IS COSTLY, PROBLEMATIC AFTERTREATMENT MAINTENANCE AND REPAIR UNAVOIDABLE?

NEW TECHNOLOGY IS PROVING TO BE THE SOLUTION

EXECUTIVE SUMMARY: Is painful, excessive DPF and SCR system maintenance and repair really an unavoidable cost of doing business for heavy duty operators? New technology may mean the end of our aftertreatment pain.

> "In 2005, we spent 55 hours a week on emissions exhaust in our shops, and in 2015, it was 662 hours a week" [1]
>
> **Lee Long**
> Director of Fleet Services at Southeastern Freight Lines
> *Transport Topics*

THE PROBLEM

The heavy duty industry has accepted as unavoidable that DPF diesel particulate filter and SCR aftertreatment systems fail: They cause frustrating forced regeneration delays, de-rates, and down time. Operators are feeling the pain of excessive idling for regeneration, lower fuel economy, and higher preventive maintenance costs as a result of DPF issues.

Heavy duty maintenance executives have struggled to develop maintenance protocols and repair solutions for complex DPF and SCR problems.

Maintenance executives across the industry report on average a 9-10x increase in the technician hours required to repair and maintain emissions systems since the onset of Aftertreatment systems, primarily due to the difficulty of finding complex leaks that are the root cause of most DPF problems. Some executives report that drivers, frustrated by the forced regens and frequent maintenance of the DPF systems, will disable the DPF regeneration function, leading to a clogged DPF filter and costly derating of the truck.[2]

> "The frequency of these problems is fairly high..."
> "You could see it every day, a truck running down until it derates"
> *Transport Topics*

Excessive diesel emission fluid use, frequent DPF cleaning, and forced regeneration events caused by aftertreatment system issues are chronic complaints at any gathering in the HD industry. They are also symptoms of problems outside the aftertreatment system.

> "With today's diesel vehicles needing to be clean ID certified, the exhaust/emissions systems are extremely complicated and have very specific ranges where they will work or not work. The smallest exhaust leak can cause false readings, MIL sets, de-rating of engine power and ultimately break down if gone unrepaired." [3]
> *Professional Tool and Equipment Magazine Tool Review,* Aug. 2016

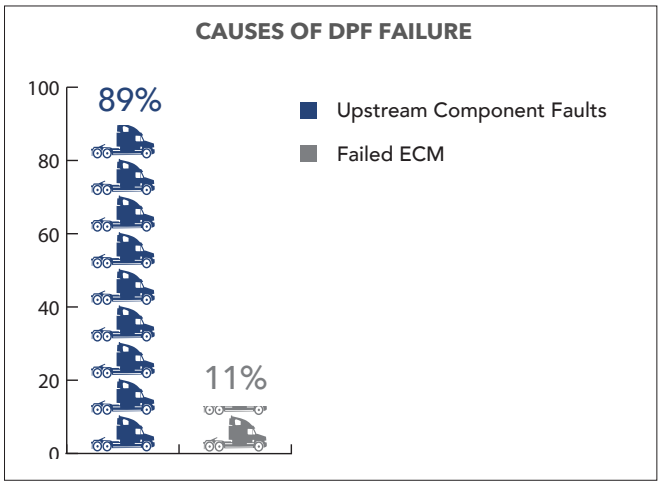
While DPF challenges are not new, they are getting more complex. These aftertreatment systems have been with us since federal clean-air mandates were enacted in 2007 and 2010. The most recent clean air standards, announced in August 2016, mean that heavy duty fleets have more air quality challenges ahead. According to the New York Times, the onus will be on truck OEMs and fleet operators:

> "The rules are intended to improve fuel economy and reduce emissions from tractor-trailers and other large vehicles that transport steel, cars, oil and a wide array of consumer products. It will be up to engine and truck-tractor makers to determine how to meet them." [4]
> *New York Times,* Aug 16, 2016

Until recently, there has been an assumption that excessive DPF maintenance and problems were unavoidable. Making the assumption that these systems work perfectly when they roll off the assembly line, there are only two causes of painful

BY GEORGE ARRANTS & BILL WOODS

and costly DPF failures: Failed ECM, which is extremely rare, accounting for 3-11% of DPF issues; or, most commonly, failures in the physical system, typically referred to as *upstream component faults*.[5]



Upstream component faults are small air leaks, often detectable only when under boost pressure. Most often the root causes of these upstream faults are defective components or component failure, ill-fitting or incorrectly installed components or parts.

