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Supplement to *Construction Equipment*

STRATEGY GUIDE FOR

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EMISSIONS MANAGEMENT

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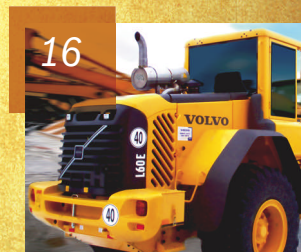
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EDITOR'S LETTER

Emissions management for compliance to diesel regulations has become a complex issue for fleet managers as CARB's recommendations filter across the nation. For many, 2009 was the year the full realization of diesel-exhaust reduction hit fleets.

Construction Equipment has been covering these issues in its Running Green series, and this special supplement contains the stories we published in

2009. We've organized the supplement to not only make it easy to find the articles, but also to enable you to find various resources published along with them.

As we did last year, *Construction Equipment* has partnered with John Deere to bring this resource to the industry. But this is only a piece of the information resource we've compiled online, which you can access at www.ConstructionEquipment.com/green.

ROD SUTTON

Editor in Chief
Construction Equipment
ConstructionEquipment.com



ONLINE SOURCE FOR EMISSIONS MANAGEMENT

Construction Equipment has been educating equipment professionals for more than two years through its Running Green series, but the resources available to fleet managers extend beyond the pages in this supplement.

We've put together a repository of resources online, accessible any time you need to research anything emissions-related. Articles, news, products and references are available at **www.ConstructionEquipment.com/green**. Again, we thank John Deere for helping us bring this resource to the industry.

Construction Equipment's Running Green Series: *Each of the 10 articles published in Construction Equipment since the series launched in November 2007.*

Q&A, with John Deere: Ask your questions and the experts at Deere will provide the insight you are seeking.

Green News: The latest news related to emissions, regulation and machine technology.

Green Tools: Interactive tables, webinars and links to sites that allow you to evaluate how your fleet measures up and helps you decide how to manage the emissions strategy.

Green Products: Equipment, engines and ancillary products designed to improve emissions, fuel-efficiency, and performance.

KEY RESOURCES

Construction Equipment Emissions Storehouse

www.ConstructionEquipment.com/green

California Air Resources Board

www.arb.ca.gov

EPA

www.epa.gov

Diesel Technology Forum

www.dieselforum.org

DieselNet

www.dieselnet.com

Renewable Fuels Assn.

www.ethanolrfa.org

National Biodiesel Board

www.biodiesel.org

Manufacturers of Emissions Controls Assn.

www.meca.org

Alternative Fuels and Advanced Vehicles Data Center

<http://www.afdc.energy.gov>



**REDUCE EMISSIONS AND
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By LARRY STEWART, Executive Editor

A Mercenary Guide to Reducing Diesel Emissions

Three technologies — automatic grade control, vehicle telematics, and fuel-tracking systems — boost profits by cutting fuel use, and improve air quality in the process

California contractors are finding compliance with in-use, off-road diesel emissions rules expensive. Those working outside California have a unique opportunity to apply a much broader range of technologies that will cut diesel emissions from their work sites, some of which will also cut operating costs.

These technologies — automatic grade control, vehicle telematics, and fuel-tracking systems — are not the kind of things that will satisfy the emissions regulations likely to spread from California to other states. But they offer equipment operations a competitive advantage, and can help reduce the need for regulation. The happiest coincidence — especially in light of 2008's fuel-price history — is that most efforts to reduce fuel consumption will also cut the volume of diesel exhaust.

One of the greatest opportunities to cut fuel costs is to idle machines less. Komatsu estimates that idling consumes nearly 20 percent of a typical construction machine's lifetime fuel burn. The California Air Resources Board mandated anti-idling programs for most diesels in the state. Telematic technologies — eye-in-the-sky boxes that combine global positioning systems (GPS) and wireless cellular networks to monitor and transmit data such as machine location, hours of use, and operating condition — are great tools for modifying operator behavior.

The most profitable way to reduce fuel consumption is to use automatic grade-control systems such as Accugrade, Trimble, Topcon and Leica grade-control products that enable machines to cut down to planned grade faster and more accurately. Users are consistently finding that they are within project tolerances on the first fine-grading pass.



A Ryan Inc. field mechanic swipes a machine's bar code with a cell phone and reader accessory before filling the fuel tank. Fuel pumped, together with machine hours keyed into the phone's keypad, allows Ryan to monitor and manage fuel consumption for each machine in its fleet.

Grade control

Caterpillar claims that its Accugrade automatic grade-control system boosts productivity by as much as 50 percent, and fuel savings by as much as 43 percent. The systems reduce the first and second largest inputs to equipment costs, labor and fuel. And each dollar saved drops to the bottom line as profit.

