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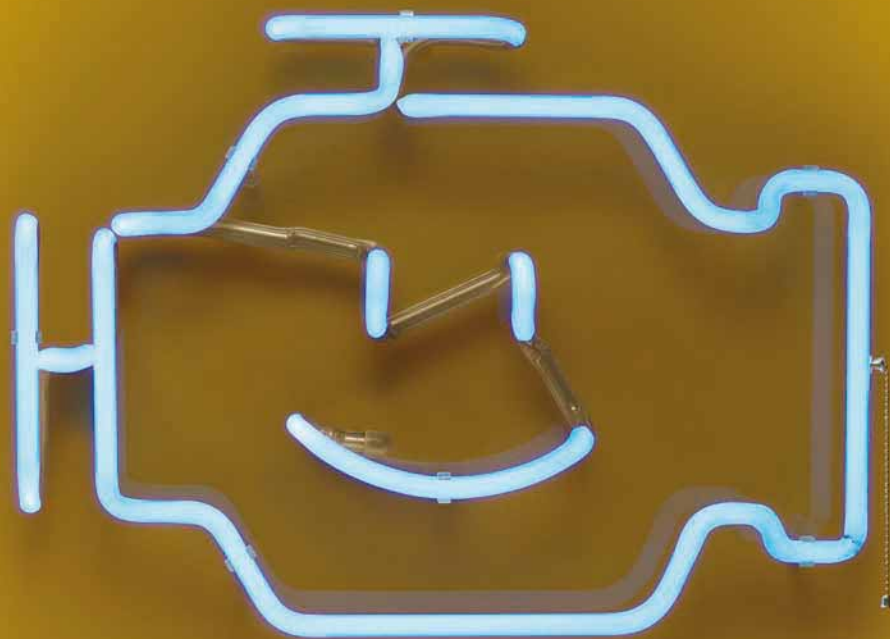


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Vol. 132, No. 4

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Evaluations have a powerful effect on today's shop performance.

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ATE STORMS ASA-WASHINGTON

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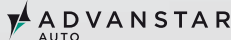
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12 Vehicle inspections — measuring the results

There are many reasons to do inspections, and lists can help you no matter the why.

plus **Stats & Trends**

Noteworthy

BEST OF THE BLOGS

TOP VIDEOS CALENDAR



Q+A WITH

14 Rich White, Car Care Council executive director

National Car Care Month is here again, and the Car Care Council is helping boost your shop's event.

88 The Trainer Testing battery faults

No crank, slow crank? Is it the battery?



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FUNNY SHOP STUFF

Would you climb into a trunk while a fellow tech hosed it down in search of a recurring leak? This tech has a story just like that.

[KEY: funnystuff]

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One Workshop member is excited to announce its next addition to your tool box: AutoVitals TV Service Recommendations.

[KEY: autovitals]

GM SELECTS AT&T'S 4G LTE NETWORK

AT&T has announced an agreement with OnStar to wirelessly deliver an enhanced suite of safety, security, diagnostic and infotainment services beginning in 2014.

[KEY: atandt]

ONLINE COVERAGE



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Pete Meier wrapped up this series, but there are several great interviews to check out.

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TECHNOLOGY

ELECTRICAL



A TALE OF TWO CIRCUITS

BY PETE MEIER | TECHNICAL EDITOR

52 Diagnosing an electrical problem with an A/C compressor, blower or cooling fan? The first step is to figure out on which of two circuits you need to focus.

UNDERHOOD

SIGNED, SEALED, DELIVERED

BY VANESSA ATTWELL | CONTRIBUTING EDITOR

58 Here are some tips on finding really difficult air conditioning system leaks.

UNDERCAR

TIME TO GET READY

BY PETE MEIER | TECHNICAL EDITOR

64 Global issues are setting the scene for an interesting year.

SCOPE & SCAN

KEEPING IT SIMPLE DIAGNOSTIC TIPS

70 Simple doesn't always mean apparent, and that's why we're here to help.

MOTOR AGE GARAGE

SECOND OPINIONS

BY RICHARD MCCUUSTIAN | CONTRIBUTING EDITOR

72 Sometimes customers tell us another shop has checked the problem – sometimes we just figure it out.

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[KEY: spoiled]

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[KEY: uactivate]

TECHSMART RELEASES SESSION

SMP has released a new TechSmart@Tech Session video featuring TechSmart electronic throttle bodies.

[KEY: techsession]

POWERTRAIN PRO



ATSG TECHNICAL TRAINING

ATSG TIPS: GM 4L60E TRANSMISSION

BY WAYNE COLONNA | POWERTRAIN PRO PUBLISHER

50 Lessons on how to fix no engagement, repeated pump rotor destruction on these transmissions.

POWERTRAIN PRO COLUMN

THAT WAS TOO EASY

BY WAYNE COLONNA | POWERTRAIN PRO PUBLISHER

30 Diagnosing olenoid electrical codes for Ford's 5R55S Transmission.



DRIVABILITY

THE 10 MODES OF OBDII

BY ALBIN MOORE | CONTRIBUTING EDITOR

40 Even the most generic Global OBDII scan tools can offer a lot of information if you know where to look.



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MANAGEMENT

HONEST RATINGS

BY BRIAN CANNING | CONTRIBUTOR

16 Evaluations have a powerful effect on today's shop performance.

PROFIT MATTERS

MARKETING THAT GETS IGNORED

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR

20 Not what you want? Then check out these tips on how to fix your mistakes.

THE OWNER'S BOX

CHANGING IN TIME

BY GREG SANDS | CONTRIBUTOR

24 It's time to be prepared and not repeat the past.

SHOP PROFILE

TALK OF THE TOWN

BY ROBERT BRAVENDER | CONTRIBUTOR

28 High-end vehicles, top-notch service.

read it on

MotorAge.com

NEW MOVING TARGETS TOOL REACHES CUSTOMERS DIRECTLY

Loyal Rewards Do-It-For-Me Email Service now offers monthly newsletters.

[KEY: **movingtargets**]

RAISING GOLDEN EGGS

We get so busy working in our businesses, we don't take time to prioritize activities and make sure we get done the things that will provide the best long-term results.

[KEY: **goldeneggs**]

SALES SLOW? ADVERTISE FAST

You would be better off spending more on advertising during the slower months and here's why, one blogger writes.

[KEY: **advertisefast**]

TRENDING



ATE STORMS ASA-WASHINGTON

BY PETE MEIER | TECHNICAL EDITOR

6 A record crowd took advantage of training from 25 notable instructors from around the country at this event.

AAIA, ASE RECOGNIZE WORLD CLASS TECHS

6 Of the more than 775,000 automotive technicians working in the U.S., 30 individuals have qualified for the prestigious 2013 World Class Technician Award.

MITCHELL 1 UPDATES MARKETING OFFERING

8 Mitchell 1 has enhanced its SocialCRM™ marketing services by optimizing the product for mobile devices.

ASA HIRES INDUSTRY VET

8 ASA has hired Dan Risley to be its new executive vice president.

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REGISTRATION BROCHURE AVAILABLE FOR GAAS 2013

GAAS this year spotlights six general sessions, four panels and four breakout sessions.

[KEY: **gaasbrochure**]

ESI ADDS TRAINING

Hour-long meetings include a presentation on a customer service skill to improve customers' experience.

[KEY: **esitraining**]

ASA RENAMES AFFILIATES

ASA has changed the names of ASA-Washington, Missouri/Kansas.

[KEY: **asaaffiliates**]

PRODUCTS

ANTIFREEZE/COOLANT

81 Prestone's new Command Heavy-Duty Extended Life Antifreeze/Coolant features extended life technology that revolutionizes the world of engine protection, the company states.

81 LED Miniatures



Wiper blades



82

APG

83

Leak detection



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Tenneco plans to take the popular Monroe Ride & Drive seminar to key industry schools.

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MIGHTY LAUNCHES TPMS VIDEO QUIZ

Mighty Auto Parts has released a new and unique video, The Pressure Zone, dealing with the technical basics of TPMS.

»» MOTORAGE.COM/TPMSQUIZ

GROUP RELEASES TOWEL STUDY

A scientific study released by ARCADIS found no evidence that laundered reusable shop towels pose any health risk to workers.

»» MOTORAGE.COM/TOWELSTUDY

PEP BOYS LAUNCHES NEW RETAIL EXPERIENCE

The redesign reflects Pep Boys' efforts to make auto repair more accessible and engaging.

»» AFTERMARKETBUSINESS.COM/PEP

MERGERS, ACQUISITIONS CHANGING THE LANDSCAPE

These transactions have played an increasingly important role in the transformation of the industry.

»» AFTERMARKETBUSINESS.COM/MANDA

DON'T SHORTCUT WORKPLACE SAFETY

With new safety components, technicians run into more potential electrical faults that need their attention.

»» ABRN.COM/WORKPLACESAFETY

IMPROVING EMPLOYEE BENEFITS AND MORALE

Different management styles or philosophies affect the people who work for a supervisor.

»» ABRN.COM/MORALE

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Dr. Mark Quarto shows ATE attendees how to incorporate hybrid service into their shops.

INDUSTRY EVENTS

ATE storms ASA-Wash.

A record crowd took advantage of training from 25 notable instructors from around the country at the Automotive Training Expo in early March.

Technicians, shop owners and educators attended the three-day event in SeaTac, Wash., hosted by ASA-Washington (now ASA-Northwest). Sessions covered technical skills and troubleshooting, shop management and educational best practices. According to Jeff Lovell, ASA Northwest executive director, nearly 600 men and women received some form of specialized instruction at this year's event.

Scott Shotton of The Drivability Guys hosted a packed classroom of techs eager to learn scan tool data analysis techniques during the first morning, and Albin Moore filled the same room that afternoon, showing ATE attendees how to do drivability diagnostics "From The Driver's Seat." Every classroom we visited was filled to capacity with some offering standing room only. Attendees received additional motivation and training from two noteworthy keynote speakers: Bill Haas and Steve Beck.

Manufacturers and service providers filled a trade show for attendees, answering questions on their offerings and services. The ATE is now the largest event of its kind on the west coast. It is expected to grow in coming years with the ASA affiliate's expansion allowing it to directly serve shops and technicians in Oregon and Idaho as ASA-Northwest.

— Pete Meier, technical editor

BREAKING NEWS INDUSTRY HONORS

AAIA, ASE RECOGNIZE WORLD CLASS TECHNICIANS

Of the more than 775,000 automotive technicians working in the United States, 30 outstanding individuals have qualified for the prestigious 2013 World Class Technician Award.

The Automotive Aftermarket Industry Association (AAIA) and the National Institute for Automotive Service Excellence (ASE) work together to recognize these professional technicians who have tested and obtained ASE certification in 22 specialty areas during the 2012 test administered by ASE.

The 2013 World Class Technicians are George A. Admire, Fort Worth, Texas; Laneard J. Aldrich, Mesquite, Texas; Shelby J. Arabie, Angola, La.; Jamie B. Blair, Grapevine, Texas;

[Technicians] CONTINUES/PAGE 8

Discussion is on-going in MotorAge.com forums

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“Passing 22 ASE tests is a monumental achievement requiring exceptional knowledge and skills.”

— Kathleen Schmatz, AAIA CEO

A. Parlett, Grapevine, Texas; Kenneth P. Peterson, Grapevine, Texas; Darren J. Rapp, White City, Kan.; Steve J. Salvaggio, El Cajon, Calif.; George P. Schgier, Mount Laurel, N.J.; William G. Seider, Grand Prairie, Texas; Robert L. Stringari, Henderson, Nev.; Peter J. Taskovic, Chicago; and Rudi H. Trickel, Philadelphia.

“Passing 22 ASE tests is a monumental achievement requiring exceptional knowledge and skills,” says Kathleen Schmatz, AAIA president and CEO.

“This recognition partnership between AAIA and ASE represents one of the most significant achievement awards available to our ASE-certified professionals,” adds Tim Zilke, ASE president and CEO.

Since the World Class Technician recognition was established 27 years ago, only 1,863 technicians have been honored. Recipients receive a special certificate signed by the presidents of ASE and AAIA, a logo medallion and embroidered shoulder insignia. Additionally, their name is inscribed in an honor book located in the Automotive Hall of Fame, which is in Dearborn, Mich.

MITCHELL 1 ENHANCES SOCIALCRM WITH MOBILE OPTIMIZATION

Mitchell 1 announces it has enhanced its SocialCRM™ marketing services by optimizing the product for mobile devices. This mobile optimization improves the effectiveness of the service reminder emails, thank-you emails, appointment requests and customer reviews when viewed on mobile devices.

According to Brian Warfield, product manager for Mitchell 1, SocialCRM detects the mobile device being used and reconfigures the emails for friendly viewing.

“With mobile device use being one of the fastest-growing trends, more emails are now read on mobile phones than on desktop computers. And when designed effectively, mobile messages get an even higher response from consumers than do traditional e-mail messages,” Warfield says. “Our decision to add mobile optimization to the SocialCRM service illustrates our commitment to maximizing the effectiveness of our SocialCRM marketing services for our customers. By keeping up with the latest technical trends and innovations, we not only help our shop

customers communicate more effectively and professionally, but also raise the shop’s brand equity in the eyes of the consumer.”

Warfield adds, “With the new mobile optimization feature, as well as all of the other features of SocialCRM, Mitchell 1 has made it even easier for shops to reach their entire customer database with a unique marketing message, while attracting new customers through authentic customer reviews and increased Internet visibility.”

Key features of the SocialCRM service include:

- Service reminder emails (including mobile version)
- Appointment request scheduling links (including mobile version)
- Customer reviews and reputation management (including mobile version)
- Search-engine-friendly review content and review links
- Facebook page creation and content management
- Unlimited targeted email campaigns
- Giveaways to encourage social sharing of positive reviews
- Dedicated marketing support consultant.

SocialCRM integrates seamlessly with Mitchell 1’s ManagerSE and many other shop management systems to provide a comprehensive digital marketing solution based on customer-specific vehicle history, the company states. For more information about Mitchell 1’s SocialCRM program, visit www.mitchell1.com or call 800-410-0529.

ASA hires industry vet as executive VP

The Automotive Service Association (ASA) has hired industry veteran Dan Risley to be the organization’s new executive vice president. He will work closely with Ron Pyle, ASA president, and the national staff based in Texas, while maintaining an office in Chicago.

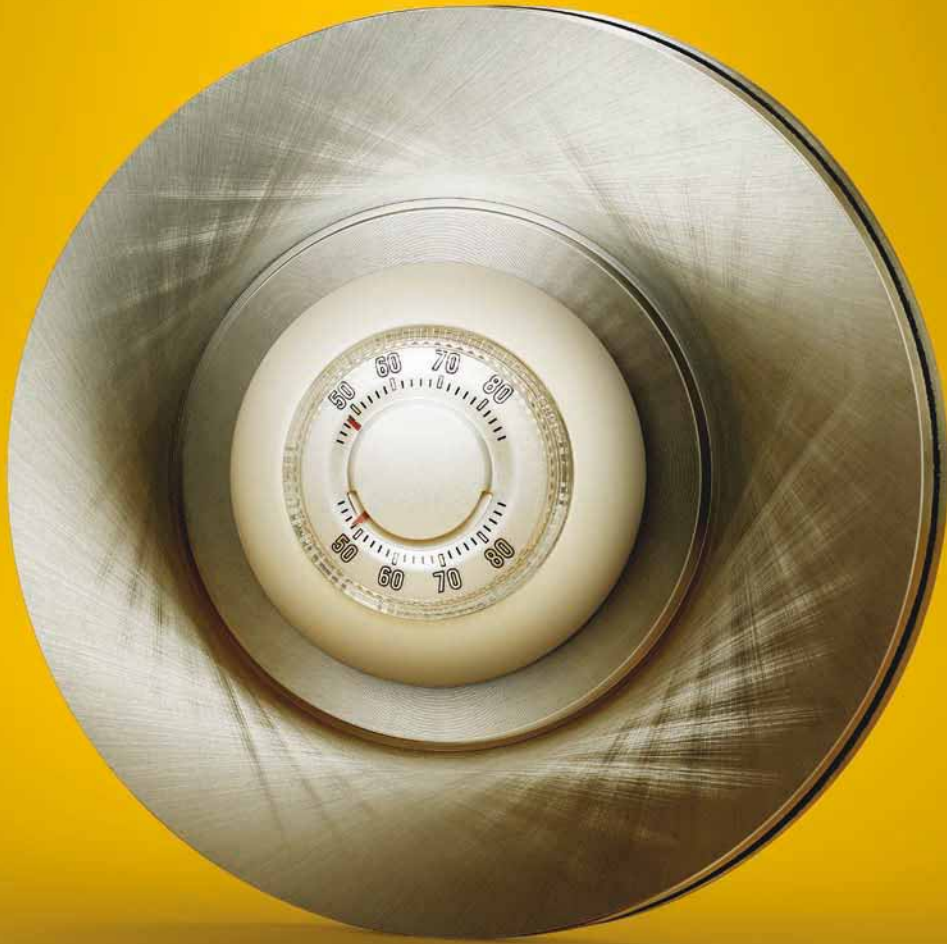
“We are excited that Dan has accepted our offer to join the ASA fam-

ily,” Pyle says. “We’ve collaborated on many projects over the past decade and I’ve always respected his professionalism and quest to do the right thing.”

Risley, who has served the industry in many roles throughout his career, comes to ASA from Allstate Insurance Co., where he was a market claims manager. Before that, he was executive director of the Society of Collision Repair Specialists.

“I’m thankful for the opportunity to represent ASA and its membership.

Ron, the board and I will be aggressively pursuing resolutions to the most pressing issues adversely impacting our mechanical and collision repair members,” Risley says. “Bringing closure to long-standing issues such as arbitrarily reducing the refinish time on repaired panels is just one of several key areas the association will address in 2013. From parts quality issues to legislative activities at the grassroots level, I’m eager to serve on behalf of all ASA members.”



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ASE GUIDES

QUESTION OF THE MONTH



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☑ **SURVEY:** Tech A is diagnosing a no compressor clutch engagement complaint. He located the fuse that powers the A/C compressor clutch coil. It powers the relay that completes the circuit path to the compressor clutch coil. Using a low amp current probe and a fused jumper wire, he turns the A/C system on with the engine running and measures the current flow. A reading of 0.34 amps tells him the:

- A. circuit path for the clutch coil is intact
- B. circuit path for the relay control is intact
- C. circuit path for the clutch coil is open
- D. circuit path for the relay control is open

Visit MotorAge.com/april13survey to answer and register for the monthly prize drawing from Federated Auto Parts.



Vehicle inspections — measuring the results

There are many reasons to do inspections, and lists can help you no matter the why.

BY SOSBORN | WORKSHOP MEMBER

For as long as I can remember, the better shops have been doing vehicle inspections when cars are dropped off for service, when a customer asks us to do a pre-purchase inspection or a new customer shows up and we want to get a feel for how well they maintained their car.

It's become a standard in most shops that we do them. Some shops call them "Laundry Lists," which would indicate it is only being done for the shop's benefit, while others appreciate the value to a customer of knowing the true condition of their

car. I choose to be the guy that places a high value on the inspection as a way to prevent breakdowns and extend the life of my customers' cars based on preventative maintenance and their input on how long they plan on keeping it. ...

How do we make this more common? Well, we start by using lists; lists that are well thought out, easily presented and professional in appearance. The list must be laid out in a consistent fashion using categories and tasks. If you break an inspection down to the process and analyze it, it all starts with a category. I use categories such as underhood, fluids, under-

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BEST OF THE BLOGS

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 BEST OF THE BLOGS are articles written by bloggers on Motor Age's community pages

Funny shop stuff

Junius/Alabama

Robert was an auto body technician I worked with who was looking for a water leak in an older vehicle that was always gathering water in the trunk after it rained. He climbed into the trunk with his MAG light and watched while Joe, a fellow body man, hosed down the trunk from the outside. Right after the hosing began, Joe was called to the phone. When his 10-minute conversation finally ended, Joe forgot about Robert and went to lunch, leaving out-of-sight and out-of-mind Robert locked in the trunk in an empty body shop with nobody to let him out. It was a lonely hour.

On another occasion a guy, whose name I don't remember, was working under the hood of a minivan in the corner of the shop with the engine running. He burned himself on the droplight, jerked his elbow back,

knocked the prop rod out from under the hood, which fell on him and trapped him. He was yelling and wiggling his legs, and it looked like the van was trying to eat him. When we found out he wasn't hurt, nobody could stop laughing.

Perils of call tracking

CSheehy/Rhode Island

Have you been tempted to use one of those marketing services that reports on how many calls your business receives from your search or social listings?

I see their ads touting their local marketing services everywhere (heck – even I get them!), so surely they must be onto something – RIGHT?

There is so much to think about when it comes to internet marketing – being able to quantify where your leads comes from

seems a no-brainer. Oh, if only if it were that easy.

I mean, businesses tell me all the time how difficult it is for them to know what marketing tactics works and which ones don't, what tools or services would be good for them and what's going to hurt them. So when a client was asking me about these services recently, I went directly to the source and sent them the following excerpt from Google to answer their question.

Q: What if I include multiple phone types?

A: You should only provide the phone number for the location of the actual local business. Types of phone numbers that should not be included are: call tracking numbers and phone numbers that are not specific to a business location (source).

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PAGE

6

COMPLETE ATE WRAPUP

WHAT YOU MISSED

We look at what happened at ATE.

PAGE

14

Q+A WITH RICH WHITE

CAR CARE COUNCIL

Get updated on Car Care Month.

PAGE

88

THE TRAINER VIDEO

PETE MEIER

Testing battery faults

car, brakes and safety. Under each category, I assign tasks. For instance, in the underhood category, we have tasks such as belts, hoses, air filters, cooling system and so on. Each task then has findings, and tasks can easi-

ly have multiple findings. If you're just getting started in designing your own inspection list, I'd suggest looking at a few from other shops. You can take a look at one I developed at www.osborn-auto.com/35pt.pdf. **TL**

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MotorAge.com/knucklesaver

3 troubleshooting tips

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MotorAge.com/keyoffdrains

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Produced in cooperation with TST.

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Pros and Cons of Rebuilding Continuously Variable Transmissions

Produced in cooperation with ATSG.

AUGUST 2013

Cooling System Service & Testing

Produced in cooperation with TST.

NOVEMBER 2013

Electrical Testing Techniques

Produced in cooperation with TST.



STREAMING PROGRAMS

Drive Radio: Pet peeves

Host John Rush and co-hosts Ken Rackley from Tune Tech and Steve Horvath from Jen's discuss driving pet peeves, winter driving and waterless coolant.

Disc brake service tips

Our first technical webinar of 2013, sponsored by Wagner ThermoQuiet Brakes, focused on tips to help you reduce or eliminate comebacks related to noise, feel and pulsation complaints after you've performed a disc brake service.

Removing Ford 3-valve spark plugs

Jay Buckley, technical trainer with Autolite, goes through the recommended method for removing spark plugs from the Ford 4.6 and 5.3 3-valve Triton engines.

APRIL 19-20

Automotive Service Association (ASA) annual meeting

The meeting is open to the membership and includes a meeting of the board of directors.

MAY 1-3

AAIA Spring Leadership Days

Leaders converge on the Hyatt Regency, Bonita Springs, Fla., for the annual meeting.

MAY 21-22

GAAS 2013

GAAS and the Aftermarket eForum co-locate this May in Chicago.

MAY 25-29

Autopromotec 2013

This biannual event is in Bologna, Italy.



2013 INDUSTRY CALENDAR



Noteworthy

comments from MotorAge's online communities

Each month, we scan the Workshop, the *Motor Age* Facebook page and our Twitter feeds to see what you're saying. Comment today to be heard.

Bobthebodyman:

If only everyone would take their car to a mechanic for service, they would be better off in the long run. The oil change shop is not the mechanic shop. I long for the days when you got gas at the same place that fixed your car.

vazzanatomiothy:

You know it's unfortunate and ridiculous that there's counterfeit refrigerant being mixed with our other refrigerants, and who ever's manufacturing it should be prosecuted to full extent

of the law. I mean come on already, service technicians have already been seriously injured and even killed. Enough's, enough already.

rlikis:

Service advisors in shops across America meet face-to-face with car owners every day. To prepare for questions, we need the facts about ethanol and its benefits. We must toss out MYTHS!