These upstream failures create inconsistent air to fuel mixture ratios that modern engine management systems can somewhat compensate for, but they also create downstream aftertreatment faults and lead to DPF /SCR failure. The most problematic areas for upstream component failures are:

- Leaking injectors
- Leaking exhaust pipes
- Manifold gaskets
- Coolant leaks
- EGR (exhaust gas recirculation) cooler leaks
- The so-called 7th injector (doser valve)
- Turbo failure, and turbo housing failures
- Sensors and wiring harness failures which will trigger a check engine light

> "There has been lots of trial and error for matching maintenance protocols with the type of work to be done. Maintenance executives also have learned to hunt for upstream problems that throw contamination downstream to DPFs. They also said they have to grapple with diesel exhaust fluid that crystallizes around SCR dosing valves."
>
> *Transport Topics,* August 2016

Aftertreatment system problems appear to be universal across all OE brands. As HD vehicles cover millions of over road miles, often in grueling stop and go conditions and inclement weather, the best-made vehicles, tight when they rolled off the assembly line, rumble loose. Those jarred, cracked and worn components are often the root cause of hard-to-diagnose aftertreatment problems.

For instance, a loose fitting exhaust manifold gasket can rob the DPF of heat needed for a passive regen. The CAC and tubing/clamps surrounding the CAC have been found to be a leading source of leaks resulting in premature DPF servicing.

Turbo housings comprised a large percentage of upstream faults as well; some manufacturers of turbo systems are using new technology to bench test turbos that are returned as faulty and data indicates that over 90% of these returned turbos may be fine. The faults/ leaks are in the flanges, housing, tubing or clamps adjacent to the turbo but until now, there has been no way to find these leaks. EGR coolers were also found to frequently be the source of leaks that cause excessive DPF clogging. For SCR systems, dosing valves that do not close precisely are often an issue that becomes costly as it requires replacement of the valves.

Trucks may burn through excessive diesel exhaust fluid, caused by upstream component faults adjacent to the dosing valves. The leaks draw oxygen into the system which causes DEF to crystalize before it does its job, resulting in a vehicle that appears to be running well but operating costs increase because of excessive diesel exhaust fluid consumption. Excessive use of DEF, drivers carrying large containers to frequently "top off" diesel emissions fluid, is a red flag that there are upstream component leaks that are causing the DPF system to burn more DEF, compromise performance, and increase fuel usage. Many upstream component faults cause a decrease in performanc and fuel economy but are only identified after the after-treatment system has de-rated the vehicle.

> "Leaks can also cause a diesel engine's air management system to overcompensate with the fuel rate. "The truck could be running 10 to 20% fat, not enough to smoke but enough to cause a DPF to clog. It might cause a .5 mpg drop in mileage, which won't throw a fault code... It's the worst-case scenario for shops: there's no code, but the truck is having a problem and they can't find the cause." [6]
>
> *Diesel Progress,* July 2016

STANDARD PRACTICE

Standard practice for heavy duty technicians in search of diesel faults since the 1950's has been to pressurize a system by starting the engine, slide under the running truck, and spray soapy water to look for bubbles that indicate a leak point. Not only is this method imprecise and dangerous, it's near impossible to reach many components in modern trucks to see the soap bubbles if they appear and it can take many tries to locate a leak. The existing alternative, using an ultrasonic listening device, is equally unreliable in noisy shop environments.

Computer controls that maximize truck performance also make it nearly impossible to test using soapy water; many computer management systems will not allow the engine to produce boost while sitting in a bay. But the upstream component leaks that technicians are searching for only create bubbles when under boost; it's the air leak exiting through the soapy water that makes the bubbles. Many vehicles need to be moving -or at least have the parking brake

released and foot brake off- to build boost pressure. This practice creates substantial safety concerns surrounding ways that some technicians are attempting to create boost in a repair facility bay.

