIS

As HVAC systems have added features and new technologies, the cost of service and repair has grown. Today's systems offer more data, utilities and tests through the scan tool. Carquest Technical Institute and WORLDPAC Training Institute partner to provide a webinar that will introduce some of these tests and data along with the diagnostic direction that can be gained from their use.

MOTORAGE.COM/HVACDATA

MotorAge

MOTORAGE.COM

Endeavor Business Media, LLC

1233 Janesville Avenue, Fort Atkinson, WI 53538.

Phone: 920-563-6388

EDITORIAL STAFF

KRISTA MCNAMARA

EDITORIAL DIRECTOR

kmcnamara@endeavorb2b.com

CHELSEA FREY

SENIOR ASSOCIATE EDITOR

cfrey@endeavorb2b.com

PETE MEIER ASE

DIRECTOR OF TRAINING

pmeier@endeavorb2b.com

BRANDON STECKLER

TECHNICAL EDITOR

bhsteckler@gmail.com

DAN WARD

ART DIRECTOR

STALIN ANNADURAI

SENIOR DESIGNER

JAMES HWANG

EDITORIAL DIRECTOR, ASE STUDY GUIDES

jhwang@endeavorb2b.com

(714) 513-8473

CONTRIBUTORS

ROBERT BRAVENDER

CHRIS CHESNEY

MICHAEL EILBRACHT

CHRIS FREDERICK

BOB GREENWOOD

DAVE HOBBS

TIMOTHY JONES

DAVE MACHOLZ

RICHARD MCCUUSTIAN

MIKE REYNOLDS

SCOTT SHOTTON

BERNIE THOMPSON

G. JERRY TRUGLIA

PRINTED IN U.S.A.

Connectiv
The Business Information Association, a division of SITA

SUBMISSIONS:

Motor Age welcomes unsolicited articles manuscripts, photographs, illustrations and other materials but cannot be held responsible for their safekeeping or return.

MEMBER OF:



ENDEAVOR BUSINESS MEDIA

CEO – **CHRIS FERRELL**

CRO/CMO – **JUNE GRIFFIN**

VP KEY ACCOUNTS – **SCOTT BIEDA**

COO – **PATRICK RAINS**

CTO – **ERIC KAMMERZELT**

VP, ACCOUNTING – **ANGELA MITCHELL**

VP, FINANCE – **JESSICA KLUG**

VP, TRANSPORTATION – **REGGIE LAWRENCE**

VP, DIGITAL BUSINESS DEVELOPMENT –

MONIQUE LEJA

VP, PRODUCTION OPERATIONS – **CURT PORDES**

CHIEF ADMINISTRATIVE AND LEGAL OFFICER –

TRACY KANE

BUSINESS STAFF

KYLIE HIRKO

VP/GROUP PUBLISHER

MICHAEL WILLINS

BUSINESS DEVELOPMENT DIRECTOR,

MOTOR AGE TRAINING

BREANNE WARD

MARKETING DIRECTOR

JILLENE WILLIAMS

SALES COORDINATOR

DOMESTIC SALES

MIDWEST & WESTERN STATES,

CLASSIFIED SALES

MICHAEL PARRA

mparra@endeavorb2b.com

ILLINOIS, EASTERN & SOUTHERN STATES

PAUL ROPSKI

propski@endeavorb2b.com

OHIO, MICHIGAN & CALIFORNIA

LISA MEND

lmend@endeavorb2b.com

PRODUCTION & ADMINISTRATION

KAREN LENZEN

SENIOR PRODUCTION MANAGER

TRACY SKALLMAN

CIRCULATION MANAGER

REPRINT SERVICES

Brett Pettilo at Wright's Media

bpettilo@wrightsmedia.com

CUSTOMER SERVICE

Subscription Customer

ServiceMotorAge@omeda.com

(877)-382-9187

Motor Age (USPS 925560) (Print ISSN: 1520-9385, Digital ISSN: 1558-2892) is published monthly, by Endeavor Business Media, LLC, 1233 Janesville Avenue, Fort Atkinson, WI 53538. Periodicals postage paid at Fort Atkinson, WI 53538 and additional mailing offices. Subscription prices: U.S. one year, \$73.50; U.S. two year, \$130.20; one year Canada, \$111.30; two year Canada, \$206.85; one year international, \$111.30; two year international, \$206.85. POSTMASTER: Send address changes to Motor Age, P.O. Box 3257, Northbrook, IL 60065-3257. Please address subscription mail to Motor Age, P.O. Box 3257, Northbrook, IL 60065-3257, Canadian G.T.S. number: R-124213133R7001.

©2020 Endeavor Business Media All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical including by photocopy, recording, or information storage and retrieval without permission in writing from the publisher. Authorization to photocopy items for internal/educational or personal use, or the internal/educational or personal use of specific clients is granted by Endeavor Business Media for libraries and other users registered with the Copyright Clearance Center, 222 Rosewood Dr. Danvers, MA 01923, 978-750-8400 fax 978-750-4700 or visit <http://www.copyright.com> online. For uses beyond those listed above, please direct your written request to Permission Dept. fax 847-564-9453.

Endeavor Business Media provides certain customer contact data (such as customers' names, addresses, phone numbers, and e-mail addresses) to third parties who wish to promote relevant products, services, and other opportunities that may be of interest to you. If you do not want Endeavor Business Media to make your contact information available to third parties for marketing purposes, simply call toll-free 877-382-9187 or email MotorAge@omeda.com and a customer service representative will assist you in removing your name from Endeavor Business Media's lists.

Motor Age does not verify any claims or other information appearing in any of the advertisements contained in the publication, and cannot take responsibility for any losses or other damages incurred by readers in reliance of such content. While every precaution is taken to ensure the accuracy of the ad index, its correctness cannot be guaranteed, and the publisher waives all responsibility for errors and omissions.

AD DEADLINES: Insertion orders—1st of month preceding issue date. Ad materials—5th of month preceding issue date.



THE JOURNEY OF ULTIMATE DURABILITY

STARTS AND STOPS WITH ADVICS

ADVICS (Advanced Intelligent Chassis Systems) is a supplier of ultra-premium OE brake system components that are engineered and manufactured with industry-leading technology and innovation for the aftermarket. With the combined experience of AISIN, DENSO and SUMITOMO ELECTRIC, three of the world's premier automotive suppliers, the ADVICS journey represents the very best of Japanese quality, global expertise and environmental sustainability for the road ahead.



PADS | ROTORS | MASTER CYLINDERS | WHEEL CYLINDERS | BOOSTERS | CALIPERS

ADVICSAFTERMARKET.COM



MARKET TRENDS

INDUSTRY RESILIENCE SHOWN IN RECESSION RECOVERY

KRISTA MCNAMARA //
Editorial Director

COVID-19 has hit the automotive industry hard, but if the industry is one thing, it is resilient.

Mike Wall, executive director, automotive analysis with IHS Markit presented an industry outlook during the virtual Auto Care Leadership Days, showing the contraction during the pandemic and also the growth expected.

The industry recession is likely deeper than that seen during the financial crisis of 2008-2009, Wall said. The industry was down 5 percent in 2008 and 3 percent in 2009, and currently the growth in 2020 sits at nearly negative

18 percent. "The difference is how deep the contraction is right now, but the market is expected to surpass 2018 and 2019 levels by 2021 and continue growing into 2022," he said.

First-time buyers are helping push automotive sales globally, with many driven to buy vehicles as a way to reduce use of public transportation, and because of upcoming planned travel, Wall said.

Wall also gave an overview of the vehicles on the road today. "The pool of potential buyers remains strong," he explained, showing that 43 percent of vehicles on the road are MY 2008 or older. "So the repair factor is going to remain

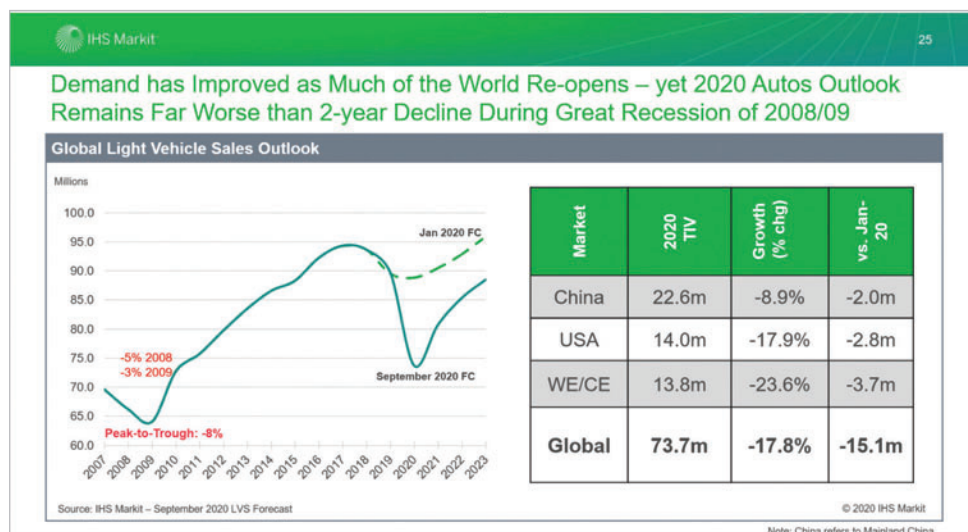
resilient," Wall said.

Light vehicle sales recovery is expected to be quick, but there is concern that a second wave of COVID-19 could derail the market. He presented three forecasts:

- **Baseline** — Efforts to contain COVID-19 shutter large swaths of the economy and create a deeper recession than 2008-2009. Inventory offsets some of the plant disruption impact, yet also limits near-term growth prospects. OEMs prioritize production of more profitable programs (e.g. trucks).
- **Optimistic** — The forecast reflects a broader V-shaped recovery as stimulus measures are expanded globally.

Additionally, IHS Markit data points to COVID-19 boosting interest (bio-safety) and increasing demand for private car ownership in the U.S., Western Europe and China. A stronger economic response in 2021-2023 accelerates recovery in light vehicle demand.

- **Pessimistic** — High COVID-19 infection rates create the risk of a W-shaped cycle with a second downturn in the global economy in late 2020. Additionally,



TRENDING

GARAGE GURUS OFFERS UPDATED E-LEARNING PLATFORM

Garage Gurus relaunched its e-learning platform for technical training with more than 110 different courses for techs to choose from that are live 24 hours a day.

[MOTORAGE.COM/NEWGURU](https://www.motorage.com/newguru)

BOSCH, BROADLY TO COLLABORATE

Bosch and Broadly have collaborated to unite Bosch Car Service with Broadly's reputation management and customer communication tools to improve online customer experiences.

[MOTORAGE.COM/BROADLY](https://www.motorage.com/broadly)

CALIFORNIA LOOKS TO PHASE OUT GAS CARS

California Governor Gavin Newsom issued an executive order instructing CARB to draft regulations requiring all new cars and passenger trucks sold in the state to be zero emissions by 2035.

[MOTORAGE.COM/ZEROGAS](https://www.motorage.com/zeroGas)

THE POWER OF APPOINTMENTS

This Remarkable Results podcast discusses delayed maintenance and the power of appointments in helping bring in additional dollars to your business. Get information to make some strategic changes.

[MOTORAGE.COM/APPOINT](https://www.motorage.com/appoint)

EPICOR LAUNCHES "EPIC RESULTS"

Epicor's "Epic Results" initiative aims to help shops increase revenue and improve efficiency in a fast-changing market environment. It includes a no-cost Profit Clinic consultation.

[MOTORAGE.COM/EPIC](https://www.motorage.com/epic)

DON'T MISS PAVE VIRTUAL EVENT

With most in-person training events canceled in 2020 and for the foreseeable future, leading automotive industry organizations have joined together to create PAVE — Professional Automotive Virtual Education — that aims to be the ultimate virtual training event for automotive professionals. The best auto repair associations have joined together with top instructors and vendors to bring you the three-day event, Jan. 8-10, 2021. Learn more at MotorAge.com/PAVE



stimulus measures prove ineffective and unemployment rates remain elevated. Economic recovery begins later and at a much slower rate. Severe contractions last through the first quarter of 2021 and consumer confidence remains depressed.

On the vehicle production side, North America is down 3.6 million units in 2020 from where it was anticipated, Wall said. Looking out to the future, the industry will be making gains in production, but from through 2027 will still produce 9.1 million fewer units than anticipated going into 2020.

The pandemic has also created delays in launching new vehicle models, Wall said. Launches in 2021-2023 could be subject to further delay, reprioritization or even cancellation. OEMs will review portfolios to extend current vehicles — possibly integrating new minor facelifts to extend the lifecycles.

There will be extensive growth in

battery electric vehicles (BEVs), with more than 35 new nameplates. “Automakers are still moving along on an electrified path. When we get to 2022 and beyond, we are expecting much more EV adoption,” Wall said. “And not just for new upstarts; it includes GM, Ford and many others.”

Another COVID-19 impact has

been a change in vehicle ownership trends. Going into 2020, ride sharing and lower vehicle ownership rates were on the rise. But currently, “personal ownership of vehicles is looking good. That’s not to say Uber or Lyft are going away. They are not moving a lot of people right now, but they are moving a lot of product,” Wall said. *MA*

“Parts department,
PLEASE HOLD...”

**NEVER WAIT TO
ORDER AN OEM
PART AGAIN WITH
REPAIRLINKSHOP.COM**

Search and buy thousands of
genuine OEM parts **ONLINE**, 24/7.

**Visit RepairLinkShop.com
to sign up.**

Why you stink at selling maintenance to women

If your shop doesn't cater to female preferences, you are missing an opportunity

What does your customer base look like? If your answer is mostly men, then you're missing a huge opportunity! Decades ago, this was not the case. It was not as common to have women customers in a shop, let alone making auto repair purchasing decisions. However, with more than half of women in the United States working outside the home and accounting for 47 percent of the workforce, they are quickly becoming the primary customer and target audience for auto repair shops nationwide. In fact, women control 85 percent of purchasing decisions, so if your shop does not cater to their preferences, they'll likely pass you by or overlook your services entirely.

If you're missing the mark on attracting women customers and you want to change that, then the following article from ATI Performance Coach Charlene Parlett is a must-read.

I was revisiting an article written in 2007 by one of my fellow (male) colleagues. The article was about how the market had changed from 30 years ago,

when cars broke down more often and the stereotype of an automotive technician was a guy in a greasy shirt carrying a greasy rag in a greasy paw with a pinup girl calendar on his toolbox. The article focused on selling maintenance to women since most shops were seeing a shift to more female customers. It talked about having a clean, professional image, taking down those offensive calendars, and remembering to oblige our female customers with "guidance and structure in our maintenance programs."

THE MAJORITY OF YOUR FEMALE CUSTOMERS ARE THE BREADWINNER FOR THEIR FAMILY, ARE MUCH MORE TECH SAVVY AND CAN GOOGLE.

It made me cringe a little reading it. I grew up around technicians and blue-collar working guys, so I'm a little thick-skinned when it comes to male bias toward women. But in today's

environment, while the wording was never meant to offend, we are living in a new world where the majority of your female customers are the breadwinner for their family, they are much more tech savvy and they can Google faster than you can talk. As a nation we are also much more sensitive (enlightened?) to how we may offend someone with our words and behavior. Try telling a woman today that you are going to provide her with guidance and structure, and she will most likely give you a few choice words and walk out the door. I'm from the deep south, so I know the difference between calling me "hun," because it is a local friendly expression, and patronizing me. So does your customer. We learn to sense sexism coming our direction early on. I believe in many cases there was no intent to offend, but perception is reality. Since your shop's reputation can be decimated by a few clicks on a smartphone, you need to listen up, hun.

Automotive repair and service as an industry has made strides in embracing diversity. More young women are considering the trades as a career choice, and there are some rock-star women technicians out there. Almost half the shop owners that I work with are women, and the same holds true for service advisors in those shops. If we can continue to support the value of diversity, the industry will continue to be a microcosm of the modern world. More than half of women in the United States work outside the home, accounting for 47 percent of the workforce. They are gaining ground in all industries, earn-



UNCOVER HIDDEN
PROFIT
IN YOUR SHOP

ATI

JOIN OUR
AUTO SHOP OWNER EVENTS!

REGISTER NEARBY OR ONLINE AT WWW.ATIEVENT.COM

ACCESS LIVE, COLLABORATIVE TRAINING FROM ANYWHERE

**VIRTUAL
CLASSROOM**

POWERED BY



Virtual Classroom from CTI+WTI delivers a live, interactive experience just like your team is in front of the instructor. Access classroom-style training from industry-leading instructors at a time and pace that fits your schedule.

Start today at my.advancepro.com/shoptraining.



ing higher level management positions and outpacing men in education and investing. The number of women-owned businesses has grown by 114 percent in the past 20 years.

Women control 85 percent of purchasing decisions. If you search your shop database over the last 10 years, you will find a dramatic increase in the number of women you are serving — unless your (negative) reputation precedes you. I challenge you to check how many of those women came back for a second visit. And while you're at it, take a look at your online reviews and see how many were left by women.

Women typically buy based on different criteria than men. When we teach service advisors our 7-Step Sales Process and discuss the different buying personalities, it's not by chance that women fall into certain buying personalities more often than men and vice versa. Let's talk about the top priorities for most of your female customers.

1. Be relatable. Women put their trust in people, not brands. Would your wife/sister/daughter be comfortable inviting your service advisor to a group gathering? Does the service advisor make your customers of all genders feel welcome? The majority of service advisors are great at checking cars in, creating estimates, and ordering parts; they are not great at building customer relationships. Automotive service is NOT a one-and-done purchase; the goal of every interaction should be to build that trust and rapport, so customers look forward to seeing your smiling face again in the future. Women consumers are more loyal to great service vs. a brand or price.

2. Treat her like the guy in the suit. Both men and women tend to treat a man in a suit with an air of importance, respect and appreciation. We don't talk down to him, talk over him or ignore him. The most common complaint

for women customers is feeling patronized or treated like a child. Guess what? Your male customers don't know any more than your female customers do about modern automotive technology. Assume that woman is smart and successful. Take time to educate and explain the recommended services. Extra bonus points: if she is the customer and has a male friend or relative with her, direct your conversation to HER, not him. She is the decision maker.

3. Let her talk. Here is where a difference in gender behaviors comes into play. In general, men will interrupt you to ask questions, give their opinion, offer a different perspective, and nobody thinks twice about it. Women, however, were taught that interrupting is rude and will wait and wait and wait for you to stop talking. So — STOP TALKING. I see salespeople lose sales all the time because they keep blabbing on and on when it's clear the buyer has something to say or has already lost interest.

4. Give her something to brag about. Female consumers rely on research and reviews more than male consumers do. They trust Facebook reviews and YouTube testimonials more than your best marketing efforts. They will tell their friends about the customer service experience you provide, good and bad.

For more tips on how to appeal to the priorities and preferences of women customers, be sure to request ATI's Women Customer Checklist.

What about marketing? You should work with a marketing professional to help you create marketing that appeals to women. Most women (and men) don't care about that super cool Multimatic DSSV Suspension you just installed. Flooding your website and Facebook with photos of torn-down engines and broken ball joints does nothing to give customers a sense of what it feels like to walk in your door. They

want to know if you are going to treat them with respect and value. Do you offer pick-up and delivery service? Do you sanitize the car before and after you touch it? Do you offer a loyalty rewards program? They want to know how you are going to make their life easier by reminding them about services due and if you will be able to get their vehicle back to them in time for soccer practice or a board meeting uptown.

A play area for the kids? Not really needed in today's world. What will make a difference for that smart and successful woman consumer? A fantastic cup of coffee, free WIFI, a clean waiting room, something besides Jerry Springer re-runs on the TV, and the latest issue of a few magazines (stop being cheap, you can get them for pennies per issue on Amazon) will say you value her time and want to provide a great atmosphere while she is with you.