Douglas Reed via Facebook:

Your ground is not "OK" or good until you've load tested it with more than a

light bulb. Chevy Colorados come to mind with their cheesy splice pack.

Cliff Shenkel via Facebook:

Oh, how I wish I knew the power of a low and high amp current probe 20 years ago!

mighty pawns:

I've done about a bazillion of these and have tried all sorts of ways. I now use a high speed air impact to remove the plugs. Most of the time I get all eight out without breaking them. Sometimes I break one to two plugs.



the community—
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Q+A WITH RICH WHITE

EXECUTIVE DIRECTOR,
THE CAR CARE COUNCIL

IN THE MIDST OF NATIONAL CAR CARE MONTH, THE CAR CARE COUNCIL MAKES IT EASY TO PROMOTE SERVICE.

BY PETE MEIER | TECHNICAL EDITOR



April is National Car Care Month, and the Car Care Council has many resources available online for your shop to help consumers this month, and every month.

Rich White, executive director of the Car Care Council, says the group understands that today's shop owners and technicians have a lot on their plates to service vehicles quickly and accurately. The Council's new Industry Tool Box is just one way it hopes it can help spread the word of preventive maintenance.

MA: What is the Car Care Council and what is its mission?

RW: It's a simple mission. The Car Care Council is a 501(c)(3) nonprofit organization. It has a very simple mission, and that is to educate consumers about the benefits of regular vehicle, maintenance and repair. It is purely an educational outreach program, affiliated with no company. It is funded by the Automotive Aftermarket Industry Association, but it is a separate entity.

MA: How do you describe NCCM?

RW: April is National Car Care Month, time for the industry to celebrate all of the contributions it makes to vehicle safety, efficiency, fuel economy and the environment. Of course, we feel every month is

Car Care Month, so every week is Car Care Week. But this is one of the months we have heightened publicity, outreach and hopefully heightened awareness of taking better care of your vehicle.

MA: There is quite a lot of info on the website. Tell us what is available.

RW: That's the mother ship of the campaign is the website. Everything we do is to drive people to the website to establish service schedules for their vehicle (and) just learn all that they care to learn about vehicles. It's a one-stop shop. It has two purposes. One is to provide information for consumers. And there also is a brand new area on the website called the Industry Tool Box. That is designed to help WDs, jobbers and repair shops, store owners and technicians learn how they can get involved in the campaign as well as the Car Care Month in April and October.

MA: This sounds like a great way to bring in new customers.

RW: (People) do not like mandatory vehicle safety inspections, however, they just love these free car care events that have a vehicle check-up component to them. It's something that a shop can do by itself by inviting folks to the shop and doing a check-up in the bay, or they can do a



whole partnership with other groups in the community. Just imagine inviting the car owners in a community to come by from 10 to 4 or 10 to 2, whatever it may be, and they come in and you have the technicians there and some auto shop students from the community college.

It's a non-selling event, the customer comes in with their vehicle, we have special inspection forms that they use so we can capture the data of the vehicle, and (technicians) give the vehicle a thorough checkup and talk to the customer one-on-one about what they have found and what they might want to do. They're not selling their services, they're just giving them a free diagnosis. It's like if you had a chance to talk to an attorney or doctor for 15 minutes free of charge. And where are you going to go if you need service? You're going to go to the person who was so nice to you at the checkup event. **TZ**

Photo: Car Care Council

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OPERATIONS

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IN THIS SECTION

- 16 Management
- 20 Profit Matters
- 24 The Owner's Box
- 28 Shop Profile



THE TAKE AWAY

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MANAGEMENT



HONEST RATINGS



Excellent
Very good
Good
Average
Poor

EVALUATIONS HAVE A POWERFUL EFFECT ON TODAY'S SHOP PERFORMANCE.

BY BRIAN CANNING | CONTRIBUTOR

AS SHOP owners and service managers, we love to compete and are willing to take on the world in our efforts to attract and service customers. But we seem to lose that aggressive attitude when it comes to our own people, particularly when it comes to performance reviews and evaluations.

I am strongly of the opinion that excellence — just like mediocrity — is a choice. In our hiring, our standards and our shop process, we have the opportunity to be extraordinary or to be something else. If we truly want to be among the very best shops in our market, then we not only have to talk about it, but we also have to hire the right people, set standards for service and performance and be willing to lead our people in directions that will set us and our shop above the competition.

People are funny, and while they can upset us and leave us high and dry, they also can surprise us in very good ways and exceed our expectations if we let them. If we are asking them for nothing, nothing is generally what we will get. But if we ask them for something better and support them in the effort, they are likely to give us all we would of them, maybe more.

The Right Approach

Rather than approaching those biannual or annual reviews in the same way we approach a colonoscopy or those dental appointments we have every five or six years whether we

need them or not, I suggest going into them aware of where we are, aware of where we want to be and prepared to talk about what it is going to take for us, both as individuals and as a team, to get to where we need to be.

If we truly have a process in place (those who do are in a distinct minority) and our people have clearly defined roles and responsibilities, then these annual or biannual reviews are truly nothing more than a recap (good or bad) of what our staff members have done since their last evaluation. If they have done well (met or exceeded our expectations), tell them so and in the most descriptive, specific terms we can come up with. If in your last meeting, you took the opportunity to define success for them, and if they were in fact successful, this review and evaluation needs to be nothing short of a celebration. If in that last meeting you laid out clearly defined goals and expectations and they were not met, we have the opportunity to redirect the efforts of our staff member and understand what is holding him or her back.

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This is not a time to waiver or back off on reasonable expectations, but it is a time to show our support for someone who is struggling to do the things that need to be done. With a strong process in place with clearly defined expectations built into it, we have the opportunity to measure and manage the performance of our staff members. More importantly, our staff members understand each and every day what is expected of them and how they need to be spelling success. Everyone is aware and there are no surprises when it comes time for that evaluation. And never forget, honesty is by far the best policy.

Making up Ground

If, on the other hand, our process up to now has been haphazard and poorly defined and we are unclear as to how successful our staff members have been, we have done them and ourselves a disservice. We need to take immediate steps to define our expectations and success so that our staff members have some chance toward achieving what we want and the opportunity to move the shop in better directions.

Remember, if we are not asking our people for something better as we sit down with them, they are not going to give it to us. However, if we make each one of these evaluations an honest and open discussion of where we are and where we need to be, we might find ourselves inching toward something better and approaching those goals we had set for our self and our shop those many years ago.

We are not going to get there without our people, I can promise you that, but with just a little effort toward defining our expectations and developing a process that we and our staff members can believe in, we just might find that success we have been looking for. This whole process is nothing more or less than us defining where we want to go, sharing it with our people, managing the process and leading our people in the right direction.

Susan M. Heathfield of the Society for Human Resource Management says, "An effective performance management system sets new employees up to succeed, so they can help your organization succeed. An effective performance management system provides enough guidance so people understand

what is expected of them. It provides enough flexibility and wiggle room so that individual creativity and strengths are nurtured. It provides enough control so that people understand what the organization is trying to accomplish."

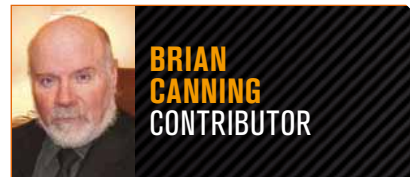
Remember, We're All Human

Nobody, and I mean nobody, likes performance evaluations. That is because over the years, businesses have made them more confrontational than objective and more a means of thwarting pay increases or promotions than the review of an individual's performance that they could and should be.

Another reason they are hated universally is because the process behind them tended to be fractured and prone to bias. If my objective, as laid out in my performance plan, is to sell 100 widgets in a year and though I sell 130 widgets, my annual review says I was somehow less than successful or highlights that I was late three times and dismisses those widget sales, how am I supposed to spell success? More importantly, why would I put myself out and try harder if I am only going to get shot down anyway. We have the opportunity to define success and our responsibility is to praise it and reward it. If you define success and your staff members are accomplishing the things you ask of them then they are successful and our shop should be as well.

That is unless we are not asking for enough. It is up to us to define success. When we sit down to evaluate our people and to set goals for the coming year, we should do something different and ask them for something better. They might surprise us.

What reality is coming out of your biannual and annual evaluations? The truth might just set us free. **ZZ**



**BRIAN
CANNING**
CONTRIBUTOR

Brian Canning is 30-year veteran of the automotive repair industry. He has been a leadership coach, Goodyear service manager, retail sales manager for a distributor, run a large fleet operation and headed a large multi-state sales territory for an independent manufacturer of automotive parts.

Email Brian at brimarc@hotmail.com

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CREATE MARKETING THAT GETS IGNORED

WAIT. THAT'S NOT YOUR GOAL? THAT'S A GOOD START. NEXT IS TO CHECK OUT THESE TIPS ON HOW TO FIX MISTAKES YOU'VE BEEN MAKING.

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR

I WAS listening to a great story being told to one of our clients by Coach Eric Twiggs, and I thought you would enjoy it. Twiggs said marketing is not the real key to your success.

Now that I have your attention, let me clarify the point. I am reminded of the story of a young man who had an encounter with an older rich man wearing an expensive suit. The young man asked him how he made his money. "Marketing was the key to my success," replied the older man. "I invested a nickel in an apple. I spent the entire day polishing the apple and at the end of the day, I sold the apple for 10 cents.

"The next morning, I invested those 10 cents in two apples. I spent the entire day polishing them and sold

them at 5 o'clock for 20 cents. I continued this system for a month and accumulated a fortune of \$9.80. Then my wife's cousin died and left us 2 million dollars!"

Marketing alone does not guarantee your success.

Remarkable marketing is the real key to getting more cars to your shop. Competition for your customers' attention is at an all-time high. According to a 2010 study conducted by Hotmail, the average customer gets four marketing-related emails per day from various businesses. A recent *New York Times* study revealed that the average person is exposed to 3,000 marketing messages a day when you factor in TV, radio, email, newspaper, the Internet and visits to the local store.

Your customer wants to know what makes you different. If the ad you create fails to answer this question, it will get lost in the clutter and will be ignored. So, how do you create marketing that triggers an emotional response?


Create Compelling Headlines

According to a Copyblogger study, 80 percent of customers will read your headline, but only 20 percent will read the rest of your content. Based on the headline they read, they decide whether to continue reading. If your headline fails to make an impact, your marketing will get lost in the clutter I mentioned earlier. There are three ways to make your headline compelling.

First, you need to keep it short, a statement of seven to 10 words at the most. Shorter headlines are easier to read and to remember. Another effective technique is to create curiosity through shock value. The headline of this article is an example. The typical reaction to this type of headline is, "Where is he going with this?" The curiosity created from the surprise will motivate the customer to keep reading.

A second example of a shock value headline is one that I saw from a shop



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“WHAT WAS THE BIGGEST DIFFERENCE IN SHOPS THAT HAD GOOD CAR COUNT IN 2012 VS. THOSE THAT DID NOT? THOSE THAT DID BECAME VERY AGGRESSIVE IN ACQUISITION AND RETENTION MARKETING IN 2012.”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

advertising an A/C service promotion. The shop owner used the following statement: “Your Wife Is Hot.” As you read on, you realized the point of the ad was to get you to come in and get your air conditioning serviced so that your wife doesn’t have to ride in a hot car.

Last, the promise of a future benefit will get the rest of your content read. In addition to wanting to know what makes you different, your customer wants to know what’s in it for them. Your headline should communicate how their lives will be better as a result of reading your copy. For example, many of the email newsletters I see from shops have a headline that reads “April Monthly Newsletter.” If your goal is to be ignored, then this is a good way to do it. A better statement would be, “How to Keep Your Old Car Running Longer.”

Make a Valuable Offer

As humans, we feel a natural obligation to reward a positive action with another positive action. The technical term for this is the law of reciprocity. Studies show that reciprocity is a powerful marketing trigger.

For example, researchers in the restaurant industry discovered a major difference in the tips received by waiters who left a mint on the tray when bringing the check compared to those who did not. The waiters who left a mint received up to 20 percent more in additional tip dollars. This is why a marketing piece that demonstrates added value will get more attention than one



that does not. Below are two ways to communicate value in your offers.

First, make sure you use dollars and not a percentage to communicate savings in your ad. It is easier for the customer to feel a \$25 savings than 10 percent off. You take dollars to the bank and not percentages. Using dollars also makes it easier to control your marketing costs. A 10 percent off promotion on an engine sale will cost you more than a \$25 off any purchase over \$200 offer will.

Second, be sure to communicate both the regular and the sale price. Your customer will feel more value if they know how much they are saving. If you advertise a winterization special for \$89.99, I might not understand the value of the offer. If you tell me that the regular price is \$129.99 and the sale price is \$89.99, the value is clear. Marketing that communicates a clear and valuable offer is less likely to get ignored.

Use Effective Testimonials


According to Nielson research, 92 percent of customers report they trust recommendations from other customers more than any other form of advertising. In this section, I will share my two keys to effective testimonials.

First, the testimonials must look authentic. One way to accomplish this is to include a picture of the customer giving the testimonial along with the testimonial itself. It helps to do marketing research to determine who your ideal customer is before posting the pictures.

For example, if your research indicates that your ideal customer is a woman between the ages of 35 and 40, it would be good to have a picture of a happy customer from this demographic. Doing this will attract more of your ideal customers to you. If you are advertising on the Internet, video testimonials are very effective as well.

The second key is to have the testimonial communicate the results your customers care most about. Based on ATI research, the typical automotive customer is looking for fast service, accurate diagnosis and honest estimates. It will be harder for a customer to ignore marketing that features a testimonial from someone who looks like them and demonstrates the results they are looking for in a shop.

By having a compelling headline, valuable offer and effective testimonials, your marketing will get noticed in spite of all the competition. If you apply these three keys to your next ad, your marketing will not get lost in the clutter.

Are you doing everything you can to get more cars to your shop? Find out by completing the ATI Car Count Checklist. We have created a checklist with 34 acquisition and retention strategies you should consider to stabilize your car count. Visit ationlinetraining.com/2013-4 to print our list. 



CHRIS “CHUBBY” FREDERICK
CONTRIBUTOR

Chris “Chubby” Frederick is CEO and founder of Automotive Training Institute, founded in 1974. ATI’s 99 associates train more than 1,150 shops every week across North America to drive profits and dreams home. This article was written with the help of Coach Eric Twiggs.

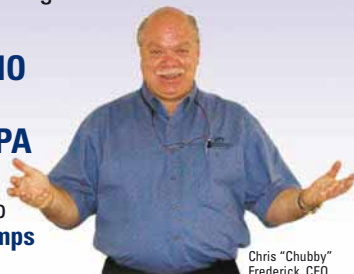
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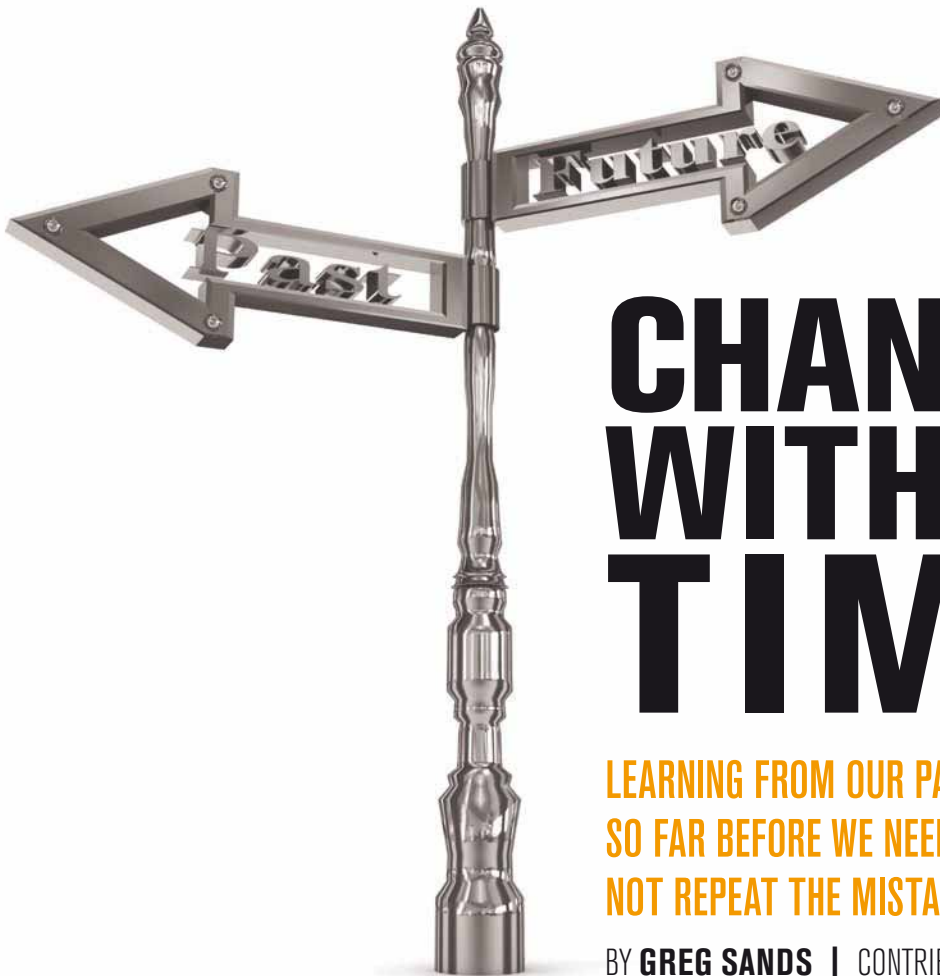
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CHANGING WITH THE TIMES

LEARNING FROM OUR PAST ONLY TAKES US SO FAR BEFORE WE NEED TO BE PREPARED TO NOT REPEAT THE MISTAKES WE HAVE MADE.

BY GREG SANDS | CONTRIBUTOR

SOMETIMES to get a glimpse of our future, we have to look to our past. That might sound as cliché as, “Those who do not learn from history are destined to repeat it,” but both sayings are more relevant today than they were when they first were uttered decades ago.

I recently was asked, “What is the biggest obstacle shop owners face?” I didn’t have to go very far to find the answer. Just look at the sectors that traditionally were filled with mom-and-pop-owned businesses to see where our industry is heading. Like it or not, the chain location shops are coming, and if we as independent shops don’t change, we could face the same fate.

Times They are A-Changin’

Depending on how old you are, you might remember the days when you

couldn’t go to a grocery, a drugstore or even grab a meal at some restaurants on Sundays. Today, supermarkets are open seven days a week, some 24 hours a day. The same goes for drugstores.

Many of the smaller grocery stores and drugstores went out of business because they simply didn’t change with the times. Independent repair shops face a similar and very real danger. Not only are many shops closed on Saturdays, almost all are closed on Sunday. This has to change in order for these shops to become more competitive.

A New Vision

Many independent shop owners belong to a training group, which consists of 20 shop owners that meet every quarter and exchange ideas to help one another improve. Training groups started about 50 years ago and have made a great impact in our industry. Unfortunately,

their thinking hasn’t changed much.

For example, members of many of these groups continue to keep hours short during the week and close on weekends because they believe it keeps costs down. In contrast, my shops are open on Saturdays, and many are now open on Sundays as well. The business I do on Sundays alone makes up for any extra costs I incur. Chances are, your shop will experience similar business. This extra business would more than pay for an extra manager.



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You also have to be prepared to spend more money than you might be used to to reach potential customers and to keep your current ones. The chain shops are hitting your customers from all angles. If you are a shop that doesn't believe in advertising, you're going to lose market share. If your shop relies mostly on word of mouth, realize that once you lose a customer to a chain shop, you also lose that word of mouth.

Kill Them With Kindness

The reality is chain shops are attracting more customers because they are more convenient and provide lower prices in general than individually owned shops. I realize that, for the most part, individually owned shops can't beat chain stores on cost. However, cost isn't the only thing that attracts customers, and that's where the small shop owner can succeed.

You have to ask yourself, "Why should someone come to me rather than the chain shop?" You have to be as convenient as the chain shops. That means providing better benefits,

such as longer warranties, a customer shuttle or loaner cars and an easy-to-navigate website. You can overcome having slightly higher prices than your competition if you're convenient and your benefits are better.

Changes don't have to happen overnight. Instead of closing at 5 p.m., close at 7 p.m. or 8 p.m., or try staying open for half a day on Saturday. As you expand hours, you'll start to see business increase.

The other thing our industry needs to change is our use of technology. Update your point-of-sale (POS) systems to move customers through easier and track them better. Develop a better website, make use of Twitter and Facebook to reach potential customers and keep current ones. We have to do a better job of communicating to our customers through technology.

Unless you have a monopoly in your immediate area, chances are you already are battling or soon will be competing with a large chain shop. However, it's more than possible to survive. If you're not part of a 20 Group,

consider joining one or a similar organization that matches your ideas and is aggressive in helping motivate members to reach their goals.

We have the ability and technology to change and survive, but independent shops need to wake up before we go the way of the mom-and-pop drugstore. Read your customers. They will tell you what benefits they want and if you need to expand your hours.

If you would like a list of resources to help overcome obstacles your shop faces, email me at greg@mudlickmail.com. 



GREG SANDS
CONTRIBUTOR

Greg Sands started in 1993 as manager of a repair chain in Houston, later becoming minority owner. In 2001, he launched SRSANDCO LLC, and now owns and operates 29 auto repair shops in four states, and is founder and CEO of Mudlick Mail.

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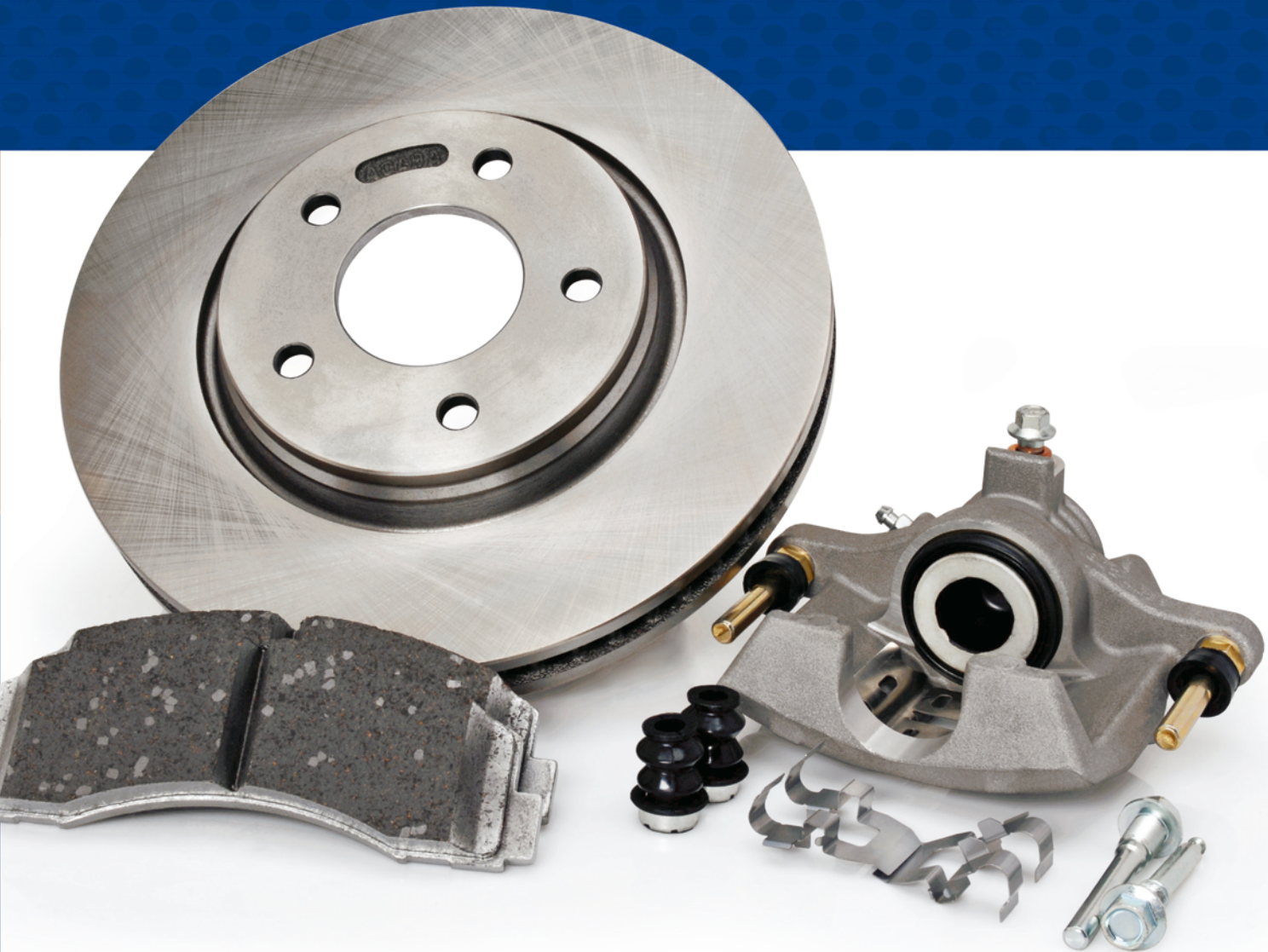


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OPERATIONS

SHOP PROFILE

A snapshot of one of the industry's leading shops

PRECISION IMPORTS / MANCHESTER, N.H.