Even if technicians figure out how to build boost to replicate a running engine for the test, modern diesel engines heat up so quickly that any water evaporates before bubbles can even be formed. Once this occurs it takes up to another hour for the engine to cool down adequately so that the technician can try again. Costly and inefficient, this practice becomes even less effective when there are multiple leak points, which appear in 64% of vehicles tested.

> "The problem with trying to use a stethoscope to listen for an exhaust leak is as soon as the engine starts there is enough heat to quiet the leak due to metals expanding and sealing it up." [7]
>
> **Barry Hoyland**
> Diagnosing and Repairing Emission Issues
> *VehicleServicePros.com,* June 17, 2016

Time consuming, dirty, and imprecise, the outdated standard practice of locating upstream component faults with soapy water or a supersonic listening device often results in trucks spending unnecessary days in the repair facility, out of service. A de-rated vehicle can be sidelined for days while highly skilled technicians utilize ineffective strategies to search for faulty components and workmanship, make the repairs, then clean and reset the DPF system.

Parts and component costs are higher than necessary as assumptions are made about failing components which are replaced, only to find that it wasn't the fault and that the leak remains, sometimes referred to in the industry as "parts darts." 64% of vehicles have more than one fault/ leak point, and many leave the repair facility with secondary leaks that go undiagnosed, triggering come-backs, or even tows.

> "Leaks in a heavy-duty truck's exhaust system can be a health hazard to operators and errant holes in an air intake system cause big problems with aftertreatment devices. Tracking down the source of a leak can be a time-consuming and thankless task. New patent pending technology is helping heavy-duty equipment technicians and engineers in that search. It turns a troubleshooting task that can take hours into a solitary 10 minute procedure."
>
> *Diesel Progress,* July 2016

NEW TECHNOLOGY OFFERS THE SOLUTION

A new technology is proving to be a surprisingly efficient solution to this complex problem. Developed in partnership between a major truck manufacturer and an equipment engineering company, the tool is disrupting the assumption that DPF issues are an unavoidable cost of doing business for fleets. The manufacturer has several thousand of these units in the field working in different fleets with quantifiable results that indicate it is saving substantial repair time, cutting parts and overall PM costs, and improving fleet fuel economy.

> "This technology will change the way we deal with DPF/ regen issues forever. It's impossible to imagine another way to find leaks so quickly and accurately"
>
> **Stacey David**, former host of
> *TRUCKS* on Spike TV and Host of *Gearz*

The tool, HD PowerSmoke®, uses regular compressed air to reach and maintain a variable pressure of 2 to 20 psi throughout the vehicle's intake and exhaust system. Patented, durable expanding block off adaptors fit any size and shape orifice to cleanly seal off intake and exhaust. Compressed air is injected into the system, followed by a visual vapor, which replicates the boost load of the running engine, with the engine safely off; many upstream component leaks only appear under boost. The dense, highly visible vapor flows throughout the truck's hoses, tubes and related components and escapes anywhere there is a leak. The vapor is created by vaporizing Chevron Superla white mineral oil, a safe inert medicinal grade product. Independent research indicates that the vapor contains no solvents or contaminants that could harm or coat sensors. As the visible vapor flows through the pressurized system, within minutes it indicates all faults that are present throughout the entire system, making it easy to see precisely where the problems are, with 100% accuracy and reliability.