And yes, you do want more female consumers in your door. Lots of us. Because women literally hold the purse strings to the \$188.5 billion that the U.S. consumer spends on auto repair and maintenance. Don't make me pull out my walking boots.

For more ideas on how to get women customers and keep them coming back to your shop, request ATI's Women Customer Checklist at www.ationlinetraining.com **come/2020-11** 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 Charlene Parlett. chubby@autotraining.net

SPEED POWER EFFICIENCY

ALL IN

X-431 *DIAGNOSTIC TOOLS*



FULL FUNCTION



FULL SYSTEM



FULL COVERAGE

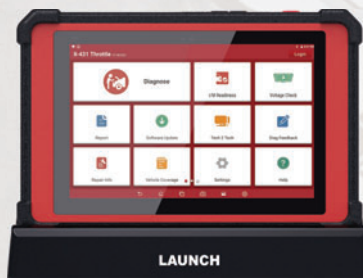


X-431 Torque



PROFESSIONAL

- ✓ Auto Detect VIN
- ✓ VW & AUDI Guided Functions
- ✓ 10.1-inch IPS Screen
- ✓ OBD I Adaptor Kits
- ✓ Code Assist by Identifix
- ✓ Security Gateway access by FCA



X-431 Throttle



ULTIMATE

- ✓ Auto Detect VIN
- ✓ ADAS Calibration
- ✓ VW & AUDI Guided Functions
- ✓ IP65 Waterproof & Dustproof
- ✓ Quick Charge technology
- ✓ Docking Station
- ✓ Battery Test, Sensor Simulator, Videoscope
- ✓ Code Assist by Identifix
- ✓ Security Gateway access by FCA



X-431 Turbo



COST-EFFECTIVE

- ✓ Auto Detect VIN
- ✓ Remote Diagnosis
- ✓ Open Android 9.0
- ✓ Code Assist by Identifix
- ✓ Security Gateway access by FCA

SECURITY GATEWAY ACCESS By FCA | **CODE ASSIST By IDENTIFIX**



Time to really focus on attention to business detail

Be sure not to fall into routines of the past to ensure future success

Believe everyone is doing their best to work their way through these trying times with COVID-19 playing into your life and business world on a daily basis. We must take all precautions of course, but let us not forget about the important details that must be looked after in our business.

It is time to get focused with the correct mindset. It is easy to be lazy and fall into the old routines of the past. Heading into 2021, let us ensure it is different.

Do a basic site critique and make sure all items have been addressed completely within your operation. Review the overall business attitude throughout the building, as you know people can “feel” the attitude of the business when they enter it. Do you have the right number of personnel on your team in order to deliver a high-quality service to your clientele? Is your equipment up to date for dealing with today’s vehicle realities? Do you stock the right inventory used frequently by your clientele and are you measuring the right earn turn index by line to ensure your money is being used wisely in the inventory category? Is your balance sheet in a strong position to move forward into 2021? If these items have not been addressed, get it done now and delegate a team member where possible to get their input as well.

Review the apps used in your business and ensure all staff members understand these new tools and are using them fully.

Review all time clock procedures to ensure time is being tracked properly to ensure accurate billing at the front counter and concentrate on capturing

diagnostic time and billing it accurately for the next 21 days to get this habit set within the business culture.

Review your training plan for the next one-year period and get all staff registered now into the courses that provide the right education to bring the shop team together so they understand why the business must operate this way and how to serve the client in a very professional manner.

Review the administration procedures to capture the business numbers in a precise format so the trend lines of the business can be measured accurately and in a timely manner.

REVIEW THE OVERALL BUSINESS ATTITUDE THROUGHOUT YOUR BUILDING, AS YOU KNOW PEOPLE CAN FEEL IT WHEN THEY ENTER.

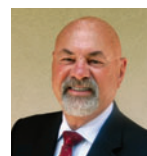
Ensure the communication lines with every staff member are open in a positive way. Give each staff member at least one verbal positive compliment each day. Look them in the eye when you do it. This is important in building their confidence that they are moving forward in their own development with this team.

Finally, I will end with this personal thought: “Having a negative person in your life or on your team is a choice, not a necessity. You do not have to have negative people in your life or business; you just must have the strength to confront their behavior and let them know

FOCUS ON PHONE SKILLS IN THE SHOP

Fixed Ops University, in partnership with The Network Academy, is offering “Telephone Skills,” a six-part series for service advisors on basic and advanced skills and etiquette every professional should know before answering the phone. Don’t let these little details get overlooked! Help your staff to increase sales while delivering excellent service. Check out the training at **MotorAge.com/phoneskills**.

it is unacceptable or let them go. That means any person who is negative; there are no exceptions. Do not ever forget the agenda of negative people is always about them and control. Their behavior is designed to move you toward their negative space and away from your positive thinking. When you give them this entrance into your world, they will not only take advantage of it, they will use it to wear you down and take control of your life and your business. Do not give them permission to do that. **ZZ**



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**



When you take a spark plug out of a customer's vehicle, you might automatically replace it with the same brand. Did you know that you actually have a choice? **Autolite® Iridium** plugs give you OE-level or higher performance, they're available for most late-model engines that come into your shop and they come with a limited lifetime warranty. Next time, don't be intimidated by what's written on that four-inch plug you pull out. Just toss it in the trash, replace it with Autolite and feel better about your decision.

Autolite®
IGNITING YOUR PASSION™

Find YOUR spark at **autolite.com**

©2020 FRAM Group IP LLC

E85: WHAT YOU DIDN'T REALIZE YOU NEEDED TO KNOW

WHEN ONE COMES INTO YOUR SHOP, YOU NEED TO BE READY TO REPAIR IT

SCOTT SHOTTON // Contributing Editor

Flex-fuel vehicles (FFVs) that run on any combination of ethanol and gasoline have been around for decades. Depending on your geographic location, E85 fuel may not be readily available. As a result, you may have not seen an ethanol-related drivability issue. However, when one does come into your shop — and it will — you will need to be prepared to deal with it. Too many technicians feel this may not seem like a concern. I hear things like, “There are no gas stations with E85 in my area” or “Customers with flex-fuel vehicles only run gasoline.” Both of these statements may be true to an extent. Allow me to elaborate.

There are areas of the country where E85 is available. One of the most common areas to find E85 is along major highways. Watch the next time you go on a road trip and see if E85 is available. Now think about it for a minute — a tank of fuel can get you about 300 miles on average. What if one of your customers filled their tank while on a journey? Could a customer have accidentally filled their tank with the wrong fuel 200 miles from your shop? It happens! My first experience with E85 was almost two decades ago. A customer brought a 1998 Chevy T10 Blazer



A SCAN DATA RECORDING OF A NON-FFV being driven with too much ethanol in the fuel tank.

with a 4.3-liter engine into the shop for an MIL illumination complaint. This vehicle was a non-FFV (only designed to run on conventional gasoline) that had lean DTCs stored and no obvious performance issues. My diagnosis took some time; I learned as I went and I determined that there was ethanol in the tank. About 54 percent ethanol, according to my test. Since then, my techniques have been corrected and honed.

What I want to address today can be broken into two parts: non-flex-fuel vehicles with ethanol in their fuel tank and flex-fuel vehicles that have learned ethanol content incorrectly. In both cases, our goal is to have a quick indi-

cator of the potential issue and an easy way to confirm the situation. Before we can address these two possibilities, we need to cover some theory first.

Oxygen sensors, A/F sensors and fuel trim

First, oxygen sensors do not “measure” oxygen. Air-fuel ratio sensors behave similarly. Both of these types of sensors (when working correctly) report Lambda. Lambda is a value that represents stoichiometry. We are probably all familiar with the stoichiometric air to fuel ratio of 14.7 to 1. This is the stoichiometric ratio for gasoline. The stoichiometric air-fuel ratio for ethanol is closer to 10 to 1.



LOCAL SEARCH

Attract more customers with optimized websites and online appointments



PROSPECT™

Check in vehicles efficiently and perform complete inspections



MANAGER™ SE

Write accurate estimates, schedule jobs and access customer history



PRODEMAND® with SureTrack®

Diagnose the issue and complete the repair with maximum efficiency



MESSAGE CENTER

Text message customers with questions and progress reports



SOCIALCRM

Engage customers after the visit with thank-you emails and reviews



DRIVE REPAIR EFFICIENCY AT EVERY STEP

Save time, money and headaches with the industry's most complete line of auto repair software & services for your professional repair shop.

Mitchell 1 is by your side from the moment your customer searches for auto repair on the internet, all the way through the diagnosis, estimate, repair and final invoice.

Award-winning solutions for every step, to help you increase efficiency and build your business — now and for the future.

GET STARTED NOW

with a FREE demo and special savings!

Call us: 800-896-3126 | Visit us: www.mitchell1.com

Or find your local Mitchell 1 sales representative:

www.mitchellrep.com

repair information | shop management | shop marketing

Mitchell1®
In your shop, at your side

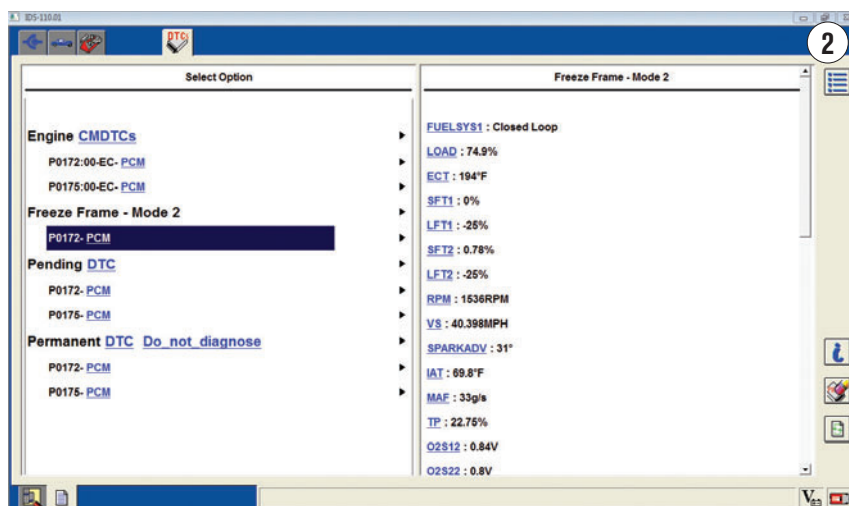
The sensors in question report lambda (or stoichiometry) to the PCM, regardless of the fuel type. For now, let us avoid the chemistry, physics and engineering details of these sensors.

Second, fuel trim numbers are based on the previously mentioned sensor inputs. Total fuel trim (short term + long term) will be our key to diagnosing ethanol-related issues. To be fair, fuel trims are extremely valuable when diagnosing a myriad of issues. Using fuel trims for effective diagnosis involves operating the vehicle under different conditions. For example, a vehicle with a vacuum leak will present with high positive total fuel trim under idle conditions and be closer to normal at higher RPMs. Conversely, a restricted fuel filter might result in normal fuel trims at idle but have high positive total fuel trim numbers under load. Different fuel types behave differently. Because the fuel “TYPE” is different, total fuel trim numbers will be skewed equally, either high or low, under all driving conditions.

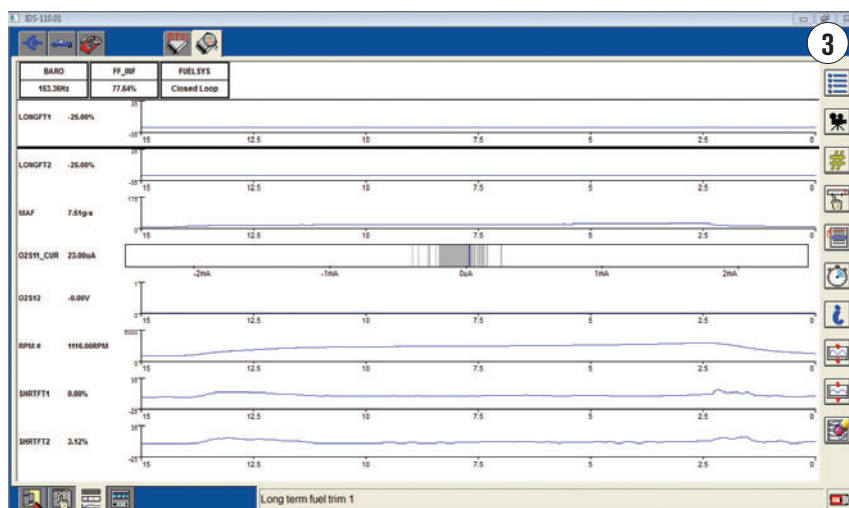
FFV ethanol in the fuel tank

When a non-FFV is accidentally filled with E85, it usually exhibits complaints such as MIL illumination, lean DTCs, low power and even crank no start. If the vehicle starts and runs, the previously mentioned fuel trims will point us in a direction quickly.

I was recently called to diagnose a 2016 Subaru Forester that had been in and out of a shop. The original complaint was of MIL illumination for P0171 – Lean Exhaust Bank 1. The spark plugs, air filter and fuel filter had already been replaced. A “Fuel System Service” had also been performed, which I believe meant some type of injector flush. The DTCs were cleared, and the vehicle was returned to the customer. A week later the vehicle returned with the same lean DTC, and the shop was leaning towards an A/F sensor



FREEZE FRAME DATA FROM AN F-150 that is setting rich exhaust DTCs for both banks of the engine.



VARYING RPM AND WATCHING how fuel-trims behave.

issue. Time to start from scratch.

The vehicle still had a P0171, so the DTCs were cleared after gathering and recording baseline data. A fuel trim reset was performed, and the car was taken on a test drive. Scan data was recorded and can be seen in **Figure 1**. For reference, the top trace is engine RPM. This PID allows you to see that the vehicle was driven under multiple conditions. Please note that after the fuel trims were cleared, the engine would start and stall as it did in the first few moments of the capture. Opening the throttle slightly and “playing” with the

throttle angle got the vehicle running. This is another good indicator of a potential air/fuel-related issue. The next three PIDs in order from top to bottom are as follows: Loop status, short-term fuel trim and long-term fuel trim.

I know it is hard to see in the scan data because you cannot move the cursor around, but allow me to share what I gleaned from the recording. I measured total fuel trim (STFT+LTFT) at multiple places in the capture. The highest number I observed was positive 39.3 percent and the lowest number I found was positive 32.8 percent. If we look at deviation

Your vehicles
crave approvals
& specifications



Viscosity does not equal OEM approvals!

Visit **www.liqui-moly.us** or ask your
repair shop or automotive retailer about
the best LIQUI MOLY motor oils
and additives for your car.



Find your right oil!



LIQUI MOLY – made in Germany since 1957

(highest minus the lowest), our window of operation is only a 6.5 percent under all conditions. If we stick with the rule of thumb that seems to be popular in the industry, plus or minus 5 percent are good fuel trim numbers. That equates to a 10 percent window. Although the trims on this Subaru are high under all conditions, they are definitely within a 10 percent window no matter how the car is being driven. This is a good indicator of ethanol in the fuel tank or potentially other fuel-type issues.

The next step was to take a fuel sample and test for the ethanol content. In this case, the ethanol content was around 73 percent. That is not going to sit well with a vehicle not designed for E85. How I perform an actual ethanol test on a fuel sample will be covered later in this article.

FFVs that have learned ethanol content incorrectly

On the other side of the coin, we can have FFVs that have accidentally learned their ethanol content incorrectly. The fuel trim numbers will be our key to diagnosis in these cases as well. FFVs usually have an ethanol PID (or something with a similar name) in the data list. If this number is high, the tank could have ethanol in it — or maybe not. If the learned alcohol value is higher than what is actually in the tank, the PCM ends up confused. What usually happens, in this case, is the vehicle stores rich DTCs.

The next vehicle in question is a 2011 Ford F-150 with a 5.0-liter engine. It has a P0172-Rich Exhaust Bank 1 and a P0175-Rich Exhaust Bank 2 stored. The freeze frame data was retrieved and both banks of the engine have extremely negative fuel trim numbers (Figure 2).

Just like the Subaru, it is time to test drive the vehicle under multiple operating conditions and observe the fuel-trim numbers to choose our diagnostic



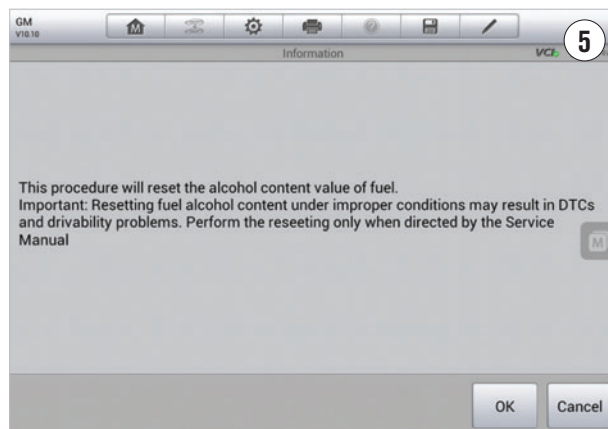
FUEL TRIMS FROM A 2011 SILVERADO with an incorrectly learned ethanol value

path. Because this is an FFV, the ethanol PID will also be checked. In this case the FF_INF (Flex Fuel Inferred) PID is at 77.64 percent. The test drive also confirms that the fuel trims are negative under all conditions (Figure 3). If we do the math as we did for the

Subaru, Ford's fuel trim numbers also fall within a 10 percent window. These numbers indicate a fuel-related issue, but in the opposite direction.

The next step was to take a fuel sample and test for the ethanol content. The fuel in the tank of this F-150 tested to be approximately 7 percent ethanol, which is a very common percentage to come out of the ground of a non-E85 gas pump.

Now we have a dilemma: How do we relearn the correct ethanol content? On this particular vehicle, there is no option for an ethanol reset in



USING A SCAN TOOL to perform an Alcohol Composition Reset

the scan tool. The DTCs were cleared and the FF_INF number remained. A KAM (Keep Alive Memory) reset was performed with no success. At this point, we only have two options that I am aware of. First, we could pump most of the fuel out of the tank and drive the vehicle. Then we turn the vehicle off, refill the tank and drive the truck to force the relearn to occur. This option is not high on my list.

Second, we could trick the PCM. Since the PCM uses the fuel level sensor to determine if there has been a fueling event between key cycles, we can use



Designed to pass. Built to last.

ELEVATE TO THE BLUE STAR STANDARD

OTC equipment meets all ASME PASE-2019 safe lifting standards and offers a limited lifetime warranty.



SEE THE NEW EQUIPMENT AT [OTCTOOLS.COM](https://www.otctools.com)

QUESTIONS?
800 533 6127

that strategy to our advantage. Instead of draining the fuel tank, install a resistor of an appropriate value to make the fuel gauge read low, drive the vehicle for a short period, turn the key off, remove the resistor and drive the vehicle again. This will trick the vehicle into thinking it just had a fueling event and should force the inferred ethanol to learn to take place.

Some vehicles allow ethanol reset with the scan tool, which makes the fix much easier. The scan data shown is from a 2011 Chevy Silverado with a 4.8-liter engine (**Figure 4**). It exhibited the same DTCs identical fuel-trim behavior to the previous F-150.

On this vehicle, the “Fuel Alcohol Content” PID read 76 percent. An ethanol test was performed on a fuel sample and the result of approximately 4 percent was obtained. This particular application allowed “Fuel Composition Reset” in the “Special Functions” menu of the scan tool. After the reset was performed, the vehicle was driven. The “Fuel Alcohol Content” PID adjusted to 3 percent; fuel trim numbers were now normal, and the rich DTCs did not return.

Testing for ethanol

There are a few ways that we can test a fuel sample for the ethanol content. One way is to acquire a fuel composition tester such as the J-14475. Another way, and a more cost-effective one, is to use an empty bottle or a graduated cylinder. I prefer the latter because it will yield an approximate ethanol percentage as opposed to a pass/fail result.