The Talk of the Town

For high-end vehicles, this service provider is top-notch.

BY **ROBERT BRAVENDER** | CONTRIBUTOR

It often takes more than mere determination to be successful; When he was a novice mechanic at a dealership, Dick Horan noticed that senior technicians were avoiding cars with electronic ignition or fuel injection. "I made a decision to take the weakest part of the shop and make it my strongest," says the New Hampshire native of his newfound philosophy. Besides, it actually looked a little easier.

"Working flat rate next to a guy working on the little Hondas, he could take the cylinder head off and put it back on in four hours and make three or four hours time," Horan recalls. "I would take the cylinder heads off a big GM V8 and it would take me all day, and I would lose two hours. I thought, 'This is stupid; why would anybody want to do this for a living?'"

He eventually became the go-to guy for imports. Pushing himself to the front, Horan started Precision Imports on Feb. 1, 1980, now one of the leading shops in Manchester, N.H. In fact, a little more than a year after opening his doors, he was testifying as an expert witness in front of the Federal Trade Commission during an investigation into Volkswagen's valve stem seal failure problem.

As per Precision's tag line, "we do high end to Hyundai," before opening the shop Horan had been a Volkswagen and

Mazda technician for a number of years, and before that had worked on Honda, Renault, Mercedes and Volvo. Specializing in German and Asian makes, they work on everything including domestics — well, except maybe old British ones.

Having graduated from what's now Manchester Community College, Horan takes a keen interest in education. Serving on local college boards, he's also chairman of his alma mater's Automotive Steering Committee. "The bottom line is (the schools) need to be teaching basic skills; we'll take them to the next level," he says. "You can't just breeze through and get a degree and then go out and get a job, because no one is going to hire you unless you have some experience. That's more true now than it's ever been."

Manchester is the biggest city in New Hampshire at around 110,000, rated the second most tax-friendly city in the U.S. by Kiplinger, 13th out of the "100 best cit-

AT A GLANCE

Precision Imports

Shop name

Dick Horan

Owner

Manchester, N.H.

Location

1

Number of locations

34

Years in business

9

Total number of employees

5

Number of technicians

5,700 square feet

Shop size

9

Number of bays

60

Average vehicles per week

\$500

Average weekly repair ticket

\$1.5 million

Annual gross revenue

Bosch, NHADA, ASA

Shop affiliations

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ies to live and launch a business" in 2009 by CNNMoney.com. Horan notes that his

Photos: Dick Horan



There are nine bays in the shop for today's foreign and domestic vehicles.

marketing strategies have changed over the decades, but still are pretty basic (no newspapers, and a direct mail shopper). Most of his \$53,000 annual marketing budget goes to radio, a medium that recently began playing a bigger roll in Horan's own life. He is co-host of "Talking Cars With Dick & Ron" from 9 to 10 a.m. every Thursday on WFEA 1370 AM.

But as sensitive as he is to technology, Horan hasn't mastered the latest marvel: the Internet. "Not as much as I'd like," he admits. "(I've read) a lot of articles about people having success using the Internet for the marketing of new cars, services or whatever. Some of these guys are saying it kind of works, while others are saying they're putting 65 percent of their effort into the Internet, because it works better than the older (marketing strategies)."

A new website for Performance Imports is in the works. And Horan is well aware the Internet is more than a marketing tool. "Service information has become so accessible now," he says. "We can track pattern failures on these cars to the point where a car comes in that's bucking only when its cold out and only two days after putting fuel in it; you can go and look up those exact symptoms on the internet and it will go, 'Bang, this is what it is, check this first.' ... That's pretty cool." *MZ*



ROBERT BRAVENDER
CONTRIBUTOR

Robert Bravender graduated from the University of Memphis with a bachelor's degree in film and video production. He has edited magazines and produced shows for numerous channels, including "Motorhead Garage" with longtime how-to guys Sam Memmolo and Dave Bowman.

✉ Email Robert at rbravender@comcast.net

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That was too easy

DIAGNOSING SOLENOID ELECTRICAL CODES FOR FORD'S 5R55S TRANSMISSION

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

I RECENTLY diagnosed the cause to a vehicle's electrical problem in a relatively short order of time. I am not patting myself on the back as to how quickly I nailed it, but rather how easy it was to diagnose it because of the vehicle's configuration. It was so easy it was pleasant.

The vehicle was a 2007 Ford Explorer 4.0L (VIN E) with a 5R55S RWD transmission. It arrived to the shop with a customer complaint of a sudden no up shift slipping condition. Upon the initial road test, I determined that it was in a

no shift fail-safe condition. The higher gear launch in the Drive position (fourth gear only) felt like it was slipping to the owner of the vehicle. After clarifying the complaint, I retrieved the codes.

As you can see in Figures 1 and 2, it was loaded with solenoid electrical fault codes. This reminded me of GM vehicles having shift and torque converter clutch solenoid electrical codes because of a faulty ignition switch. These faulty switches would cut power to the solenoids, which the computer would pick up as an electrical fault on the controlling ground side of the circuits.

This prompted me to pull a wiring diagram to see if this Explorer might be experiencing a similar condition. As you can see in Figure 3 (page 34), when the PCM commands the Power Relay to close via an ignition signal, the relay supplies power to various circuits in addition to the transmission solenoids through 15-amp fuse number 38.

Clearly the possibility of a detective ignition switch can be ruled out, as an inoperative PCM power relay would cause several other problems in addition to these solenoid codes and there were none. But a blown fuse No. 38 becomes a likely candidate causing a loss of power to the transmission solenoids.

I have only road tested the vehicle, pulled codes and consulted a wiring diagram at this point, nothing really hard or time consuming. But here is where the actual diagnostics became easy and enjoyable due to the vehicles configuration. The fuse box (Figure 4, page 34) and PCM (Figure 5, page 34) are conveniently and readily accessible under the hood. With the ignition on, I quickly tested both legs of fuse 38 for power (Figures 6 and 7, page 34). To my surprise, I had good KOEO voltage on both sides of the fuse, so I pulled it out to inspect the condition of the fuse blades and terminals. They looked good also (Figure 8, page 34).

Honestly, at this point I would have hoisted the vehicle to take a look at the transmission case connector, but a lift

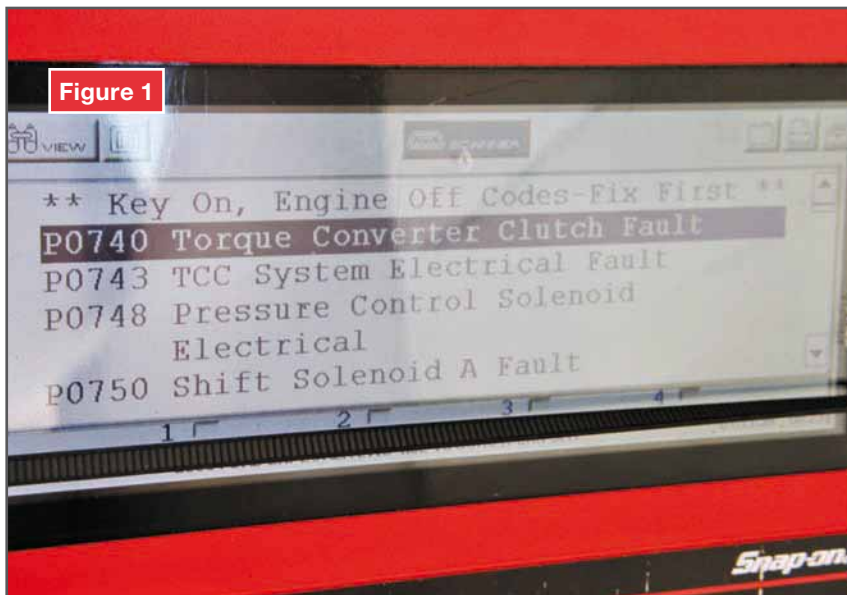


Figure 1



WAYNE COLONNA

is President of the Automatic Transmission Service Group (ATSG) in Cutler Bay, Fla., and a frequent speaker/instructor for transmission training around the globe.

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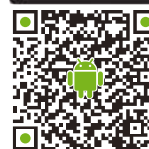


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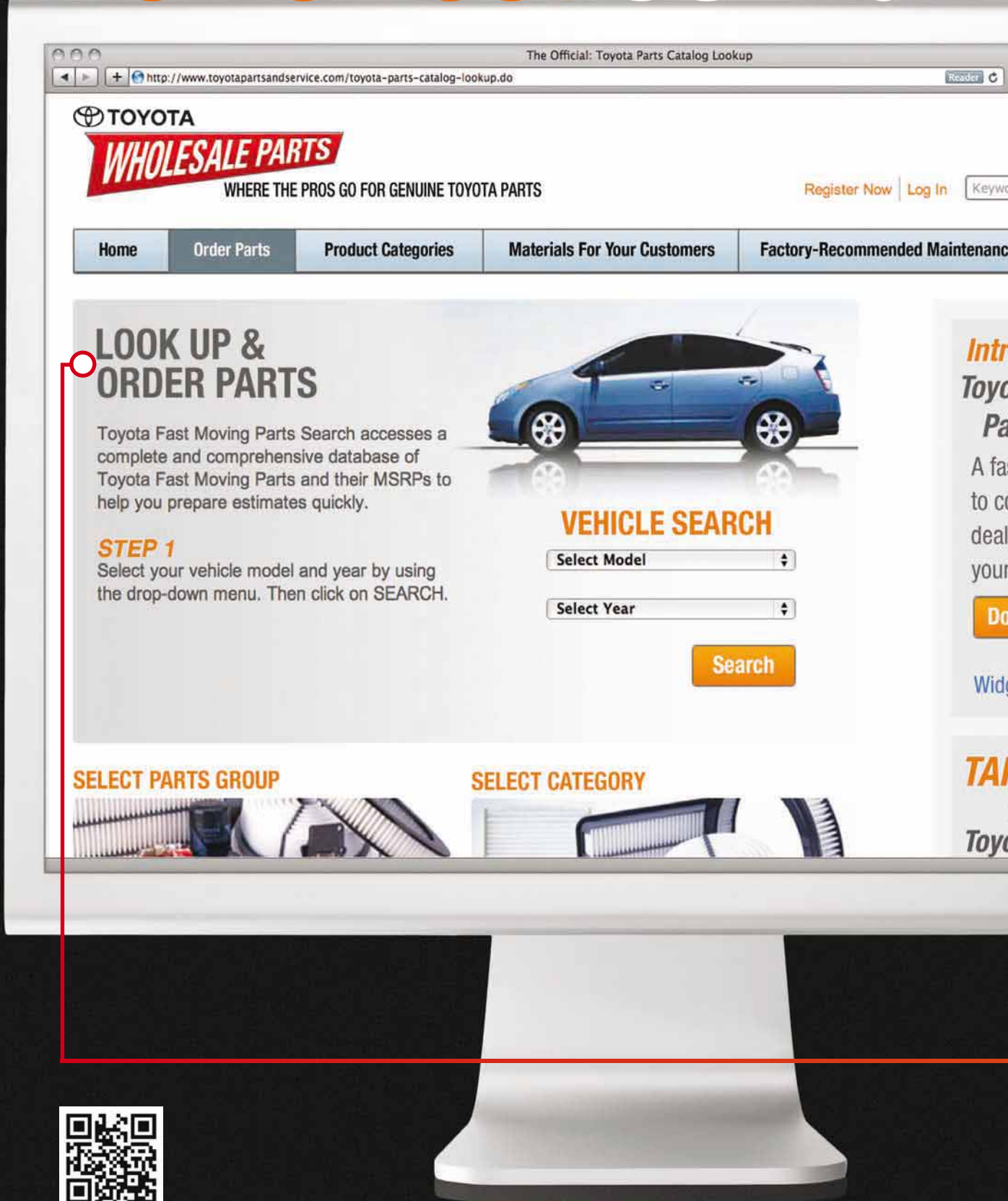


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SELECT CATEGORY



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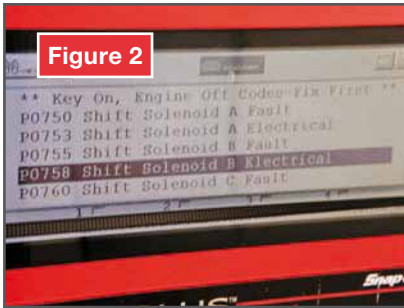


Figure 2



Figure 6



Figure 7

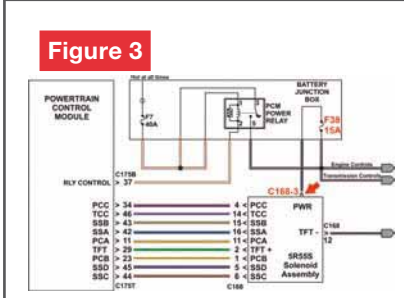


Figure 3

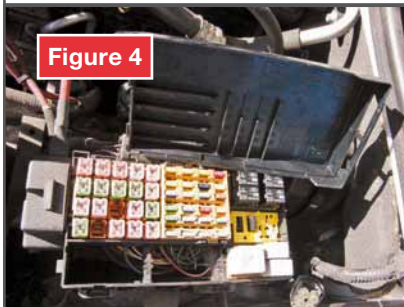


Figure 4



Figure 5

wasn't available at the time. So while waiting for one, I thought to myself that because the PCM and fuse are so eas-

ily accessible, I would make some additional solenoid circuit checks.

Another aspect of this vehicle in terms of transmission diagnostics is not only is the PCM easily accessible, but also the upper-most connector is the C175T connector where all the solenoid ground wires are located (Figure 9). There is no need to lie on your neck trying to probe PCM wires deep under the dash with this vehicle. And as with most connectors, the terminal numbers are conveniently embossed into the connectors for circuit identification (Figure 10) in conjunction with a wiring diagram.

Because I already pulled out the fuse, I located the circuit from the fuse leg that feeds voltage to the solenoid body, turned the ignition off and carefully inserted a test lead (Figure 11). I then modified a paper clip end to be inserted into the PCM connector and started doing a resistance check of each solenoid (Figure 12). Pressure Control Solenoid A (PCA) at terminal 11 was the first solenoid I checked.

The range for this solenoid is 3.3 to 7.5 ohms. Once again, to my surprise, I was within range with 6 ohms (Figure 12). The same occurred with checking all of the other solenoids with the exception of the TCC solenoid. This solenoid has a range of 9 to 16 ohms, yet this one measured 0.513K ohms (Figure 13).

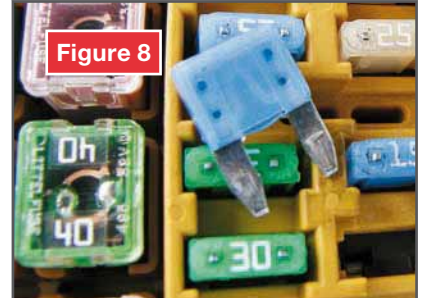


Figure 8



Figure 9

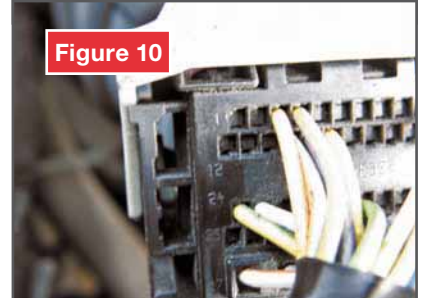


Figure 10

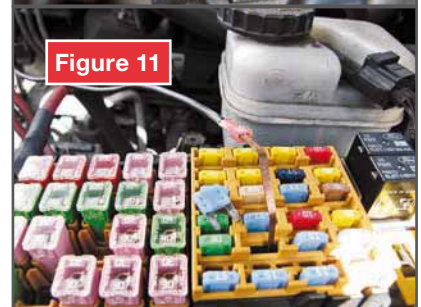


Figure 11



Figure 12

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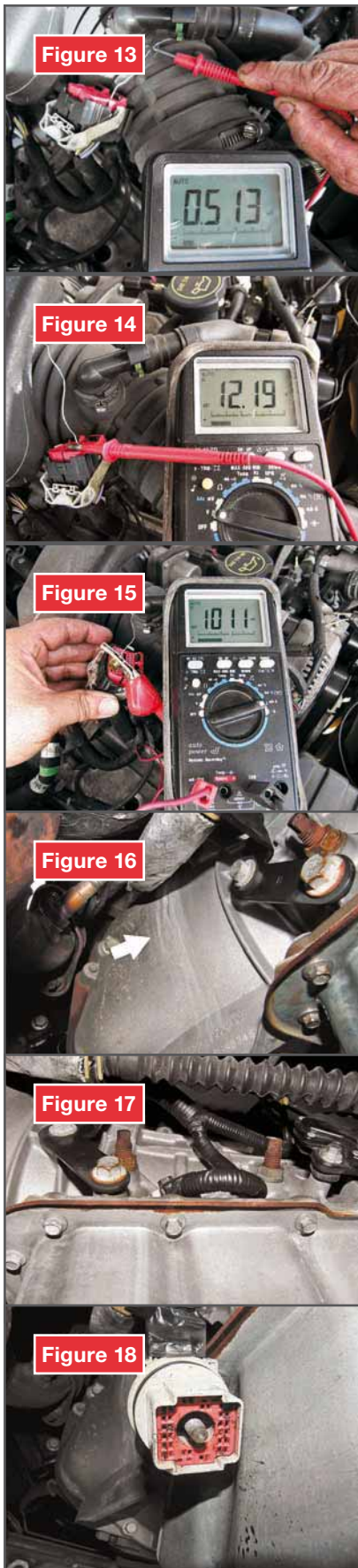
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I then poked the fuse back in, turned the ignition to ON to see if voltage was present at the PCM connector for PCA and there was (Figure 14). In fact, all of the solenoid ground circuits showed similar voltage readings. With these results, I still am not quite seeing what is causing all the solenoid codes.

Because a lift had yet to open, I decided to do some amp checks. This only required changing the meter setting to amps and moving the positive lead to the appropriate jack. I saw unusual results when I performed this test procedure. Amp readings for all the solenoids fluctuated in and out of range, some worse than others. I managed to capture Pressure Control Solenoid A as it was fluctuating as low as 1 amp (Figure 15). No doubt something is very wrong.

With a lift now available, the truck went up on the hoist, and I immediately saw a water problem. Evidence of dripping water from the A/C system stained the converter housing (Figure 16) causing rust all around the area where the harness plugs into the transmission (Figure 17). As soon as the harness was unplugged from the solenoid block, an ample amount of water dripped out of the connector (Figure 18). Upon a closer look, two pins from the solenoid block remained inside the harness connector (Figure 19). Once I removed the solenoid block, the terminals that separated from the block (Figure 20) were identified as the power terminal for the solenoids and the ground circuit for the TCC solenoid.

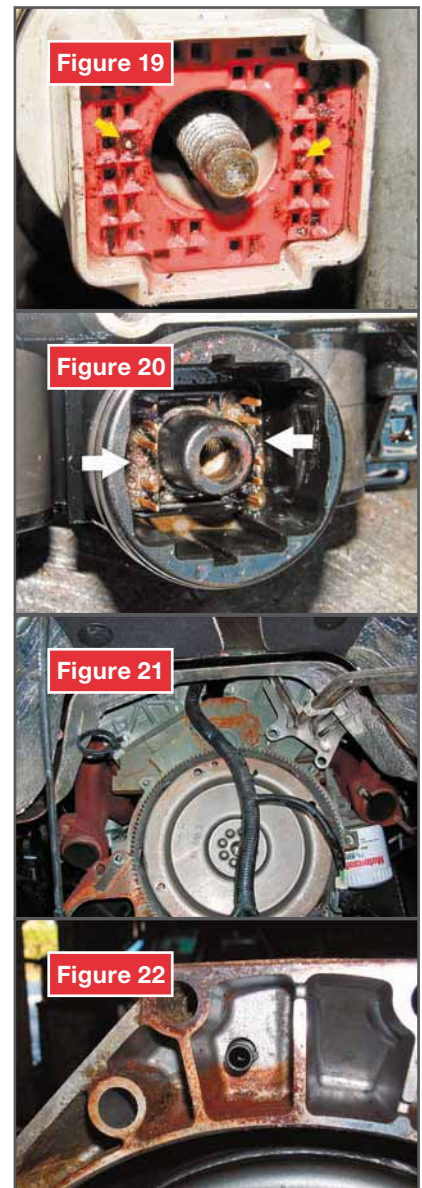
The combination of water in the connector and two compromised terminals in the solenoid block caused the erratic amp readings. It's a good testimony in that doing resistance checks does not always discover a problem. In this case, putting the circuit under a load flushed out the problem (no pun intended). If I had a scope handy to do the amp checks with, I might have been able to catch greater detail in the fluctuating amps due to the power terminal having a small surface connection where it was corroded at the base of the solenoid block. Nonetheless, it was interesting to see how the amps presented themselves under such conditions.

Obviously, had I been able to put this truck up on the hoist right away I would have made this discovery immediately without having made all of those circuit checks. But seeing how these checks

can be made so easily, it can be helpful to know these procedures when dealing with a problem not so easily discovered.

You can correct this water intrusion coming from the A/C system by inserting a makeshift shield under the system to redirect it to a more suitable location.

This water problem can cause internal transmission failure as well. Figure 21 is a picture of the back of the engine block with the transmission removed. There is evidence of water dripping down the back of the block between the cylinder heads. Figure 22 (page 36) is a view of the transmission converter housing where it mates the block in the area where the water is collecting. Notice there is a waterline mark in the area of a hose. This hose is the transmission



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For technical questions, contact the Ford Powertrain Assistance Center at 1-800-392-7946 or visit FordParts.com.

*See dealer for limited-warranty details. Remanufactured diesel engines are covered by a two-year/unlimited-mile warranty.

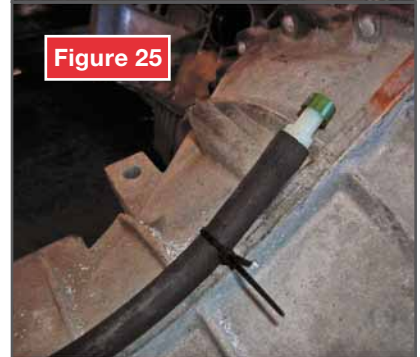
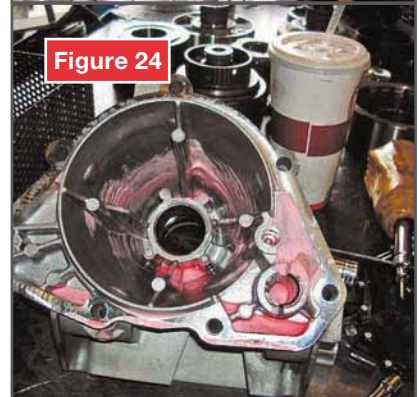


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vent as you can see clearly in Figure 23. This hose originates from the extension housing and is purposely routed to the front of the transmission. This arrangement now allows this intruding water to enter the transmission contaminating the fluid as Figure 24 reveals.