Roxwell Construction, a small commercial sitework company from Thousand Palms, Calif., has been using GPS grade control less than a year, and company president Roxwell Fontenot is impressed with the technology's fuel-saving aspects. The company has a new Cat D4K bulldozer equipped with a Trimble GCS900 Grade Control System. It ties into a Trimble SPS780 Smart GPS Antenna that serves as the base station. The system allows Fontenot to compete for more complex projects, and it reduces machine hours needed to achieve planned grade.

"Our work is so accurate with one pass that we've eliminated rework," states Fontenot. "On our first job (with automatic grade control), I learned how accurate we can be with just one pass. The developer came out and checked our grade and we were within 1/10th on each of the 74 shots they made."

Roxwell is ahead of schedule on a Brawley, Calif., project that will eventually move 60,000 cubic yards of silty clay to make way for several three-story apartment buildings. Plans call for the firm's six-person crew to over-excavate four feet for sub-surface drainage under the parking lots that will replace open retention ponds.

"We're completing our finish grading in half the time because we're using GPS machine control," says Charlie Hollingsworth, site manager and operator for Roxwell.

Interstate Highway Construction, an early adopter of GPS-based machine control systems, has enjoyed most of the technology's benefits at one time or another. Their recent complete reconstruction of 6.67 miles of I-75 in central Michigan illustrates how even the reduced need for grade stakes saves fuel.

"Virtually all of the grading on this job was done without staking, except for the reference



stakes we placed every 300 feet or so to reassure the Michigan Department of Transportation (MDOT) inspectors," says Brad Miller, project supervisor. "Because there were no grade stakes to work around, we could spread the entire width of the grade. That saved a lot of time."

Telematics

Komatsu claims that if you can eliminate even half of the average construction machine's non-productive idle time, fuel costs are cut by 10 percent. That's significant, and reduced idling also improves resale value.

Komatsu literature offers an example, comparing two PC200 excavators that actually work 600 hours per year doing identical work. One machine idles 40 percent of the time whereas the other idles 20 percent of the time. After five years, the machine that idles 40 percent of the time runs up 5,000 hours on the service meter, while the machine that idles 20 percent of the time will register fewer than 4,000 hours. Not only is the machine with fewer hours worth more, it will also have had two fewer maintenance intervals, which cuts cost and increases availability.

The example is part of Komatsu's sales pitch for its Komtrax telematic system for monitoring machine condition, location, and

"We're experiencing time savings and greater productivity by virtue of the fact that our work is so accurate with one pass that we've eliminated rework," says Roxwell Fontenot. "On our first job (with the GPS grade-control system), I learned how accurate we can be with just one pass. The developer came out and checked our grade and we were within 1/10th on every one of the 74 shots they made."



Stakeless grading saved Interstate Highway Construction passes when rebuilding six miles of I-75 in central Michigan "because there were no grade stakes to work around; we could spread the entire width of the grade," says Brad Miller, project supervisor.

operation (a system like Caterpillar's Product Link or Qualcomm's GlobalTracs). By measuring and graphing machine idle time versus work time accurately, data from telematic systems can help modify operator habits to save fuel as well as increase residual value.

Ace Asphalt, the largest parking lot builder in Arizona, expects to save nearly \$150,000 worth of fuel in its first year on idling reductions alone thanks to a fleet management service it purchased from GPS Fleet Management, a Phoenix-area vendor. Ace implemented GPS Fleet Management's solution throughout its fleet, installing GPS equipment in 283 mobile machines.

"Initial reports show that we have cut unnecessary idling by nearly 50 percent since the start of the program (in June)," reports Darin Soll, chief information officer for Ace.

"The 'Ignition On, Ignition Off' feature is our flag to know if a vehicle is running or not," Soll adds. "If it idles for more than a few minutes, the system generates an exception (report) that notifies us by e-mail and text message so we can quickly address it."

Fuel tracking

In the past, diesel was cheap enough that it was not worth the effort required to accurately

measure how much fuel was burned in each machine in even a modest-sized fleet. With diesel retaining something like a \$1.30 premium over the cost of a gallon of gasoline, few can afford to make a living using diesel equipment without knowing specifically how much fuel individual units consume.

Luckily, technology has provided a number of options for tracking fuel use automatically, or nearly so. Very often the process of gathering fuel-consumption information raises awareness of a firm's need for fuel-efficiency enough that simply implementing a tracking system cuts fuel use. The data inevitably improves fleet-management efforts.

Ryan Inc. Central's fuel vendors use Nextel phones with bar-code-reading accessories to tag each gallon of fuel they pump to a machine ID. Phones communicate via Bluetooth to laptops in the fuel trucks, so data can be uploaded directly to the Janesville, Wis.-based earthmover's fleet-management software, a home-grown system called Iron IQ.