We all are likely aware that gasoline and water do not mix. However, ethanol and water do. Using this fact to our advantage, mix 50 milliliters of a fuel sample with 50 milliliters of water. The dividing line of the two liquids should be easily visible. To make things a little easier to see, I sometimes use a couple of drops of food coloring, which also will not mix with the gasoline. Shake

the sample carefully and let it sit for a moment to allow the two liquids to separate again.

Observe where the dividing line of the two liquids settles. The dividing line would be at 50 milliliters if the sample was 100 percent gasoline and 0 percent ethanol. If the line rises, say to 55 milliliters, that is an increase of 5 milliliters. Multiply that increase by 2 ($5 \times 2 = 10$) and that is our approximate ethanol percentage (10 percent). No hardcore chemistry lab is required.

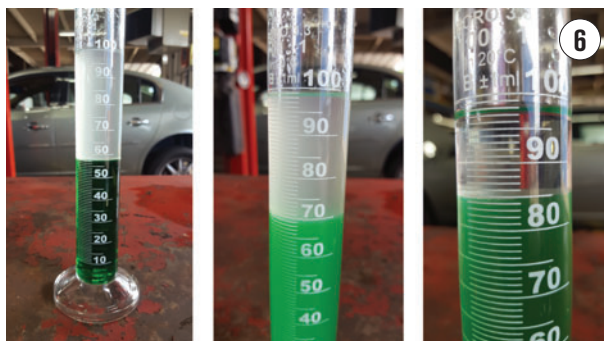
Here is the result of three ethanol tests (**Figure 6**). The first sample yielded a 7-milliliter increase, which indicates an ethanol content of approximately 14 percent. The second sample rose 20 milliliters, which indicates 40 percent ethanol. The last sample settled 35 milliliters higher than our starting point, which equates to 70 percent ethanol.

This test is easy, quick and very useful for identifying ethanol in the tank of a non-FFV. It is also useful for checking to see if an FFV’s ethanol content PID matches what is actually in the fuel tank.

An additional note

Please be aware that the fuel trim technique covered above can be used to find faults other than ethanol miscalculations. What I am referring to is even less common than ethanol issues (but can still happen). In most cases, the other issue that comes to mind is usually man-made and pertains to injector fuel flow rates.

If an engine is replaced with a used unit, there is a possibility that the fuel injectors on the used engine have a different flow rate than the original fuel injectors. If this occurs, all of the cylinders will receive either too much



ETHANOL TESTING. FROM LEFT TO RIGHT: 14 percent, 40 percent and 70 percent ethanol content.

or too little fuel (under all conditions) if the injectors are operated with the original vehicle’s injector pulse width. These situations usually present with either rich or lean DTCs and do not usually have any other drivability concern. Again, the equally skewed fuel trim numbers under all conditions are the key to finding this quickly. After performing an ethanol test to rule that possibility out, the next step would be to start investigating the injectors. On the same note, if all of the injectors are replaced on a vehicle that has the wrong flow rate the result and diagnostic technique would remain the same.

I do not mean to point fingers at technicians when this happens. Remember, we are all human and mistakes happen. The same statement applies to customers who accidentally fill their fuel tank with E85 (accidents happen). Either way, a basic understanding of what to watch for, how to perform a few simple tests, and a sound logical process will lead you quickly down the road to making an accurate diagnosis. **ZZ**



SCOTT SHOTTON is owner of The Driveability Guys, and he performs mobile diagnostics, reprogramming, industry training and has been a college instructor for the past 14 years. With a degree in Automotive Service Technology, Scott holds more than 21 ASE certifications.

scott@driveabilityguys.com

ONLINE TRAINING

ANYTIME. ANYWHERE.



On Demand.

24/7 online streaming +
one-on-one personal training
concierge to jump start your
shop's training path



Relevant.

new industry-driven content
added every month + access
to industry blogs, news,
tech tips & articles



Advancement.

improve professional skills
& capabilities with ASE
test preparation classes &
automatic progress reporting

TheNetworkAcademy.com

support@thenetworkacademy.com

HELPING YOUR CUSTOMERS PREPARE FOR WINTER

THE COLDER IT GETS, THE MORE IMPORTANT THESE SIMPLE CHECKS CAN BE

PETE MEIER // Director of Training

Operating a motor vehicle in cold weather places demands on its systems unique to the season. It's up to us, the automotive professionals, to assist our customers in ensuring that their vehicle is ready for the challenge.

Cooling system

Near the top of the list in preparing a vehicle for winter driving is a check of the cooling system. I'm sure everyone reading this knows that it is important that the mixture ratio between the concentrated coolant and water is maintained between 40 percent to 60 percent. This can easily be checked with a specialty test strip or most accurately, with a refractometer.

In addition to the mixture ratio, it is equally important to check the pH, or acidity, level of the coolant. This is an indicator of the health of the additive package that every coolant has. These additives, or "inhibitors," are used to extend the life of the coolant, lubricate cooling system components and protect the components from rust and corrosion. In this case, the use of a specialty test strip is required.

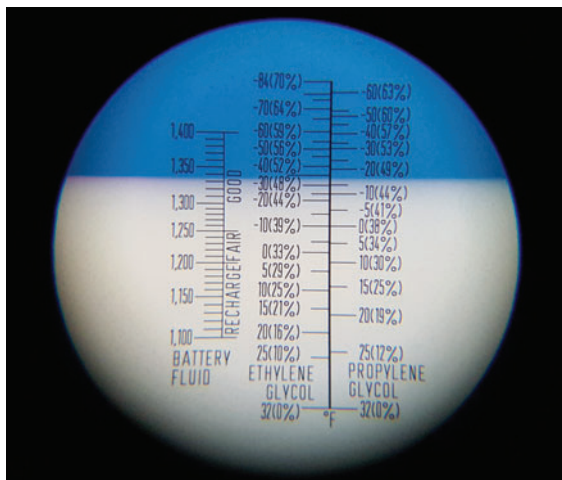
If the coolant passes the pH inspection but fails the mixture ratio check, you can correct the condition by adding the proper coolant concentrate or deionized (or distilled water, if deionized is unavailable) to the system. However, even if the mixture ratio is spot on,



THE REFRACTOMETER IS THE MOST ACCURATE WAY TO CHECK the coolant mixture ratio. It should be between 40 percent and 60 percent. Too much water and freeze protection is affected. Too little and the ability to disperse heat is reduced.

if the pH is out of specification, the cooling system must be flushed, and the coolant replaced with a fresh fill — regardless of time or mileage.

Also, a word on the water you use. Never use tap water to service the cooling system. Tap water has minerals and other contaminants that can quickly deplete the additives, resulting in a coolant mixture that can no longer protect the system. That leads to prema-



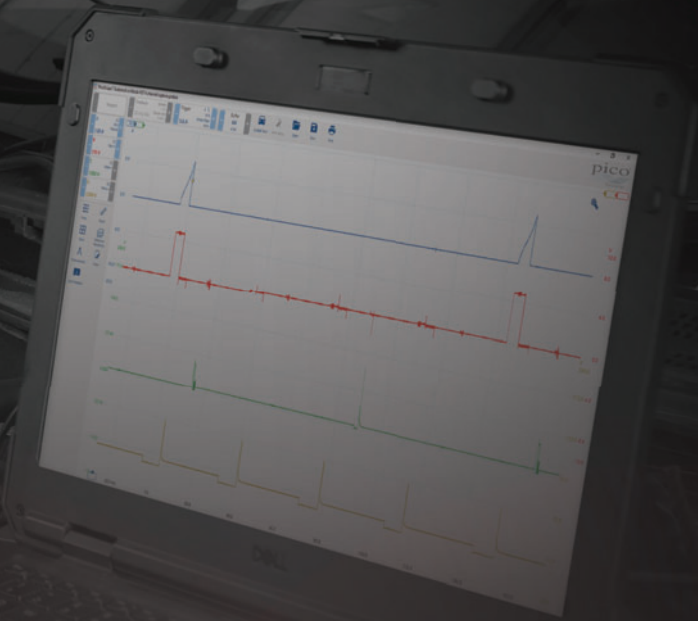
THE REFRACTOMETER IS EASY TO USE. Be sure to zero it before making your test, following the instructions that came with your tool.

PicoScope® 4425A

Active Diagnostics



WINNER



Probe recognition • Scope-powered probes • Fast sampling
Deep memory • Future-proof



To find out more visit
www.picoauto.com/A705

Email sales@picotech.com. Errors and omissions excepted.
Please contact Pico Technology for the latest prices before ordering.

pico
Technology

ture failure of water pumps and heater cores, and erosion in the passages. Tap water is also typically aerated to improve the taste. Air may make the water attractive for drinking but introducing air into the cooling system is always a bad idea.

Finally, and probably obviously, check the level of the coolant. Coolant doesn't evaporate, and if it's low, that means there's a leak somewhere. The leak can be external or internal and both can be a challenge to pinpoint, especially on today's multiple flow path systems. Consider using a dye to help identify external leak sources and specialized techniques for identifying internal issues.

Battery

Among the most popular wintertime complaints, usually occurring in the middle of a winter blizzard, is the call from the customer that "my car won't start." We all know that available voltage potential at the battery is reduced as the thermometer falls. That's why performing a battery and charging system test is so critical before the cold weather hits.

One of the very first measurements we need to take when assessing the condition of the battery is the Open Circuit Voltage (OCV). The OCV indicates the State Of Charge (SOC) of the battery and must be more than a

specified level before accurate testing of the battery can be done. But is your OCV measurement accurate? And what minimums are acceptable before pro-

ceeding with further tests?

Davis Knauer, vice president Automotive Battery and Diversified Products Engineering for East Penn

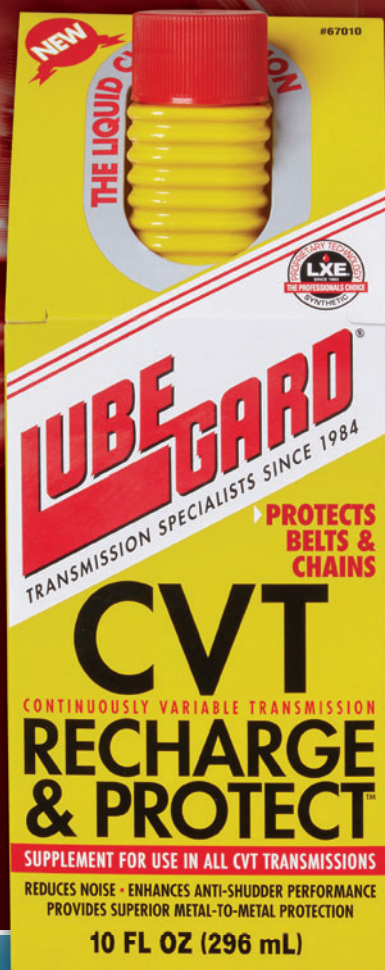


CHECK THE COOLANT DIRECTLY AT THE RADIATOR if the system uses a coolant reservoir to avoid inaccuracies caused by the recent addition of water or coolant. Be sure to use caution when accessing a hot system.



A HANDHELD BATTERY TESTER is a quick way to check the condition of the battery. Just remember that the SOC has to be a minimum of 12.4 volts and always verify directly at the battery to confirm a failed test.

Amazing on their own. Even better together.



CVT Recharge & Protect™

**A CONDITIONER FOR USE
IN ALL CVT TRANSMISSIONS**

For new or used fluid

Reduces noise

Enhances anti-shudder performance

Provides superior metal-to-metal protection



Complete™ CVT Fluid

**ELIMINATE THE NEED TO STOCK
OVER 60 DIFFERENT CVT FLUIDS
WITH THIS MULTI-VEHICLE FORMULA**

Longer anti-shudder performance

Minimizes friction

Excellent cold weather performance

YOU CAN USE ONE WITHOUT THE OTHER, BUT WHY WOULD YOU WANT TO?



INTERNATIONAL LUBRICANTS, INC.
PH 1-800-333-LUBE (5823)
WWW.LUBEGARD.COM



SCAN THIS QR CODE OR
SEARCH "LUBEGARD
RESOURCES" TO
DOWNLOAD THE APP NOW



Manufacturing says, “Accurate testing requires a minimum State-of-Charge level. A rested open-circuit voltage (that means it’s been over 24 hours since the battery has been exposed to charging) of 12.4 minimum is required before load testing.”

Where you test can also have an impact on your test results. If you just brought the car in and connected your meter or handheld battery tester to the battery’s cable ends, your test results may be suspect. This is especially true if you’re trying to test a remotely mounted battery using the jump points under the hood. If techs test the battery using the underhood booster terminals, this may lead to falsely diagnosing a battery as bad. Additional resistance caused by the length of the cable can often result in inaccurate battery diagnosis. If a remote-mounted battery is tested and fails, repeat the test directly at the battery to confirm if it’s an issue with the battery or if the issue is elsewhere.

But even then, most experts agree that the battery can’t be condemned in the car. “Testing failures in a vehicle must be confirmed after the battery is removed from the vehicle. Readings made while connected in the vehicle can be affected by poor connections, active loads and effects from recent operation,” added Knauer.

Once you’ve determined that the SOC is enough to proceed, the gold standard for testing is a load test conducted according to the Battery Service Manual published by BCI (Battery Council International). A load of half the CCA rating is applied for 15 seconds. The voltage must not fall below a limit that depends on the core battery temperature at the start of the test. The battery must initially be at least 75 percent charged, which correlates to a well-rested, open-circuit voltage of 12.4 or higher. Remember what that means?

It’s been over 24 hours since the battery has been exposed to charging!

Conductance testers that correlate to BCI standard load test results are an alternative to the traditional load test. You may trade some accuracy for speed, but it is generally worth the time saved. The user must be sure to connect it properly, avoid putting in incorrect data to the tester (which means to first properly identify what kind of battery it is — conventional or AGM), charge the battery properly before retesting when requested by the tester and reconfirm failed results obtained in a vehicle after the vehicle connections are removed from the battery terminals and the terminals are cleaned. Proper connections to side or stud terminals require that charging adapters be used properly.

No matter what testing method you use, if the battery is marginal, recommend its replacement. Be sure to replace it with one meeting the OEM specifications and, if needed, let the appropriate control module know you replaced it!

Wiper blades and washer fluid

You wouldn’t think that wiper blades would come up as part of a winter inspection, did you? But if you live in any part of the U.S. that sees snow, you know that most of your customers use the wipers to clear their windshields rather than get out and use the scraper. Of course, the wiper blades were never designed for that purpose and quickly become ruined. Later, when the glass is just smeared or dirty from the road salt that has been laid down, the blades can only smear the mixture across the glass instead of cleaning it.

Of course, that also depends on whether there is any washer fluid in the reservoir. I made a habit of topping off the reservoir whenever I serviced a vehicle. And nearly every one that came in was very low or empty. It’s one of those things a customer thinks about when they need it and forget about when they don’t.



IF YOU WORK IN THE SNOW BELT, you’ve probably seen your share of torn wiper blades. But even if you live down South, wiper blades should be inspected at each service and replaced every 6 months.



THE WASHER FLUID IS AN OFTEN-OVERLOOKED maintenance need. Make a habit of checking the fluid level and topping it off if needed.

Using a washer fluid designed for automotive use is also a great way to protect the system from freezing.

These are just a few of the inspection items that need a little extra attention paid to them as we near another winter season. I’m sure you can add a few of your own. And taking the time to inspect these little things is one great way to show your customer that you care about their car — and their business. *TM*



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.

pete.meier@ubm.com

TYC[®] Expect More. Expect TYC.



Comprehensive Availability, from Old to New.

- Wide availability of replacement mirrors for the most popular models.
- Tested to meet or exceed FMVSS 111, the federal safety standard for automotive mirrors.
- Designed, engineered, and produced to be OE-like for easy installation.
- Tested in simulated extreme environments, including vibration, for ultimate reliability.



TYC is a Proud Supporter of Novitas Foundation

Your gift can save lives, bring hope and build a future for a world in need go to NovitasFoundation.com.



SCAN QR CODE
TO LEARN MORE

*(Select Applications)

For more information about TYC™ replacement automotive parts, consult your local TYC™ parts distributor or look up parts online at www.TYCUSA.com.

DIESEL SCR SERVICE

AS DIESEL USAGE CONTINUES TO GROW, YOU NEED TO PREPARE FOR THESE SERVICES

TRACY MARTIN // Contributing Editor

The use of diesel power for cars and light trucks in the U.S. is on the rise. The demand for diesel engines (**Figure 1**) has increased due to their reliability, fuel efficiency and lower cost of operation. Over the last three years, buyers of light trucks have checked the diesel engine option enough to grow diesel usage 35 percent. Even diesel sales for cars and SUVs have shown a growth. If your shop doesn't currently perform much repair work on diesel vehicles, keep this in mind.

Diesel engines are more fuel-efficient than gasoline engines because diesel fuel contains about 10 percent to 15 percent more heat energy. Unlike conventional gasoline engines, where power is controlled by the air/fuel mixture, diesel engine power is directly controlled by the fuel supply. This creates very lean mixtures of 25:1 (or higher), even at full power. The lean-burning nature of diesel engines comes at a price because lean mixtures produce high combustion temperatures. This results in significant production of nitrogen oxides (or NOx). With no emission controls, diesel engines produce 20 times more NOx than a gasoline engine of the same size.

Similar to gasoline engines, diesel engines use exhaust gas recirculation (EGR) to reduce NOx. EGR works by recirculating a portion of the exhaust gas into combustion chambers. This inert gas dilutes the oxygen in the incoming air stream and absorbs combustion heat, reducing peak temperatures. Lower combustion chamber temperatures facilitated by EGR reduces the amount of NOx in the exhaust.

The downside of EGR diesel applications is that engine performance and fuel efficiency are decreased. Also, EGR gases cause engine oil to become contaminated rapidly, resulting in more frequent oil changes. Because EGR reduces the amount of fuel burned during the power stroke, particulate matter (PM) or soot is increased. The very design of a diesel engine causes a conflict in chemical factors between PM and NOx. When the engine is operating most efficiently for power, minimal PM is produced, but NOx levels are high. When exhaust gas is recirculated back into the intake manifold through the EGR system, NOx is reduced, but the PM levels are high.

Diesel exhaust soot is reduced by the use of a diesel particulate filter (DPF) that captures and intermittently burns



PHOTO: BMW NORTH AMERICA

THIS 2010 BMW 5 SERIES 3.0L FOUR-CYLINDER, TWIN-TURBO diesel engine is required to have a selective catalytic reduction (SCR) system to control NOx emissions. The 3.0L outputs 425 lb.-ft. of torque and 265 hp plus returns EPA mileage of 19 mpg city and 26 highway, thanks in part to SCR technology.

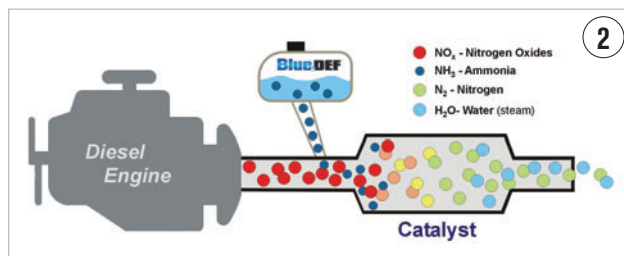


PHOTO: TRACY MARTIN

DIESEL ENGINES ARE FUEL-EFFICIENT BECAUSE THEY OPERATE ON VERY LEAN MIXTURES that produce high levels of NOx. This output is reduced when NOx molecules in the exhaust are mixed with ammonia from the diesel emission fluid (DEF) tank and converted into nitrogen and water in the SCR catalyst.

off about 90 percent of PM. The operation of a diesel engine makes the removal of NOx a challenge, as EGR alone does not reduce it enough to meet 2010 and later emission standards. The only method to remove NOx gases from diesel exhaust (without affecting engine performance) is to treat the exhaust.