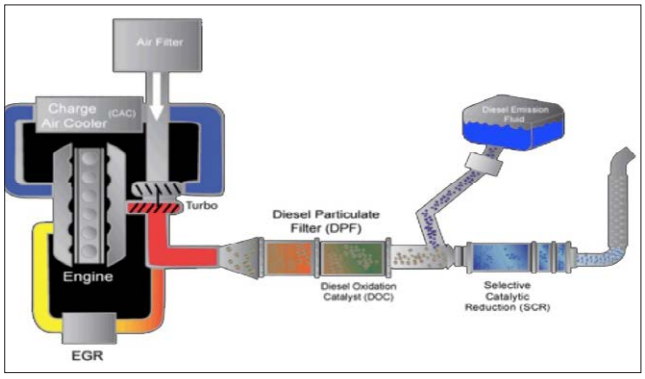
> "The biggest issue I had to overcome in getting HD PowerSmoke technology approved at Navistar was convincing the Engine Division that the tool would not drive up warranty costs. However, after saving possible buy-backs and resolving issues on multiple warranty visits with incomplete or erroneous repairs, they understood and embraced the technology. The Engine Division not only approved HD PowerSmoke but agreed to mandate it as an essential tool."
>
> **Tom Hoffmeister,** Retired SFSE Navistar

Developed in collaboration with International Trucks, HD PowerSmoke™ replicates a high-pressure boost load so the entire system can be tested for faults with the engine safely off. It is the only diagnostic machine in the heavy duty market that can, in a single 10-minute procedure, reliably detect high-pressure and low pressure upstream faults, pinpoint exact locations and precisely identify failing components. By ending unresolved upstream faults and the associated after-treatment issues, the technology is dramatically cutting warranty costs and comebacks.

> "We tested the machine on a new Western Star that had failed the original leak test for the air system. The technician probably would not have diagnosed the leak without the use of the HD PowerSmoke machine."
>
> **Joe Young**
> Product Trainer
> *Johnson & Towers*

BY GEORGE ARRANTS & BILL WOODS

> "We are using this technology every day and saving an average of 45 minutes on drivability diagnostic time on every truck we diagnose"
>
> **Joe Young**
> Product Trainer
> *Johnson & Towers*



Patented, inflatable block off bladders with pressurized vapor pass-through allow technicians to test an entire boosted intake and exhaust system at once. Inflated with compressed air to conform to any size / shape intake or exhaust, the block off bladders allow technicians to reliably simulate boost with the engine safely off and feature protective safety pressure blow off valves. By injecting the visual vapor through the pass-through / block off bladders, the technician is able to dial up or down the variable pressure to locate all exhaust leaks, even very small leaks that would be invisible any other way, but that can compromise DPF function and vehicle performance.

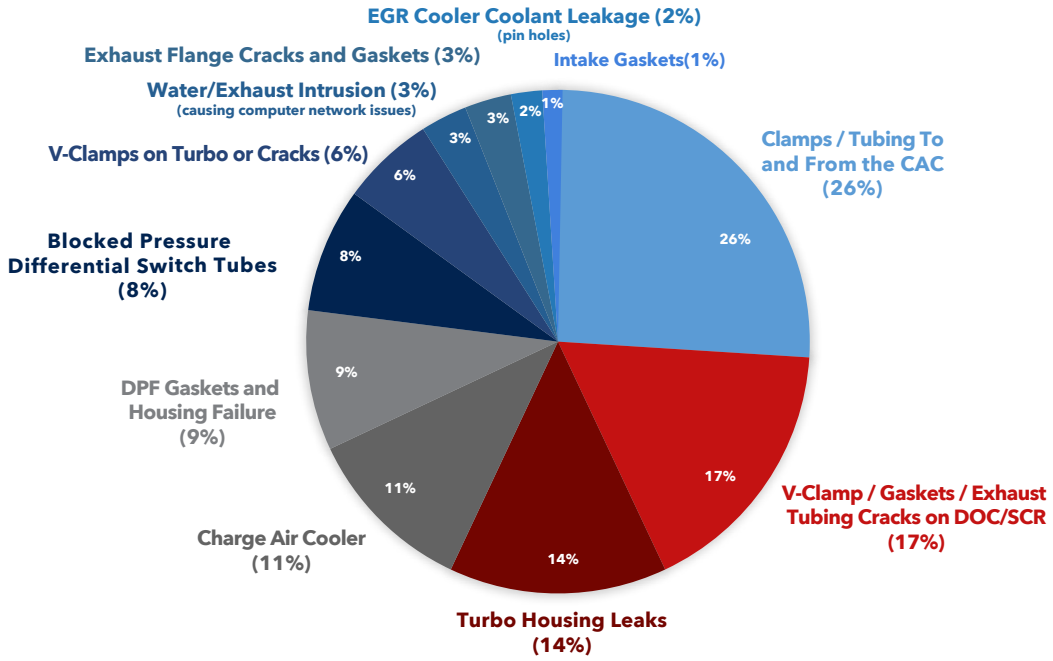
The entire testing process takes 10 minutes. Field tests on over 100 heavy duty vehicles indicate that in under 30 minutes a technician can set up the equipment, run the tests, and locate all upstream component faults with 100% certainty. Once the repairs are completed, another 10-minute vapor test is done to validate that repairs are done accurately the first time and that the vehicle is free of all faults/ leaks and the associated aftertreatment problems.