This is another good reason to insert a makeshift shield to be placed under the A/C system redirecting the water to a more suitable location. What you do not want to do is what you see in Figure 25.

Cutting the hose short of the front of the case and sticking a vent cap into the end of it is not a safe solution. This hose purposely is placed so that should the transmission fluid ever vent out, it will not be a potential fire hazard hitting the catalytic converter. Instead it will dump into the converter housing and safely drip out the bottom. Though someone might mistake this to be a front seal leak, it is better than to make the mistake of seeing the vehicle go up in flames.



By the way, a must-have app is the Automatic Transmission to Vehicle Guide by Transtec Corteco for both Apple and Android smartphones. If you do not have a smartphone, you can access it at www.transtec.com.

This app is a quick way to know what type of transmission is in the vehicle. It is hard to keep track of all the names and their applications, which is why this app is helpful. Additionally, the idea of import and domestic has changed in many ways. A 722.6 transmission in many Mercedes passenger cars also is used in Dodge and Jeep vehicles as the NAG1 transmission. A 4F27E in a Ford is the FN4A-EL in Mazda. This is app provides a worldwide distributor list and their contact information, as well as a variety of technical bulletins, and is all at no charge to you. **TZ**

Photos: John Parmenter

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10 Modes of OBDII

EVEN THE MOST GENERIC GLOBAL OBDII SCAN TOOLS CAN OFFER A LOT OF INFORMATION IF YOU KNOW WHERE TO LOOK.

BY **ALBIN MOORE** | CONTRIBUTING EDITOR



I can remember a few years before the advent of computers when the automobile seemed to be simple. A distributor, a carburetor, road draft tubes for crankcase breathers — oh, yes, those were the days when things were simple. Every time I walk past an idling classic car, I remember those days and can smell them, too. I can only imagine the air quality now if vehicles had stayed with the technology of the 1960s.

To combat the smog problem in the Los Angeles basin, the state of California started requiring emission control systems on 1966 model cars. The federal government extended these controls nationwide in 1968. In 1970, Congress passed the Clean Air Act and established the Environmental Protection Agency (EPA).

Many of us remember the days of on-board diagnostics (OBDI). There were

few standards, and each manufacturer had its own way of doing things. In 1988, the Society of Automotive Engineers (SAE) set a standard for the Diagnostic Link Connector (DLC) and developed a standard list of fault codes. The EPA adopted most of these standards, based on the SAE recommendations. OBDII is an expanded set of standards and practices developed by SAE and adopted by the EPA and California Air Resources Board (CARB) for implementation by Jan. 1, 1996.

Thinking back to 1996, I can remember some auto technicians complaining how hard it was going to be to work on those new, totally computer-controlled cars, and I also saw several of those technicians abandon the trade for simpler things to do. I saw many older technicians get some training, embrace the change in technology and come out the other end better technicians who

were able to take on the challenge. I guess I would ask, would you guys and gals rather work on cars from the pre-OBDII days, or the cars that support OBDII technology?

As we discuss the 10 modes of OBDII, keep in mind that the OBDII system is designed as an emissions program and not a diagnostic system. The OBDII standards are applicable only to the emissions-related functions of the vehicle, like the engine, transmission and drivetrain components. Body controls, antilock brakes, airbags and lighting, while they also might be computer controlled, do not fall under OBDII jurisdiction and are manufacturer-specific items. Many good things have come from the OBDII emissions program, one in particular that we all enjoy is the standardized diagnostic connection.



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Communication protocols also were standardized. As long as you are doing only emissions-related repairs, a technician can get by with a global OBDII scan tool. Global OBDII provides technicians the ability to access the engine and transmission data that is needed to analyze problems that result in an illuminated Check Engine light.



What are the 10 Modes?

With 10 different modes, Global OBDII might seem a little complicated. There's more to it than just plugging in a scan tool, pulling some codes and installing a part or two to fix that check engine light. The OBDII emissions program is an ongoing program that is in a state of constant change. This program also is governed by many rules, which are subjected to extensive research and development so that we have a working and functioning program.

Once you understand what the 10 modes are, however, you'll see that it isn't too involved. Some of you already are used to and use them every day. Others, while new, will open new diagnostic doorways for you once you understand them. Let's go through them one at a time. Oh, and don't worry about the "\$" sign in front of the numbers. That just means the number is a hexadecimal, a num-

ber the computer understands.

Mode \$01 — Request current powertrain diagnostic data. The purpose of Mode \$01 data is to have access to current live powertrain data values. What's neat

is that this sensor data must be actual readings and not default or substitute data like a manufacturer might use in their "enhanced" datastream. (Might want to write that down.)

Mode \$02 — Request freeze frame information. The purpose of Mode \$02 is to allow access to emissions-related data that is stored at the time the related code was set. The rules allow some expansion to meet manufacturer-specific requirements that will exceed the requirements of OBDII. One example of this is the General Motors freeze frame and failure records.

Mode \$03 — Request emissions-related diagnostic trouble codes. The purpose of Mode \$03 is for the external test equipment (scan tool) to have access to emissions-related Diagnostic Trouble Codes (DTCs) that are stored in emissions-related modules. These are the "P" codes that turned on the Malfunction Indicator Lamp (MIL) and have matured as defined by OBDII standards.

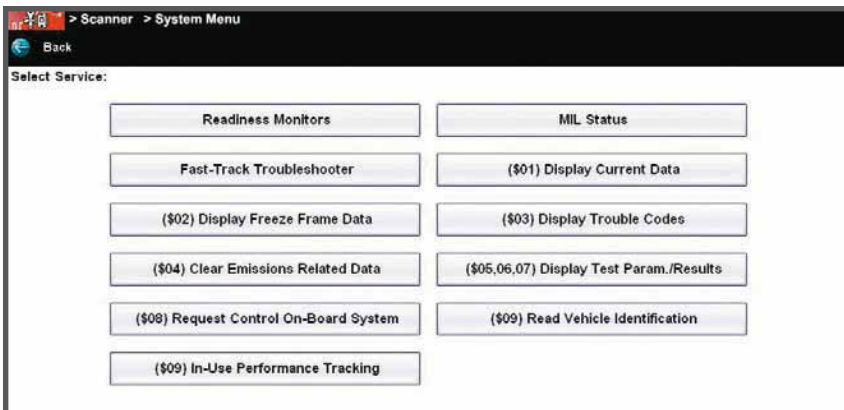
Mode \$04 — Clear/reset emissions-related diagnostic information. The purpose of Mode \$04 is to clear the

emissions-related diagnostic information from the modules that have stored this information. This function includes clearing not only the DTCs, but also the freeze-frame data, all stored test data, and it resets all monitors and turns off the check engine light.

Mode \$05 — Request oxygen sensor monitoring test results. The purpose of this mode is to allow access to the engine control module's oxygen sensor monitoring test results. The same information can be obtained by the use of Mode \$06. The Mode \$05 information is not available on vehicles using the Controller Area Network (CAN) system. For those cars, you'll need to go directly to Mode \$06.

Mode \$06 — Request on-board monitoring test results for specific monitored systems. The purpose of Mode \$06 is to allow access to the test results for on-board diagnostic monitoring tests of specific components that are both continuously monitored (misfire monitoring) and non-continuously monitored systems. The Mode \$06 test information has nothing standard between vehicle makes or models. The only way to understand what you are seeing is to either have a scan tool that defines all of the data for you, or to print out the Mode \$06 information from service information then compare the printed data to the scan tool data.

Mode \$07 — Request emission-related diagnostic trouble codes detected during current or last completed driving cycle. The purpose of Mode \$07 data is to allow the scan tool to have access to codes that have been stored on the first drive cycle after an ECM reset. This is the pending codes selection you see on many scan tool menus.



This is a screen from a Snap-On Verus scan tool. Different scan tools will display this same data, though it will be in a different format depending on the scan tool manufacturer.



Because this data is from a 2002 model year vehicle, the data is quite limited. In later years, the data stream has increased to a very large PID list.

Mode \$08 — Request control of on-board system, test or component. The purpose of the Mode \$08 is to allow a scan tool to do bidirectional control of an onboard system or test. Typically, it is currently limited to some evaporative emissions systems and allows the user to seal the system for leak testing.

Mode \$09 — Request vehicle information. The purpose of Mode \$09 is to allow a scan tool access to the vehicle identification number and calibration numbers from all emissions-related electronic modules.

Mode \$0A— Request emissions-related diagnostic trouble codes with permanent status after a clear/reset emission-related diagnostic information service. The purpose of mode \$0A, referred to as Mode 10, is to allow a scan tool to obtain DTCs that are stored as “permanent codes.” These are codes only the module can clear. Even if you’ve made a successful repair and have cleared the codes in Mode \$04, these codes will remain in memory until the computer has completed its own system test.

OBDII has changed over the years and it is still a work in progress, so when you hook up your scan tool and go look for Mode \$05 (oxygen sensor monitoring test results) you might not see anything especially if you are hooked to a 1998 (or earlier) model vehicle. The reason is this information was not available for that year on some cars. As OBDII changes, so does the application.

Real World Application

Now that we know what all of the different modes of OBDII are, applying the theory to a problem shouldn’t be too difficult. I think that most all techs have been using several of the modes of OBDII for several years and having great success, but do we know how to get the most out of the tools we use?

As an example of using Global OBDII data for a diagnostic problem, let’s take a look at a 2002 Subaru Outback with a “my check engine light is on” complaint. The vehicle is equipped with an automatic transmission, a 2.5-liter engine and has 168,000 miles on the odometer. There are no drivability complaints other than the MIL is glowing. With a scan tool hooked up, a code P0420 was stored in memory.

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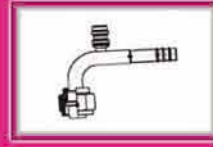
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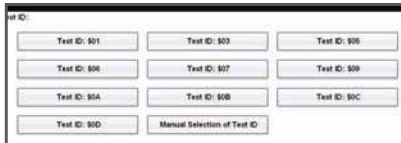
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Scanner > Engine > Generic OBD-II Freeze Frame	
ECU ID: S	E1
ENGINE SPEED(RPM)	2138
FUEL SYSTEM 2	NOT USED
INTAKE MAP(inHg)	12.4
LONG TERM FUEL TRIM BANK 1(%)	1.6
P0420 Catalyst System Efficiency Below ...	
FUEL SYSTEM 1	
CLOSED LOOP	
ENGINE COOLANT TEMPERATURE(°F)	186
SHORT TERM FUEL TRIM BANK 1(%)	0.8
VEHICLE SPEED(MPH)	55

Mode \$02 information, freeze frame data. Freeze frame data is said to be stored at the time the code was stored but this is not the case. Most of the time, freeze frame data is stored over a period of several seconds. Things like short term fuel trim, throttle position and engine speed can change and not be correct in freeze frame data.

Because the P0420 is the only code that is stored, this rules out a lot of things that I normally would want to test. In this case, I want to do a visual of the engine to make sure all of the emission hoses and vacuum hoses are hooked up, check the oxygen sensors for proper operation, check for any air leaks into the exhaust system and if all these check out, then its time for a new catalytic converter.

Because we have several different onboard tests that are accessible using my scan tool's Global OBDII mode, maybe it would be a good thing to see what the onboard computer has to say about this problem.



Mode \$06 information, Monitoring test results. This is data can be different between vehicle model years and will be different between vehicle manufacturers. To apply this data to a vehicle problem, you will need to go to service information and print out the Mode \$06 data, then compare to the scan tool data. This is an area where different scan tools display the data differently, and if you want to use this data to your benefit, you need to have a scan tool that will interpret this data for you.

OBDII is all about the check engine light. The light has been illuminated because the calculated tail pipe emissions are above 1.5 times the federal test procedure (FTP) certification. In this case, the problem being flagged is a catalytic converter with a low oxygen storage capacity.

In a case like this my first move is to check the Mode \$02 information (freeze frame information). In the freeze frame information, I want to see if the vehicle was in closed loop operation at the time the code was registered, were both long term and short term fuel trims within limits (total fuel trim within 10 percent), was the engine coolant temperature in the normal range, and did other Parameter Identifiers (PIDs) indicate that the engine was in its proper operating ranges. In this case, nothing is out of order.

Mode \$01 (current diagnostic data) is the next place to look. With the live data, I want to see if the front and rear oxygen sensors are working properly. Because I did my homework on how the module tests for a P0420 fault, I knew that it relied on the input from these two sensors. In this case, the front sensor is a wide band air fuel ratio sensor.

Manufacturer Specific Test
ECU ID: SE1 Test ID: \$01 Component: \$01
Min: N/A Max: 180 Value: 205
Result: Failed

Mode \$06 catalytic converter test information. Test id (TID) Component ID (CID) This test shows the catalytic converter test has failed quite badly.

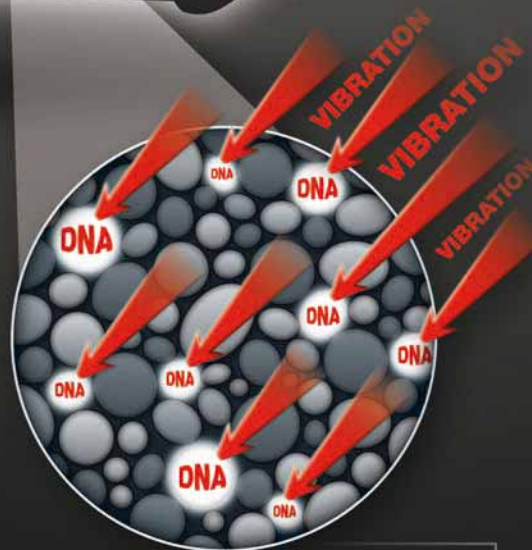
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This is our example vehicle, a 2002 Subaru outback with a non-turbocharged 2.5L engine, automatic transmission, all-wheel drive and 168,000 miles.

Mode \$05 is oxygen sensor monitoring test results. In the case of this vehicle, this function of OBDII is not functional, so the live oxygen sensor and fuel trim data will be the place to look.

The scan tool was set to record the data, the vehicle was taken on a short test drive and the stored data viewed. We found no problems with fuel con-

trol. The next place to look is for any air leaks in the exhaust system or any vacuum leaks. Because both could affect the operation of the sensors and skew the test results, this is an important check when diagnosing this particular code. On inspection nothing was found in these areas.

Mode \$06 information will be the next stop on our diagnostic journey. Service information shows that TID 01 and CID 01 (these are test identifiers) is the catalytic converter testing results. The Mode \$06 test results show the maximum test value is 180, while the test results are showing 205. These numbers alone don't mean anything unless you take the time to review the Mode \$06 definitions or have a scan tool that does all the translating for you. (For more info on how to use Mode \$06, visit MotorAge.com or the AutoPro Workshop.)

The final step in the diagnostic process is to take a look at the Mode \$09 information. This is the PCM calibration identification. By going to the Subaru programming website, I found

that there is a software update available, but it is not an update related to the P0420 code I found stored.

The diagnostic process is now finished. With no exhaust leaks, the engine in proper fuel control, the front air fuel ratio sensor and the rear oxygen sensor working properly, the only thing left to do is to recommend a new catalytic converter be installed on this car. OBDII is a great emissions system with a lot of diagnostic power available to the technician and the best thing; this is all available from the comfort of the front seat of the vehicle. *MM*



ALBIN MOORE
CONTRIBUTING
EDITOR

Albin Moore spent 21 years in logging before opening in 1992 a shop that specializes in drivability problem analysis. He is an ASE CMAT L1 technician with 40 years of analyzing and fixing mechanical and electrical issues.

Email Albin at bwrench@yahoo.com

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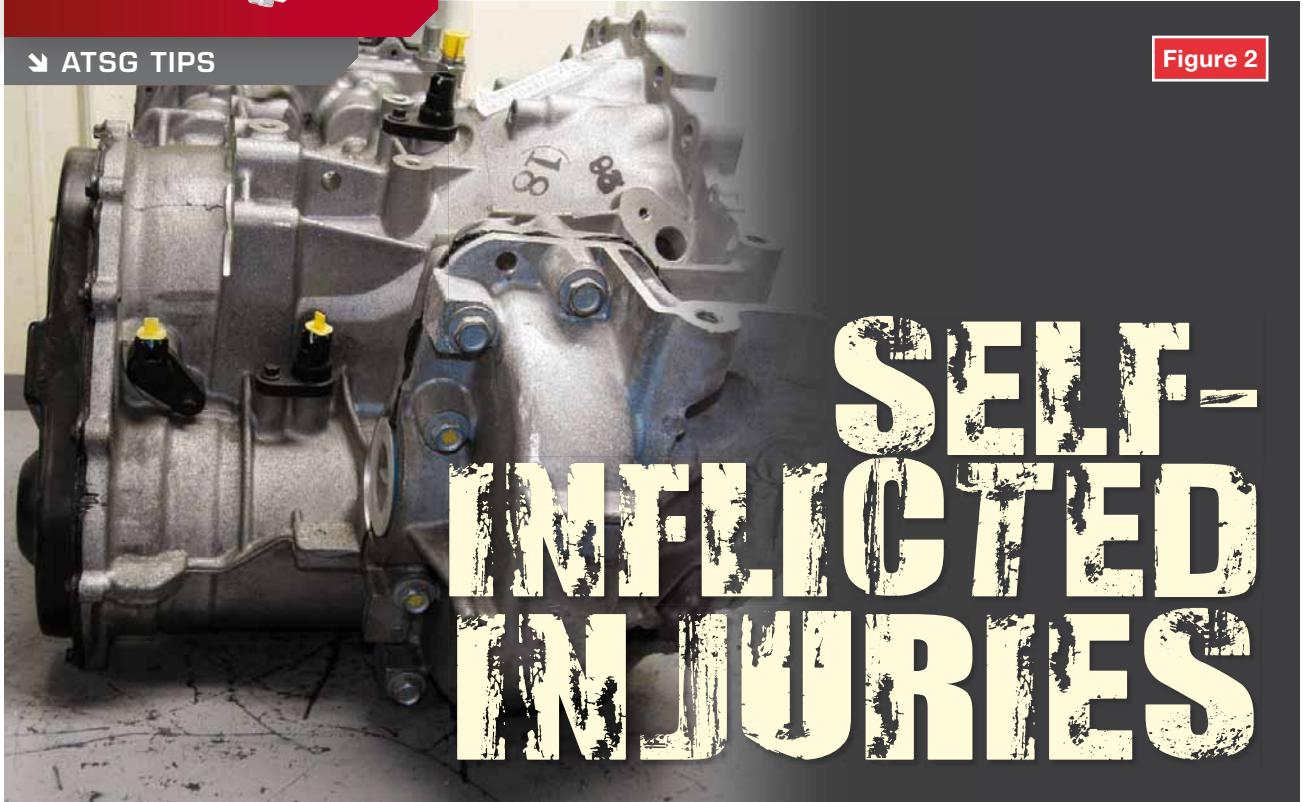


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↘ ATSG TIPS

Figure 2



CROSS-CONNECTING CONNECTORS CAN TRIP YOU UP, LEAVING YOU AT FAULT FOR SOME PROBLEMS.

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

One undesirable aspect of our lives is known as “human error.” Because no part of life is exempt from this facet of living, we know it extends into automotive repair.

The problem in this article concerns cross-connecting connectors, specifically several current cross connect scenarios. The idea is to recognize cross connect possibilities and tag them for proper reconnect as a preventive measure.

The most common connector cross connect occurring today has to do with

a transmission called the 62TE (Figures 1 and 2). This 6-speed front wheel drive transmission is used in vehicles such as the Avenger, Caravan, Dart, Journey, Ram Van, Pacifica, Sebring, Town & Country, Voyager, 200 and oddly enough, the VW Routan. This transmission has three speed sensors: an Input Shaft Speed Sensor (Nt), a Transfer Shaft Speed Sensor (Nc) and an Output Shaft Speed Sensor (No, Figure 3). Due to their close proximity, the TSS and the OSS easily can be cross-connected, because their connec-

tors are of the same configuration. This connector cross-connect causes erratic shifts followed by P0730 series gear ratio codes (P0731, P0732 etc.).

These sensors usually have a dark green wire with a violet tracer in their connector. The Nc will have a dark green with a light green tracer wire in its connector, while the No will have a dark green with a brown tracer wire in its connector.

The next most common cross connect is on Nissan Altima, Maxima and Quest vehicles using the RE4F04B transaxle.



Figure 1



Figure 3

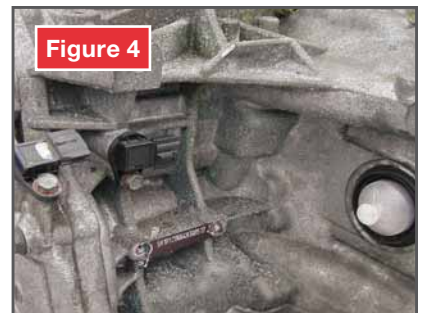


Figure 4

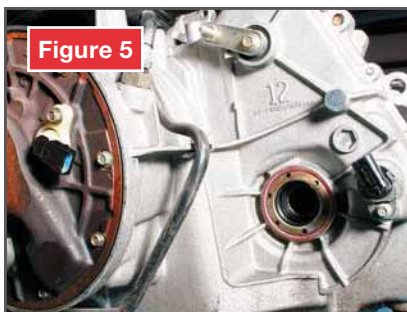


Figure 5



Figure 6



Figure 7

a light blue tracer wire in its connector, while the OSS/VSS has dark blue with a yellow tracer wire in its connector.

On Acura and Honda vehicles, particularly the 2001-2002 MDX and Odyssey vehicles, the transmission has several external solenoids paired with black and brown colored connectors (Figure 6). Shift Solenoid A and C can be cross-connected with Shift Solenoid B and the TCC solenoid. Or these solenoids can be a cross-connected with the two Clutch

Pressure Control Solenoids.

Other cross connects occur with the ISS and OSS in Chrysler/Dodge vehicles using the 41TE (A604) transmission, or GM's 4L80-E transmission. We also have seen early Mitsubishi vehicles using the KM175 4-speed transmission having the Pulse Generators cross connected with the Shift Solenoids. I've seen some Kia vehicles getting the IAV cross-connected with the TPS (Figure 7), so these checks need to be in one's diagnostic arsenal. *ZZ*

Both the Turbine Shaft Speed Sensor (TSS) and Output Shaft Speed Sensor (OSS) are side by side, facilitating an easy cross connect mistake (Figure 4). This causes a no up-shift condition with a P0720 OSS code to be stored. The TSS is excited by the lugs on the forward clutch drum, which is held stationary in first gear. With the OSS harness connector plugged into the TSS, the TCM doesn't receive an OSS RPM on take off preventing a shift, causing the P0720 code to set.

The next occurs with 2001 and newer Ford/Mercury vehicles using the CD4E (Figure 5) transmission (Contour, Cougar, Escape, Mariner, Mystique, Probe and ZX2). The TSS and OSS/VSS with this transmission can be cross-connected. When it is, a speedometer reading will occur while in Park during engine rev.