NOx reduction via SCR

Selective catalytic reduction (SCR) is an exhaust system emissions control technology that converts NOx into nitrogen, water and carbon dioxide (**Figure 2**). SCR technology reduces NOx by 90 percent through the use of a catalytic converter,



**NEXT-DAY
DELIVERY**

PARTSOLOGY.COM

- ✓ GREAT QUALITY PARTS
- ✓ EXCELLENT PRICING
- ✓ WARRANTY ON ALL PARTS
- ✓ LARGEST SELECTION OF ENGINE PARTS AND KITS

TOLL FREE (844) 800 6866
HABLAMOS ESPAÑOL
info@partsology.com

INTERNAL ENGINE PARTS

*FREE NEXT DAY DELIVERY ON
ORDERS OVER \$75, BEFORE 3:00PM

WHAT OUR CUSTOMER SAY



Quality parts

Quality parts, fast shipping and a fair price. What else can you ask for.

Brandon E.



Right on time

Right on time, parts are as advertised, good price and service.

Enrique R.

Your Trustscore

★★★★★ 4.5

★ Trustpilot

www.partsology.com

where the NO_x is oxidized and converted into other elements.

In 2010, the Environmental Protection Agency (EPA) required the reduction of NO_x in diesel-powered light trucks and automobiles, to the extent that only vehicles equipped with SCR technology could pass the new emission standards.

To reduce NO_x, the SCR system injects ammonia into the engine's exhaust. Diesel exhaust fluid (DEF) provides ammonia used in the SCR process. DEF is made up of urea and deionized water. Automotive-grade urea is synthetically produced. Deionized water has most minerals removed such as sodium, calcium, iron, copper and other elements. The ratio of urea to water in DEF is 32.5 percent urea and 67.5 percent deionized water. The American Petroleum Institute (API) rigorously tests DEF to ensure that it meets industry-wide quality standards, and their certification label appears on all approved DEF containers.

In addition to reducing NO_x emissions, SCR simultaneously reduces HC and CO by 50 percent to 90 percent and PM emissions by 30 percent to 50 percent. In some applications where SCR and PM filters are combined,

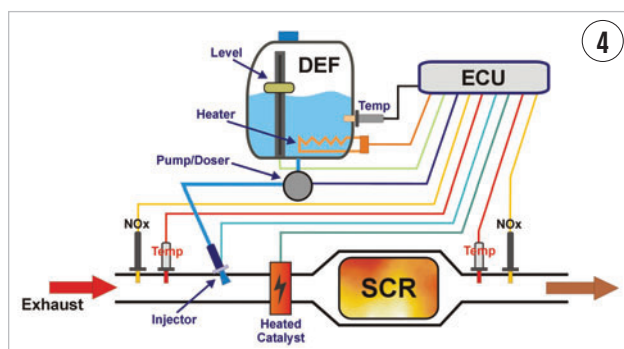
fuel efficiency has increased from 3 percent to 5 percent. While SCR has a positive effect on exhaust from diesel engines and increased fuel economy, it does have some downsides. SCR system components, including the DEF tank, tank heater, DEF injector, level sensor, temp sensors, NO_x sensors and the SCR catalyst, all add cost to the vehicle. And like any other system, SCR components have to be maintained and/or repaired.

SCR in action

Figure 4 shows a generic SCR system and how the ECU controls its operation. Starting with the DEF tank, the fluid level sensor inside the tank provides information to the ECU, or dashboard DEF gauge, regarding how much DEF is available.

The tank temperature sensor input signals the ECU to turn on the heater, which keeps DEF fluid from freezing. The heating element can be electrical or engine-coolant based. Another function of the DEF tank temperature sensor is to help the ECU determine the service life of DEF. When in-tank temperatures are above 104° F, DEF ages/ expires in only two months.

The pump or doser valve provides pressurized fluid to the DEF injector that sprays DEF into the exhaust (**Figure 5**). On some systems, the injector is also heated electrically or with engine coolant. There are two NO_x sensors with the upstream sensor indicating the level of NO_x in the exhaust. This sensor input allows the ECU to determine how much DEF to inject. The downstream NO_x sensor measures



UPSTREAM NO_x SENSOR DATA is used by the ECU to determine how much DEF to inject into the exhaust. The downstream NO_x sensor checks that NO_x levels have been reduced after the SCR catalyst. The temp sensor in the DEF tank provides the ECU with information about DEF aging and when to turn on the tank heater.



THIS FLUID-O-TECH GEAR PUMP

provides a precise, high-pressure source of urea for diesel SCR systems in passenger cars and light trucks. The Italian company is a major global OEM supplier for automotive emission control equipment.

the efficiency of the SCR catalyst. The upstream exhaust temperature sensor tells the ECU when the exhaust is hot enough for SCR operation and when to activate the heated catalyst. The downstream temp sensor measures SCR catalyst efficiency.

DEF and vehicle owners

Unlike other emission-related systems on diesel vehicles, SCR requires that the vehicle owner do something to keep it operational: ensure that the DEF tank doesn't run dry. On most vehicles, DEF range in miles corresponds with engine oil change intervals — usually around 7,000 miles. The logic is to have the DEF tank filled when changing engine oil. However, many owners overlook filling the DEF tank.



ALL DEF CONTAINERS SHOULD HAVE THIS American Petroleum Institute (API) label that certifies the quality of the DEF fluid. DEF can be purchased at auto parts stores, Walmart, truck stops and some convenience stores.

Next Generation Diagnostics



The ONLY full diagnostic platform redesigned for mobile!



- ✓ Full OE-level diagnostic coverage through 20MY
- ✓ Supports ADAS Calibrations
- ✓ Pre-/Post-scanning to XML, text message, email, and PDF
- ✓ Full DTC output, bi-directional controls and system tests
- ✓ Reset adaptations and calibrations



OPUS | IVS

Powered by
AUTOENGINEUITY

AutoEnginuity.com

(480) 827-TOOL (8665)

SCR systems don't kid around when it comes to low or no DEF fluid. A low level will result in warning lights or text on the vehicle's digital display. There is no standard among OEMs regarding DEF warnings. On some vehicles, the digital display may have a "DEF refill in XXX miles" function. Also, OEMs provide a variety of progressive warnings regarding decreasing DEF levels. A low DEF warning, and/or instrument panel light may display around 1,500 miles. Other messages may include a text warning of "No engine restarts possible soon. Fill DEF tank" and "Distance to NO ENGINE RESTART 100 miles." Once the "No Engine Starts Possible" warning is displayed, the vehicle must have DEF added before the engine is turned off.

If the engine is turned off, the ECU will prevent a re-start. If the vehicle is driven until the DEF tank is dry, the ECU puts the engine into limp-in mode, limiting vehicle speed from 5 to 10 mph. Limp-in mode and no engine restarts are mandated by the EPA and show how serious they are about uncontrolled NOx spewing from diesel exhaust.

Common SCR system problems

An often overlooked component of SCR systems is DEF fluid. Automotive-grade urea like BlueDEF, AdBlue and other brands

are API-certified to contain 32.5 percent urea and 67.5 percent deionized water. When faced with a "DEF Contaminated" code or scan tool message, it's a good idea to find out what is in the DEF tank. Some SCR systems have a DEF quality sensor or use ECU software to indirectly determine DEF quality. For example, the ECU

activates the DEF injector to spray fluid into the exhaust. The downstream NOx sensor reports that NOx levels are too high, the ECU injects more DEF into the exhaust, but NOx levels don't drop, causing a DEF contamination code or "Exhaust Fluid Quality Poor" message.

DEF testing should be done first when diagnosing DEF-related trouble codes. There are several DEF testers available, including optical and electronic. A DEF refractometer is an optical tool that uses light to determine the percentage of urea contained in DEF fluid. These tools read the percentage of urea in 0.5 percent increments. Any reading other than 32.5 percent is a good indication that the DEF is contaminated, too old, or not present in the tank. Drain the tank, clean it, purge the lines and injector then refill with fresh DEF.

DEF fluid is unique among automotive products in that it has a shelf life. Every container of DEF has a date code, aka "Born-On-Date" or "Sell-by-Date." A typical code of "GA153590089" can be read where: GA is the plant that made the DEF; 15 is the year of manufacturing plus 1 year (this batch was made in 2014 + one year = 15); 359 is the day of the year (365 - 359 = 6 so this batch was made on the sixth day of the year, or January 6, 2014) and 0089 is the batch code.

Repair shops need to consider the environment where they store DEF. When stored at temperatures above 95° F, the DEF shelf life is shortened to six months and above 104° F to two months. Some customers want to be prepared in case they run low on DEF while on the road, so they keep a container in the trunk or inside the cab of their pickup truck. This is not a good idea, as these locations can reach temperatures of over 140° F on a hot summer day. By the



BLUEDEF DIESEL EXHAUST FLUID is formulated to meet the stringent requirements of the American Petroleum Institute (API). The company also offers reusable DEF dispensing systems for fleet, retail and commercial applications that provide significant savings over single-use containers.

PHOTO: PEAK

AMI AUTOMOTIVE MANAGEMENT INSTITUTE

Management & Administrative

- Training
- Education
- Career Paths
- Certificates
- Professional Designations
- Learning Support

Convenient, effective, online courses and advanced instructor-led classes.

The knowledge you need for the business you want.

amionline.org



time they need the DEF, it will be way past its shelf life. The BlueDEF spec sheet states that “The shelf life of DEF is directly related to the temperature at which it is stored. Storage temperatures between 12° and 86° F are recommended to maintain the optimal shelf life of up to two years. If BlueDEF freezes, its efficacy will not be affected upon thawing.”

Most SCR systems don't require an undue amount of service, but some common things can go wrong. There are around 100 OBDII SCR-related trouble codes, and using a scan tool to diagnose SCR problems is, to say the least, helpful. Not listed in any particular order are some basic, common SCR issues provided by the SCM Hotline (a company that for more than 25 years has offered automotive diagnostic support to professional technicians). The most common issues are:

- DEF tank/injector heater failures
- Blocked or restricted DEF lines
- DEF injector plugged and contaminated

- Expired DEF fluid.

The following are some common SCR trouble codes.

DTC P20EF is defined as, “SCR NOx Pre-Catalyst Efficiency Below Threshold.” When the DEF tank is refilled, the SCR Catalyst Efficiency monitor is triggered. After the monitor is complete, and the SCR function is normal, the monitor continues to calculate the cumulative efficiency of the SCR system. Each subsequent value for cumulative efficiency is included in two filtering routines — one for short-term efficiency and the other for long-term efficiency. If the difference between the two filtered efficiencies becomes greater than a pre-set threshold, the P20EF fault is set. Common problems that set a P20EF are DEF contamination, DEF injection failure, faulty NOx sensor(s) and SCR catalyst failure.



THE BOSCH AUTOMOTIVE SERVICE SOLUTIONS OTC 5095 DEF TESTER is similar to the refractometer tools used to test coolant. After placing a drop of DEF on the tool's prism, the user points the tool toward a bright light and looks through the eyepiece. By adjusting the focus ring, the reticle scale will indicate the percent of DEF to water. The OTC 5095 retails for around \$100.

There are some other common codes for specific applications. DTCs P249D and/or P249E on the 6.6L Duramax engine for “Poor DEF” digital display message indicate incorrect DEF fluid, expired fluid and too sensitive recalibration. The 3.0L Duramax engine may show a P208E for DEF heater

PHOTO: BOSCH AUTOMOTIVE SERVICE SOLUTIONS



THE BOSCH AUTOMOTIVE SERVICE SOLUTIONS OTC 3095 TESTER simplifies DEF testing. By placing a drop of DEF on the tool's sensor the percent of urea is displayed. The tool can also measure the freezing point in degrees F of windshield washer fluid. The OTC 3095 retails for \$579.

NO MORE O2 SENSOR OR DIESEL KNOCK SENSOR REMOVAL ACCESS PROBLEMS!

LT994 SHOCKIT SOCKET O2 SENSOR REMOVAL KIT

USE YOUR AIR HAMMER TO EASILY REMOVE OBSTRUCTED O2 SENSORS & DIESEL KNOCK SENSORS

- Air hammer powered Shockit Sockets to access, loosen, and remove frozen and obstructed O2 sensors
- Includes low profile design for limited access and long profile design for deep recessed Ford, Toyota and Lexus applications
- Removes knock sensors on Kenworth, Cummins, International, Detroit and Volvo diesel truck engines
- Non-slip self centering air hammer angled 11° punch for limited access applications
- 18mm dual sided tap/bottoming die for O2 sensor and mounting hole threads
- Dual ear socket design for 90° rotation without repositioning socket
- Works when ratchets, wrenches and regular sockets don't fit
- Engineered to precise German DIN standards
- Patent #7,677,143 and other patents pending
- Lifetime warranty



Scan QR code or search LT994 on YouTube to see tool work!



Additional punches available -

LT1910PS 5.5" Short Punch

LT1910PL 22" Long Punch



PARTS LIST & SIZES

LT994-1	22mm SHORT SOCKET
LT994-2	22mm DEEP SOCKET
LT994-3	18mm THREAD CHASER
LT1910P	11" STANDARD PUNCH



We Make Good Ideas

LOCK TECHNOLOGY, INC.

Toll Free 800-421-7241

www.ltitools.com

ltitools@ltitools.com

◀ **INTRODUCING** ▶

The All New MaxJax® Portable Car Lift



See it on
YouTube



For Holiday Savings visit
MaxJax.com/holiday

Fits in Low-Ceilings

The MaxJax portable two-post lift is one of the most versatile DIY tools ever invented. Its patented design allows you to get full-sized lift advantages in spaces with limited ceiling heights. Best of all, MaxJax is completely portable and can be setup virtually anywhere. For more info call **1-844-629-5291** or visit **www.MaxJax.com/holiday**.

1. Roll It



2. Work It



3. Stow It



1-844-629-5291 • www.MaxJax.com/holiday

*Free shipping to direct shipping points within the 48 contiguous United States only.

©2020 MaxJax, LLC, a subsidiary of BendPak Inc.

The MaxJax is protected by one or more patents or claims of patents in the U.S. and elsewhere. PATENT NO. US 8,256,577 B2 - PATENT NO. US 9,150,395 B2.

MAXJAX®

It's Like An Arctic Storm For Your Shop



SCAN ME



MSRP \$1,235
*FREE SHIPPING!



26°F COOLING



AUTOMATIC
SWING-LOUVERS



LARGE COOLING AREA

WORKPLACE HEAT-EXPOSURE HAZARDS KNOW THE LAW

Did you know that OSHA law requires employers to provide a workplace free of heat exposure risks? Every year, thousands of workers become sick from occupational heat exposure – sadly, many cases are fatal. The Cool Boss™ portable evaporative air cooler uses plain tap water to chill stifling hot air up to 26-degrees F cooler for about a buck a day**.

It's automatic fill system, combined with a massive 30" fan, automatic swing louvers and programmable digital control make the Cool Boss the most compact, space-cooling powerhouse on the market. To learn more call **855-223-2665** or visit **www.thecoolboss.com**.

**Operating costs and cooling efficiency may vary depending on location, humidity, and ambient temperature.



WWW.THECOOLBOSS.COM

*Free shipping to direct shipping points within the 48 contiguous United States only.
© 2020 BendPak Inc. Cool Boss is a registered trademark of BendPak.

COOL BOSS™
A BendPak Company

electrical connectors. The VW Touareg 3.0L V6 can set P20EE, P204F or P207F codes for wrong DEF fluid and incorrect urea amount, and the Ford 3.0L Powerstroke engine may set a P204F, reductant filter, plugged DEF line or DEF injector.

DEF and diesel fuel mix-ups

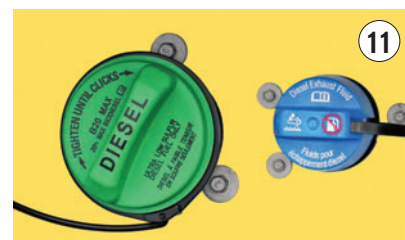
One would think that putting fuel or DEF in the wrong tank would be difficult to do. The filler caps are marked “Diesel” and “Diesel Exhaust Fluid” and are different

colors and sizes. Still, owners manage to add DEF fluid to the diesel fuel tank and vice versa. Either scenario results in huge problems and costly repairs.

What happens if diesel is put into the DEF tank? SCR systems have built-in warnings to detect non-DEF substances. The ECU will signal the driver with a warning and/or code of impending SCR interruption if non-DEF is detected. If contaminated, the DEF tank should be drained and thoroughly cleaned with deionized water before refilling. Because diesel fuel is less dense than DEF, it will float on top of the DEF but eventually make its way into the exhaust system. If diesel fuel enters the catalyst, it may be damaged to the extent that replacement is the only option.

Worse by far than diesel in the DEF tank is the opposite. This can cause rough idle, excessive exhaust smoke, low power, engine knocking, fuel rail pressure slow-to-build or no engine start. Because DEF is corrosive it can cause steel lines to rust, fuel injectors to stick open and high-pressure injection pump failure. The DEF fluid crystallizes and can cause irreparable harm to components that use metals like carbon steel, brass, aluminum, copper, magnesium, nickel and zinc.

If the owner realizes that they added DEF to the fuel tank and have NOT started the engine, or turned the ignition key on, they could have their vehicle towed to a repair shop. In this case, the fuel tank needs to be drained and cleaned. If the key was turned on, the low-pressure side of the diesel fuel system will have to be cleaned as well. If the engine was started, DEF will be on the high-pressure side of the fuel system. The injectors may need to be removed and cleaned along with all fuel lines; fuel pump flushed and cleaned; fuel filters replaced and the fuel/water separator replaced. The worst-case scenario is when the engine has been op-



EVEN THOUGH THE DIESEL FUEL AND DEF FILLER CAPS ARE DIFFERENT COLORS,

sizes and are clearly-marked “Diesel” and “Diesel Exhaust Fluid” owners can, and do, mix up what goes into each tank. The wrong liquid in either the DEF or diesel fuel tank can cost thousands of dollars in repair bills.

erated for some time with DEF present in the fuel tank. The corrosive DEF can damage beyond repair high-pressure fuel injection components. Depending on the vehicle’s age and mileage, these types of expensive repairs could exceed its blue-book value.

Service and repair of SCR system components are another revenue stream for independent repair shops. The use of a scan tool to verify system operation and/or read fault codes is a must. Don’t forget to perform a visual inspection of SCR system components looking for loose electrical connectors and blocked or leaking DEF lines. Testing DEF fluid quality is a good place to start any diagnosis. Educate your customers about where to store DEF to preserve its shelf life. Inform them of the consequences of putting DEF in the fuel tank and vice versa. Finally, explain what running low, or out of DEF entails. A small amount of advice will pay off in the long run and keep your customers coming back for more. *TM*



TRACY MARTIN has covered the powersports industries since 1998. He is also the author of six Motorbooks Workshop

Series books published by the Quarto Publishing Group and is a regular contributor for *Motor Age*.

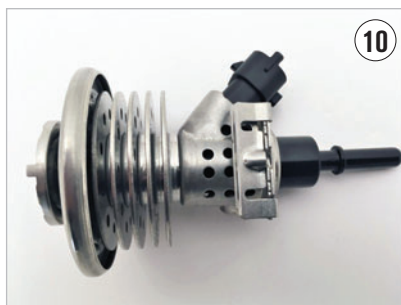
www.tracymartin.com

PHOTO: BOSCH AUTOMOTIVE SERVICE SOLUTIONS



THIS BOSCH AUTOMOTIVE SOLUTIONS NOx SENSOR AND CONTROLLER are integrated as one part. Because NOx sensors can’t differentiate between NOx readings and ammonia in DEF fluid a malfunction in the SCR system could set a code for a faulty NOx sensor. To read true NOx sensor values, put the system into regen (cleans out any ammonia in CAT) so scan tool values for NOx will be accurate. Symptoms of a bad NOx sensor are increased fuel consumption and/or rough idle quality.