> "No rating goes high enough to put a number on this piece of equipment."
>
> "I can't stress enough how helpful this tool is in finding the elusive failures that used to result in hours of tear down and inspection"
>
> **Professional Tool and Equipment News,** *Tool Review*
> August 2016

The technology is being used in the following applications:

- Preventive maintenance to locate faults before they trigger excessive forced regens or a de-rate
- Test the integrity of the air intake and exhaust system at once, as the vehicle came in, without disturbing components to perform test
- Use for fast triage diagnostics when vehicles came in "on the hook"
- Determine if unfiltered air is entering engine (prevent engine dusting)
- Quickly determine if delta pressure switch tubes are clear

FAILING COMPONENTS / ISSUES DIAGNOSED BY HD POWERSMOKE



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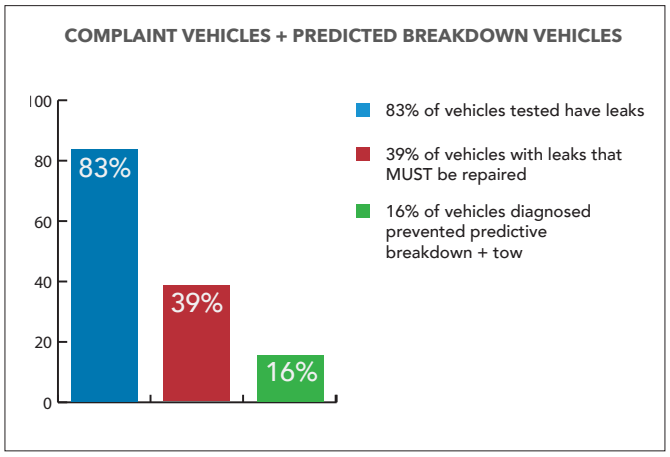
- DPF Protection – not plugging filter due to unresolved upstream leaks (exhaust bellows, v clamps, exhaust manifold flanges, cracked tubing, compressed air charge leaks)
- It was noted that previously, CAC leaks frequently went undiagnosed
- Used to prevent the uninstall of a leaky tube or component to test CAC then re-install of the leak
- EGR cooler diagnostics, determine if internal coolant or exhaust gaskets are leaking
- Determine engine performance variables / confirm clamps on charge air system are correct
- Used to find SCR leaks and prevent DEF crystallization
- Locate crank case oil leaks quickly w/o washing engine first
- Determine if crank case filter is plugged
- Locate point of water intrusion in the cab
- Locate point of potentially dangerous carbon monoxide cab leaks
- Validate repairs are completed and systems are sealed before returning vehicle to customer preventing comebacks

In a field test of 100 heavy duty trucks *without complaints*, 83% had leaks that were substantial enough to lower fuel economy and DPF performance.



"Using this technology has saved us around two thirds the time in locating faults. We have improved our customer service by 38%. By adding this technology, we are repairing 2 more vehicles every day. That's huge."

"I don't know how we were able to operate without this technology before."