The fueler scans a bar code on the machine to gather the unit number, and the computerized fuel truck records the measure of fuel pumped into the tank. Fuel pumped equals the amount of fuel burned since the last fueling. The fueler punches hour-meter readings into his keypad with each fuel stop, and that data is correlated with gallons pumped to compute fuel consumption for each of Ryan's machines. Nextel's GPS chip identifies the machine location.

The process complements fuel-consumption and hour-meter data gathered by Qualcomm's GlobalTracs asset-tracking systems. Ryan has 500 units with Qualcomm boxes.

"We paid for the Qualcomm boxes in six months just with the increased utilization on small equipment," says Greg Kittle, Ryan's equipment manager.

Iron IQ's automated data gathering eliminated several thousand hours of data processing at Ryan. Because the data fuel-truck drivers gather every time they top off a tank is used to generate the vendor's invoices, the system also eliminated 3,000 hours of vendor data processing. One result is that Ryan pays significantly less on bulk fuel than most.

"Saving our vendors money is important to Ryan," says Kittle. "That's how you build partnerships. It also allows us to negotiate service charges — we expect to get some of the benefit of saving them money."

Brubacher Excavating became a partner in the Environmental Protection Agency's SmartWay program because the brothers who own the company are committed to minimizing their impact on the environment, and because the process of cleaning up their operations has also tended to improve operating costs. SmartWay focuses on the trucks in their machine fleet.

"It's not hard to become a SmartWay partner, although the program is geared to carriers and shippers," says Myron Brubacher, equipment manager and part owner of eastern-Pennsylvania-based site-prep firm. The company owns 60 medium and heavy trucks — 30 of which are Class 8. "You enter a lot of baseline data — full descriptions of all your trucks, average miles per year, idling hours per year, fuel consumption — into a pretty complex fleet model in Microsoft Excel."

The SmartWay report includes disclosing all of the existing fuel-efficiency strategies used in the fleet. For Brubacher, that includes low-friction drive-train lube and speed limiters. The model calculates fleet average fuel economy and tons of carbon emitted per year.

"After you establish your baseline, you can change your fleet model to include changes in equipment or maintenance or engine setup, and the model will show what those changes will gain in savings due to efficiency."

Brubacher is considering trying super singles, assuming they can find some that are suited to their vocational duty. Reducing the maximum road speed is another possibility. For now the company is focused on effectively reducing idling time.

"We have a lot of trucks getting 35 to 45 percent idling time — some log over 1,000 hours of idle time every year," Brubacher says. "Some trucks burn a gallon of fuel per hour when they're idling."

Implementing a three-minute idling limit has begun to reduce fuel consumption in less than a year of practice. Company policy dictates that operators should turn trucks off if they're to be left running at idle for more than three minutes. Three out of four trucks in the Brubacher fleet are electronic, and they've been programmed to shut down automatically after five minutes of idling.

Operators quickly discovered that any clutch input will restart the five-minute countdown. Eliminating the clutch sensor from the loop shifted driver attention to the accelerator. Any movement of the throttle likewise gives another five minutes of idling. Supervisors continue to encourage drivers to reduce idling at regular toolbox talks and discuss their effectiveness during employee reviews. Long-standing behaviors are beginning to change.

Brubacher is also working to get operators accustomed to maintaining tire inflation pressure. They're required to check tires on equipment and trucks weekly. The company has installed air hoses with tire chucks on vehicles that have on-board compressors. Brubacher has more than a year's experience with two trucks that have the Doran Pressure Pro wireless pressure sensors, and the company recently installed four more systems on trucks to see if they repeat the initial success.

"A display on the sun visor tells the driver how much pressure is in each tire," says Brubacher. "It saves the operator 15 minutes every week, which adds up pretty quick with 60 trucks. And the system also will warn the operator if there is a sudden loss of pressure from any tire. That saves a lot if he takes care of it before he sees tire shreds in the rear-view."

Not all of the expenses required to clean up diesel exhaust will cut operating costs, but most of those that also reduce fuel consumption inevitably will pay for themselves. How long it takes to break even will be determined by how much fuel you burn, and by how much a gallon of diesel costs.

RESOURCES

DOE Alternative Fuels & Advanced Vehicles United States (Federal) Incentives and Laws

www.afdc.energy.gov/afdc/progs/fed_summary.php/afdc/US/0

Idling regulations by state: American Transportation Research Institute

www.atri-online.org/index.php?option=com_content&view=article&id=164&Itemid=70

EPA SmartWay Program

www.epa.gov/oms/smartway/

By LARRY STEWART, Executive Editor

Now Is Not Too Soon to Retire Tier 0 Diesels

California's model for the nation suggests the only sure way to comply with diesel rules profitably is to dispose of the oldest engines well before you're forced to

The writing on the wall says your Tier 0 diesels have to go. Same thing goes for most Tier 1 machines. Owners have some control over when, but by 2013 or 2014 in California, few firms will be able to afford to keep pre-1998 off-road diesel engines. You won't want them and, here's the kicker, neither will anybody else.