PHOTO: BOSCH AUTOMOTIVE SERVICE SOLUTIONS



BOSCH AUTOMOTIVE SOLUTIONS DEF INJECTORS are mounted on the exhaust inlet pipe (just ahead of the SCR catalyst). Notice the heat fins that cool off the injector’s electrical components.



**YOUR MOST
IMPORTANT TOOL
IS YOUR KNOW HOW**

NAPA Autotech Training will help you get the most out of your techs by giving them the latest knowledge, so you can get the most out of your business.

Learn more at napaautotech.com



AUTOTECH™

A/C PERFORMANCE TESTING

LEARN PROCEDURES THAT WORK NEARLY ALL THE TIME

MARK DEKOSTER // Contributing Editor

Evaluating the performance of an air conditioning system is not a difficult task, especially in the hotter climates. The A/C system is tasked with transferring heat energy out of the hot cabin and into the atmosphere. It's typically quite obvious to both consumer and technician when the A/C isn't performing properly. But how do you test the A/C system in your shop in December in Michigan or anywhere else where it's winter and cold? The answer? We'll get to it shortly.

As with any article or other automotive technical training, there is no perfect, "works every time it's tried" method for repairing cars. What we go for are procedures that work as close to "nearly all the time they are used" as possible. This is one of those procedures, based on my training and my experience, that works nearly every time it is tried.

As a technician who spent his career in Michigan, I can say that we did very little A/C work in December. At one point in my career, I worked in a Toyota store and most of the work I did was installing A/C systems in new cars. Otherwise, it wasn't until sometime in the spring when the temperature and humidity went up and people turned their systems on and nothing happened. A frantic call to the service department and the first available appointment later and I was doing A/C work.

The real question to answer is not



THIS TYPE OF MACHINE IS REQUIRED BY THE EPA for each type of refrigerant that you service in your shop. When purchasing a new machine, make sure that it meets the latest SAE specification for accuracy and ability to recover refrigerant.

"How do you test in December?" The real question is "How do you test an A/C system?" And "How do I know that the newly installed A/C system worked correctly?"

As a Ford trainer and a college educator teaching A/C systems, how could I teach A/C diagnosis? How could I demonstrate it? How could I know the techs/students had learned how to test the system and be confident that the techniques would work when called upon when evaluating A/C in the winter? How do you test an A/C system in December? These answers are coming.

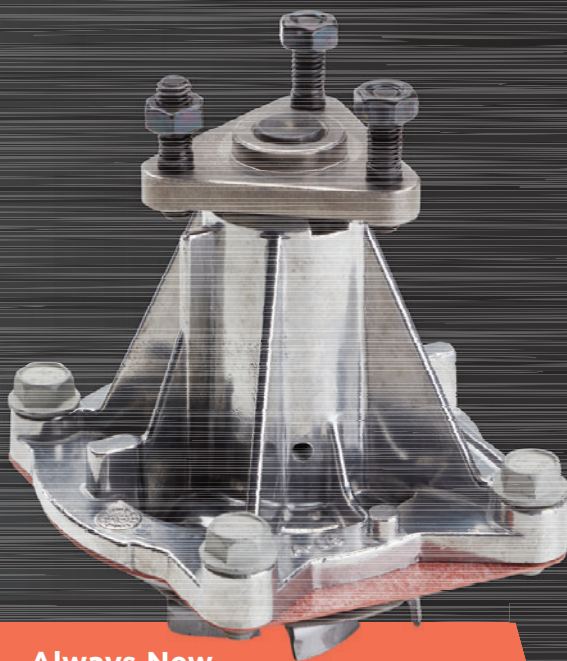
Let's start by answering just the

first question. How do you test an A/C system? If you're an old-school tech like me, you were likely taught that you open the hood, connect the gauge set, fire up the engine, set engine rpm to 1500, A/C controls set to max-cold and max-fan, doors open and check the pressures. While there certainly were and may still be some cars that require you to do that, many today don't work that way. Plus, there are other steps that you will want to do before you even think about connecting your gauge set or recycle machine up to the vehicle.

Let's review a good procedure for any time you test the A/C system,



CHANGING YOUR NEXT WATER PUMP JUST GOT EASIER



Always New,
Never Re-manufactured

Rapid Fit™ Premium Water Pumps by Carter

Engineered to provide a time-saving installation; this patent-pending premium water pump includes a pre-adhered gasket and recessed holes with pre-installed bolts. Just like all Carter engineered pumps, the Rapid Fit™ pump comes with a limited lifetime warranty to provide you peace of mind. Make your next water pump install a rapid one – after all, time is money.

Look for the
Rapid Fit™ Label!

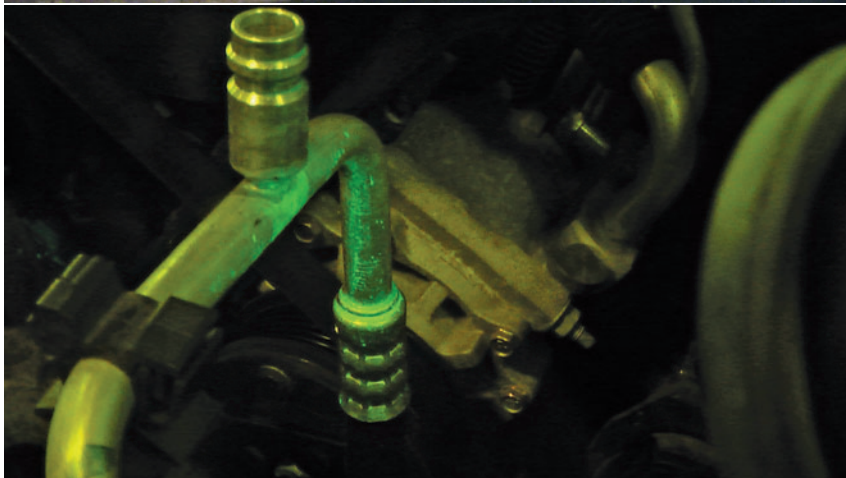
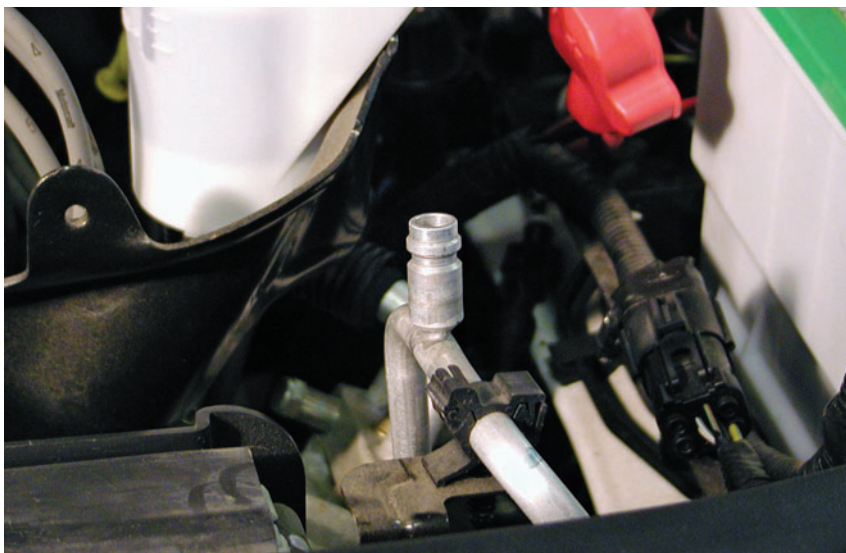


**HERE ARE EXAMPLES OF TOOLS NEEDED TO TEST THE AC SYSTEM.**

From left to right, a leak detector, sealant detector and identifier.

starting with the legal requirements. In my most recent review of Federal Section 609 requirements for motor vehicle HVAC technicians, the first requirement when performing A/C work for consideration is to be Section 609 Certified. "For consideration" means that you are receiving some form of compensation for doing the work. As long as you have been 609 certified, you may legally work on R-12, R-134a, EPA SNAP refrigerants and R-1234yf for consideration. The EPA is requesting that techs re-certify for R-1234yf but are not requiring it at this point. You may also purchase refrigerants in larger containers. Be aware the federal regulations do not require that you do leak repair. They advise it. There are some states and cities that do require leak repair. You will also want to keep in mind that certain vehicles with R-1234yf may be regulated under OBD II emissions. Manufacturers have been given emission credits for using R-1234yf. Modifying those vehicles A/C systems may fall under emissions tampering.

Federal regulations also require that for each type of refrigerant that you service in your shop you must have a unique and dedicated recovery-recycle machine. The exception to that is a recovery mechanism that is only used to recover contaminated refrigerant. You will also want to have a refrigerant identifier, leak detector and sealant detector that you use before connecting your gauges to the vehicle (**Figures 1, 2**).



A GOOD VISUAL INSPECTION CAN FIND MANY PROBLEMS. This missing cap represents a leak of about one-quarter pound of refrigerant a year. Always make sure the caps are on and secure.

At one point in time, many manufacturers recommended that if you found sealant in the system that you button it up and give it back to the owner. The only repair at that time was the complete replacement of the entire A/C system. Compressor, lines, receiver-dryer or accumulator and heat exchangers. I was recently talking with a sales rep from one of the large parts house chains and he was explaining that they sold a device that attached to your machine and would strain the sealant out during evacuation, protecting your machine from damage. You will want to investigate the availability and efficacy of those items.

The EPA has indeed identified certain refrigerants that you may use in place of R-12 or R-134a, these are SNAP refrigerants, Significant New Alternative Policy. If another shop installed one of those refrigerants it should be tagged under the hood and have fittings that are different than those for either R-12 or R-134a. This also means that your equipment may not be able to connect to the system.

Let's get back to how to test the A/C system of that car sitting in your stall regardless of the month and ambient conditions:

1. Look up the test procedure in

DanAmAir®

PROFESSIONAL ALUMINUM COMPRESSED AIR PIPING SYSTEM

SAVE MONEY

EASY TO INSTALL YOURSELF OR HAVE
PROFESSIONALLY INSTALLED

Measure & Cut ➤
Push to Connect

*Use for new
installation, or to
expand or modify
your current
system*

***SAVINGS**
up to 35% *Savings may vary
compared to steel or copper installation!

- ENERGY EFFICIENT
- EASY TO INSTALL
- Modular design
- Corrosion Resistant
- Leak-free guarantee
- Removable and reusable
- Push-to-connect technology
- Immediate pressurization
- Full bore design
- 1/2" to 6" pipe sizes

For a FREE quote call: 800-533-8016

Dan-Am Co.® • One Sata Drive • Spring Valley, MN 55975

service publications. I'll explain why that is critical in just a moment. Check for TSBs and other possible pattern failures during this check.

2. A good visual inspection — Are there any obvious leaks? Are the service port caps on and tight? Any new components installed? Wires disconnected? (**Figures 3a, 3b**)

3. Test for sealant in the refrigerant system. If found, follow the procedure that your shop has for systems that are contaminated with sealant (**Figure 4**).

4. If no sealant is found, connect an identifier and check for what refrigerant and other possible contaminants may be in the system (**Figure 5**).

Getting back to the EPA and regulations here: If you found that the system contains two or more refrigerants, consider it to be contaminated. Again, your shop should have a procedure based on federal and local regulations of what to do next.

5. If you have gotten past the first three, connect your gauges machine and note static pressures. There is a direct temperature-pressure relationship with all refrigerants and you will want to note this on the RO (**Figure 6**).

6. Connect a scan tool and see if there are any DTCs from the HVAC system or PCM that may be keeping the system from operating. Certain performance issues will keep the PCM from turning the A/C compressor on (**Figure 7**).

7. Using service publications prepare the vehicle for testing. Prepping the vehicle is critical to being able to test and use the test results to analyze possible concerns (**Figure 8**).

8. Run a performance test, as described in service publications, on the system, and note the pressures as well as ambient temperature and humidity.

Note: These two steps are why you check service publications early in the process to find out test procedures, any



THIS VEHICLE HAS SEALANT IN THE SYSTEM. The initial starting point for this test was the band at 2.4 on the scale. After 90 seconds, the flow has dropped to 1.0 indicating sealant in the system.

TSBs, system operating strategy and specifications.

9. Compare your results to the tables in the service manual (**Figure 9**).

10. Based on the tables, determine if the refrigerant system is working as designed.

You're saying, "Wait, this seems like the process I use in the summer." Give me a minute to finish the process and I'll explain the differences for cold-weather testing. I always like to baseline my training so everyone is on the same foundation. That way, what I say will make sense to all.

11. Make repairs as necessary and rerun the performance test to confirm repairs.

By now I am sure that most of you have figured out the answer to the question of testing in cold weather. The way you test an A/C system in December is the same way you test the A/C system in every other month of the year: by the book. As a Ford trainer and as faculty in Ferris State University's Automotive Program, I often had to teach A/C classes in November, December, January, February and March in Michigan. It is often quite cold in those months, yet I never had difficulty in teaching this subject for those techs and students. The Per-



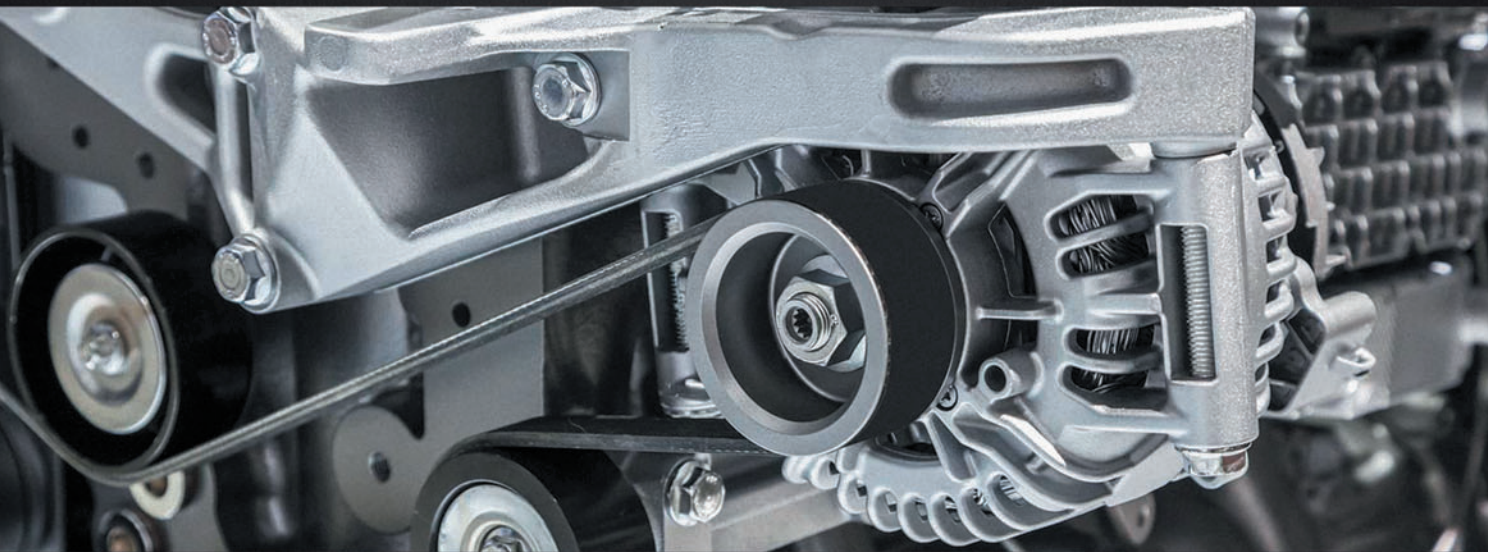
THERE ARE CHOICES FOR IDENTIFIERS. This one is showing that the system has 100 percent R-134a in it. This machine does not tell you whether the system is low or overfull, simply what is in it.



THIS GAUGE SET HAS BEEN CONNECTED TO A SYSTEM that has not been in operation. It is showing that ambient temperature is ~70 degrees and the refrigerant pressure is ~70psi. By comparing this to your chart for R-134a, this is a good indication that what is in the system is R-134a and there is enough refrigerant in the system to begin testing.

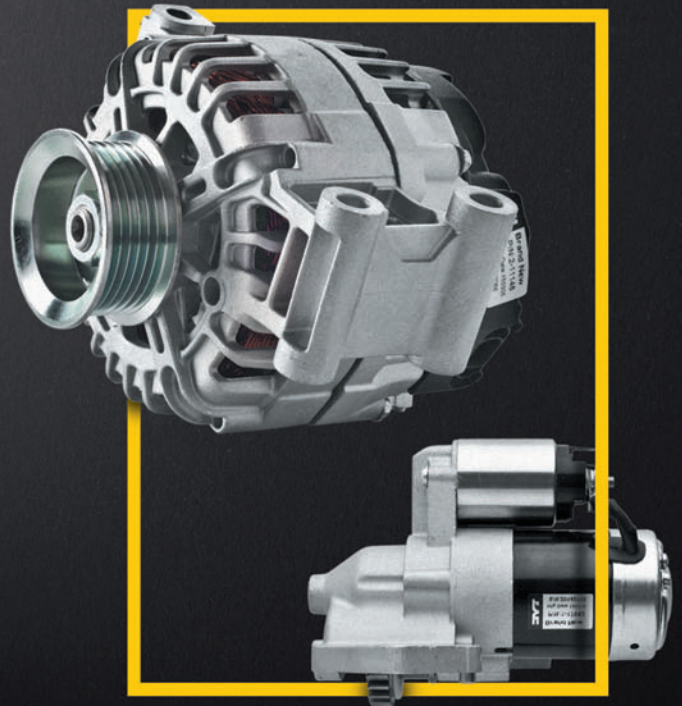
formance Test, FOLLOWING SERVICE MANUAL PROCEDURES, (sorry to yell) is the key to the process.

TYC[®] Expect More. Expect TYC.



No Time for Core Worries?

- 100% brand new, inside and out, with no recycled components.
- Industry-leading quality and reliability that is the cornerstone of all TYC products.
- Individually in line tested for reliable performance right out of the box.
- No Core Returns, No Core Charges, No Core Worries



TYC is a Proud Supporter of Novitas Foundation

Your gift can save lives, bring hope and build a future for a world in need go to NovitasFoundation.com.



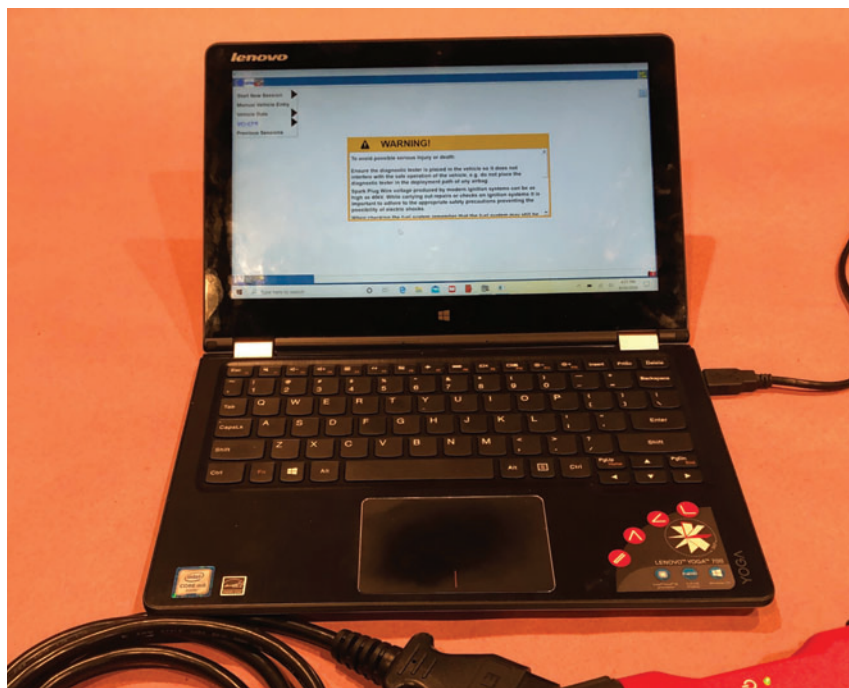
*(Select Applications)

For more information about TYC[™] replacement automotive parts, consult your local TYC[™] parts distributor or look up parts online at www.TYCUSA.com.