While driving, it will be noticed that vehicle speed is approximately 15 to 20 mph slower than what it should be. It will attempt a shift into third, but suddenly downshifts to second or first and then sets P0730 series gear ratio codes. Usually, there's a brown wire with a light green tracer in each of the harness connectors. The TSS has a white wire with



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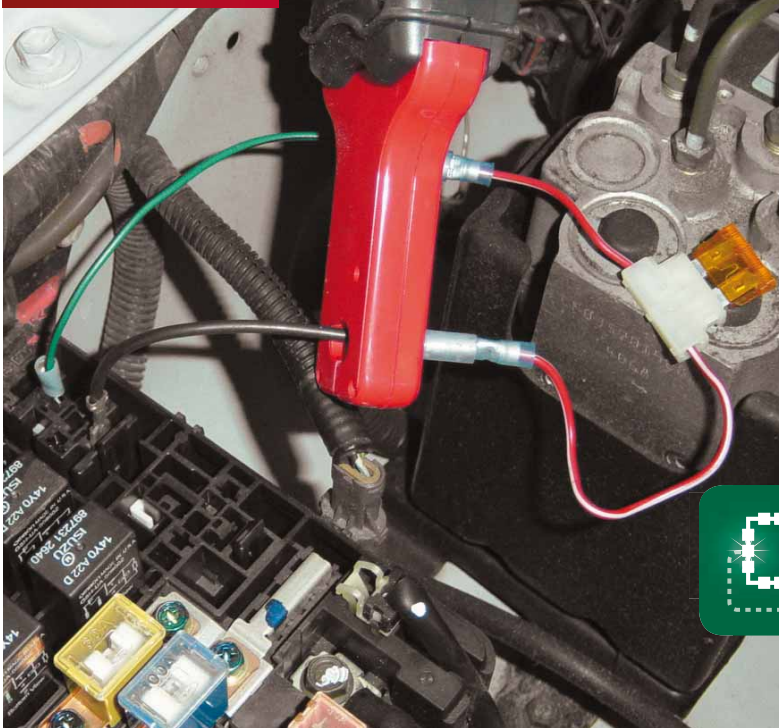
- 52 Electrical
- 58 Underhood
- 64 Undercar
- 70 Scope & Scan
- 72 Motor Age Garage



THE TAKE AWAY

ECUS USE RELAYS TO OPERATE HIGH CURRENT LOADS. ONE CURRENT TEST QUICKLY CAN ISOLATE WHERE THE PROBLEM LAY.

ELECTRICAL



A TALE OF TWO CIRCUITS

Use a fused jumper wire with the correct fit terminal ends in place of the fuse to provide an easy current-measuring access point.

DIAGNOSING AN ELECTRICAL PROBLEM WITH AN A/C COMPRESSOR, BLOWER OR COOLING FAN? THE FIRST STEP IS TO FIGURE OUT ON WHICH OF TWO CIRCUITS TO FOCUS.

BY **PETE MEIER** | TECHNICAL EDITOR

The automotive A/C system has several high current components that the electronic control units (ECU) manage, including the A/C compressor coil, blower motor and fan motors. Current flow through these components can run from three amps or so, to better than 20 amps. Current flow of that kind would spell almost certain death if it passed directly through the driver of a typical ECU, so a little electrical device known as the relay acts as an intermediary.

The current required to turn a relay on or off usually is no more than a few

tenths of an amp, a level the controller can handle. While the use of relays to control high current devices certainly is not limited to the A/C system (fuel pumps and window motors jump to mind), because this is our A/C issue, we'll focus on those applications.

One Fault, Two Circuits?

If you remember your electrical fundamentals, you know that every circuit has five basic elements: a source (typically the battery), a load (the component that the circuit is designed to operate), a circuit protection device (a fuse, circuit breaker or fusible link), a

control (a means to open or close the electrical pathway and turn the load on or off) and a complete path that connects all of them together. When a load doesn't work the way it's supposed to, the fault has to lie in one of these five areas. Easy, right?

How does all of this apply to a relay-controlled circuit? The relay is an electrically operated switch that closes and opens the current path to the primary component (the compressor coil, blower or fan motor) we're trying to operate, doesn't it? That makes it a control in the primary component's circuit.

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But it is electrically controlled. Something else is turning the relay on (the electronic control unit that is managing the primary component). Doesn't that make the relay a load, too? That's another circuit entirely.

The first step in diagnosing a problem in a relay-controlled circuit is to figure out whether the problem is on the primary component side of the relay or the load side of the relay. Most of us understand this instinctively when we glance over the schematic. The relay marks an electrical crossroads of sorts. I know I'm not the only one who has stolen a relay from another section of the fuse box and swapped it with the suspect relay.

If the primary component now works, though, does that mean it was the relay's fault? And what did we learn if the component the relay is supposed to control still doesn't work?

What's Working?

If an electrical circuit is complete and operating, current will be flowing through it. Measuring the amount of current can provide a quick answer to what is working and what's not.

To use current to isolate which of the two circuits to focus on, go back to the schematic for the component you want to troubleshoot and identify its relay control. Trace the two power feeds at the relay (one for the relay, one for the component) back to the battery. Along the way, you'll pass through at least one fuse, and that makes a great test point for your current measurement.

Read more
on the ins and outs
of setting up your
low amp
current probe at
[MotorAge.com/
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Often, the same fuse will be protecting both power feeds to the relay, allowing you to identify the problem side with one measurement. If not, you'll need to take a measurement at each fuse. For the purposes of this discussion, we'll assume that one fuse feeds both.

Remove the fuse and replace with a fused jumper wire. Place your low amp current probe around it, turn the primary component on and read the current measurement. A reading of 0.0 amp tells you how the circuit where the relay is the load is working. No current is flowing, so the relay is not on when it is supposed to be, and you need to diagnose why the circuit is open. There is either a physical open in the circuit or the control module in charge is not closing the circuit path on purpose.

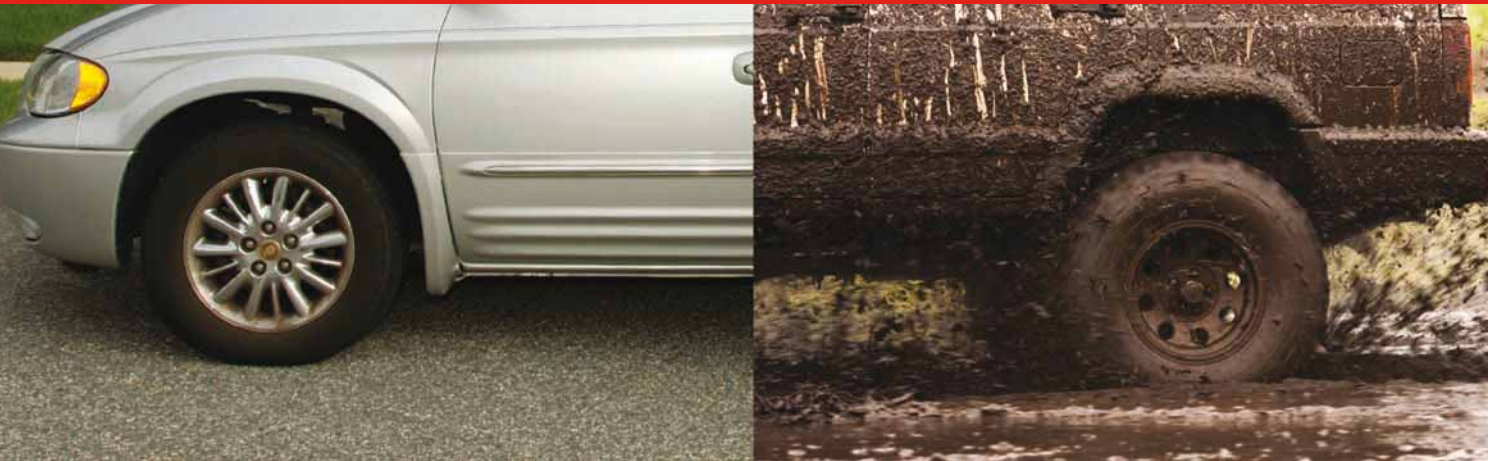
To remove the relay itself as a possibility, swap it out with an identical relay and repeat the current test. If the current reading remains 0.0 amp, verify power to the relay. Once power is verified, connect your scan tool to see if any circuit-related codes are stored. Are all the input parameters that the control module uses to decide when to issue the on command intact? Can you command the relay on with the scan tool? Is the circuit path to the control module intact and free of excessive voltage drop?

A reading of less than 0.5 amp or so tells you that the relay is on and that whatever parameters the control module needs to see to turn it on are all present and accounted for. The primary



(Left) You can quickly determine which of the two circuits needs your attention using a low amp current probe and your meter. (Right) The relay lies in the intersection of the circuits it is a part off and needs to be considered as a load AND a control.

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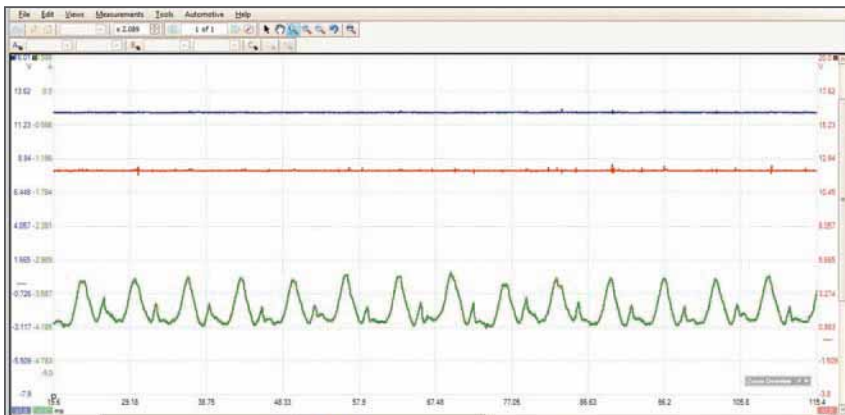


Electrical problems and low refrigerant aren't the only reasons a compressor won't engage.

component, however, is not on, so focus instead on the circuit that uses the relay as a control. Again, you're looking for an open circuit condition, just this time it's focusing on the path where the primary component is the load.

To isolate the relay as a cause, simply jumper the relay panel's terminals with a fused jumper wire to see if the primary component starts working. If not, verify the integrity of the circuit paths on both the power and ground side of the primary component using the voltage drop testing method. If power and ground voltage drops are in specification, the fault has to lie in the component itself.

The last possible measurement will be in the whole amp range (1.0 to 20.0-plus, depending on the primary component type). That tells you that, electrically, all is well. If the primary component isn't working, it is likely a mechanical fault with the component and not an electrical one. Some examples are A/C compressor clutches that have an excessive air gap, or blower motors that are mechanically seized.



Seeing the current as a scope pattern can help pinpoint problems meter readings alone may miss.

TESTING ELECTRONIC CONTROLLED VARIABLE COMPRESSORS

Ever-increasing fuel economy requirements as well as stricter emissions standards impact nearly every system on new cars. The automotive air conditioning system is certainly no exception. Today's mobile A/C systems provide better cabin cooling using smaller amounts of refrigerant in more tightly sealed systems, run by more efficient compressors; all leading to reduced emissions and better gas mileage.

Electronic Controlled variable displacement compressors (ECVs) are becoming more and more the norm for this very reason. Controlled by the Powertrain Control Module (PCM), compressor displacement (and pumping ability) can be precisely controlled to deliver the most efficient operation possible under any given combination of conditions.

Unlike variable displacement units that are controlled as a direct result of the heat load on the evaporator (GM's V5

or V7, for example), ECVs are controlled through an electronic solenoid that receives a pulse width modulated command from the computer. Displacement on an ECV can be quickly and seamlessly controlled in a matter of milliseconds. And since most ECVs have no clutch, traditional methods of diagnostics might lead to unnecessary compressor replacement.

That's where the CLT1 ECV compressor driver tool (from Four Seasons, a Standard Motor Products company) comes in. This tool allows the user to command the compressor displacement up or down while monitoring system pressure and temperatures. The kit also includes a compressor solenoid simulator that plugs into the main harness to prevent the accidental setting of HVAC-related trouble codes.

Voltage What?

Using current is an easy, convenient way to isolate which circuit you need to focus on, but many of us don't own a low amp current probe. And even if you do, you still will need to perform some traditional tests to pinpoint the exact problem. Let's start with the circuit where the primary component is the load, because that is the simpler of the two to troubleshoot.

With just three measurements, two taken as close to the load as you can get, you should be able to narrow the problem down very quickly. The main

issue will be accessing the component. Some compressors are buried in the engine compartment, making access to the connector a little difficult. Ideally, you want to backprobe the wiring directly at the component's connector. If you must pierce the wiring, be sure to use some liquid electrical tape to seal any holes you made, or you will have set the stage for a future failure.

One alternative I also have used successfully is to disconnect the harness from the primary component and reposition it for easier access and then substitute a different load (like a sealed



ECUs control a variety of high current components by relay, an electronic switch.



Excess resistance can be the cause of an inoperative component. Voltage drop tests will help discover where they are hiding.

beam headlight). This still allows you to test the circuit path for voltage drop issues. Just be sure to make up a jumper harness that uses the correct size terminals so you don't create any new problems while trying to solve the original one.

With the circuit on, measure the voltage directly at the battery and record your reading. Now measure the voltage available on the power side of the primary component, as close as you can get to the actual component itself. Keep the negative meter lead at the battery's negative terminal to insure you are

testing as much of the circuit path as possible. Record your second reading. Last, measure the voltage available at the ground side of the component and record that reading.

Voltage available at the power side should be nearly equal to what you measured at the battery, while voltage measured on the ground side should be nearly non-existent. That is basic electrical theory. Voltage is used to overcome resistance and allow current to flow. Whichever side of the load isn't reading as it should is the side with the problem. Start backtracking along the circuit path towards the battery until your reading does return to normal. Your problem lies between those last two measurement points.

If the power side and ground side readings are OK, the problem lies between your first two test points or in the component itself.

No power to the component? Bypass the relay to eliminate it as the problem, being sure to use one identical to the one you're testing. If the relay is OK, you'll need to perform the same type

of voltage drop tests on the relay control circuit. Make up a load substitute using an old turn signal bulb. Just be sure to use terminal ends that match up with the female relay connector sockets to avoid damaging them.

You should see the bulb light when the control module turns the relay on. If not, command the relay on using your scan tool and perform the same two load-side voltage measurements you performed on the primary component earlier to identify which side of the circuit path has an issue. **ZZ**



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

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TECHNOLOGY

UNDERHOOD



Often overlooked is physical damage to the condenser. A good visual inspection offers clues to hard use.

HERE'S SOME TIPS ON FINDING REALLY DIFFICULT AIR CONDITIONING SYSTEM LEAKS.

BY VANESSA ATTWELL | CONTRIBUTING EDITOR

One of the smartest techs I know always checks customers' air conditioning systems during the winter months, long before the first hot day arrives. By quickly checking a system to make sure it operates, he figures he will find any problems in a system long before the customer does, which keeps customers happy and keeps any possible repairs in his service bay.

It's a great idea, but the thing about checking an A/C system months before anyone will use it is that he has to be absolutely sure he has found any refrigerant leaks on the vehicle. Otherwise, the refrigerant he puts into the system gradually will leak out over the cold months, and he would then have to fix the vehicle again when he would likely be busy doing other things.

So he has to be absolutely sure he's found even the smallest leak and that he's fixed the problem properly. That

can be tough, because some refrigerant leaks are really difficult to find.

No doubt, locating really tough refrigerant leaks can be a nightmare, and unfortunately fixing-by-guessing just isn't an option, because (among other reasons) refrigerants are so strictly regulated. But it really is possible to find even the smallest, slowest leaks if you use a systematic approach of forming suspicions and then proving or disproving them along with some real-world testing techniques.

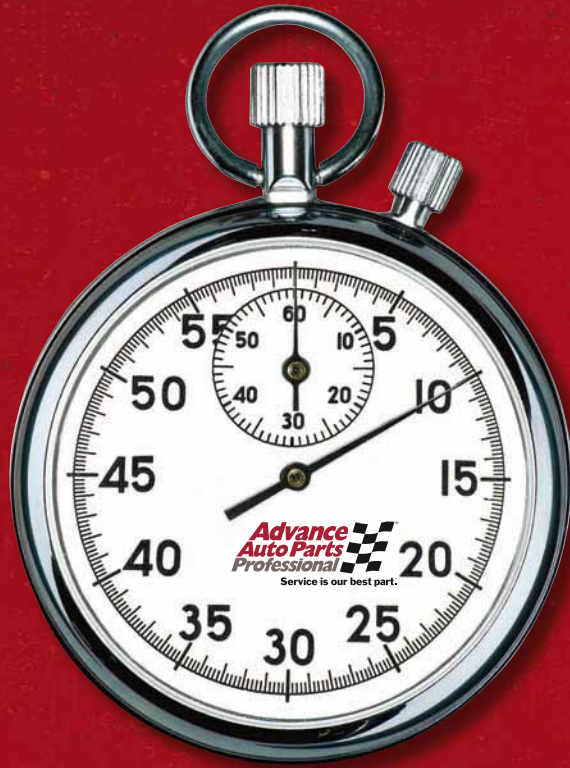
If you're sure an A/C problem indeed is due to low refrigerant level because of a leak (and not because of an electrical problem, belt problem or some other problem) and you can't find that leak using the typical testing methods in your diagnostic arsenal, here are a few ways you might not have thought of to find even the toughest leaks, keep your customers happy, your wallet full and keep vehicles from coming back with



their air conditioning systems empty after you've repaired them.

Always Start With Fundamentals

As with pretty much every other diagnostic strategy, visually inspecting the system for anything obvious at the beginning of a diagnosis can save quite a bit of time. In this case, you're looking for signs of trouble, such as stone chips on the front paint, recent body work, new components near air conditioning parts, oil stains or even signs of corrosion on or under components. Check the front of the vehicle particularly carefully – a rock through the condenser is common. If the front has a lot of stone chips or dead bugs, then it's quite possible that something hit the condenser causing a leak that let the refrigerant out.



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It's not unusual to have a slight leak at a charge port. That's why it has a seal with an O-ring cap.

Also check for components that might have rubbed or vibrated against something else and caused a leak, or signs that something has punctured or contacted one of the delicate A/C pipes or components. Note though that this isn't the stage where you identify the cause of leak and order replacement parts. This is the stage where you try to develop a suspicion about the cause of the problem; you'll prove or disprove those suspicions in the next few steps.

Unless you found an obvious leak during the preliminary step that needs to be repaired before further testing, completely fill the A/C system, allowing for lines and rear components if applicable. Check the service information to find out how much refrigerant is supposed to go in the system if you're not sure or have any doubts. And don't forget the compressor oil if required. You don't want to cause more problems during the diagnosis. When the system is full, let the refrigerant circulate through the system for at least a few minutes before you start looking for the leak (this gives you the best chance of finding the leak).

If you identified anything suspicious during the preliminary inspection, this next step is when you confirm or disprove those suspicions by testing the suspicious area and finding out for sure. Start by making sure the leak detection tool is working correctly.



Assuming you're using the sniffer tool, follow the manufacturer's recommendations on calibrating the tool, make sure its batteries are OK, check to make sure its tip is not contaminated and that it's set to detect the correct refrigerant.

Then, using the sniffer, check for leaks systematically, inspecting one component at a time, moving along the

system and paying close attention to the bottom of components, connections or fittings, because refrigerant is heavier than air and will tend to sink.

The reason for checking the components systematically, in order, is so that you don't accidentally overlook anything and you can be absolutely sure you've tested everything involved in the system. If you're checking the system while it's operating, make sure that the condenser fan isn't blowing away the evidence of a leak.

There are two things to be mindful of at this stage if you're looking for a



Fin damage and debris lodged in between the fins can reduce the condenser's ability to release heat.

tough-to-find leak in addition to confirming or disproving your suspicions. First, just as with electrical systems, connections can be weak spots in A/C systems so checking areas such as O-rings, hoses that flex, welds, clamps and connections very carefully really can pay off.

The other thing is that the components you can't easily see, such as those under the dash, rear A/C components, valve cores, under clamps and the like can be challenging to test. But if you're trying to find an elusive refrigerant leak, you need to expose and check those hidden components carefully. Odds are good that if you can't find the leak after carefully checking the exposed components, then it's probably in something that's hidden from view.

Additionally, even if you found a leak in the previous step, you still need to make sure that it's the only leak in the system. The extra attention now will save you from comebacks later.

“With a systematic plan of attack, some diagnostic tricks and sometimes a whole lot of patience you can find any leak and confidently repair A/C systems at any time of year.”

An Alternative To Sniffing

If, after testing all the components in the fully charged system with a functioning sniffer tool, you still can't find the leak (or if you don't use a sniffer tool) using A/C tracer dye is a good way to find an elusive leak. Be sure to use the correct amount of dye for the system you are testing and stay away from using oil with a dye added.

That might be OK when you are doing a component replacement, but it is not as the means to getting dye in the system. Be sure to run the A/C and allow enough time for the dye to circulate through the system and leak out. Then inspect the system carefully for leaks.

If you still can't find the leak — or if you can't use dye or a sniffer — charge the system to its maximum capacity, taking into account what the A/C systems lines hold, and then spray all of the connections with soapy water and look for the tell-tale bubbles or sputters that indicate leaks while the system operates and also when it's shut off.

It might take a while for the leak to show up using this method, so you might want to park the vehicle some-

where and move on to another task for a while, then come back to it. The reason for doing the soapy water test after doing the sniffer and dye tests is because the soapy water will wash away any dye or oil stains that could have helped you out with those other two tests.

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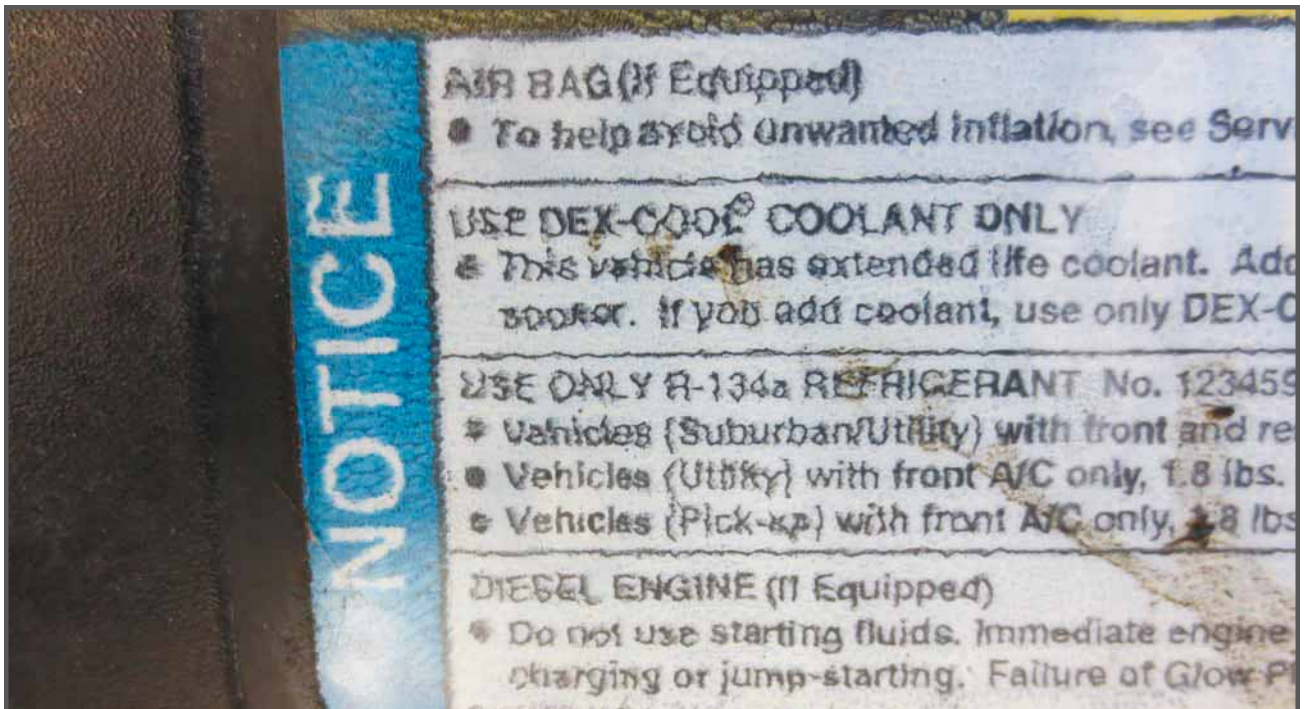
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Always make sure you are charging the proper amount of refrigerant into the system. Often, TSBs are issued that alter the original charge specification.

two important steps to make sure that the vehicle is fixed properly and doesn't return in a few weeks with the A/C inoperative again. The first step in verifying your repair occurs during the recharge of the system. Pull the system into a full vacuum and let it sit for at least five minutes. If vacuum is lost, odds are there still is a leak somewhere in the system.