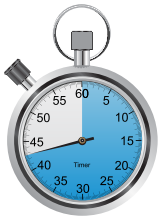
Chris Michael
Valley Power Systems

CONCLUSIONS + RESULTS

A field study of 100 heavy duty trucks executed over a 24 month period indicate that utilizing the tool saved between 43-120 minutes per vehicle in preventive maintenance and repair. Many technicians field testing the equipment reported substantially greater time savings on "problem" vehicles, where they had searched for the issue on repeated return visits, after replacing multiple suspected components, only to have the problem re-occur.

Comments from validating technicians included testimonials that this technology immediately found the problem that could not have been found any other way. Excessive forced regens are being eliminated in 96% of vehicles as reported by technicians in this study. Further, fleets utilizing this technology are reporting an increase in fuel economy of up to 0.5 MPG.

In fleet maintenance and repair facilities the tool provides substantial savings of time and cost in both preventive maintenance and in the diagnosis and repair of problem vehicles.



Diagnostic Time Saved

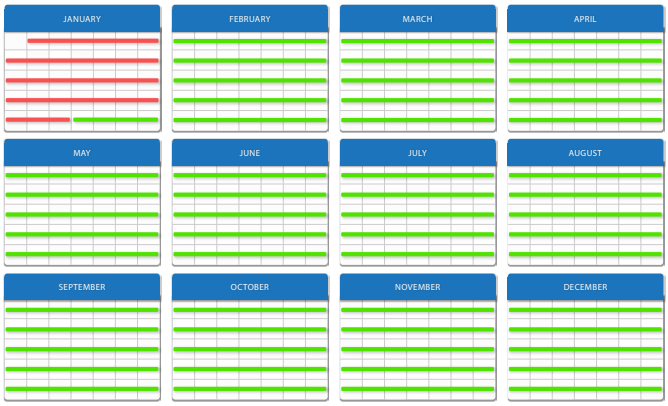
***43 minutes** saved per vehicle*

The tool is also being used by heavy duty OEMs for bench testing engines and on assembly lines at the point of installation to ensure that components are correctly installed. OEM mandated by a major American truck manufacturer, the tool has also been adapted for use by a leading automotive OEM for both gas and diesel engines, where it has been globally mandated as essential equipment for the repair and maintenance of primarily turbo diesel vehicles in 112 countries.

Field tests and feedback indicate that his technology will change the way in which aftertreatment systems and their associated, chronic problems are diagnosed and managed. The costly, problematic aftertreatment issues that the HD industry had previously accepted as unavoidable are no longer a necessary evil, a cost of doing business. With an average payoff return on investment in just 4.63 weeks, the HD PowerSmoke technology provides a cost-effective, safe alternative that will change standard practices for heavy duty preventive maintenance and repair.

ROI = 4.3 WEEKS

EQUIPMENT PAID FOR ITSELF ON AVERAGE IN 4.3 WEEKS



"We are using this equipment every day and are seeing substantial savings in time, parts, costs, and overall efficiency. I can't imagine any fleet or repair facility not adopting this.

We have NO MORE unsolvable upstream leak issues. This technology is going to change the way we test, diagnose and repair heavy duty vehicles."

Chris Michael
WheelTime Champion at Valley Power Systems

ABOUT THE AUTHORS

George Arrants is the Director of Training & Recruitment for the Wheel Time Network, which includes the Wheel Time University that provides on-line assessments, training and ASE test preparation for WheelTime member technicians. As an Automotive Education Consultant specializing in NATEF/ASE Accreditation, George works with instructors and administrators to develop partnership with local business and industry through the programs advisory committees. George also works closely with ASE, NATEF & AYES to develop and implement initiatives for the medium/heavy truck industry to partner industry and education and open opportunities for student internships across the country. George has chaired the Technology and Maintenance Council TMC Suptertech Competition since 2005 as well as the Future Technicians Skills Competition. In 2015, he was awarded the Council's highest honor, the Silver Spark Plug. George has served on the National Automotive Technicians Education Foundation NATEF's board of trustees and was named liaison to the Automotive Youth Educational Systems. He earned his Bachelor's degree in Business Management and Marketing from Carthage College and he holds ASE certifications in Automotive and Medium/Heavy Duty Truck, Parts Specialist (Truck & Auto), and Service Consultant.