Regardless of whether or not your state adopts California's In-Use Off-Road Diesel Vehicle rule, in the next five years most major metro areas in the United States are going to force by regulation or lure by incentive heavy equipment owners to retire or replace Tier 0 and Tier 1 diesel engines and upgrade Tier 2 and Tier 3 engines to cleanest exhaust emissions standards.

Modernizing fleets will be expensive, and the

cost will only increase with time. Before regulations begin to demand compliance, there are government grants to help pay for replacement engines and exhaust filters. (The American Recovery Act — our federal stimulus package — for example, supplies \$300 million to support EPA's Diesel Emissions Reduction program.) After regulations go into effect, government support funding goes away.

The next couple of years will provide a measure of just how crushing waiting until the last moment to act will be for contractors in California. March 1, 2010, is the first hard compliance date for large (more than 5,000 horsepower) fleets to meet either fleet-average targets or apply best available control technologies (BACT) to 20 percent of their machines. The intent is to slash production of today's key diesel-exhaust pollutants: oxides of nitrogen (NOx, which combines with ozone to make smog) and particulate matter (PM, unburned diesel soot).

Medium fleets (2,501 to 5,000 horsepower) don't have to meet emissions targets until 2013, and small fleets have until 2015 to comply. But the important fact is that almost nobody in California should expect to make decent money selling machines with Tier 0 engines ever again.

Medium fleets (2,501 to 5,000 horsepower) don't have to meet emissions targets until 2013, and small fleets have until 2015 to comply. But the important fact is that almost nobody in California should expect to make decent money selling machines with Tier 0 engines ever again.

Cleaire's Allmetal VDECS is not yet verified, but designed to deliver Level-3 performance (reduces PM more than 85 percent) for 300- to 600-horsepower diesels. The filter regenerates passively, but exhaust temperatures must run to 500 degrees Fahrenheit or more at least 25 percent of the time.



"I'd start getting rid of the Tier 0s immediately," Andy Recalde, equipment manager at The Don Chapin Co. in Salinas, Calif., recommends to contractors working in areas nationwide that fail to attain the Clean Air Act's standards for PM and/or NOx. "You've got to get rid of them way ahead of time, while they're still marketable. The markets are flooded with Tier 0s in California, and equipment values have dropped substantially because everyone is selling Tier 0 equipment."

Complicating disposal of unregulated engines is a provision in the CARB rule that forbids California contractors from adding Tier 0 machines to their fleets as of March 1, 2009.

The off-road diesel rule is complex. Rod Michaelson, equipment manager with Bay Cities Paving and Grading in Concord, Calif., estimates he has 500 hours of study and participation in an industry advisory committee to CARB invested in developing his firm's compliance strategy. He has retired 10 of Bay Cities' Tier 0 machines since 2007 and will have retired 18 Tier-1-powered machines by year's end.

"We really haven't changed too much of our mode of operation, except maybe getting rid of some of the older dirty equipment earlier than planned," Michaelson explains. "Some of it was bigger dirt equipment. As we slide into the recession, dirt work is not going to be as big for us. When big earthwork work comes back, we'll buy newer machines then."

Nevertheless, more than 20 percent of Bay Cities' fleet is expected to remain Tier 1 or older until at least 2013. The algorithm that calculates compliance offers some flexibility for fleets that start cleaning up early.

CARB is spurring equipment owners to act early on fleet compliance with a number of recently approved provisions amended to the In-Use Off-Road Diesel rule. Fleet owners can claim an exemption for up to 15 percent of their total horsepower from future turnover if they install retrofits before March 1, 2011, and fleets can claim double credit for NOx retrofits installed by March 1, 2011. Medium and small fleets can claim double credit for PM retrofits installed by March 1, 2012.

Double credit means a contractor who fits a 220-horsepower diesel engine with a Level-3 VDECS this year banks PM BACT credit for 440