The second step in verifying that the repair was successful is to go back over the leak area you found originally and retest it. In most cases, there still is enough dye in the system to indicate any problems if you didn't get it corrected or you can use the sniffer

to recheck. Be sure to check over the entire system. Sometimes you can fix one leak, only to have another appear that you didn't, or couldn't, detect the first time around.

This next step seems obvious, but it's well worth mentioning to make sure that there's enough compressor oil — and the correct oil for the system — in the A/C system after the repair. One parts representative told me very recently that close to 100 percent of compressors that fail after an A/C repair do so because there wasn't enough oil in the system, and the resulting debris is almost impossible to remove from the tiny orifices inside

the air conditioning system. Be sure to follow the OEM service guidelines on adding oil after a repair or component replacement.

No doubt, finding elusive leaks can be a real diagnostic challenge. Sometimes conventional testing methods don't work, and guessing and hoping are just not acceptable repair methods. But with a systematic plan of attack, some diagnostic tricks and sometimes a whole lot of patience, you can find any leak and confidently repair A/C systems at any time of year, keeping your customers happy — and keeping you busy making money rather than fixing previous mistakes. *VZ*



(LEFT) An evaporator core leak is one of the hardest leaks to nail down. Use the drain tube or remove the blower motor resistor to gain better access to the interior of the case. (RIGHT) Be wary of pinholes hiding under line wrappings.

VANESSA ATTWELL CONTRIBUTING EDITOR

Vanessa Attwell is a Master Technician for two major manufacturers and has also worked on the bench of an independent shop. She has developed and delivered training for both vehicle manufacturers and independents, and helped develop government training and regulations standards.



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Ward Atkinson, former SAE committee co-chair, briefs MACS attendees with his state of the industry.

GLOBAL ISSUES ARE SETTING THE SCENE FOR AN INTERESTING YEAR.

BY PETE MEIER | TECHNICAL EDITOR

One focal point of the annual Mobile Air Conditioning Society Worldwide's (MACS) convention is the state of the industry presentation delivered by Ward Atkinson, past Society of Automotive Engineers (SAE) Interior Climate Control committee chairman. Atkinson always has insights to offer as to what the future might hold for the motor vehicle air conditioning (MVAC) industry, and his crystal ball typically proves highly accurate in forecasting the challenges we'll face in the coming years.

This year, Atkinson painted a picture of an industry in flux. Those who have relied in the past on A/C and cooling system repair alone to support their businesses are seeing that market shrink, forcing them to expand their service offerings or close their doors. And the refrigerant we were so sure would be the accepted alternative for R134a is under fire.

Alternatives are being raised; not only in the type of refrigerant but the type of system design future automobiles will use to cool their occupants. And the familiar blue container of R134a sitting in the storage room of your shop might contain anything but, with some contaminants wielding the ability to kill or maim an unsuspecting service tech.

Safety First

A few years ago, several workers were killed in separate instances involving contaminated R134a in the commercial refrigeration industry, specifically by the commercial shipping containers used to transport perishable cargo around the world. These containers violently and unexpectedly exploded during routine service of the refrigeration systems.

Investigators determined that the explosions were caused by the introduction of a counterfeit R134a refrigerant containing significant amounts of meth-

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Scan this QR Code to read watch on your smartphone a conversation with Neutronics' Peter Coll. Or visit MotorAge.com/r40video

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yl chloride (also known as chloromethane or R-40) and R-22. R-40 chemically reacts with the aluminum components found in the air conditioning system and generates highly reactive and/or toxic compounds. One suspect compound is Trimethylaluminum (TMA), a pyrophoric (a flammable liquid or vapor that ignites on contact with air).

Early in the investigation, it was apparent that all of the contaminated containers had received a refrigerant charge in Vietnam. But continuing investigations have found refrigerant contamination in containers serviced in other major sea ports, as well as in in-stock refrigerant containers.

Is this a situation you should be concerned with? Here's what DuPont had to say in a recent blog on its company website, as reported by ACR News:

"Illegal blended mixtures being mar-

Photo: Pete Meier

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keted online and elsewhere as R134a for automotive air conditioning and refrigeration uses can actually contain R-40, R-12, R-22 and/or R-30 (methylene chloride) and a variety of other hydrocarbons. These counterfeit refrigerants have the potential to cause not only harm to a company or end user, but there are also serious physical dangers associated with these fraudulent products.”

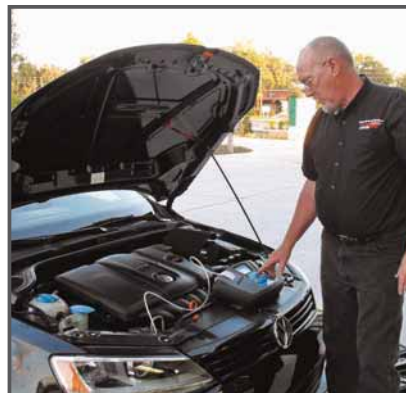
While I know of no reported instances of R-40 counterfeits surfacing in the U.S. market to date, that doesn't mean there won't be. And I don't want any of our readers to be the first to discover this dangerous counterfeit uninformed. The very first step you can take to protect yourself is to make sure you buy your stock from a known good source, where the product can be easily traced all the way back to the manufacturer.

The Air Conditioning, Heating and Refrigeration Institute (AHRI), in a recent white paper, suggests you verify the quality of the refrigerant in the virgin cylinder before use, verify the quality of the refrigerant in the vehicle system before repair or servicing and properly label and isolate systems suspected of contamination.

One clue to a possible R-40 counterfeit blend is the presence of identifiable R-22 but for now, anything less than a 100 percent pure reading should be treated with caution. Certainly, do not rely on any type of pressure/temperature relationship check. That might help identify the presence of air in that virgin tank but will not conclusively eliminate any counterfeit product.

Remember, the real problem with R-40 is what happens after it has been installed in a customer's car. The reactant chemicals, at the least, are highly damaging to the system components and, at the very worst, will cause an explosive hazard triggered when you open the system for repair or during the recovery of the gas into your machine. Organizations worldwide are still working on the best procedure for dealing with a system found to contain R-40.

While I've focused on R-40, the counterfeit problem is not limited to just this one chemical. According to Peter Coll, vice president at Neutronics Inc., “We have had the opportunity to examine over 1,000 sets of test data on R134a during the past 18 months. While some contained R-40, the amount of R-22,



With the rise of counterfeit blends worldwide, it only makes good sense to test what is in the car before you attempt to service it.



High end identifiers made starting in 2012 are the only ones capable of detecting R-40. Any reading less than 100 percent pure R134a should be treated cautiously.



We found many listings for R134a on sites like eBay. But if it's too good to be true, it probably isn't.



News was breaking over Daimler's decision not to use HFO1234yf even as the SAE committee was meeting in Orlando.

Photos: (TOP THREE) Pete Meier; (BOTTOM) MACS

R-142b and (other) hydrocarbons was extensive. It looks like the unscrupulous refrigerant manufacturers and packagers are putting any combination of refrigerants in the bottle if they can make a few extra dollars.”

The AHRI white paper backs up Coll's comments, stating in part, “Compounds such as R-40, R-22, R-142b, R-152a, and R-12 have been found mixed with R134a in newly filled refrigerant cylinders marked as containing R-134a. There have also been instances of counterfeited brand name R-134a cylinders sold containing refrigerants other than R-134a.”

On To HFO1234yf

If you've attended any trade shows in the last few years, you might have noticed that all the heavy hitters in the A/C business have been unveiling new tools and Recovery/Recycling/Recharging (RRR) equipment designed to meet the SAE standards for servicing the newest automotive refrigerant, HFO1234yf. Many models globally are using the new gas and domestically, at least one manufacturer has chosen to include it in a platform offered for sale right here in the U.S.

The decision to identify a replacement for R134a was made in response to regulations the European Commission passed, banning the sale of “new model platforms” using R134a starting in 2011 and banning the use of the gas all together by the 2014 model year. The concern was the global warming potential of R134a, an environmental condition where certain chemical compounds act as a blanket of insulation in the upper atmosphere. One of the first alternatives to be considered was CO₂, also referred to as R744.

At first glance, this appeared an ideal solution. Refrigerants (and other chemicals) were being analyzed and rated in terms of their global warming potential and assigned a numeric grade called a GWP number. R134a has a GWP of 1,300, according to the online resource, EngineeringToolbox.com, and the maximum allowed by the new rules was a GWP of 150. CO₂ is actually the baseline for establishing a GWP rating, making its rating 1. But there were other concerns that surfaced as the idea of using R744 in an automobile was being considered.



All of the latest and greatest products and services were on display at the MACS trade show in Orlando.

Photo: MACS

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First, in order for it to work, the system would have high side operating pressures in the 2,000-plus psi range. This could pose safety issues to both the technician and the passengers if used in a conventional design.

Second, CO₂ systems weren't that good at cooling cabins in climates that were on the high end of the normal temperature range.

Third, in terms of total emissions, CO₂ systems polluted more than their R134a counterparts. And fourth, the cost of a system using secondary loop design features to keep the high pressure circuit out of the cabin (and also control the threat of high CO₂ cabin levels in the event of a system leak) were costly and complex.

Other alternatives were assessed and considered, including the substitute eventually agreed on, HFO1234yf. Unlike others, though, HFO1234yf had pressure and temperature characteristics very similar to R134a. It was nearly a drop-in replacement that would require very little on the manufacturing side to adopt. One flaw to HFO1234yf is its classification as "mildly flammable."

But tests conducted proved to everyone involved that the risk was manageable. (As a side note, it was found that several other fluids residing under the hood were more susceptible to combustion in an accident scenario than the new gas was). The conclusions appeared to be so favorable that Atkinson even told *Motor Age* in a past interview that the topic of "R744 was a dead horse" and that "1234yf would



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be the replacement of choice."

Aftermarket tool and equipment companies spent resources and capital to bring the needed service equipment to market and as noted, some manufacturers started producing production vehicles fitted with HFO1234yf systems.

Some auto manufacturers, however, were holding back. Late last year, Daimler dropped a bombshell announcement, stating that tests it had conducted independently assessing the flammability risk of the new gas indicated issues that were outside of what they considered an acceptable level. It announced publicly that, because of these test results, they would not consider the use of HFO1234yf in any of their products and even recalled a few models that had been delivered state-side fitted with HFO1234yf systems.

What makes the announcement even more staggering is that Daimler, along with other German manufacturers that have since added their support to Daimler's position, where part of the original process that selected HFO1234yf in the first place.

In response, another Cooperative Research Project (CRP) was begun so that all of the original participants could review Daimler's new data. An interim report from the group released just before Christmas suggested that data collected at that stage had so far failed to uncover any new concerns about the safety of the refrigerant. Furthering the frustration felt by the industry as a whole was the announcement that Daimler was withdrawing from the CRP, followed soon thereafter by VW/Audi and BMW.

Honeywell, co-developer of HFO1234yf, said in press release shortly after the announcements, "The decision by Daimler to pull out of the cooperative research program, which had included 13 automakers from Europe, the U.S. and Asia, shows its unwillingness to accept the SAE's proven, scientific, peer-based approach that repeatedly demonstrated the product is safe as well as the fact that other automakers have been able to effectively and safely use 1234yf.

Unlike the SAE approach, Daimler's testing was conducted without the participation of any reputable third party and without consultation with others in the industry."

Daimler stands fast in its refusal to use the new refrigerant even though it might face serious fines for failure to comply with the EC rules. It had asked for an extension (and has been denied) so that it may pursue an alternative it feels is more attractive. The alternative they want to pursue is R744.

What does all this mean for us? While R744 is on the EPA Significant New Alternatives Program (SNAP) list and approved for use in automotive air conditioning systems, the systems are only in the design phase. In the meantime, other automakers are staying with R134a for models they offer in the U.S.

Even though some are calling for a phase down (rather than a phase out) of R134a in the U.S., right now the EC rules apply only to models offered for sale in Europe. While we have a few out in the domestic marketplace using HFO1234yf (primarily for the CAFE credits they can earn by making the switch), dealers likely will be tasked with taking care of the recovery and recharging tasks for the time being.

But that could mean unnecessary complications down the road.

According to an observation offered by Coll, "Unfortunately, small shops, large chains and ultimately the consumer will suffer greatly if the industry finds itself with different (refrigerant) cooling fluids from different OEMs. The 'We service all makes and models' may become a thing of the past unless service facilities are willing to spend excessive amounts of money on equipment and training."

And you thought having to own more than one scan tool was a pain. **ZZ**



Like any other area of automotive repair today, working on a/c systems requires up-to-date training and tooling.



PETE MEIER
TECHNICAL EDITOR

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

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DIAGNOSTIC TIPS: KEEPING IT SIMPLE

SIMPLE DOESN'T ALWAYS MEAN APPARENT, AND THAT'S WHY WE'RE HERE TO HELP.

BY "G." JERRY TRUGLIA | CONTRIBUTING EDITOR

I have a few simple, but maybe not so obvious, tips to share this month. Then TST member Ed Hazzard offers a few lessons learned in the bays.

Let's start with a couple of ways to keep "Keep Alive Memory" going when we change a battery or have to disconnect one to perform a system test.

One way is to get another fully charged battery or a commercial 12-volt jump pack and connect it to the feed side (that's the B+ post) of the alternator and a good engine ground. If the vehicle has posts under the hood for jump-starting, then you can connect to those instead.

Another way is to use a jump box with a diagnostic link connector (DLC). There are DLC jump leads that have a power cord connection on the other end to plug into the power cord outlet on your existing jump box. Simply plug right into the DLC connection under the dash.

Using either method will make sure the control modules stay powered up when you disconnect the main battery. That means no reprogramming radio codes or relearning any engine/transmission management parameters. But remember the positive battery cable is hot. Don't let it arc to ground while you are working. Use a shop rag to wrap the end of the cable, then tie wrap or tape the rag in place until you're ready to reinstall it.



Changing out a battery is a routine task, but have you ever been bitten by a radio that locked out as soon as you disconnected the cables?

Using an Amp Clamp

Amp clamps are great, because there is no worrying about blowing fuses, it's non-intrusive and it's easy. There are two kinds of amp clamps: low current and high current, and they work exactly the same. To work properly, though, the amp clamp's jaws need to be entirely closed and the 9-volt battery that powers it has to be good before you calibrate it.

You attach the amp clamp to your COM and V/mV ports on your meter/scope (those are the same connections you would use to take a voltage measurement), put it around the wire you want to measure the current in and that's it. Some scopes require a BNC connector, which allows you to plug into one channel on your scope. However, the meter you're using an amp clamp with is not set to display amps. That's because the amp clamp converts the current it senses into a millivolt signal your meter or scope can understand.

Take a look at the images at the meters we have connected at the battery during a check of key off battery drain. The readings are almost exact. The meter to the left is installed in series between the negative battery cable and the battery and set to the DC A scale, reading 14.14 amps (or 14 amps and 140 milliamps) while the meter to the right is using an amp clamp and is set on DC volts, reading 1.449 volts (which, when corrected per the amp clamp makers directions equals 14 amps and 490 milliamps). Note the headlights are on and a circuit breaker is used in series with the amp meter (left meter) to protect it from an accidental current overdose.

1994 Chevy Lumina 3.8L Late-Shifting

By Ed Hazzard, TST Member

The vehicle in question is a 1994 Chevrolet Lumina with the 3.8 V6 (Vin L) engine with 118,000 miles on the odometer. The customer was complain-



Photos: "G." Jerry Truglia

ing that the transmission would shift late, the engine would idle erratically and the check engine light would come on.

The technician had a code P0122 stored in the engine control module (ECM). That's a code for Throttle Position Sensor-Low Voltage. A throttle position sensor (TPS) that gives the PCM an incorrect reading could allow the transmission to shift improperly, so he replaced the TPS and the vehicle ran fine.

But the repair didn't last, and the shop replaced it three more times without discovering why the car was eating sensors. Yes, the tech installed a quality part, even using an OEM part from the local dealer on the last swap.



This box has a DLC connector that will keep all the modules going. The old days of a 9-volt battery plugged into the cigarette lighter are long gone.



These are identical meters, one using an amp clamp on the millivolt scale and one reading directly using the DC amps scale. Both reading nearly identical.



To keep KAM alive, you can connect a jump box or free-standing battery to the alternator B+ post and a good engine ground.

Even after replacing the sensor with the OEM part, the vehicle returned a couple of months later with the same concern. Now this becomes "The Challenge." It makes you ask yourself, "What did I miss, what didn't I see?"

I hooked up my scan tool to look at the data the sensor was displaying, and the voltage was, indeed, low. The correct specification for this throttle position sensor Key On Engine Off (KOE) is 0.33 to 0.46 volt. My reading was only 0.06 volt. Next, I disconnected the TPS harness connection and checked the 5-volt reference from the PCM at the A terminal of the connector. The reference voltage was correct.

Checking the sensor's ground at terminal B showed no problems with excessive voltage drop either. It is looking like a failed sensor. But the repeat failures tell me there is a reason all of the replacements experienced a short life span.

Based on my interpretation of how the system works it seemed like the sensor has failed again. After all, my reference voltage and my ground were good. I removed the sensor from the side of the throttle body to do a bench test, and you won't believe what I saw. The backside of the throttle position sensor was covered in a white powdery substance. I'd seen this kind of stain before: antifreeze.

The antifreeze was seeping out of the throttle body (which has a couple of coolant hoses going into it) and into the sensor. On this car, it was almost impossible to see unless you were looking for something that wasn't obvious.

Upon removal of the TPS, I saw traces of dried coolant residue where the sensor was mounted, but the coolant loss wasn't enough to alert the technician that a coolant leak was present. Lesson learned? Use your eyes, ears, nose, hands and brain. Those are the tools you really need to diagnose the car. *TZ*



G. Jerry Truglia, president of Technicians Service Training, has been in the auto repair business for a long time as a tech, shop owner and nationally recognized trainer/author. He founded TST to bring affordable training to his fellow techs and shop owners.

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SECOND OPINIONS

SOMETIMES CUSTOMERS TELL US ANOTHER SHOP HAS CHECKED THE PROBLEM.
SOMETIMES WE JUST FIGURE OUT THAT IT HAPPENED.

BY **RICHARD MCCUUSTIAN** | CONTRIBUTING EDITOR

I get quite a few help email requests from people through my website. A surprising number of them will rant about how a customer went to a shop, was charged \$800, went to a second shop when the vehicle wasn't fixed and was charged another \$500. They went to a third shop because the second shop also failed to fix the concern, and finally wound up at a shop where they were given a \$600 estimate but were afraid to give the green light. They want my opinion as to whether the third shop's repairs would take care of the concern.

What do you tell somebody like that? In this consumer-driven world, folks tend to take their business elsewhere if they don't like the merchandise or service. Rather than giving the first shop

a chance to straighten things out, they just try another shop.

I usually ask, "Why didn't you take it back to the first shop and have them make good on their repair instead of bouncing to another shop and then another?"

They almost never reply to that question. Granted, some of them tell me they have gone back to the first shop only to be told that more money needs to be spent to fix the same problem, and that kind of thing is frustrating beyond words. Who wouldn't lose confidence in a shop that pulls that kind of stunt?

From the shop owner's/technician's perspective, sometimes it seems like the deck is stacked against us. At the Ford dealer, I once drew a ticket on a mid-1980s Ford pickup that barely had the hood opened since it was new. It was a rough-idle-stall issue, and I found clogged idle air control passages and throttle body, filthy gasoline-laced engine oil, spark plugs that had almost melted completely away at their tips, plugged fuel filter, late ignition timing, a noisy TP sensor signal and a bevy of vacuum leaks. We created an estimate, received the go-ahead, made the repairs and test-drove the truck (which ran very well). But a week

later he came back and threw the "my truck still ain't fixed" flag. I discovered on that visit that the lift pump in the fuel tank was dead and that when the fuel tank was low on gas, the pressure pump on the frame might or might not begin to lose its prime. (From 1985 until 1989 Ford Pickups had that two fuel pump system.)

I had not sold this man anything he didn't need on the first trip, but when I gave him the estimate for replacing the dead in-tank fuel pump, he wanted me to guarantee that the fuel pump was going to fix his ragged, rusty, bald-tired ill-maintained ride. If this was your customer, what would you tell him?

Paying Tribute

Larry's son lives a few hours to the north of us, and he drives a Mazda Tribute, which had no symptoms other



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Vehicle Year/Make/Model

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Transmission

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than an illuminated Check Engine light. Because the son was in town, Larry brought the Mazda to have us look at it. My technician promptly pulled a P0135 code, which points to an open in the HO₂S 1/1 heater circuit, and while pinpoint tests abound for this kind of concern, it isn't rocket science to troubleshoot an O₂ heater.

First, though, it's wise to make sure you're checking the right sensor, particularly on a vehicle that has two upstream and two downstream sensors. Back in 1994, I botched that up on a brand new Thunderbird when I kept checking the wrong sensor because I didn't know which sensor was which. In those early days of OBDII, I was erroneously thinking 1/1 and 1/2 should be the front sensors and 2/1 and 2/2 should be the rear ones. Everybody now knows how wrong that is.

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HO₂S 1/1 is upstream of the catalyst on the same bank of the engine where cylinder No. 1 is located, and HO₂S 1/2 is the downstream sniffer on that side. That bank isn't on the same side on every V-engine vehicle. On this Mazda, the rear bank is where the number one spark plug is located. The No. 1 cylinder is the one attached to the front connecting rod on the crankshaft on every engine I've ever seen, and on GM and Dodge engines, the No. 1 cylinder is on the opposite bank from Ford-Mazda packages.

With a heater code like this, the sensor itself usually is the problem. But as we investigated, we found that somebody already had screwed a new one in there. The O₂ sensor connector was pretty and white, which didn't match the green harness connector in color. But that in and of itself wasn't a problem. I did wonder who screwed the new

sensor in, how much they charged and why they gave up after replacing the part. His son isn't that wrench savvy — this sensor is tough to get to. Maybe he took it to a parts store, got a sensor and had a wrench-friend screw it in? Larry hadn't a clue, and I didn't press the issue, because there was no point in it.

We started by measuring the resistance of the O₂ sensor heater. Those two wires will just about always be the same color on the sensor pigtail. The heater is usually fed by two white wires, two brown wires or two black wires. On this one we found 5.5 ohms, which is fairly normal.

Vectoring In on the Concern

The next thing we did was to utilize one of my own inventions, a handy homemade tool. I take a matching O₂ sensor connector (cut from an old sensor) with a light bulb wired into the two sensor wires. This is a cheap tool to build and always gives reliable results. With the engine started, the sensor heater should be powered and grounded and the light should illuminate.

With that plugged into the green harness connector, we started the engine to see if that light would come on. If it did, we would know we had both power and ground at the sensor. It didn't illuminate, and that took us one step closer to the repair, but we hadn't arrived at our final prognosis.

We found that the sensor had good 12-volt power available to the heater so we didn't need to go that way, but

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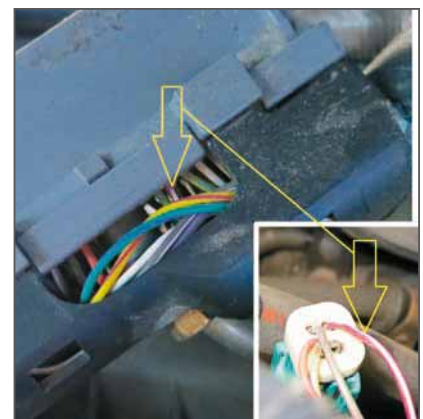
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This was the circuit in question. Using the connector pinout and wire color to make sure we were checking the right wire, we found this one to be an open circuit between the PCM and HO₂S1/1.