As you probably know, when the ambient temperature is below 32 degrees, the system won't turn on. Therefore, you must do all testing inside a heated building. Another typical operating characteristic is that when placed in defrost mode, the HVAC system will usually engage the compressor even when the temperature setting is calling for heat. This is done to provide dry air to help defog the windshield. My caveat to, "will this work every time?" When you have high-temperature extremes, you may have trouble reproducing a concern. Let me explain that with an actual example. Ford introduced the Flex in the late summer of 2008. The first TSB on that car was 08-20-5 about poor A/C performance in ambient temperatures above 100 degrees. This TSB directed the techs to evacuate the system and recharge with a specific amount of refrigerant. It also required a recalibration of the PCM. Let me translate that for you to be very clear: You cannot fix that car without access to service publications and a scan tool and/or J2534 pass through.

I digress — back to Step 8. The performance test is designed to find refrigeration system concerns and is based on the reality that for any given temperature and humidity level, a properly charged, correctly operating system will have defined pressure readings. If something is not right (airflow across a heat exchanger, the flow of refrigerant in the system and passing the restriction, or lack of one), all of these concerns create an effect on pressure readings. These defined readings will tell you, based on the charts, what is the likely concern. You can trust these charts if you've done the performance test as required by the OE in service publications.

During hands-on training, I would create bugged vehicles that the technician or student had to analyze for the likely/correct fault. I would simulate



A NECESSARY TOOL FOR SYSTEM ANALYSIS IS A SCAN TOOL. You may use a factory tool like this Ford IDS or any number of aftermarket tools that can reprogram and test using bi-directional control.



THIS 2005 FORD EXPLORER IS READY FOR A PERFORMANCE TEST. The engine is at operating temperature, and the A/C system has been running for at least 10 minutes. Hood and hatch are open, passenger doors are open and front doors have the windows open, all according to the Ford service manual. The next step is to set engine speed to spec and monitor outlet temperatures and note pressures to compare to the chart to determine if the system is working as designed.

airflow issues by placing obstructions in between the condenser and radiator, faults in cooling fans, even faults in engine sensors for them to find. Using the performance test results and the associated charts in service publica-

tions, the testing procedure would find them or put them on the right course to find them every time. I mentioned that sensors can cause problems. One of the first cars I owned with automatic temperature control was a Pontiac

TRAIN YOUR SHOP FOR THE FUTURE



Get the most comprehensive automotive technical and business training solutions for your shop with CTI+WTI. Access training and certifications for each member of your team, no matter their current skill level.

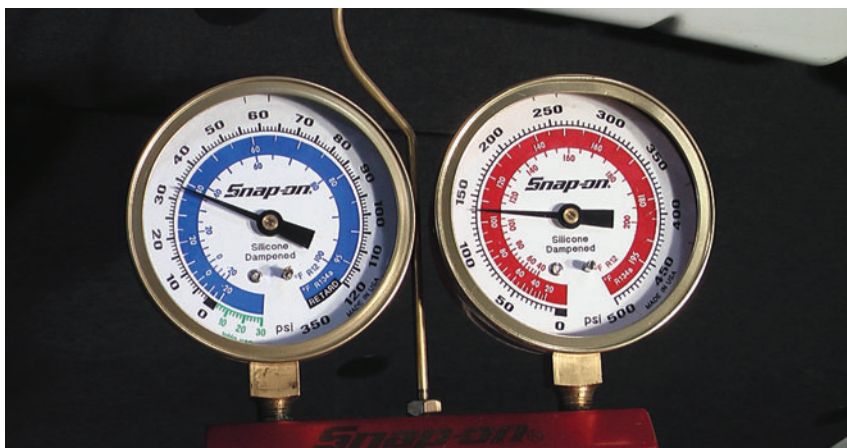
Start today at my.advancepro.com/shoptraining.



Bonneville SSE. One of the primary sensors for the control of the system was the ambient temperature sensor in front of the condenser behind the grille. In those days when I would be out shopping with my wife, I would sometimes wait in the car while she ran in to pick up whatever it was she was after. One time it was a day in December, the ambient temperature was about 32 degrees and the inside temp set to 70. At first, everything was fine. After about 10 minutes, I noticed the air blowing out was getting colder and colder, and I heard the A/C clutch engage. What was going on? I looked down at the controls and noticed that the outside air temp was reading 110 degrees. The ambient temp sensor was close to the radiator and not in a position to have outside air blowing over it while parked. It was reading underhood temperature. Added to that, it was a sunny day, so between the sun load sensor and the ambient sensor the system “thought” it was hot outside and turned the A/C on to meet the request for an inside temperature of 70 degrees. Today, most automatic systems have a strategy built in to ignore

DON'T MISS MACS 2021!

Mark your calendar for the annual Mobile Air Conditioning Society (MACS) Worldwide 2021 Training & Event Tradeshow, Feb. 3-6, 2021 in Orlando, Fla. MACS is planning the event with careful consideration to the current pandemic and is including safety and security measures as they move forward to create a valuable training and networking experience. For more info, visit MACS at www.macs.org.



WHILE DOING YOUR TESTING ON A CYCLING SYSTEM, you need to read the gauges just as the compressor shuts off. On a constant running system you read the gauges after the system has stabilized. Note these readings on the repair order and then compare to the analysis charts in the service manual.

the ambient sensor when the vehicle is standing still.

For approximately the last 30 years, the A/C systems (both manual and automatic systems) have an HVAC module in communication with the Powertrain Control Module to control compressor and cooling fan operation. Look at this list of requirements for the PCM to engage the A/C compressor on a late model Ford Expedition:

When an A/C request is received by the PCM, the A/C clutch relay is engaged when all of the following conditions are met:

- Excessively high or low refrigerant pressure from the A/C pressure transducer is not detected.
- Ambient air temperature is above approximately 0°C (32.0°F).
- Evaporator temperature is above approximately 1°C (33.8°F).
- Engine coolant temperature conditions are within normal parameters.
- Wide Open Throttle (WOT) condition is not present.
- Engine torque conditions are within normal parameters.
- Battery state of charge conditions is within normal parameters.

On this vehicle there is communication across three networks and

between four ECUs, just to turn the compressor on!

In this article, I focused on just testing the refrigeration part of the AC system. Electronic controls and the possible concerns that may be caused by skewed sensors, faulty programming and drivability issues are each worth their own articles. As you work on vehicles (and I cannot emphasize this enough), the importance of understanding how the system works and using service publications to direct your steps as you analyze whether or not the system is working like it is designed is extremely high.

How do you test the A/C system in any weather, anywhere? Follow the OE's service procedure, be ready to fix seemingly unrelated concerns and for refrigerant concerns, rely on the performance test. **TL**



MARK DEKOSTER has been fixing or teaching people how to fix cars for over 30 years. He has been a tech, trainer for Snap-on and Ford Motor Company,

and currently is an associate professor at Ferris State University. He is the lead instructor in The Automotive Management Degree Program.

mark.dekoster@gmail.com



ONE STOP SHOP

From brake service to wheels and tires, when you want the job done right, choose Ranger. Advanced engineering, breakthrough technology and the highest standards deliver shop-tested performance you can depend on. Enjoy industry-leading performance backed by an assurance warranty that is clear, easy to understand and comes with the best support possible for your business. Call 1-800-253-2363 or visit www.BendPak.com.

\$10,980

Tire Shop Package
SKU# 5140135

FREE SHIPPING!



TIRE SHOP PACKAGE INCLUDES:

(1) R980XR Tire Changer + (1) DST30P Wheel Balancer + (1) RL-8500 Brake Lathe + (1) Wheel Weights Combo

1-800-253-2363 ■ www.BendPak.com

*Free shipping to direct shipping points within the 48 contiguous United States only.

© 2020 BendPak Inc. Ranger Products is a registered trademark of BendPak.

Ranger

A Division of BendPak

A TWO-FOR-ONE REPAIR

IT'S NOT EVERY DAY THAT I PERFORM A MAINTENANCE SERVICE ON A VEHICLE AND INADVERTENTLY FIX A DRIVABILITY PROBLEM.

TIM JONES // Contributing Editor

At our shop, it seems we get frequent calls regarding tune-ups. The customer is often price shopping to find who can install tune-up parts to fix their drivability problem. During the customer interview process, we find frequently that they haven't even scanned the vehicle for fault codes. I think a lot of people still live in the '80s era when plugs, wires, caps and rotors fixed most of the rough-running concerns. With today's modern vehicles, it is challenging for a service advisor to sell a tune-up because they do not know what parts it should get. Does the vehicle have ignition wires? Does the vehicle have an external fuel filter? Is the positive crankcase ventilation valve a replaceable part or is it integrated into the valve cover? As a rule of thumb, we advise the customers that we must physically inspect the vehicle to determine what a tune-up should include. The other majority of calls we receive are the people who need someone to diagnose their issue. These customers typically have replaced a lot of parts on the car and it is still broken. This scenario presents another challenge to the service advisors to sell diagnostic tests.

When a 2008 Audi Q7 4.2L automatic transmission with 110,579 miles was brought to us, the customer had already invested a lot of money into the vehicle (**Figure 1**). As we like to say, "the parts cannon had been unloaded." Although the initial checkout gave me a solid direction, selling some addi-

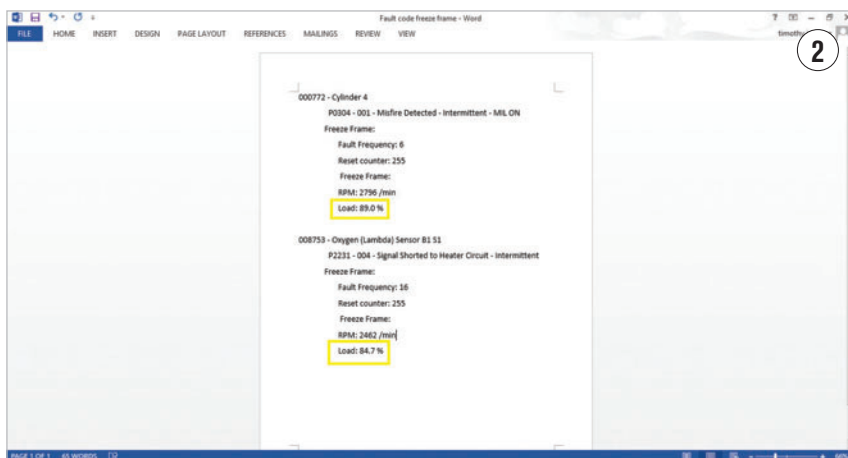


tional diagnostic time helped me win this battle. This vehicle was brought to us because of a misfire fault code and flashing check engine light. The repair order stated that the customer had been trying to fix a misfire on cylinder 2. I was not made aware of what the customer did in an attempt to fix the misfire. I was also not made aware of how to duplicate the misfire concern. I think that sometimes the history of a vehicle can be necessary and other times it is not needed at all. Each situation dictates the tactics used to diagnose the vehicle efficiently. How to duplicate the problem is something that always needs to be relayed from the customer to the technician. More often than not, if I interview a customer, I can get them to tell me how to drive the vehicle to duplicate the concern. That also means that if I have to interview a customer,

something got lost upfront during the check-in process.

In our shop, we have what is called an initial vehicle inspection (IVI). This inspection is the starting point for every concern with few exceptions like maintenance checks, brake inspections, etc. This IVI allots one hour to the technician to diagnose up to three concerns. In that one hour, we're not guaranteeing to be sure what the fix is to those three problems. What we guarantee is that the technician will follow the IVI checklist for each problem. This checklist is a guideline for the technician to follow so that easy stuff doesn't get overlooked. To explain how we built this checklist, I will give you a scenario that has happened to me more than one time.

I have been into a diagnosis for three hours and traced the prob-



lem back to a blown fuse. This sort of oversight cannot happen, so we added checking fuses into our initial vehicle inspection process. There is a valid reason for every bullet point on the checklist. At the end of the inspection, what we always try to provide the customer is two options. The first option is additional pinpoint testing because we couldn't diagnose the problem within the allotted hour of the IVI. The second option would be to sell the customer a part that we concluded is faulty. When it comes to a misfire under load, there are some bullet points that I can safely overlook in the guideline, but some I still have to follow. The guidelines I followed for this diagnosis were:

- Performing a visual inspection
- Performing a full module scan
- Confirming the customer concern

I could see that new coils and spark plugs were present from the visual inspection. I also could see that the intake manifold had been recently removed. I concluded this was likely to perform cleaning of the intake valves, because this engine is a gasoline direct injection system. Coils, plugs and carbon build-up on the intake valves are some of the most common causes of misfires on these engines. When I work on VW/Audis, I always perform an auto-scan

using VCDS (A popular VW/Audi scan tool). I then save the entire file to my computer for later access. These log files are impressive for drivability concerns, because they offer a freeze-frame attached to each fault code (**Figure 2**). Using VCDS for VW/Audi can provide some insight on how to drive the car to duplicate the problem, in the event the service advisor was not able to relay that information from the customer to the technician.

In the log file, there were three misfire fault codes: a P0300, P0302 and P0304. There was also a fault code that I was not familiar with — P2231, “Air-Fuel Signal Shorted To The Heater Circuit.” What I noticed between the misfire faults and the P2231 was that they were all setting under heavy load. I now knew how I needed to drive the vehicle to duplicate the concern. I tried to cheat by doing a heavy brake-torque in reverse, but I could not duplicate the misfire in the bay. Before I went on the road test, I thought that based on the calculated load results in the freeze frame and my personal experience, I was going to be condemning an ignition component (I have seen plenty of cheap aftermarket coils bad right out of the box). It had been my personal experience with VW/Audi that I could frequently reproduce the symptoms of a bad coil or plug right in the bay. It's

AUTEL MAXISYS™

SMARTER DIAGNOSTICS

STARTS
HERE

MAXIFLASH VCI NEW PROTOCOLS

- OR -



MAXIFLASH VCI FIVE-IN-ONE VCI

- BOTH TABLETS FEATURE -

INTELLIGENT DIAGNOSTICS

- REPAIR ASSIST
- GUIDED DIAGNOSTICS

TOPOLOGY MODULE MAP

- ALL SYSTEM STATUS SCREEN
- COLOR CODED FAULTS

POWERFUL HARDWARE

- OCTA-CORE PROCESSOR
- 128GB MEMORY



AUTEL.COM/ULTRA | 855.288.3587

@AUTELTOOLS



©2020 AUTEL U.S. INC., ALL RIGHTS RESERVED

AVAILABLE NOW! CONTACT YOUR LOCAL DISTRIBUTOR

very rare for me to need to drive the car to observe misfire activity data on the scan tool.

As I prepared myself for a road test I started thinking about what PIDs may be valuable if an ignition component was NOT the cause. After all, I only got an hour to diagnose a concern that is only exhibited while driving. Based on any heavily loaded misfire, my top three suspect-areas were:

- Ignition components
- Fuel restrictions
- Airflow restrictions

What I have noticed on CAN (Controller Area Network) controllers for VW/Audi is that they typically don't turn the injector off for a misfire. This is particularly important when monitoring fuel trims during a misfire. If the PCM shuts the driver off for an injector, the exhaust gasses will be lean once that occurs. As I started to work on more UDS (Unified Diagnostic Services) controllers, I saw this exact situation very frequently. I typically find a P130a associated with a misfire fault code. This fault code indicates to the technician that an injector has been shut off to protect the catalyst. In my experience, once the PCM detects a misfire, the injector is shut off until the next key cycle or the codes are cleared. The controller in this Q7 is a CAN controller. For me, it is safe to say that if I feel a misfire, I can trust that the fuel trims are a valid diagnostic indicator, because the engine controller did not stop pulsing the injector for that applicable cylinder. As a result of the injector still functioning, I should not experience a lean exhaust scenario (one that is induced by the engine controller).

I did a total of four test drives with this vehicle. During the first, I monitored all eight cylinders' misfire counters. I found that under heavy load, cylinder 4 was counting misfires rap-

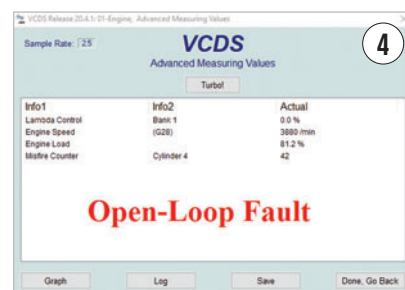
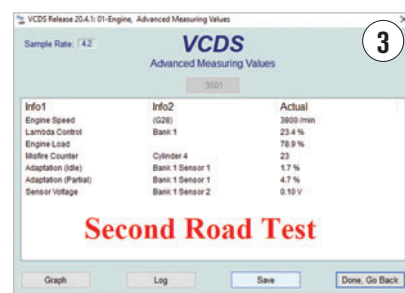
idly. This brought my attention to a different cylinder than the customer has been trying to fix. During the second road test I monitored:

- RPM
- Load
- Lambda bank 1
- Downstream oxygen sensor voltage b1
- Misfire counts for cylinder 4
- Fuel adaptations for partial load and idle

In the VW/AUDI world, Lambda-Control is another term that replaces short term fuel trim. This is the PCM's response primarily to the air-fuel sensor input or upstream oxygen sensor input. I was unsure that I could trust the air-fuel sensor due to the circuit fault DTC set, so I used the downstream sensor as a backup. What I found was that as load increased, the Lambda-Control would climb positive, the downstream oxygen sensor was indicating lean and the misfire counts started racking up (**Figure 3**).

This information tells us a lot about the agreement between the upstream air-fuel sensor and the downstream oxygen sensor, but there was a small problem that I'll explain in a moment. Short term fuel trim or Lambda-Control in the VW/AUDI world is the addition or subtraction of fuel to keep the exhaust in a stoichiometric condition. Lambda went positive during the second road test, showing an addition in fuel, likely because the air-fuel sensor input indicated lean (or above 1.0). The downstream sensor also went lean. This suggests that the air-fuel sensor agrees with the downstream oxygen sensor output.

I was still convinced that I had a problem with the air-fuel sensor, because VW/AUDI can also use the downstream oxygen sensor to influence fuel trim. When I did my road test, I never monitored the pumping



current or actual output value of the air-fuel sensor. This meant I was taking some liberties concluding that the two sensors agree with one another. What if the PCM used the downstream values for Lambda-Control? A lean downstream HO₂'s value can cause the PCM to add fuel to that bank. The next fastest way for me to rule out the air-fuel sensor was to just unplug it.

My third road test included me unplugging the air-fuel sensor and duplicating the problem one more time in an open-loop fault strategy (**Figure 4**). Since the air-fuel sensor is the primary input for fuel control verification, that bank would now go into open loop fault because it was not reporting any data. This effectively puts the PCM strategy in base fuel control, based on load. My thoughts were if the engine cannot run well in base fuel control, the misfire must not be caused by an air-fuel sensor problem. This technique was not necessary for older vehicles. Wide-open throttle typically forced open-loop drive/ full-throttle enrichment. This effectively puts the engine into base fuel control, with no oxygen sensor input.

CUT YOUR BRAKES DOWN TO SIZE (TO COIN A PHRASE)



BE SURE TO WATCH
"THE NICKEL TEST"

Ranger
PRODUCTS
**Precision
Combination Brake Station**



Model RL-8500
MSRP \$6,295

The RL-8500 by Ranger Products was made to offer techs faster rotor and drum resurfacing than any other brake lathe. With infinitely adjustable feed rates, operators can easily modify the speed of each cut with the turn of a dial. Get the precision finish you need, whether it's an initial rough cut or a single-pass micro-finish. Includes built-in, super-bright LED lamps, a standard heavy-duty bench and optional 32-pc. truck adapter set. There's simply no job too big for Ranger's RL-8500 brake lathe.