ENGINE TIERS

Year	Horsepower Groups							
	25-49	50-74	75-99	100-174	175-299	300-599	600-750	750+
1995	T0	T0	T0	T0	T0	T0	T0	T0
1996	T0	T0	T0	T0	T1	T1	T1	T0
1997	T0	T0	T0	T1	T1	T1	T1	T0
1998	T0	T1	T1	T1	T1	T1	T1	T0
1999	T1	T1	T1	T1	T1	T1	T1	T0
2000	T1	T1	T1	T1	T1	T1	T1	T1
2001	T1	T1	T1	T1	T1	T2	T1	T1
2002	T1	T1	T1	T1	T1	T2	T2	T1
2003	T1	T1	T1	T2	T2	T2	T2	T1
2004	T2	T2	T2	T2	T2	T2	T2	T1
2005	T2	T2	T2	T2	T2	T2	T2	T1
2006	T2	T2	T2	T2	T3	T3	T3	T2
2007	T2	T2	T2	T3	T3	T3	T3	T2
2008	T4I	T4I	T3	T3	T3	T3	T3	T2
2009	T4I	T4I	T3	T3	T3	T3	T3	T2
2010	T4I	T4I	T3	T3	T3	T3	T3	T2
2011	T4I	T4I	T3	T3	T4I	T4I	T4I	T4I
2012	T4I	T4I	T4I	T4I	T4I	T4I	T4I	T4I
2013	T4	T4	T4I	T4I	T4I	T4I	T4I	T4I
2014	T4	T4	T4I	T4I	T4	T4	T4	T4I
2015	T4	T4	T4	T4	T4	T4	T4	T4
2016	T4	T4	T4	T4	T4	T4	T4	T4
2017	T4	T4	T4	T4	T4	T4	T4	T4
2018	T4	T4	T4	T4	T4	T4	T4	T4
2019	T4	T4	T4	T4	T4	T4	T4	T4
2020	T4	T4	T4	T4	T4	T4	T4	T4

Source: California Air Resources Board

horsepower to be used toward meeting the fleet's BACT target if they fail to hit the fleet-average target for PM. Owners who have some large-frame Tier 0 machines they want to keep, like Bay Cities, might buy those engines' passage through the next couple of years by retrofitting engines more suited to exhaust filters, such as Tier 2 and newer Tier 1 machines. The oldest engines — anything built before 1998 — make too much soot for today's DPFs.

This is where good fleet management intersects with compliance. Buying a DPF or powering a machine changes the costs of a machine pretty dramatically, but it is still just a cost/benefit decision. Those who want to make as few of those choices as possible should gather a complete inventory of diesel engines.

Some California fleets find they can comply while retaining a few Tier-0-powered machines if they retire the rest and retrofit select high-horsepower Tier 2 and Tier 3 engines with diesel particulate filters. "About a year and a half ago," says Andy Recalde, a Salinas, Calif.-based fleet manager, "we decided there's just no way we could possibly buy anything less than new."

STRATEGY GUIDE FOR EMISSIONS MANAGEMENT



Engine Control Systems' (ECS) Combifilter is a CARB-verified, Level-3 VDECS verified for 2007 or older off-road diesels. The electrically regenerated, active system must be plugged in (typically once per day) to burn soot off the element, or a clean filter can be swapped into the vehicle in a couple of minutes when the dirty filter is removed for cleaning.

Year of manufacture and horsepower is all you need, but it's best to organize them by machine unit number. A great place to keep this inventory is in CARB's Fleet Average Calculator (www.arb.ca.gov/msprog/ordiesel/documents/documents.htm#fleet). The online spreadsheet can be downloaded with no registration requirement or information to submit.

The calculator shows a fleet's compliance status relative to the current CARB off-road diesel rule. Modifying the data to reflect various engine repower, retrofit, retirement and replacement choices shows the affect on fleet-average PM and NOx relative to prescribed targets. It also calculates how much horsepower must have exhaust filters in order to comply using the BACT approach.

Tier 0, and perhaps some Tier 1, machines are the only real candidates for emissions-compliance repowers. Long lives of frames and other major components make repowering larger machines most cost effective. Wheel loaders, crawler loaders, motor graders and scrapers are machine types most capable of productive lives extending beyond the 15,000-hour range, according to *Construction Equipment's* lifecycle research. Of course, consistently high utilization is necessary to make investments like this pay.

Retrofitting CARB-verified diesel emis-

sion control strategies (the official acronym for compliant exhaust filters is VDECS) is typically going to work best on Tier 2 and Tier 3 engines.

"If you've got your Tier 2 and 3 equipment retrofit and you've put a modest amount of Tier 4 Interim equipment into your fleet, you can keep your Tier 2 or 3 equipment because you're more than likely going to make the fleet average," says Mike Buckantz, principal with environmental consultancy Associates Environmental. "But for people outside of California right now, if I could avoid retrofitting anything, I would avoid it. We've seen a slew of (technology-verification) activity recently with respect to retrofit devices,

and I think that we're probably going to see a lot more activity like that over the next year or two. And the technology is getting better."

Advance work is necessary to get the right kind of filter. There are two basic types of VDECS: the first regenerates passively — burning excess soot and ash off the element at the high-temperature points in the vehicle's duty cycle. But vehicles must operate at 500 degrees Fahrenheit or hotter for significant portions of their shift in order for passive filters to be effective.

The second type of VDECS is an active system. Active electric systems must be plugged in to shore power, and active diesel systems have a built-in fuel burner to regenerate the filter medium. Active VDECS — particularly fuel burners — tend to be more expensive than passive filters, and their added complexity is expected to demand added maintenance. Some equipment managers are not even considering them.