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With an old HO₂S pigtail and a light bulb, you can make a very reliable O₂ sensor heater circuit checker. The one I have in my toolbox at home is a breakout harness with a long lead. I plug in between the sensor and the vehicle harness so as to check heater operation and live sensor voltage right there in the driver's seat.

the PCM delivers the ground (and measures O₂ heater current draw), so we switched our focus to the dark side. I explained to my student that while most learners are quick to check the bright side of a circuit, they have to learn (using my Darth Vader voice) that you don't know the power of the dark side. Grounds frequently are overlooked, but this ground is a controlled output from the PCM, and here we were.

“I cautioned Derrick to make sure he put the feed hose on the heater core tube with the restrictor crimped into it. The return flow shouldn't be restricted.”

From the PCM to that O₂ sensor is a straight shot — no connectors en route, and so we drew on our ALLDATA wiring schematic to find that pin 93 feeds ground to the O₂ sensor heater on this one.

With the PCM disconnected, it was a simple matter to first examine pin 93 for damage or push-back. But it looked brand new. Then we measured current carrying ability from cavity 93 to the wire right there at the connector, checking for a bad crimp or maybe some oxidation, but that crimp was solid. The PCM is only about 24 inches from the O₂ sensor connector and the circuit is cocooned in convolute loom. There was no continuity between pin 93 and the appropriate O₂ sensor connector pin.

This vehicle's wire harness looked like factory. Nobody had hacked around behind the engine and there were no chafing or burning concerns, so how this perfectly undisturbed harness could have developed an open circuit in just one of the myriad of wires traveling through it represents a mystery. The detective in me wanted to split the harness and find out what was going on in there, but the production-oriented mechanic in me decided to have Daniel, my student, run an overlay through a small piece of split loom secured to the harness.

A properly run overlay is the smart way to handle this kind of thing. Solder, heat shrink, loom, wire ties (preferably black ones), etc. and we had a closed circuit heater once again. Check Engine light out — current readings on the scan tool normal. Mission accomplished. This was a textbook troubleshooting and repair operation.

Other Jobs Under Way

As usually is the case, there were other jobs under way in my shop. One was a 1996 Taurus that was purchased as a used car and immediately developed overheating and transmission concerns (cooling system loaded with rust and intermediate clutch pack fried). Another was an Expedition that had a leaking heater core (replaced two years ago for leaking but was leaking again).

The Expedition was fun, and while the guy I gave it to is fresh out of high school, he has at this point completed most of my courses as a dual



This was the first thing Derrick, my student, noticed when he removed the panel and plenum down to the blend door and the heater core. The blend door was installed incorrectly (note the rust from the leak). After some work, he replaced the heater core and installed the blend door correctly.

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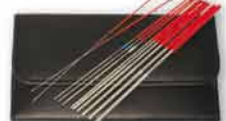
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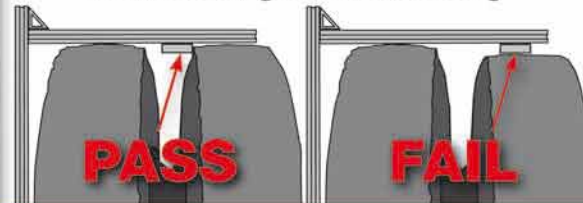


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The left hand tube on this heater core is outfitted with an orifice. Connecting the heater core backwards in this case would pressurize and burst the core.

enrollment student, and he's cruising toward a profitable career as an automotive technician. I have him working afternoons at a very busy independent shop.

That's a story in itself; the owner of the shop called me to see if I had anybody he could use. He aired his frustration at the fact that every technician he has hired for the past two years has disappointed him. They start out strong but after a month or two, just about every one of them turns lazy, unprofitable and undependable.

He explained that he had to turn work away, because he didn't have sufficient help to get it out of the shop. I sent him Derrick last fall, and he couldn't be happier with this young fellow's work energy, enthusiasm, work ethic and willingness to take on virtually any job. Derrick puts in his Monday through Thursday mornings with me,

and his afternoons, Fridays and some Saturday mornings at that shop.

He dug into the Expedition heater core job with knowledge and understanding because he had done the job on other Expeditions at the garage where he works. When Derrick got the instrument panel and air box cover off to expose the heater core, he pointed out that the blend door had been improperly installed by the previous technician (no wonder the heat didn't work) and the rusty water that was leaking out of the core indicated that there was probably some electrolysis going on. A vigorous cooling system flush would be in order. But there was more.

The replacement heater core was different from the heater core we were removing. It was outfitted with a restriction in the heater core inlet, and when I saw that, I cautioned Derrick to make sure he put the feed hose on



With this clear hose bypassing the front heater core, we started the engine and it became clear which way the coolant was flowing. We flushed this nasty system before reconnecting the new front heater core.



This was our fix on the Plymouth Breeze – soldered, heat-shrunk, loomed and taped. One of my favorite axioms (and I tell my guys this all the time) is that every job is a picture of the person who did it.

the heater core tube with the restrictor crimped into it. The return flow shouldn't be restricted or the heater core will burst from internal pressure. Interestingly, there were no instructions with this replacement heater core regarding the restrictor. Because both tubes are the same size, it would be easy to make a comeback-generating mistake. The restrictor typically is there to reduce noise, and it also allows the water to travel more slowly through the core so as to release more heat.

The feed hose generally comes from the water pump, but we wanted to be absolutely sure which way things were flowing on this one, so we used a piece of clear hose from the hardware store and looped out the two hoses. When we started the engine, we saw which way the coolant went. There was no guessing, and we also were able to determine that we had good coolant flow. A rusted out water pump impeller might keep the engine cool, but move very little through the heater core.

We replaced the core as well as the quick connect fittings, and I personally took the Expedition to the wash rack and ran clean water from a hose through both heater cores, flushing out enough rust to paint a parking lot. With everything reassembled, the rest of the cooling system flushed with the big machine and a 50/50 coolant mix flowing, we saw a 175-degree temp ceiling.

Replacing the thermostat raised it to 200 degrees, which was much better. That and a blend door finally got some heat flowing. ZZ



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'EVERYTHING GETS OLD'...EXCEPT THE RIDE CONTROL OPPORTUNITY

Shock absorbers and struts are hidden beneath the vehicle, and many motorists simply aren't aware of when and how they wear out. In contrast, many other consumer goods – furniture, clothing, tires, and batteries – offer obvious signs that tell the owner it's time to replace old with new.

Tenneco's Monroe® shocks and struts brand is committed to closing the gap between consumer replacement of everyday worn products and the ride control components that help keep motorists safe. The brand's innovative new "Everything Gets Old. Even Your Shocks" integrated marketing campaign is reminding millions of vehicle owners that shocks and struts get old – just like their favorite chair or pair of shoes.

"Shocks and struts often wear out so gradually that many vehicle owners fail to detect the loss of steering precision, stopping performance and stability," said Monroe Brand Manager Carri Irby. "Our campaign reminds consumers that ride control components are just like most other products, including tires and brakes – they get old. And when they do they can compromise the safety of their vehicles and should be replaced at 50,000 miles¹."

The Monroe campaign includes thousands of print, online and network radio ad placements and hundreds of strategically selected roadside billboards. The "Everything Gets Old" message also will appear in high-visibility banners behind the plate and along the baselines of several leading Major League Baseball stadiums. Digital placements include engagement-driven Web banners, "in-app" music/radio ads and a variety of elements designed specifically for users of mobile electronic devices.

Tenneco is coordinating its radio presence with the launch of billboards in several major markets. In addition, popular radio personalities will make special appearances in conjunction with local Monroe "Ride & Drive" ride control training events to reinforce the importance of inspecting and replacing worn shocks and struts.

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When consumers do invest in replacement ride control products, Tenneco offers a comprehensive portfolio of premium Monroe shocks and struts engineered to help restore "like-new" ride and handling:



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¹ Actual mileage may vary depending upon driver ability, vehicle type and type of driving and road conditions.

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PERFORMANCE SHOCKS

Tenneco's Rancho brand of performance suspension and shock absorbers has recently added Rancho torsion key systems for Chevrolet/GMC Silverado/Sierra 1500, 2500HD and 3500HD trucks to its product line. Designed to level the truck's stance, Rancho torsion key systems are a fast and easy way to add 1 to 2 1/4-inches of lift over stock, according to the company. The new kits allow the truck owner to clear up to 33-inch tires and help compensate in instances where there is added front-end weight such as snow plows, heavy-duty bumpers or winches.

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www.tenneco.com.

Tenneco Inc.



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The new Snap-on Ball Joint Remover (BJR1) for Subaru vehicles makes removal of stubborn ball joints on select Subaru models a lot simpler, increasing productivity and saving time, the company states. By using the BJR1, service technicians can safely remove ball joints as the tool helps deal with low clearance and heavy corrosion. It is ideal for use on a variety of Subaru models, including Baja (2003-2006), Forester (1998-2010), Impreza (1993-2010), Legacy (1990-2010) and Outback (2000-2010).

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www.mightyautoparts.com

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TPMS SENSOR

Standard Motor Products, Inc. has added the Ford-banded style TPMS sensor to its growing clone-able TPMS sensor line. This new clone-able sensor matches the original for fit, form and function; and due to its advanced engineering, it can easily be cloned with the existing sensor ID, eliminating the need for a factory relearn, the manufacturer states. Standard® part TPM23A offers extensive model coverage for Ford, Lincoln, Mercury and Mazda, 2005 through 2011.

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Ingersoll Rand has expanded the IQV20 Series cordless tool line with the addition of the L5110 cordless LED task light. The L5110 is ideal for garage, industrial and maintenance applications, and is engineered for exceptional performance, versatility and durability on the job, the company states. The L5110 features a patented aluminum head that dissipates heat and is lightweight, yet heavy-duty. Like other IQV20 Series cordless tools — including the W7150 ½-inch cordless Impactool™ — the L5110 is durable and has an impact-resistant housing to protect against corrosive fluids, chemicals and repeated drops. The versatile work light has a multi-position head, hands-free standing base and hang hook to light work spaces from any angle — high or low. The L5110 cordless work light includes a powerful, ultra-bright white LED light that casts 180 lumens and lasts up to 20,000 hours.

www.ingersollrand.com

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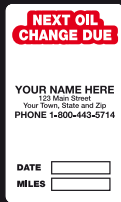
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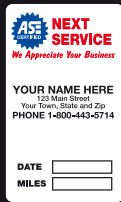
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TOOLS & EQUIPMENT

ORIGINAL HUB MASTER

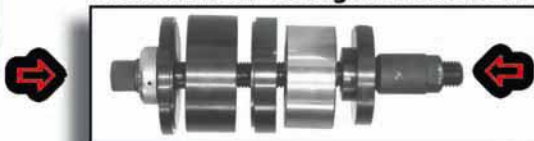
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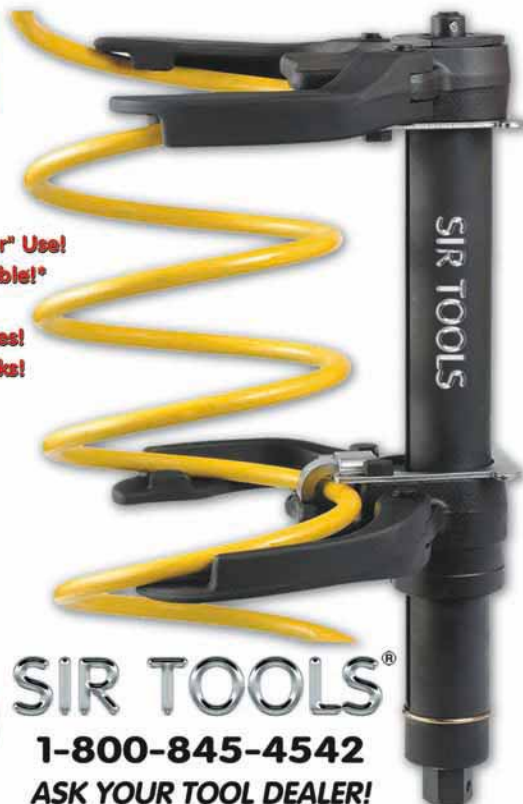
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ADVERTISING AND EDITORIAL PRODUCT INDEX

ADVERTISER INDEX.....PAGE

<input type="checkbox"/> ADVANCE AUTO PARTS PROFESSIONAL.....	59
<input type="checkbox"/> AIRTEX PRODUCTS.....	35
<input type="checkbox"/> ALLDATA LLC.....	61
<input type="checkbox"/> ANAHEIM GEAR.....	34
<input type="checkbox"/> AUTOENGINEUTY.....	75
<input type="checkbox"/> AUTOMOTIVE DISTRIBUTION NETWORK.....	49
<input type="checkbox"/> AUTOMOTIVE MGMT. INSTITUTE.....	48
<input type="checkbox"/> AUTOMOTIVE TRAINING INSTITUTE.....	22
<input type="checkbox"/> AUTOPROFITMASTERS COM.....	17
<input type="checkbox"/> AUTOZONE INC.....	26-27
<input type="checkbox"/> BENDPAK INC.....	73
<input type="checkbox"/> BESSER BRAKE PADS.....	57
<input type="checkbox"/> CARQUEST CORPORATION.....	3
<input type="checkbox"/> CHRYSLER GROUP LLC.....	10-11
<input type="checkbox"/> CORTECO.....	31
<input type="checkbox"/> EASTERN MANUFACTURING.....	66
<input type="checkbox"/> EXXON MOBIL.....	CV3
<input type="checkbox"/> FEDERAL MOGUL CORP. - WAGNER.....	46, 47
<input type="checkbox"/> FORD MOTOR MEDIA.....	37, 63
<input type="checkbox"/> GMB.....	29
<input type="checkbox"/> GABRIEL RIDE CONTROL INC.....	55
<input type="checkbox"/> HENNESSY INDUSTRIES.....	39
<input type="checkbox"/> HUNTER ENGINEERING.....	67
<input type="checkbox"/> IATN.....	48
<input type="checkbox"/> IDENTIFIX.....	41
<input type="checkbox"/> INGERSOLL RAND CO.....	23
<input type="checkbox"/> INNOVATIVE PRODUCTS OF AMERICA.....	77
<input type="checkbox"/> INTERMOTOR/SMP.....	69
<input type="checkbox"/> KIA MOTORS AMERICA.....	21, 53
<input type="checkbox"/> MERCEDES BENZ USA.....	5
<input type="checkbox"/> MIGHTY DISTRIBUTING SYSTEM ATL.....	43
<input type="checkbox"/> MITCHELL 1.....	7
<input type="checkbox"/> MUDLICK MAIL.....	79
<input type="checkbox"/> NAPA.....	9, CVTIP
<input type="checkbox"/> OREILLY AUTO PARTS.....	15
<input type="checkbox"/> PERMATX INC.....	65
<input type="checkbox"/> PHILLIPS.....	74
<input type="checkbox"/> RANSHU.....	44-45
<input type="checkbox"/> RAYBESTOS BRAKES.....	18, 19
<input type="checkbox"/> SCHAEFFLER GROUP USA INC.....	CV2
<input type="checkbox"/> STELLAR AUTOMOTIVE GROUP.....	38
<input type="checkbox"/> TENNECO AUTOMOTIVE BLDG.....	71, 78, 80
<input type="checkbox"/> TOYOTA MOTOR SALES USA.....	32-33
<input type="checkbox"/> TRACER PRODUCTS.....	51
<input type="checkbox"/> VOLKSWAGEN OF AMERICA.....	25
<input type="checkbox"/> VDO OE REPLACEMENT PARTS.....	54

<input type="checkbox"/> WORLDPAK.....	CV4
--	-----

EDITORIAL PRODUCTS.....PAGE

Prestone.....	81
Tenneco Inc.....	81
Philips Automotive Lighting North America.....	81
Hunter Engineering.....	81
Bosch.....	81
ITW/Accessories Marketing.....	82
Snap-on Tools.....	82
Mighty Auto Parts.....	82
Standard Motor Products.....	82
BOGE America.....	82
Ingersoll Rand.....	82
CORSA Performance.....	82

APG.....PAGE

Tracer Products.....	83
WORLDPAK.....	83
Advance Auto Parts.....	83
Gabriel.....	83
Intermotor/SMP.....	83
NAPA.....	83
KYB.....	83
GMB.....	83

ARTICLES.....PAGE

ATE storms ASA-Wash.....	6
AAIA, ASE recognize World Class Technicians.....	6
Mitchell 1 enhances SocialCRM with mobile optimization.....	8
ASA hires industry vet as executive VP.....	8
Vehicle inspections — measuring the results.....	12
Best of the blogs, videos and discussions.....	12
Q&A with Rich White, executive director, The Car Care Council.....	14
Management feature: Honest ratings.....	16
Profit Matters: Create marketing that gets ignored.....	20
The Owner's Box: Changing with the times.....	24
Shop Profile: The talk of the town.....	28
POWERTRAIN PRO: That was too easy.....	30
Drivability: The 10 modes of OBDII.....	40
ATSG Training Tips.....	50
Electrical: A tale of two circuits.....	52
Underhood: Signed, sealed, delivered.....	58
Undercar: Time to get ready.....	64
Scope & Scan: Diagnostic tips: Keeping it simple.....	70
Motor Age Garage: Second opinions.....	72
The Trainer: Testing battery faults.....	88

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TESTING BATTERY FAULTS

NO CRANK, SLOW CRANK? IS IT THE BATTERY?

BY **PETE MEIER**

Technical Editor

Not too long ago, I received a call late in the evening from my youngest son's girlfriend. Her Ford Explorer wouldn't start, she said, and could I please come and help? What was I going to do, say no?

I grabbed a meter and some basic tools and drove over to see what the problem was. It didn't take long to discover that someone had replaced the negative battery cable end with an aftermarket clamp-style end, and it was spinning freely on the battery's ground post. This is a classic case of voltage drop.

The connection was enough to allow the lights to work, but as soon as the high current demand from the starter tried to make its way through, the connection gave up and went open. I removed the clamp and cleaned the connection, then reattached the cable to the battery and tightened it. She started the SUV right up, and I told her to stop by the next day so I could make a more permanent repair and check out the rest of the system.

Did she listen? Of course, she didn't; she's a kid.

The next night, I got another call from her, with the same complaint. However, this time the fault wasn't a matter of voltage drop, but of voltage period. When I arrived, the battery only read 8.64 volts, nowhere near enough



to start the Ford's 4.0-liter engine. Heck, that's not enough to start my lawn mower's engine! But why is there a problem with the battery now, just a day later, when the truck started fine last night and all during the day?

When you have a problem with no crank or slow crank, you need to make sure you test both the battery and the starting system to see where the culprit lay. And if the battery is weak, you need to know why. Is there a problem with excessive resistance in the cables, like I had the first night? Is the charging system doing its job to keep the battery healthy? Or did the battery just die of old age or neglect?

That's the topic of this edition of The Trainer. The Trainer is *Motor Age's*

monthly how-to video series for today's technicians. Technicians of every caliber, including those in the classroom, can learn something from this video series. **▶▶**

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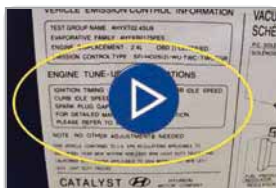


[VIDEOS]



Chasing parasites (what drains a battery)

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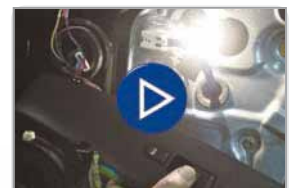
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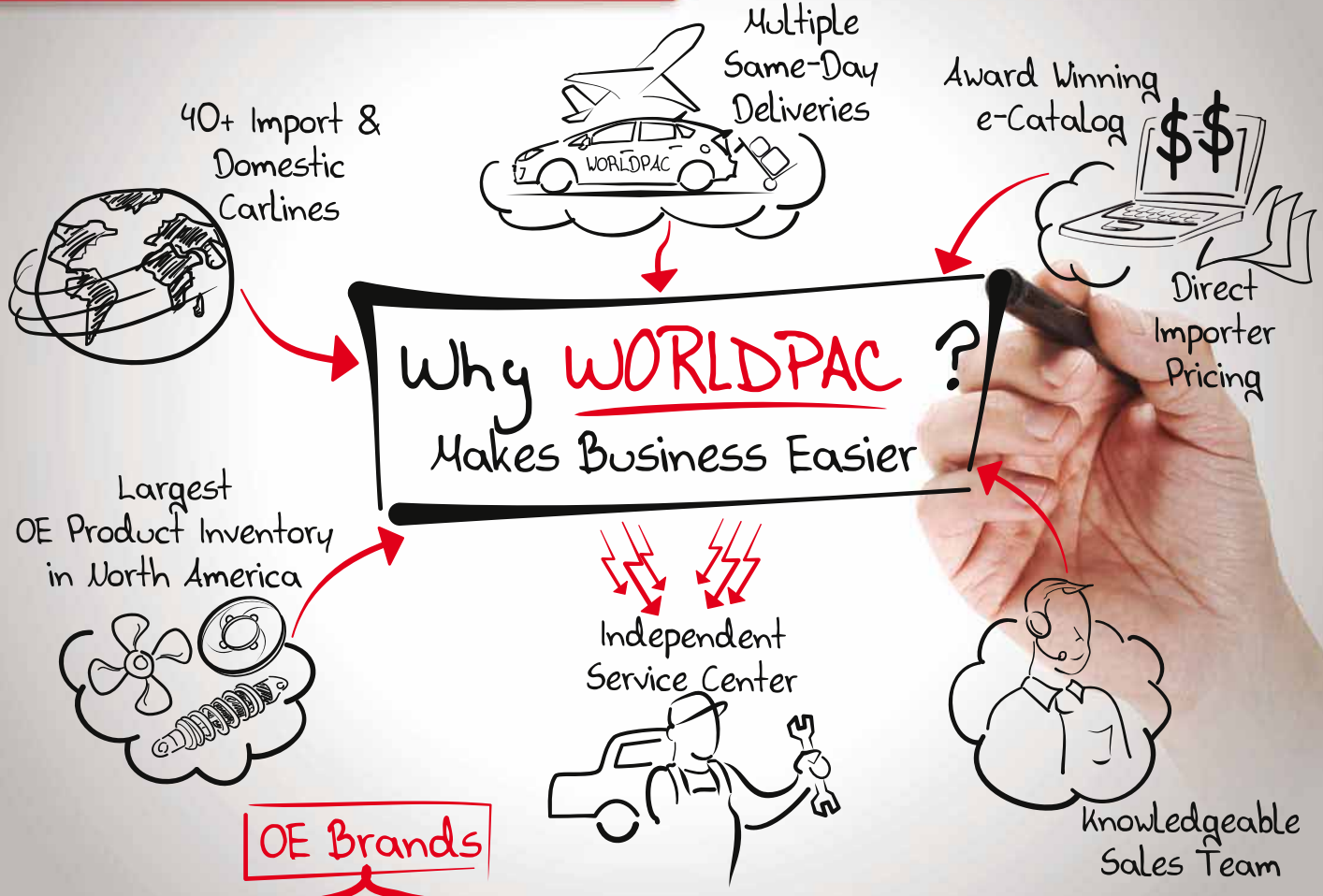
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Genuine Parts

Positive Outlook for Repair Opportunities in 2013 and Beyond

Kia Motors America (KMA) announced record-setting sales performance for the first month of the year. In addition, a number of all-new and significantly redesigned vehicles are scheduled to hit showrooms this year. The steady stream of new Kia vehicles in the market foreshadows future maintenance and repair opportunities.

KMA reported all-time record sales for January 2013. The sale of 36,302 vehicles represents a 2.2-percent increase over the same period in 2012. Continuing to lead sales for the brand, sales for the Optima midsize sedan and Sorento CUV were 11,252 and 8,005 units respectively. One of only three automotive brands to increase U.S. sales in each of the past four years, Kia surpassed the 500,000 unit annual sales mark for the first time in 2012.

Sustaining KMA's momentum in the

New vehicle launches combined with the number of Kia vehicles on the road provide tremendous opportunities for service providers.

new year is the arrival of several all-new or significantly redesigned vehicles. Leading the way is the debut of the stunning, all-new 2014 Cadenza premium sedan. Cadenza is the most technologically-advanced vehicle Kia will introduce in North America. It is expected to start to arrive in Kia retail showrooms in the second quarter of the year.