See it on
YouTube

Search "Ranger Nickel Test"



Fully equipped tool package comes standard



1-800-253-2363 • bendpak.com/brakes

© 2020 BendPak Inc. Ranger Products is a registered trademark of BendPak.

R Ranger

Now, with modern vehicles, the engine remains in total fuel control under almost all conditions, including wide-open throttle. The road test results with the air-fuel sensor unplugged revealed cylinder 4 misfires were still counting up under heavy load, even while in open-loop/no trim correction. I thought to myself that I could safely rule out an air-fuel sensor fault. I then started to focus on the added fuel trim to compensate for a lean exhaust gasses.

For more great information on fuel trim, reference “Increased use of turbochargers brings new lessons to using fuel trims for diagnosis” (September 2017) by Scott Shotton. He addressed some in-depth fuel trim analysis and how it can apply to misfire diagnostics. You can check it out, as it backs up what I’m saying at MotorAge.com/fueltrimdiagnosis.

Before we say “this looks like an injector issue,” let’s start with what can we deductively conclude this is NOT:

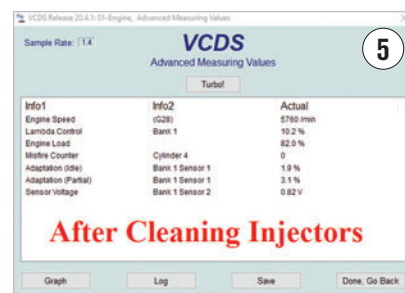
- I could likely rule out an ignition issue. In my experience with VW/Audi, I have never seen high trims due to an ignition misfire. On a Ford, that’s a different story. Even a lot of older Ford products would disable the injector for a misfire, and this would cause a lean exhaust condition.

- I could likely rule out an airflow restriction on the intake side. If the valves were loaded with carbon or the valves couldn’t fully open, the result would be a rich combustion event. Because the injector is in the combustion chamber on this engine, fuel is going to get into the chamber, unlike other injection designs (such as port injection where the fuel is delivered into the intake manifold).

I couldn’t definitively rule out an exhaust path restriction for that cylinder, so I took some liberties with my hypothesis. Based on my knowledge and experience, and since the engine

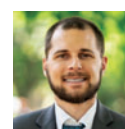
is quiet, I was comfortable with saying that an exhaust path restriction on this engine was unlikely. When I started to look at the position of cylinder 4 in the engine layout, I noticed something that stood out to me. It was at the back of the fuel rail on bank 1 (I will elaborate on the significance of this shortly).

So what was the next step? Should I scope the injectors to make sure my current flow is equal to that of the known-good injectors? High resistance in the injector circuit may cause an issue with fuel delivery. I’m usually all in for scoping the injectors, but I thought that if there was a circuit problem with this injector, the PCM would likely set a DTC. Could I AC-couple the high-pressure fuel rail sensor, sync off an injector and look at the injection pulses? That test can be done, but in my experience, it’s highly unreliable. Since the fuel rail pressure sensor covers a wide range of pressures, the pressure pulses can be hard to detect. Simply put, the signal is not sensitive enough to do so accurately. To view these pulses well, there has to be a lot of vertical enhancement done with the scope and the result is a bad quality image. Another problem with this test is the rail pressure sensor can be dampened heavily with all of the fuel rail tubing. The dampening absorbs the pressure drops related to the injector firing event. What about the location of the injector? On a GDI system, the high-pressure side is returnless. On a lot of vehicles, I have encountered clogged injectors and the injector that is clogged is at the end of the rail where contaminants cannot exit from. As I mentioned earlier, cylinder 4 is at the back of the rail. The location of the injector influenced my hypothesis that a restricted injector was probable. So my options at that point were to replace the injector, swap the injectors or try and clean them.



Swapping a GDI injector is a lot of work with additional parts for an outcome that may not reveal any results. The same goes for putting a brand new injector in the vehicle. I decided to run a can of BG 44k (a popular fuel injection system cleaner) through the rail on this vehicle. I have a lot of luck cleaning GDI injectors that are restricted with BG fuel cleaning products. This is maintenance that really should have been done a long time ago. Even if it didn’t fix this vehicle, I wasn’t going to beat myself up for selling an overdue maintenance item. But to no surprise, the vehicle was fixed. My fourth road test included all the same PIDs as described in the previous road tests — but without misfires (**Figure 5**). Lambda-Control is in a good range and the downstream exhaust is reporting “rich” (meaning the CAT is functioning well by storing and using the oxygen).

The right scan tool can be a very powerful tool when coupled with some knowledge and experience. Sometimes performing maintenance fixes broken cars. For me, it is a rare situation, but when it happens it’s usually the best-case scenario for the customer! **TJ**



TIMOTHY JONES has been in the automotive business for seven years. He currently holds a Master ASE certification including

A9 and considers himself a humble technician that embraces continuous education, helping others, with the goal to become an instructor in the near future.

tim@finetuneauto.com



WE SUPPORT
PROFESSIONAL CERTIFICATION
THROUGH THE
National Institute For
**AUTOMOTIVE
SERVICE
EXCELLENCE**

INTERACTIVE VIDEO TRAINING
TO HELP YOU **PASS THE ASE**

GET YOUR FREE TRIAL

Connect.MotorAgeTraining.com

PUT THE POWER OF TRAINING IN YOUR HANDS

AVAILABLE 24/7

TRAIN ON YOUR SCHEDULE

- ▶ **Guided** Module-Based Training
- ▶ **New Videos** Added Bi-Weekly

OVER 350 VIDEOS IN THESE SUBJECT AREAS



**AUTOMOTIVE
ELECTRICAL**

73



**ENGINE
PERFORMANCE**

118



**ENGINE
MECHANICAL**

16



**DRIVELINE
SYSTEMS**

10



**STEERING &
SUSPENSION**

16



**BRAKES & VEHICLE
DYNAMICS**

15



**HVAC
SYSTEMS**

12



**VEHICLE
SERVICING**

6



**TOOLS &
EQUIPMENT**

57



**TECHNICAL
INFORMATION**

29



ADVICS advanced braking technology

ADVICS (Advanced Intelligent Chassis Systems) ultra-premium disc brake pads and rotors, made for Asian and domestic vehicles, are engineered to work together.

For three decades, ADVICS ultra-premium braking and chassis components, for Asian and domestic vehicles, have set the standard of excellence in the aftermarket.

ADVICS ultra-premium disc brake pads are developed from advanced ceramic friction technology. Master engineering results in the aftermarket's best performing ceramic brake pads that provide superior stopping power and peak performance capabilities.

Our rotors are meticulously constructed using OE-quality precision machining constructed to achieve tight,

precise tolerances, maximum friction reduction and heat diffusion. ADVICS ultra-premium disc brake rotors feature standard carbon and certified high carbon* content, which is evenly distributed through the steel for consistent heat diffusion and better fade resistance, providing optimal performance and stopping power.

When a brake pad and rotor are designed for an OE application, they're made to work together. ADVICS ultra-premium replacement rotors have the same characteristics as the OE rotor, and are designed to work in combination with our ultra-premium disc brake pads. Using these pads and rotors together provides longer life, less noise and consistent pedal feel. In fact, testing has proven that ADVICS ultra-premium

disc brake pads can even have longer pad life, less noise and the same pedal feel as the OE product.

ADVICS offers a full product line that was developed with exacting standards and engineering expertise from the company's OEM business. ADVICS ultra-premium aftermarket product line includes disc brake pads, master cylinders, wheel cylinders, brake boosters, disc brake rotors and calipers.

For more information visit <https://www.advicsaftermarket.com/>.

*where applicable

ADVICS

1650 Kingsview Drive
Lebanon, Ohio 45036
amsales@advics-na.com



Complete diagnostics in the palm of your hand

Giotto™ powered by AutoEnginuity® is the only diagnostic platform reinvented for mobile. **Giotto** offers full coverage OE-level diagnostics through 2020 model year on Windows, iOS, and Android devices across all major Asian, Domestic and European brands. This scan tool software supports ADAS calibration with pre-/post-scan reports to XML, text message, email, and pdf. **Giotto** is complete with full DTC output, bidirectional controls, and system tests. Perform reset adaptation and calibrations, including SAS, Yaw Rate, Zero Calibrations, DPF Relearns and more.

Giotto's user interface is designed with simplicity in mind so you can focus on what's important — servicing the vehicle. The following processes have been streamlined to save you time:

- Automated VIN decoding
- Reading and Clearing Trouble Codes from the entire vehicle in a single step
- Printing live data or DTC / Emissions reports with a single step
- Quick installation with true USB Plug and Play (no device drivers necessary)

With **Giotto™ powered by AutoEnginuity®**, you get a powerful, full-featured diagnostic scan tool that can grow to fit



the needs of your growing business.

About OPUS IVS

Opus IVS helps shops repair complex vehicles fast with diagnostics, programming and live repair guidance from OE brand-specific master technicians.

Opus IVS is committed to helping mechanical and collision shops complete repairs with intelligent vehicle support today, for a safer world tomorrow.

Opus IVS is the Intelligent Vehicle Support division of **Opus Group**, formed through the industry-leading acquisitions of **DrewTech**, **Autologic**, **Farsight**, **Blue-**

Link, and **AutoEnginuity** to address the evolving needs of independent repair shops, giving them the confidence to get the most complex vehicles back on the road safely and fast without having to send work out to the dealer.

OPUS IVS

1819 N Rosemont
Mesa, AZ 85205

480-827-8665

sales@AutoEnginuity.com

www.OpusIVS.com



4 steps to quick car count

With few exceptions, car count is down for shops all over the country since this pandemic began. Fortunately for a lot of shops average tickets are up and are helping bridge at least part of the gap in lost sales.

As more consumers are venturing back onto the roads it's important to have the right plan in place to attract them to your shop. So, let's go over the four key steps that you must have in place for effective and profitable campaigns.

Step #1: Know who you want to attract

Just because a consumer has a pulse and a set of car keys in her hand, doesn't mean she is the right fit for you. Far too often shop owners are doing what I call, "Shotgun Marketing" the equivalent of pointing a shotgun at the sky, pulling the trigger, and hoping that someone gets hit. While somewhat effective, it forces you to weed through a lot of prospects to attract the right customer, with the right vehicle, and the willingness to spend the money to fix and maintain it.

Instead, focus on marketing to your current customer database. There are several benefits:

- They already know, like, and trust you.
- You have a history with them and

know their buying habits

Marketing to your own customers is 5 -10 times more effective

Chances are there are more vehicles in their driveways than you are seeing currently

Step #2: Send the right message

The average person sees over 4000 advertising messages every single day, so it's your job to grab their attention and make them an offer to take immediate action. No need to give away the store mind you, but powerful enough to compel them to call or drive to your shop RIGHT NOW! Otherwise, with all the distractions everyone sees every day, you'll risk losing their focus and let them get on to the next big thing in their life.

Step #3: Use the right media to deliver your message

Even the best message, sent to the best prospect, will fail miserably unless it gets seen. So where are your customers looking and how will you get your killer offer in front of them where they can see it?

Use a multiple-media approach by using the same media that they use every day - email, text, social media, di-

rect mail, and phone. Not only are these highly effective channels to use, but they have the added benefit of being very inexpensive or even free to use.

Step #4: Time your marketing properly

The best time to be marketing is the same day that the brakes start to squeal, the air conditioning fails, or some other problem appears. The problem is, we don't have a crystal ball to tell us when that is. So, the best thing to do is always be marketing to increase your odds of being in the right place at the right time. Use all of the media that I spoke about earlier, and make sure to spread it throughout the entire month.

More detailed information is available online

The Network Academy is proud to announce a partnership with Repair Shop Coach to provide video training specifically for shop owners in the areas of Car Count, Sales, Profitability, and Leadership over the coming months.

For more in-depth training on the four steps referenced in this article, go to www.TheNetworkAcademy.com to watch our free Car Count webinar and to access the 6-Module Car Count Now training course.



Make sure your transmission jack isn't out of whack

8 tips for maintaining your transmission jack

Installing a new transmission or removing the old one can be a challenge without a properly working transmission jack. These powerful, multitask lifting systems are essential in most auto repair shops.

However, transmission jacks can only do their jobs if they are properly maintained, regularly inspected for damage and used correctly. Here are eight tips for maintaining your transmission jacks:

1. Regularly lubricate all moving parts. Pay special attention to the lift screw and related linkages. A medium-weight lubricating grease should be used on all external moving parts, such as the bearing surface, pivot points, and tilt screws.

2. Regularly check the oil level and top off as needed.

3. Use only hydraulic jack oil. Do not use hydraulic brake fluid.

4. If the jack fails to operate, check the oil level and/or bleed the unit before seeking service.

5. Do not use a transmission jack as a wash rack when washing or steam-cleaning transmissions.

6. Before each use, follow the pre-check list provided by the manufacturer to ensure components are in good working order. If any issues are found, remove the jack from service until repaired.

7. Do not use the jack if you believe it has been subjected to an abnormal load or shock. If in doubt, contact a local service agent.

8. Periodically check the pump piston rod for signs of corrosion. Clean exposed areas with an oiled cloth.

This content was provided by BendPak. For more information, visit www.bendpak.com.



BP BendPak®

New additive from LIQUI MOLY to prevent engine damage

DIJectron helps to combat the increasing problem of LSPI

More and more modern engines are at increased risk from LSPI (low speed pre-ignition). Similar to classic engine knocking, this can lead to serious engine damage. LIQUI MOLY has developed an additive that significantly reduces this risk: DIJectron.

Modern, high-performance engines with direct injection, suffer from an increased risk of premature ignition at low engine speeds (LSPI – low-speed pre-ignition). Here the gasoline/air mixture ignites spontaneously in the combustion chamber before the ignition spark is created. This knocking can cause serious engine damage. This phenomenon is not entirely understood yet. The contamination inside the engine certainly plays a role.

This is where LIQUI MOLY's new DIJectron comes in. It contains polyetheramine (PEA) as an active ingredient. "Active PEA is a highly effective cleaning chemical that removes even stubborn deposits from injectors, pistons and combustion chambers," explains David Kaiser, Head of Research and Development at LIQUI MOLY. "And, if used regularly, it provides lasting protection against new carbon deposits."

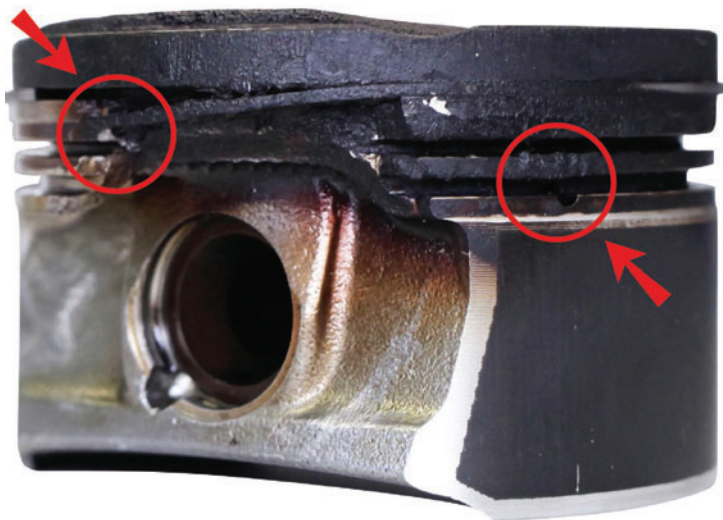
These deposits are considered an essential factor for LSPI. Modern direct-injection turbocharged gasoline engines have a highly stressed injection system. The injection nozzles reach

directly into the combustion chamber and are therefore exposed to high temperatures, pressures and the influence of combustion residues. Deposits form at the nozzle outlet openings within a short time, ensuring that the gasoline is no longer atomized so finely. This worsens the emission values and increases the fuel consumption. The deposits can begin to glow due to the high temperatures, which can then lead to LSPI.

DIJectron can be used at any inspection. It is so effective that it only has to be added every 2,400 miles.

It is suitable for all cars with a 4-stroke gasoline engine, especially for direct injectors, but also for cars with intake-manifold injection.

LIQUI MOLY has over 60 years of experience with additives and is the undisputed market leader in its home country of Germany. "Additives are useful chemical tools that every professional should have in his toolbox," says David Kaiser. "They can solve many problems faster, easier and more cost-effectively than mechanical tests."



THIS PISTON HAS BEEN DAMAGED BY LSPI.

LIQUI MOLY USA

(888) - MOLYOIL (888-665-9645)

info@liqui-moly.us

www.liqui-moly.us

5 steps to a more accurate diagnosis

Have you ever struggled with a repair job and by the end felt like you were just part swapping? Sometimes the path to a quicker and more accurate diagnosis is in your process.

One of the biggest factors that can improve your process is to fully utilize all of the automotive repair information available to you. Here are five steps that can help you gather information to build an effective diagnostic strategy.

Step 1: Verify the symptom or complaint

This is the basis of your diagnosis and a crucial step in setting yourself up for success. Having a complete understanding of the problem will guide you to the best place to start. Step 1 actually has two parts.

The first part, understanding the problem, begins the moment the customer walks in the door. That initial conversation with the customer gives you the opportunity to ask the right questions and collect as much information as possible.

The second part, replicating the problem, can give you further insight into the symptoms that maybe your customer did not notice. Sometimes this can be done in the bay, but often it means driving the vehicle to re-create the customer complaint. Resources like the Top 10 Repairs List in ProDemand repair information from Mitchell 1 can help you quickly identify the likely cause or lead you to even more specific questioning.

Step 2: Analyze symptoms

Once you've verified the symptoms, it's time to build your diagnostic strategy. This is where you do all of your thinking and plan the work, putting your diagnostic tools to good use.

- Scan tools: Pulling codes with a scanner should be your first step.
- Real-world information: OEM information may not be enough when you're running into issues like multiple unrelated codes. This is where real-world information can help. The SureTrack real-world information in ProDemand, for example, lets you see how other professional technicians have solved the same codes and symptoms for the same vehicle.
- Common repair procedures and probable components: Having information about common repair procedures and known fixes for specific codes and symptoms based on mileage trends can also help set you on the right path with the most likely components to test first. If the vehicle is equipped with ADAS features, you'll want to check special equipment and calibration requirements. ProDemand's ADAS QuickLink puts all this information right at your fingertips.

Step 3: Isolate the fault through testing

Now that you have your plan in place, you can execute the diagnostic strategy and isolate the fault through testing.

There are some great shortcuts that can help you save time. In ProDemand, these include features like Real Fixes, component test information, interactive wiring diagrams that help with electrical testing, and the Causes & Fixes tool for diagnosing multiple codes.

You will also use your handheld scan tools like the ZEUS from Snap-on, as well as oscilloscopes, multi-meters, smoke machines and more specialized equipment like fuel injection testing equipment.

Step 4: Correct the problem

Once you have identified the component/s that failed, you can move forward and complete the repair. Access the basic information you need — repair procedures, diagrams and specifications, etc. — in your repair information resource.

Step 5: Check for proper operation

Once the repair is complete, it's quality check time! Verify the fix by driving the vehicle. Look for the original code or symptom and make sure it has been addressed and no codes or check engine lights come on.

This quick overview highlights how using a resource like ProDemand can reduce diagnostic time, and give you more confidence when building and carrying out a diagnostic strategy.

MITCHELL 1

www.mitchell1.com
800-896-3126

Mitchell1
In your shop, at your side

Probe Mismatch in PicoScope 7

Ease of use has been one of the main driving factors behind PicoScope 7 and the new 4x25A Automotive scopes.

Probe Mismatch is a feature that supports this. When you want to recreate a test by loading an already saved waveform, the Probe Mismatch feature will help you make sure that your PicoScope is configured to replicate that specific test. It will do this by notifying you if you do not have the “correct” probes connected to your scope. For this feature to work, the psdata file will have to have been saved with a 4x25A scope connected and with PicoBNC+ probes in use.