"I'm going to limit myself to passive filters that I can take the element out for cleaning — that's the technology that makes sense for a regular contractor," says Michaelson. "We're not going to plug anything in. And having a diesel-burning system seems like a maintenance nightmare and make work."

Michaelson invested about \$300 in a data-logger with a temperature probe that he uses to find engines that can use passive VDECS.

"I'm just getting a snapshot of temperature data," Michaelson adds. "On the ones that look

good, I'll do a more thorough datalog and submit that to the dealer, and we'll put VDECS on some of those."

Michaelson hopes to retrofit a number of machines that take a common filter so he can stock a cleaned element and quickly swap them into service as needed. Again, higher-horsepower engines are a priority.

"We're not going to do DPFs on backhoes and other small machines because we don't want to spend \$10,000 to put a DPF on a 70-horsepower backhoe to get 140 horsepower of credit," Michaelson says. "We'd rather do a 250-horsepower excavator and get 500 horsepower worth of credit for 15 grand."

"We're concentrating on high-horsepower Tier 2 and later model Tier 1 machines," Michaelson continues. "It doesn't make sense to spend \$15,000 or \$20,000 putting a filter on a machine that's only got a few good years of life left in it."

"From what I understand, the filter elements don't like high vibration cycles," Michaelson explains. "We'll just continue to run (vibratory machines) and use our fleet average (to comply), and later replace them with Tier 3 or 4 machines as they come along."

Using the CARB fleet calculator, which is based on the original in-use off-road diesel rule, Michaelson has identified four to eight machines to fit with VDECS.

"We are doing our four 330CL excavators with Level 3 VDECS because Caterpillar has a passive system available for them that will all use one type of element," Michaelson says. "Double horsepower buys 1,976 horsepower credit to help get us through 2013 with our normal turnover schedule for the other machines. All of those (retrofit) machines could last us eight to 10 more years as they are all 2002 and newer, and the cost of the VDECS will be less than 10 percent of their replacement price."

He hangs on to four Tier 0 (1990) engines, worth 1,216 horses, aboard a pair of twin-engine scrapers through at least 2014. So Bay Cities is an example of how relatively few, smart VDECS investments this year can help California fleets skate far enough into the next decade that new engines and more abundant VDECS choices should simplify compliance.

Keep an eye on the searchable database of verified emissions systems from CARB at <http://arb.ca.gov/diesel/verdev/vdb/vdb.php>. It will sharpen your search, but Charlie Cox of retrofit dealer Ironman Parts in Corona, Calif., warns that the database isn't perfect. Buyers will have to research VDECS carefully to be sure they suit their applications.

A change to the In-Use Off-Road Diesel rule is in the works between CARB and the Cali-

CALIFORNIA LIGHTENS THE LOAD

Some of the 2009 horse trading over CARB's In-Use Off-Road Diesel Vehicle rule has softened the regulation's bite. Amendments ordered by the California legislature during late-2008 budget wrangling offered the broadest opportunities for equipment owners.

The amendments allow fleets to delay some of their compliance obligations for 2011 and 2012 until 2013. But the best deals are extended to those who clean up machine exhaust early.

New incentives to spur early action include:

- Fleets can claim an exemption for up to 15 percent of their total horsepower from future turnover if they install retrofits before March 1, 2011;
- Fleets can claim double credit for NOx retrofits installed by March 1, 2011;
- Medium and small fleets can claim double credit for PM retrofits installed by March 1, 2012; and
- Fleets can accumulate NOx carryover turnover credit for early re-powers installed.

Fleet owners can also accumulate horsepower credit to be applied toward the March 1, 2010, or March 1, 2011, compliance dates if they can demonstrate that their equipment worked less in the period from March 1, 2009, through Feb. 28, 2010, than it did in calendar 2007. Reducing overall horsepower from March 1, 2006, to March 1, 2010, also earns horsepower credit.

The CARB compliance-planning tools have been updated (see www.arb.ca.gov/msprog/ordiesel/ordiesel.htm).

An unrelated change to the In-Use Off-Road Diesel rule is in the works between CARB and the California Division of Occupational Safety and Health (Cal/OSHA) because of exhaust retrofits that block operators' view. For March 1, 2010, compliance, an interim retrofit visibility policy states that an exhaust retrofit will not be allowed to block the operator's line of sight in any direction.

When there are no possible locations on a vehicle for a retrofit to be installed without masking visibility to the front, sides or rear, that vehicle will not be required to be retrofitted for the March 1, 2010. The visibility test and exemption process are detailed at www.arb.ca.gov/msprog/ordiesel/vdecssafety.htm. This interim policy could change by March 2011, affecting even vehicles that are exempted this year.



Volvo dealers are selling the HUSS M-K diesel particulate filter as a Volvo-approved product. The active-regenerating filter has a diesel burner that clears accumulated soot from the media. The M-K is a Level-3 VDECS for on-road and off-road engines from 50 to 750 horsepower, in rubber-tired and tracked applications.