Bill Woods is the Senior Executive in charge of Heavy Duty Markets for Redline Detection. Bill has a wealth of experience in the industry, having spent 10 years in diagnostics at Cornwell Tools and at Noregon J Pro, where he was responsible for new product development. Bill holds a degree in Marketing & Finance and has extensive education in heavy duty engineering. Bill is also well known as a land speed record holder at Bonneville where he and his team have designed, built and raced custom motorcycles that have won land speed records at for the past 10 years. Bill holds Bonneville records in 125cc production, modified and forced induction, 125 P-P, 125P- PBF, 125 P-PBG, 125 MPS-BF, 650cc special construction, forced induction, 650 A-BG, 500cc special construction, partial streamline and 500 APS-AF. The 500 and 650 bikes are uniquely known as lay- down riding position bikes with fully hand-constructed frames. Bill also starred in the feature film Out of Nothing, produced by Ryan Stiles, the story of the team's race to make history by breaking the world's land speed record.

REFERENCES AND SUPPORT MATERIALS

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Truck Techs Keeping Busy With Aftertreatment Issues Significant Difficulties Described With DPF and SCR Systems,
August 8, 2016

"In 2005, we spent 55 hours a week on emissions exhaust in our shops, and in 2015, it was 662 hours a week," said Lee Long, director of fleet services at Southeastern Freight Lines, a less-than-truckload carrier based in Lexington, South Carolina. Long said SEFL's fleet size did grow by 5% to 6% over the decade. However, the complexity of the systems is the main reason for the increase to the equivalent of about 11 technicians doing nothing but exhaust work each week. "When we first started, we used the standards based on what OEMs recommended, but the DPFs were clogging fairly quickly," said Long, the 2012-2013 chairman of the Technology & Maintenance Council, a division of American Trucking Associations.

Read more at: http://www.ttnews.com/articles/petemplate.aspx?storyid=42842

"The frequency of these problems is fairly high," said Tim Moore, a vice president of roadside operations for FleetNet America, a nationwide third-party provider of maintenance services. "It was a real problem for me on the fleet side as a maintenance director. You could see it every day, a truck running down until it derates. There have been a lot of self-inflicted wounds on DPFs." Moore said he knows of drivers who have disabled the DPF regeneration function and failed to turn it back on, and that leads to filter clogging and then a derating of the truck.

Read more at: http://www.ttnews.com/articles/petemplate.aspx?storyid=42842

2. Tool Review
Redline Detection HD PowerSmoke. The reviewer says this tool is something shop owners need to see in action and invest in
by Josh Smith, September 15, 2016

http://www.vehicleservicepros.com/article/12210945/tool-review-redline-detection-hd-powersmoke

"The whole tool is just fantastic," he says. Moore and his techs at DeMary Truck in Columbus, Ohio, used the HD PowerSmoke on many vehicles – including the Mitsubishi Fuso Canter, which they are a dealer for.

"We have diagnosed emissions issues, DPF efficiencies, EGR systems," he explains. "A lot of what the Redline Detection HD PowerSmoke was used for was finding exhaust leaks in SCR systems. With today's diesel vehicles needing to be clean idle certified, the exhaust/emissions systems are extremely complex and have very specific ranges where they will work or not work. The smallest exhaust leak can cause false readings, MIL sets, de-rating of engine power and ultimately break down if gone unrepaired."

3. New York Times
New Rules Require Heavy-Duty Trucks to Reduce Emissions by 25% Over the Next Decade
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4. In 100 heavy duty vehicles, tested at professional fleet maintenance facilities across 4 states over a period of 24 months, 89% of vehicles presenting with aftertreatment problems were found to have measurable upsteam component faults that were the root cause of the aftertreatment failure.

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by Barry Hoyland, June 17, 2016

http://www.vehicleservicepros.com/article/12203463/diagnosing-and-repairing-emission-issues

REDLINE DETECTION.COM
MANUFACTURER OF PROFESSIONAL DIAGNOSTIC EQUIPMENT