Let's see it in action. In our example, we have used all four channels on a PicoScope 4425A to capture the secondary ignition event on one cylinder. We have used a mix of PicoBNC+ and BNC ignition probes.

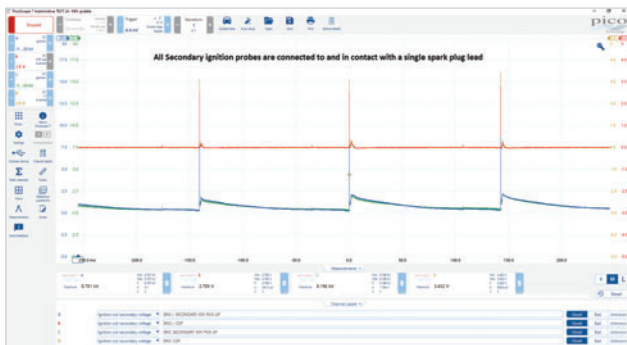
Channel A: PicoBNC+ Secondary ignition pick up

Channel B: PicoBNC+ COP Probe

Channel C: BNC Secondary ignition pick up

Channel D: BNC COP Probe

If I load this file with any automotive scope connected, the waveform will be displayed as expected (see image below).



To replicate the test, we need to manually configure the probes (for each channel) to match those used in the original capture. If we are using a 4423 or 4425, we would have to use the BNC equivalent of the PicoBNC+ probes connected to channels A and B in the above image.

With Probe Mismatch, the same procedure still applies but with a prompt at hand to help you select the correct probes.

If I have a 4425A scope connected and load the saved waveform from Image 1, the waveform will be displayed as expected. However, depending on the probes currently connected to the scope, when I press the Start/Stop button, the Probe Mismatch dialog box may appear.

The following image will help clarify:



The dialog box for Probe Mismatch will be prompted and appears before the scope starts to inform the user that the current device/probe configuration is different than the one used in the saved file.

The Probe Mismatch dialog box indicates the following:

Channel: Displays the channel letter to which the expected and found probes refer to.

Probe Expected: Displays the type of PicoBNC+ probe used during the original capture or, “No Probe” if a BNC probe was used or there was no probe connected.

Probe Found: Displays the type of PicoBNC+ probe that is currently connected to the scope or “No Probe” if a BNC probe is used or there is no probe connected.

Probe State: Indicates whether the expected PicoBNC+ probe matches the found PicoBNC+ probe, using a tick mark for a match and a cross for a mismatch.

Please do not confuse Probe Mismatch with the Probe settings within Channel Options, as these remain intact and separate.

In conclusion, the Probe Mismatch dialog box will appear when you have a 4x25A scope with PicoBNC+ probes connected, you are loading a psdata file which was saved using a 4x25A scope and PicoBNC+ probes, and you try to run the scope when the expected probes in the file don't match the probes you have connected.

The Probe Mismatch feature is a handy tool that helps you make sure that you are using the right accessories for the job. However, users have the final say and can choose to ignore the mismatch warning and run the scope with the found probes, (meaning run the scope with the currently connected probes) or click Cancel to close the Probe Mismatch dialog box without further action.

For more information, visit: www.picoauto.com.

Implementing clean air in your shop provides safety and comfort

Today's clean air requirements are more critical than ever. Air tools, blow driers, HVLP spray guns, and supplied air respirators may require more air volume and better air quality than in the past. Not only does clean air affect equipment performance, but it is also critical for paint coatings performance. Dan-Am Air's aluminum airlines, along with SATA's filtration system, can solve all of these issues.

"The Dan-Am Air system is reusable and easily adaptable to any space, not only ensuring safe, clean air for your team, but also increasing your shop's efficiency and improving your bottom line," said Brad Gravenhof, Sales & Technical DanAmAir Specialist at Dan-Am Company — the independent exclusive distributor of SATA spray equipment in the U.S. and Puerto Rico.

The three-stage filtration

SATA filtration is available in two sizes, which can flow up to 129 cfm at 90psi — an exceptional amount of air for a single filtration unit, Gravenhof says, enough to accommodate multiple booths on a single filter.

"If your shop is equipped with multiple booths, you have the option of a single SATA filter to maintain, as opposed to a filtration unit at each booth. Fewer filter cartridges to maintain equals fewer dollars spent," Gravenhof says.

The SATA three-stage filtration system is simple: The first stage is the water separator, removing the larger moisture droplets and particles down to 5 microns from the air; next is the fine filter which removes particles down to 0.01 micron; and, finally, there is the acti-

vated charcoal filter stage removing hydrocarbons, oil vapors and odors to give you perfectly clean air for breathing and spraying.

Dan-Am Air's high-quality materials

The system's airlines are made of powder-coated, aircraft-grade, extruded aluminum.

The system is easy to install, modular and reusable, lightweight, corrosion resistant, and guaranteed not to leak. Dan-Am Air fittings are constructed of a reinforced Nylon composite material with a double Nitrile seal. The manifolds and ball valves are nickel plated solid brass, and all threaded connectors are high grade steel. Dan-Am Air can be easily adapted to your current system with the variety of threaded connection options available.

Modular design

"Compared to a more typical airlines system, ours is reusable," Gravenhof says. "You can put a system up, and take



it down and put it back together very easily. It's modular, and can be easily added on to or changed if need be.

Designed with simplicity in mind, DAA allows you to do it yourself. Measure, cut, de-burr, then simply "Press-to-Connect". The direct result being lower installation times and costs. All fittings arrive pre-torqued for immediate assembly and pressurization.

Creating efficiency, saving money

"The cost of a reusable and versatile system like Dan-Am Air can pay off quickly," Gravenhof says. "It's a simple, effective system with a do-it-yourself installation option. It saves time. It saves energy. It ultimately saves money."

The airlines, and fittings, have what Gravenhof refers to as a "smooth, full-bore" design, where there are no restrictions. The air flows easily and quickly with no leaks or contaminations.

To learn more, go to www.danamair.com. Call 800-533-8016 for a free estimate.

- Energy efficient
- East to install
- Modular design
- Corrosion resistant
- Leak-free guarantee
- Removable and reusable
- Push-to-connect technology
- Immediate pressurization
- Full bore design
- 1/2" to 6" pipe sizes

DanAmAir®

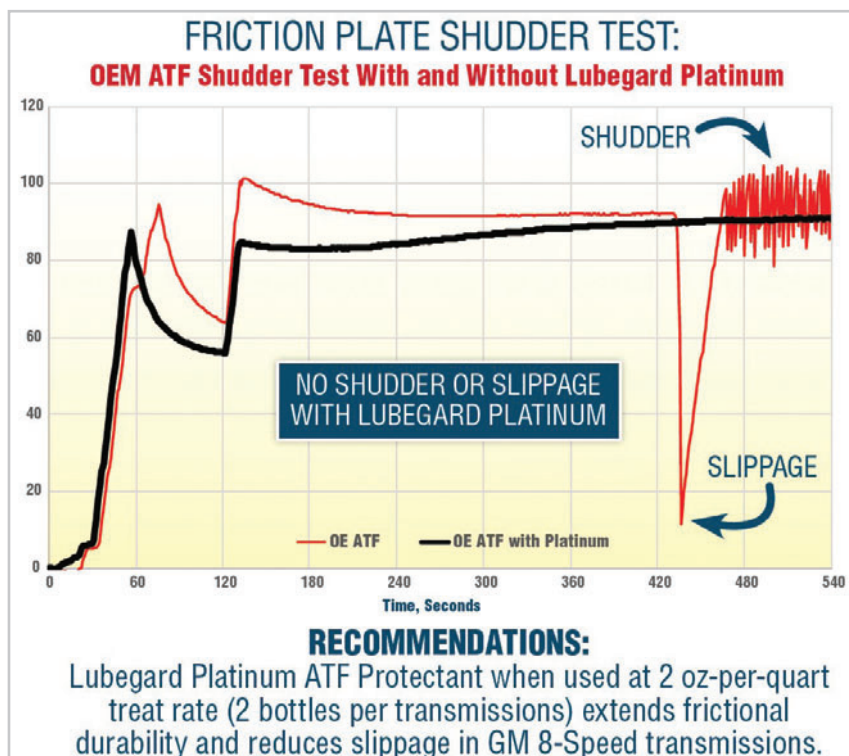
The GM 8-Speed TCC shudder solution

The results are clear

LUBEGARD® Platinum™ ATF Protectant significantly reduces torque converter clutch shudder and slippage. General Motors has issued several technical service bulletins pertaining to torque converter clutch shudder issues in two of their 8-Speed transmissions: the 8L45 and the 8L90. This problem currently affects 11 different models across Cadillac, Chevy, and General Motors between the model years 2015 and 2019. The ATS, CTS, CT6, and the Escalade, the Camaro, Colorado, Corvette, and Silverado, and the Canyon, Sierra, and Yukon (see lube-gard.com/gmshudder for full bulletin, and model year specific chart.)

GM's solution to this problem is lengthy & complicated, requiring 20 liters of ATF be flushed through the system to replace as much fluid as possible, yet still has not corrected the issue in some cases. With some of these vehicles beginning to approach the end of their limited powertrain warranties, you can expect to see an increase of these vehicles in your shop. We are here today to offer you a better, less complicated, and less expensive way to service these transmissions successfully with fewer comebacks and customer complaints.

We used our state-of-the-art Falex Multispecimen testing platform to develop conditions that caused shudder to occur between an automatic transmission friction plate and steel plate when lubricated with GM's recommended ATF specified in their technical service bulletins. We then eliminated the shudder under the same conditions by adding LUBEGARD® Platinum™ High-Performance ATF Protectant to the test



ATF at the treat rate of 2 fluid ounces per quart. An added advantage of the LUBEGARD® Platinum™ High-Performance ATF Protectant was control and stabilization of the friction at a constant level throughout the tests.

When your customer is suffering from TCC shudder and/or slippage, you can help them avoid the expensive replacement of their Mobil1® HP LV or Dexron® HP, by simply adding 2 bottles of LUBEGARD® Platinum™ ATF Protectant to their current fluid, or, if the customer insists on total replacement, you can avoid recurrence of the TCC shudder with the addition of 2 fluid ounces per quart of LUBEGARD® Platinum™ High-Performance ATF Protectant to the Mobil1® HP LV or Dexron® HP with-



out the need to flush 20 quarts of ATF through the system.

DID YOU KNOW?

ASE CERTIFIED TECHNICIANS

- ➔ **GET PAID MORE**
- ➔ **GET HIRED FIRST**
- ➔ **ADVANCE FASTER**



MOTOR AGE TRAINING
**OFFERS THE MOST COMPLETE AND EXTENSIVE
ASE TRAINING SERIES AVAILABLE ANYWHERE!**

**GET THE MATERIALS YOU NEED TO PASS ALL OF
YOUR ASE CERTIFICATION TESTS - **GUARANTEED!****

**Motor Age
TRAINING**
Self-Study Guides for ASE Certification

...YOU PASS OR DON'T PAY!

**MONEY-BACK
GUARANTEE.**



www.PASSTHEASE.com

BUILD YOUR SHOP'S SKILLS WITH LIVE TRAINING

Training from Carquest Technical Institute® (CTI) and Worldpac Training Institute® (WTI) gives automotive service professionals the skills they need to properly diagnose, service and repair today's high-tech vehicles. Our Virtual Classroom events are designed to help keep our industry moving forward while in-person training isn't an option. With Virtual Classroom technology, the CTI+WTI team brings the classroom directly to you at a time and pace that meets your schedule.

MY.ADVANCEPRO.COM/SHOPTRAINING



GET HIGH STRENGTH THREADLOCKING WITH NO DRIP

With Permatex Threadlocker Orange Gel, you can secure fasteners in high vibration applications without worrying about mess or drips. You get holding power similar to Permatex's High Strength Threadlocker Red with the removability of Permatex's Threadlocker Blue. Permatex Orange Gel features a viscous formula that won't drip, even when used in overhead, vertical, and hard-to-reach applications. It does not require heat or power tools to disassemble.

WWW.PERMATEX.COM



BRAKE DISCS

Textar engineers have utilized the know-how that comes from decades of producing premium OE brake pads to develop a perfectly matched brake disc that ensures the ultimate braking performance of your vehicle. The Textar range of brake discs is manufactured to precise German specification and are application engineered for cars driven in North America. Textar brake discs, Textar brake fluids (DOT 3, 4, 5.1), Textar anti-squeal pastes and Textar brake tools are available exclusively at WORLDPAK, as well as a full range of premier Textar brake pads, e-pads and brake shoes.

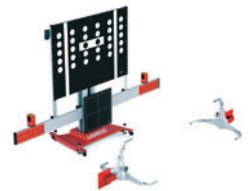
WWW.TEXTAR-WORLDPAC.COM



X-431 ADAS PRO

The LAUNCH X-431 ADAS Pro calibration tool is designed to ensure driving safety and comfort by handling the calibration of ADAS camera and radar systems. The automatic calibration frame and the multiple target boards are provided for servicing comprehensive car lines with rapid and accurate calibration. The ADAS Software's easy-to-follow process guides the technician step by step throughout the procedures. The bi-directional X-431 Throttle scanner with OE-level coverage and full diagnostic function ensures a satisfying experience for both diagnostics and calibrations.

WWW.LAUNCHTECHUSA.COM



AD INDEX

AD INDEX

ADVERTISER	PAGE #	ADVERTISER	PAGE #	ADVERTISER	PAGE #
ADVANCE AUTO PARTS.....	7	CASEY TOOL, LLC.....	31	TRICO / AUTOLITE.....	11
ADVICS.....	3, 52	LAUNCH TECH (USA) INC.....	9	TRICO / CARTER.....	37
AUTEL.....	47	LIQUI MOLY USA.....	15, 56	TYC GENERA.....	25, 41
AUTOENGINEUITY.....	29, 53	MITCHELL 1.....	13, 57	WORLDPAK.....	CV4, 43
AUTOMOTIVE DISTRIBUTION NETWORK.....	19, 54	NAPA AUTO PARTS.....	CV3, 35		
AUTOMOTIVE MGMT INSTITUTE.....	30	OEC / REPAIRLINK.....	5		
AUTOMOTIVE TRAINING INSTITUTE.....	6	PARTSOLOGY.....	27		
AUTOZONE.....	CV2	PICO TECHNOLOGY LIMITED.....	21, 58		
BENDPAK.....	32, 33, 45, 49, 55	SATA / DAN-AM AIR.....	39, 59		
BOSCH AUTOMOTIVE SERVICE SOLUTIONS.....	17	STELLAR / LUBEGARD.....	23, 60		

PRODUCTS

ADVANCE AUTO PARTS.....	62
LAUNCH TECH (USA) INC.....	62
PERMATEX.....	62
WORLDPAK.....	62

Motor Age
ADVANCING THE AUTOMOTIVE SERVICE PROFESSIONAL | WWW.MOTORAGE.COM

Content Licensing for Every Marketing Strategy



Marketing solutions fit for:

- Outdoor
- Tradeshow/POP Displays
- Direct Mail
- Social Media
- Print Advertising
- Radio & Television

Logo Licensing | Reprints | Eprints | Plaques

Leverage branded content from *Motor Age* to create a more powerful and sophisticated statement about your product, service, or company in your next marketing campaign. Contact Wright's Media to find out more about how we can customize your acknowledgements and recognitions to enhance your marketing strategies.

For more information,
call Wright's Media
at 877.652.5295 or
visit our website at
www.wrightsmmedia.com

TRAINING

Electrical How-to-Book

by Vince Fischelli (250 pages - 198 diagrams) **\$98.00**

"Vehicle Electrical Troubleshooting *SHORTCUTS*"

Troubleshooting Batteries, Cranking Circuits and Charging Systems on-the-vehicle with just a DMM & Current Clamp plus a lot more!



Veejer Enterprises Inc.

www.veejer.com 972-276-9642

HIT THE FAST LANE OF THE AUTOMOTIVE INDUSTRY

for Web Exclusives
and Advertising
Opportunities Go
to our Websites

www.searchautoparts.com

ELECTRICAL TRAINING WEBINARS

By

Vince Fischelli

[www.veejer.com/
webinars/ck](http://www.veejer.com/webinars/ck)

Let Marketplace Advertising Work For You!

Generate sales leads, maintain market presence, conduct market testing, promote existing lines, introduce new products and services, or recruit the best.

MARKETPLACE OFFER YOU AN EXCELLENT RETURN ON INVESTMENT!

**FOR MARKETPLACE OR
CAREER OPPORTUNITY
AD RATES/PLACEMENT:**

Call **Jeffrey Patton** at

Ph: 920-393-7715 or

E-mail: jpatton@endeavorb2b.com



SPARK PLUG SERVICE THE PROFESSIONAL WAY

WHETHER YOU'RE REMOVING AND INSTALLING THE PLUGS DURING A DIAGNOSTIC TEST OR CHANGING THEM AS A ROUTINE MAINTENANCE SERVICE, THERE'S STILL A "RIGHT" AND A "WRONG" WAY TO DO IT

PETE MEIER // Director of Training

When we perform a "routine" service repeatedly, it is easy to become complacent. The finer points we used to pay attention to fade into flat-rate memory as we focus on getting the job done quickly so we can move on to the next. That may have been OK in the distant past, but the high-tech engines we work on today demand attention to detail.

Spark plug service is an example of one of those "routine" services. We all know that spark plug gaps come pre-set from the manufacturer, but how

many of us take the time to verify the gap? And if you do, what kind of tool are you using to do so? And the anti-seize debate continues — do we use it or not? What is its impact on the applied torque of the plug? Oh, you don't torque the plugs when you install them? That could be setting yourself up for a comeback!

Consider the harsh environment spark plugs live in. High temperature, high pressure environments requiring high voltage potential to overcome and allow that much needed ignition spark to travel across the gap, between

electrodes. With all the challenges the spark plug faces in its normal everyday life, why add to those challenges with improper inspection and replacement techniques?

In this episode of The Trainer, we'll cover the finer points of spark plug service — removal, inspection and replacement. Have a look! [ZZ](#)

SPONSORED BY

TRICO®



SIGN UP FOR YOUR SUBSCRIPTION TODAY AT [MOTORAGE.COM/MATCONNECT](https://motorage.com/matconnect)



MORE PARTS FOR MORE CARS



AUTO PARTS

QUALITY NEVER GOES OUT OF STYLE



AAE
STEERING SPECIALISTS

ACDelco

ADVICS

AININ

AIKESONO
BRAKE EXPERTS

Alte

BANDO

BCA
BEARINGS by HTH

BILSTEIN

BOSCH

Continental

CORTECO

CSF

CTP

Delphi
Technologies

DENSO

elring

ENEOS

ebi
bilstein

FERODO

Gates

GEPA

GLYCO

GOETZE

HELLA

HELLA PAGID
BRAKE SYSTEMS

Hengst
FILTER

ISG

KYB
World Class Shocks & Struts

LIQUI MOLY

MAGNAFLOW

MAHLE

MANN FILTER

METRIX

MEYLE

MITSUBISHI

MOPAR

Motorcraft

MOTUL

NGK
THE IGNITION SPECIALIST

NTK
THE SENSOR SPECIALIST

Nissens

PENTOSIN
SAFETY ON ALL ROADS

RED LINE
SYNTHETIC OIL

REDLINE
FUEL MANAGEMENT

rein
AUTOMOTIVE

Santech
Automotive A/C Components

SCHAEFFLER

TEXTAR

TIMKEN

Valeo

VAICO
PARTS & SERVICE

VEMO
MAKING IT ON A DAILY BASIS

VDO

WBR

WORLD
SOURCEONE

ZE

AFTERMARKET
LEMFÖRDER SACHS TRAV

Zimmermann
Brake Disc - Brake Drum

WORLD PAC

Wholesale Distributor of Original Equipment Automotive Parts

worldpac.com
worldpac.ca

Become a Customer Today