Debuting at the Los Angeles Automotive Show late last year were the all-new 2014 Forte and the significantly redesigned 2014 Sorento. Poised to take the compact car segment by storm, the Forte will represent the heart of KMA's

small-car line-up. It will replace the current Forte, which has been a sales success story since launching in 2009. Both the Forte and the Sorento are expected to land in showrooms by the second quarter of this year.

New vehicle launches combined with the number of Kia vehicles on the road provide tremendous repair opportunities. And your local Kia dealer is there to help with complete coverage for all models. The best parts for Kia vehicles are Genuine Kia Parts designed, engineered and manufactured specifically for Kia vehicles. They are the only parts backed by the Kia name and warranty*. Combined with the best technical support, Genuine Kia Parts and accessory products help you put your mind at ease and ensure customer satisfaction.

Kia Motors America, Inc.

* Kia Genuine replacement parts (except battery) installed by an Authorized Kia Dealer under warranty are covered for the greater of (1) the duration of the New Vehicle Limited Warranty or (2) the first 12 months from the date of installation of the Kia Genuine replacement parts or 12,000 miles.

In This Issue

VOL. 8 | NO. 1 SPRING 2013 | *Quality Connection* is published by Kia Motors America



3

Rare Air

Keeping the HVAC system clean while preventing air restrictions



4

Visible Improvement

Chatter-free sunroof operation



8

Corrosion Resistance

Sedona heater coolant pipe replacement

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Rare Air

Keeping the HVAC system clean while preventing air restrictions

Help your customers breathe a sigh of relief by installing a Genuine Kia cabin air filter. Cabin air filters block leaves, dirt, bugs and other debris from entering the Heating, Ventilation, and Air Conditioning (HVAC) system. This helps to prevent air restrictions that reduce airflow and the output of the heater, defroster and air conditioner. Keeping the HVAC system clean also helps reduce the growth of odor-causing mold and other microbes on the A/C evaporator.

Genuine Kia cabin air filters are highly efficient and have electrostatically charged fibers that do an outstanding job of trapping even the smallest particles.

So, the next time your Kia customer comes to your shop with a poor heating or cooling condition, it may be time to replace the cabin air filter. When you install Genuine Kia cabin air filters, everyone breathes easier. 



Contact your local Kia dealer for the complete range of Genuine Kia Parts.



Genuine Parts

Visible Improvement

Chatter-free sunroof operation



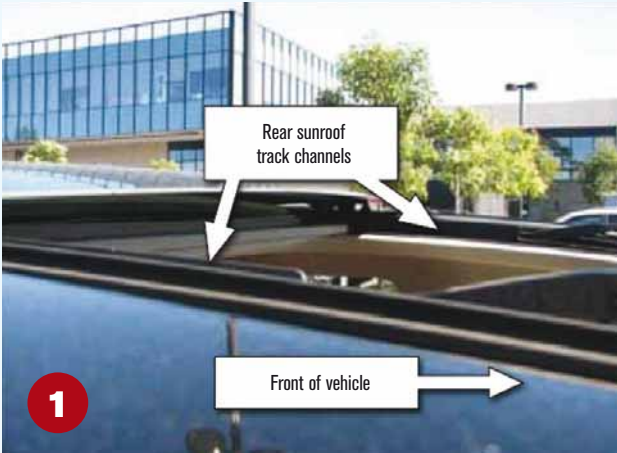
Silicone-based grease provides vibration-free operation for Kia Sorentos equipped with panoramic sunroofs. Application of Kia's dampening grease will ensure proper lubrication of your customers' vehicle.

Kia vehicles requiring collision repair service offer repair outlets opportunities to perform preventive service and enhance customer satisfaction. The Kia Global Information System – www.kiatechinfo.com - is a rich resource for 24/7-access to model-specific technical information and repair instructions. Reviewing the site for information on the Kia model in your facility will go along way to promoting loyalty to your repair facility.

Some 2011-12 Sorento models (produced prior to 11/29/11) may exhibit vibration or chatter in the operation of the sunroof during normal operation.



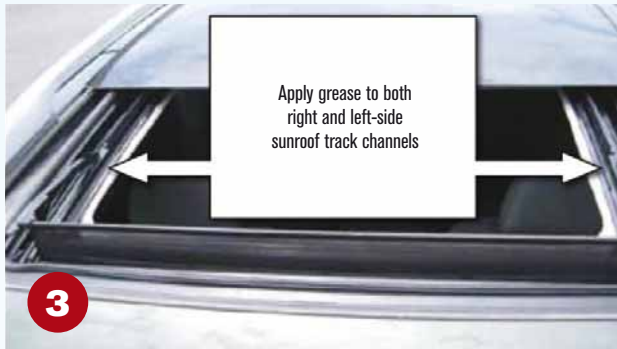
» See your local Kia dealership for model application and product availability.



Sunroof track panels must be free of debris and dust.



Ensure all existing grease is completely removed.



Apply silicone-based grease front to back on both sides of the track panels.



Apply grease evenly to prevent chatter.

This condition is caused by insufficient lubrication and/or debris in the side sunroof tracks. To remedy and/or prevent this condition, Kia offers a dampening grease, Kia part no. UM011 CH052. It is a silicon-based grease that is incompatible with hydrocarbon-based grease that may be present in sunroof's side track channels. Effected models are in the production date range from October 23, 2009 to November 29, 2011.

Replacing the grease

The following information provides the proper procedure to replace the grease to ensure chatter-free operation on affected models. *As with any procedure requiring the use of compressed air, always wear proper eye protection.*

1. Open the sunroof completely and use compressed air to blow out any foreign material or dust that has built up in the side track channels. Then thoroughly clean out the existing grease from both channels. It is important to ensure that the existing grease is completely removed, otherwise cross-contamination could occur with the new grease, reducing the lubricating effectiveness.

2. Inspect the sunroof track channels for any binding or broken components. Repair and replace if necessary.

3. Apply the new grease evenly to the right and left-side of the sunroof channel tracks. Ensure the tracks receive an adequate amount of dampening grease to completely lubricate the entire right- and left-side track channels front to rear.

4. Inspect the channel tracks for proper grease distribution. Inadequate amounts may cause chatter and noise during normal operation of the sunroof.

5. Open and close the sunroof five times to evenly spread the lubricant throughout the track channels. Allow five minutes for the sunroof motor to cool down, and then repeat the cycle one more time.

The factory-spec quality of Genuine Kia Parts guarantees quality repairs the first time every time. Contact your Kia dealer for quality parts and expert advice. **KIA**



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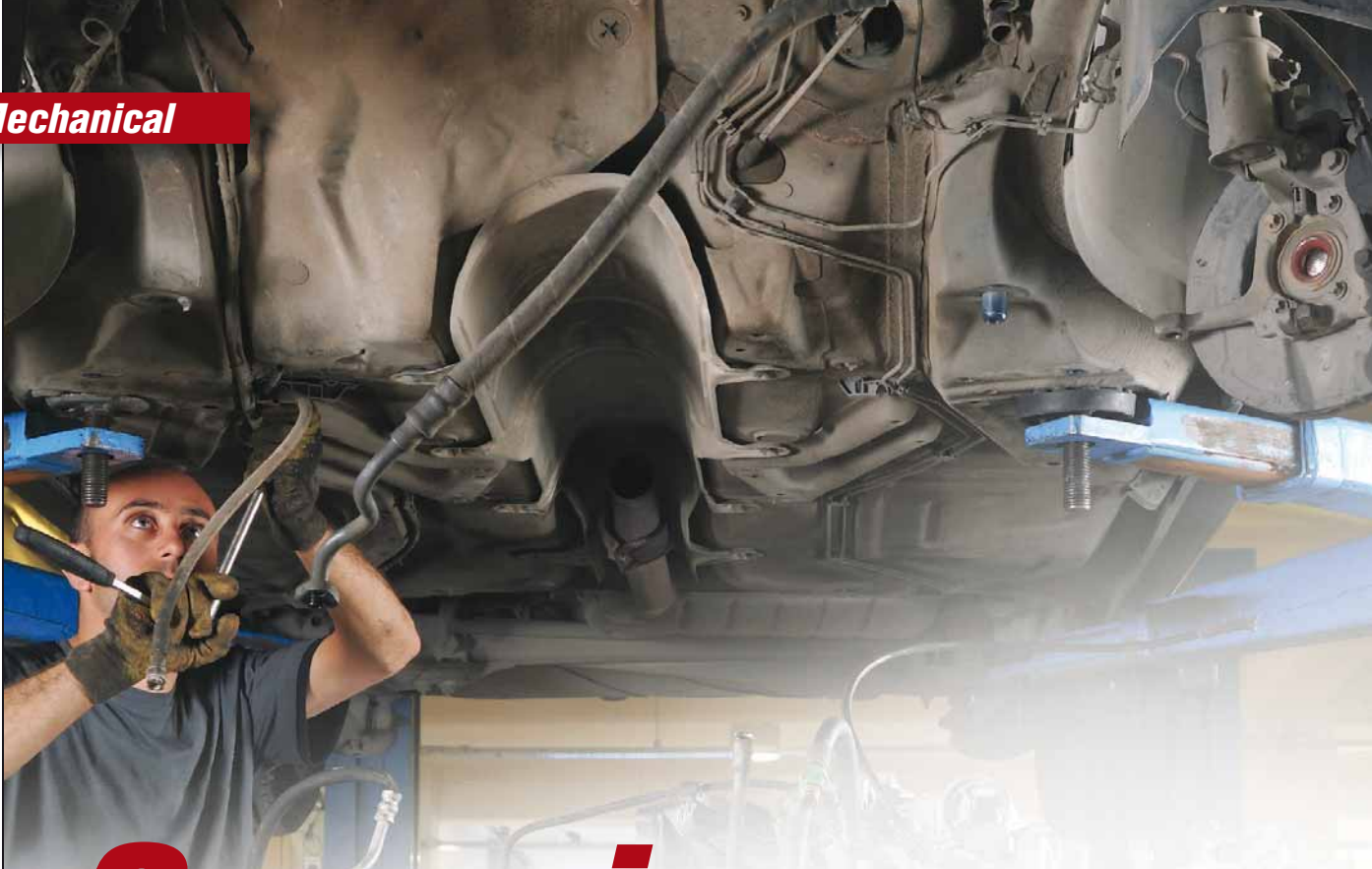
What part of “genuine” don’t you understand?

From headlights to tail lights, body parts to engine parts and lubricants, there is no substitute for genuine. And the only way to assure that you are getting genuine Kia parts, backed by the Kia warranty*, is to order them from your local Authorized Kia Dealer.



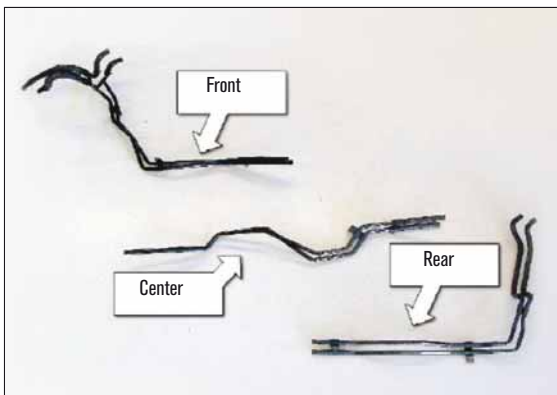
Genuine Parts

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Corrosion Resistance

Sedona heater coolant pipe replacement

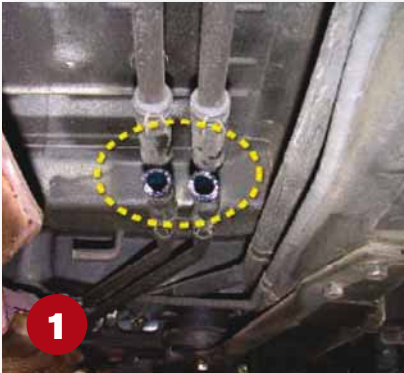


Kia Pipe and Hose Assembly Part Numbers

Front	OK52Y 61 211BFFF and OK52Y 61 211CFFF
Center	OK552 61 212NFFF and OK552 61 212MFFF
Rear	OK552 61 213KFFF

HEATER COOLANT PIPE CORROSION can occur without warning in some Sedona models. This condition is often found in areas of the country, where corrosive compounds such as sodium chloride and calcium chloride are spread on pavement to control freezing and melt ice. It is also found in warm seasons and climates to control dust on unpaved roads. Effected Sedona models are in the production range May 1, 2001 through August 30, 2005. During routine maintenance, inspect the heater coolant pipes for severe corrosion. The following procedures detail the steps required for removal and installation of new pipes.

Contact your Kia dealer for the new corrosion-resistant components needed for the procedure.



Front Pipe Removal

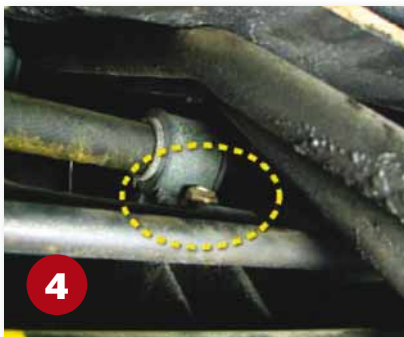
1 Once the engine has cooled sufficiently, remove the radiator cap, and raise the vehicle on a lift. Cut the two flexible coolant hoses between the front coolant pipes and center coolant pipes, and allow coolant to drain into a large container. Note that a large amount of coolant will drain from the hoses.



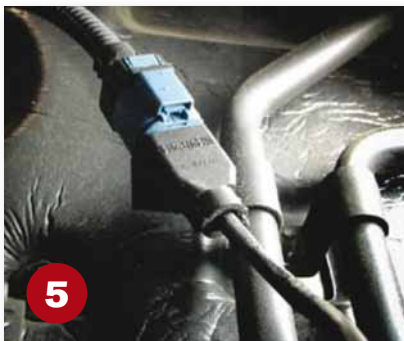
2 Remove the catalytic converter.



3 Remove the splash shield from the sub-frame on the right-hand passenger side.



4 Remove the bolt holding the power steering lines on the right-hand passenger side.



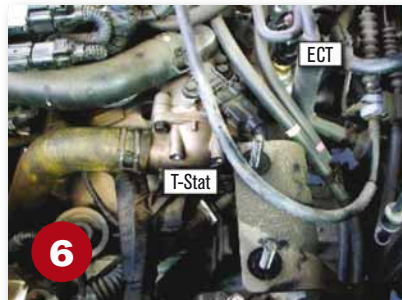
5 Detach the oxygen sensor connector from the coolant pipes,



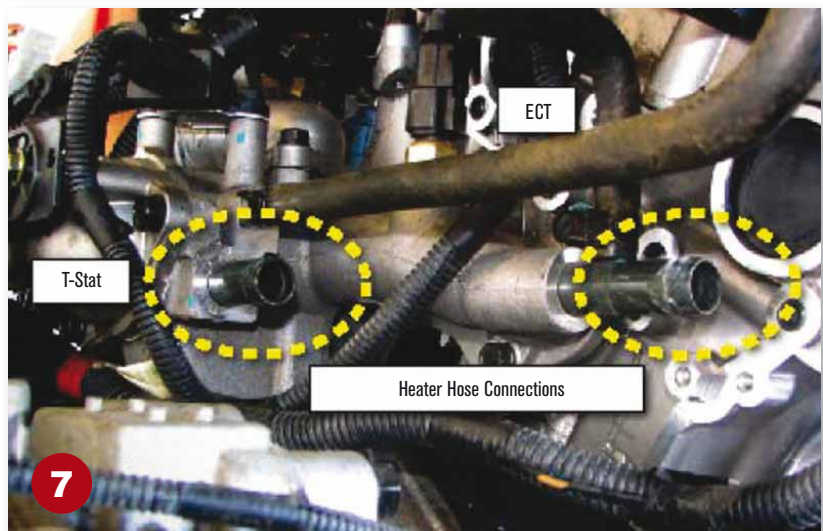
then remove the one nut and two bolts that attach the coolant pipes to the body.

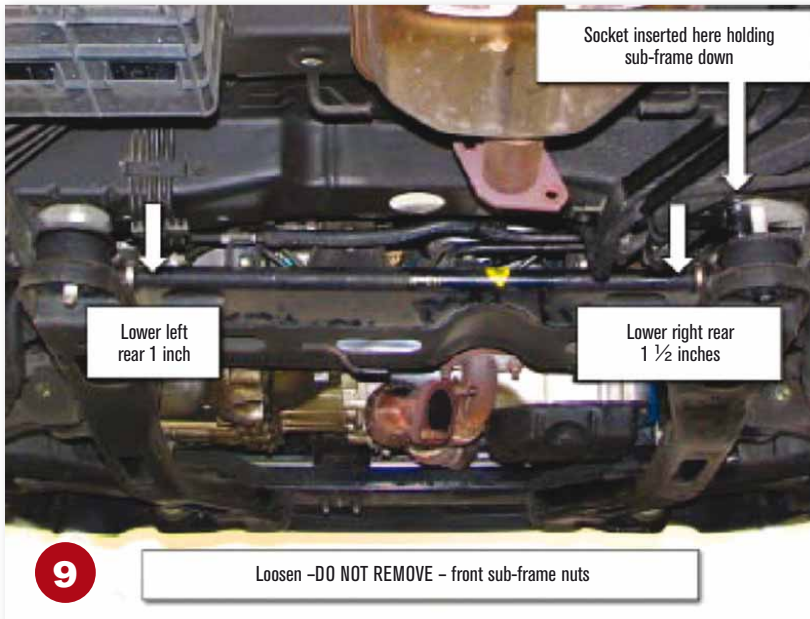
6 Lower the vehicle leaving the drain pan in place to catch any additional coolant. Remove the air filter assembly and intake hose to the throttle to access the area where the two heater hoses attach to the engine. The hose connections are below the thermostat/ECT area.

7 Disconnect the two heater hoses from the engine. Cut the two hoses just removed off of the original coolant pipe assembly as close to the coolant pipe connections as possible.



8 Cut the coolant hoses off the heater connections as close to the heater core as possible. Remove the clamps and remaining pieces of hoses from the heater core assembly. Take extreme care not to damage the heater core or its connections.





9 Raise the vehicle on a lift. Loosen but do not completely remove the two front sub-frame nuts. Remove both rear sub-frame nuts and carefully pry the sub-frame down about 1 inch on the driver side, and about 1½ inches on the passenger side. Do not pry the driver side down further than recommended. With the steering rack attached, it may be damaged. It may be necessary to hold the sub-frame down on the right passenger side while removing the coolant pipe assembly. If necessary, place a shallow socket or similar material that is 1½ inches in height between the body and sub-frame assembly on the right-hand side. Carefully remove the front coolant pipe assembly, noting its original positioning and routing for reference during installation of the new part.

Front Pipe Installation

10 In preparation for installing the front coolant pipe assembly, turn both clamps for the heater hose connections 90 degrees (¼ turn) outward. This will enable ease of positioning the pipe.



Do not remove any hoses. Install the front coolant pipe assembly. Begin by inserting the hoses that connect the engine, and carefully work the remaining assembly into place.

After the front coolant pipe assembly has been properly positioned, loosely reinstall the assembly to the body. Reattach all hose connections, and then fully tighten the coolant pipe assembly to the body. It is important to check the clearance between the coolant pipes and hose connections to ensure there is no contact with any other component, line/hose or electrical harness.

Install all remaining components in the reverse order of removal. If



replacing additional coolant pipe assemblies, stop here and skip to the procedures for removal and replacement of those assemblies.

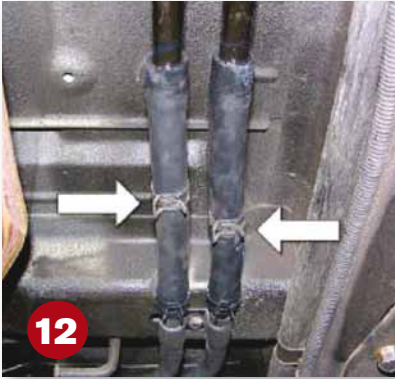
Otherwise, refill the system with the correct coolant mixture referenced below. After filling the system, the rear heater core/pipe assemblies can be bled of air by temporarily clamping off either front heater core connection while raising the engine speed to approximately 2500 RPM for approximately one minute. Check for coolant leaks, and ensure proper operation of both the front and rear heaters.

Ambient Temperature	Mixture Percentage (Volume)	
	Coolant Solution	Water
-15°C (5°F)	35	65
-25°C (-13°F)	40	60
-35°C (-31°F)	50	50
-45°C (-49°F)	60	40

Center Pipe Removal

11 Once the engine has cooled sufficiently, remove the radiator cap, and raise the vehicle on a lift. Cut the two flexible coolant hoses between the rear and center coolant pipe assemblies, and allow coolant to drain into a large container. Note that a large amount of coolant will drain from the hoses. Do not cut the hoses between the front and center pipe assemblies.

12 Loosen and slide forward the two clamps attaching the center coolant pipe assembly to the



front coolant pipe assembly, and then loosen the hose connections. Do not damage the hoses between the two assemblies; they will be reused.

Remove the bolts holding the coolant pipe assembly to the body, and then remove the original center coolant pipe assembly. Remove the two remaining clamps from the front end of the rear coolant pipe assembly and the hoses that were previously cut off. It may be necessary to loosen the two bolts at the rear of the front catalyst before removing the center coolant pipe assembly.

Center Pipe Installation

Install the new center coolant pipe assembly to the body, and then install the hose connections to the front and rear of the assembly. If replacing additional coolant pipe assemblies, stop here and skip to the procedures for removal and replacement of those assemblies.

Otherwise, refill the system with the correct coolant mixture referenced on page 10. After filling the system, the rear heater core/pipe assemblies can be bled of air easily by temporarily clamping off either front heater core connection while raising the engine speed to approximately 2500 RPM for approximately one minute.

Check for coolant leaks, and ensure proper operation of both the front and rear heaters.

» This and other technical information is available at www.Kiatechinfo.com.



Rear Pipe Removal

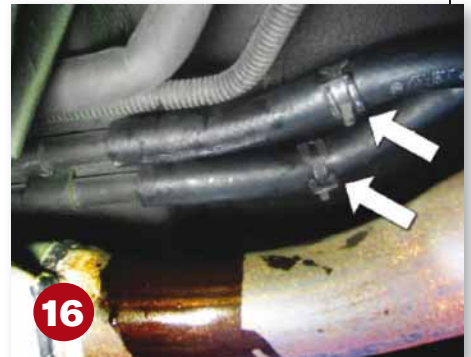
13 Once the engine has cooled sufficiently, remove the radiator cap and the spare tire assembly. Then raise the vehicle on a lift.

14 Remove the right-hand passenger side rear wheel mud flap and bracket to allow better access to the rear heater core connections.

15 Cut the two flexible coolant hoses between the rear heater core assembly and rear coolant pipes, and allow coolant to drain into a large container. Note that a large amount of coolant will drain from the hoses. Do not cut hoses between the center and rear pipe assemblies.

16 Loosen and slide forward the two clamps attaching the rear coolant pipe assembly to the center coolant pipe assembly, and then loosen the hoses connections. Take care not to damage the hoses between the two assemblies as they will be reused.

Remove the nuts holding the coolant pipe assembly to the body,



and then remove the original rear coolant pipe assembly. Carefully remove the remaining clamps and hoses that were cut off of the rear heater core assembly. Take care not to damage the heater core or its connections.

Rear Pipe Installation

Install the new rear coolant pipe assembly to the body, and then install the hose connections to the center coolant pipe assembly and the rear heater core assembly. Reinstall the mud flap/bracket and spare tire. If replacing additional coolant pipe assemblies, stop here and skip to the procedures for removal and replacement of those assemblies.

Otherwise, refill the system with the correct coolant mixture. After filling the system, the rear heater core/pipe assemblies can be bled of air by temporarily clamping off either front heater core connection while raising the engine speed to approximately 2500 RPM for approximately one minute.

Check for coolant leaks, and ensure proper operation of both the front and rear heaters. **KIA**

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