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WEB RESOURCES

Running Green Resources

www.constructionequipment.com/green

How to Get Diesel-Cleanup Grants

www.constructionequipment.com/articleDetail/CA6648709.html

CARB Fleet Average Calculator

www.arb.ca.gov/msprog/ordiesel/documents/documents.htm#fleet

CARB Verified Technologies

www.arb.ca.gov/diesel/verdev/vt/cvt.htm

EPA Clean Diesel Campaign

www.epa.gov/diesel/

The Associated General Contractors of America has mounted a challenge to the In-Use Off-Road Diesel rule that reflects the urgency of not only the economic crisis it forces on California contractors, but the inaccuracy of estimates on which the rule is based. The AGC replicated the computer model CARB used to predict emissions levels for California's off-road diesel engines. They substituted only the actual machine inventory supplied by the rule's registration requirement into the model, and then projected emissions from the state's total off-road fleet. What they found is that operators of off-road diesel equipment will exceed the ambitious emissions targets set by the California Air Resources Board with no need for further diesel retrofits, repowers or replacements until 2014 or 2015.

As a result, the AGC asked the Air Resource Board to revise its off-road diesel emissions regulations. Specifically, they want CARB to regulate "all fleets over the same period and to the same extent that ARB originally sought to regulate small fleets." This would put off further fleet requirements until 2015.

"This new data raises an important question," says Mike Kennedy, chief counsel for the association. Will California's Air Resources Board let the data drive the final decision, or simply drive the data to conform to its earlier conclusions?"

Ultimately, regulating diesel exhaust is not an end but a means to making the air healthy again. And the effort is moving nationwide.

Equipment operations working under regulation or project specifications that call for low-emissions equipment will have to sharpen their tracking of actual utilization and ownership and operating costs. Compliance will make machines more expensive, which affects repair and replace decisions, choices to rent or own machines, or to subcontract job elements.

"The thought of owning a used machine that you picked up very cheap because you only need it two weeks or a month a year, those days are gone," says Recalde. "Now if you only need a machine for two weeks per year, by all means, rent it."

"If I don't need to put as many VDECS on, I would rather put that money into a Tier 3 or Tier 4 replacement machine in the near future rather than use it to buy a filter that does nothing to improve the performance or life of an older machine," says Michaelson.

**IS MY TIER 0 EQUIPMENT GOING
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JOHN DEERE

JohnDeere.com/emissions

By LARRY STEWART, Executive Editor

CARB-Verification Makes These DPFs The Right Investment

California approval means these retrofits will satisfy "best available control strategy" clauses in emissions rules around the country

Diesel exhaust retrofits that reduce oxides of nitrogen (NOx) by 40 percent completed by March 1, 2011, qualify the fleet owner for double the horsepower credit toward NOx compliance with California's In-Use Off-Road Diesel rule. In other words, verified diesel emissions control strategies (VDECS) that can reduce NOx (for off-road vehicles, that's only Johnson Matthey's EGRT and Cleaire's Lonestar) for a 350-horsepower loader engine, for example, bank a 700-horsepower credit toward NOx compliance. Credits are applied in the first year that the contractor's fleet does not meet fleet-average targets established by the California Air Resources Board (CARB) for off-road diesel fleets.

To qualify for the credit, retrofits must be CARB verified (see the list of currently verified technologies at www.constructionequipment.com/articleDetail/CA6668098.html). Equipment owners working in locations nationwide should

be browsing the same list when considering machine rebuilds or replacements.

County and municipal ordinances and federal bid specifications are increasingly demanding that equipment working in badly polluted jurisdictions be fitted with the "best available control technology" (BACT) for reducing diesel emissions. When California gets the EPA waiver it needs to fully implement its In-Use Off-Road Diesel rule, any other state can pick up and apply the same regulation. The Associated General Contractors has identified as many as 32 other states which, for various reasons, are moving toward implementing the CARB rule (see the AGC analysis at <http://newsletters.agc.org/environment/2009/07/24/will-my-state-adopt-californias-off-road-engine-emission-standards/>). Construction-equipment owners in those states will have to use VDECS on equipment they want to keep.

The Environmental Protection Agency is deferring to CARB in determining acceptable emissions-control equipment. EPA automatically lists VDECS as EPA-verified (see www.epa.gov/otaq/retrofit/verif-list.htm). There are more products on EPA's list of verified diesel-emissions technologies, but the slim pickings available on the CARB Level-3-verified list are your only sure bets.

Cleaire's Lonestar DPF (detailed opposite) on this 2006 Deere 6081 engine is the only Level 3+ verified diesel emissions control strategy with CARB Mark 2 status (reducing NOx 40 percent in addition to PM 85 percent).



The in-use diesel rule offers no compliance credit for applications of Level 2 VDECS (50-percent reduction in PM emissions) until all of a fleet's engines five years old or older have been retrofit with Level-3 VDECS (85-percent reduction in PM emissions), if compatible Level 3 devices are available.

The range of engines for which there is a verified filter technology is narrow. Tier 1 engines produce so much soot that they challenge exhaust-filter reliability. Unregulated engines built before Tier 1 went into effect in 1996 typically must be upgraded before they can work with a DPF.

Diesel particulate filters are typically cylindrical elements of a high-tech ceramic such as silicium carbide in a steel sleeve. Diesel particulates catch on the porous ceramic walls as exhaust passes through. A diesel oxidation catalyst — a honeycombed structure coated with catalyst that generates heat when exposed to exhaust — upstream from the filter burns away accumulated soot, maintaining reasonable backpressure. The process is called passive regeneration. The assembled DPF typically looks like, and produces the effect of, a large muffler.



Caterpillar offers a verified, Level 3+ diesel particulate filter for rubber-tired and tracked off-road vehicles (non-Caterpillar machines included) with select Tier 1 and Tier 2 engines ranging up to 600 horsepower — double the horsepower of three of the other five passively regenerated DPFs. The Caterpillar **DPF** passive regeneration system requires an engine that runs at exhaust temperatures of 464 degrees Fahrenheit (240 degrees C — what Cat calls “Normal Operating Temperature”) or more at least 40 percent of the time. The Cat DPF allows the lowest temperatures among passive-regenerating VDECS. Customers will have a single point of contact for service and warranty support — Caterpillar dealers that are familiar with the equipment applications — and that can be a fairly compelling value. Pre-engineered under-hood installation options are available for some Cat machines.



Cleaire currently has three products — one passively regenerated and two active-regeneration systems — CARB verified for off-road use. **Lonestar**, the passively regenerated product, is built around a modular design that adds a lean NOx reduction catalyst to the wall-flow diesel particulate filter that is common to most Level 3+ VDECS. The lean NOx catalyst makes Lonestar the only VDECS verified at Level 3+ Mark 2, adding a 40-percent NOx reduction to the 85 percent PM reduction required for Level 3 status. It is verified for use with 1996 to 2009 engines from 150 to 350 horsepower. **Phoenix** is Cleaire's diesel-burning, active-regeneration system. It is conditionally verified for Tier 1 through Tier 3 engines (roughly model years 1996 to present) up to 12 liters. **Skyline** (formerly known as Horizon) is an electrically powered active-regeneration verified product, approved for Tier 1 through Tier 3 engines. An integrated electric heating element should be plugged in to shore power daily to process captured PM. Cleaire's **Allmetal**, which is awaiting verification, is an all-stainless version of the passively regenerating Lonestar. Cleaire's technologies are also CARB verified to Level 3 or better in its on-road packages called Longview (passive regeneration), Vista (active-regenerating diesel burner) and Horizon (active regeneration using electric power).



Independent Construction repowered several scrapers to improve reliability. Cleaner exhaust allowed the scrapers to be fit with banks of HUSS VDECS to assure compliance with CARB diesel emissions rules and preserve the scrapers' place in the California fleet as long as necessary to extract their considerable frame value.

Verifications come loaded with qualifiers stipulating the kinds of engines for which VDECS are suited, the conditions under which they will regenerate, the type of machines on which engines can be mounted (rubber tired, track mounted, or steel wheeled).

Passive VDECS for mobile off-road applications are all verified with minimum-exhaust-temperature conditions necessary for them to work. To determine if an engine can be retrofit with a passive-regenerating device, its exhaust temperature must be measured in various operating conditions with a thermocouple linked to a data recorder. The engine has to run hot enough, long enough for reliable passive regeneration.

In the ideal world, all VDECS would regenerate passively, with no need for additional

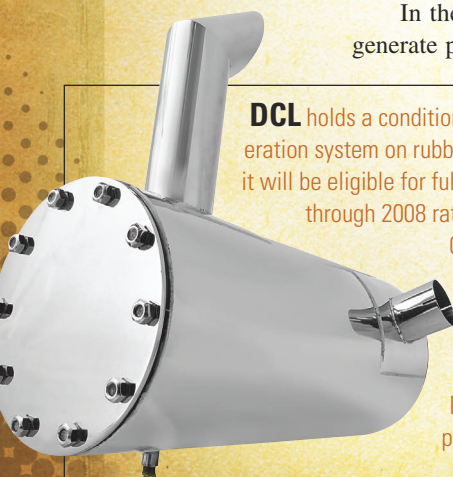
energy or supporting systems. Unfortunately, there are many engines whose exhaust temperatures are too cool for reliable passive regeneration.

Three of the five passive VDECS on the market are only suitable for engines up to 300 horsepower. Caterpillar has verified its passive DPF in applications up to 600 horsepower, and the ECS Purifilter is conditionally verified up to 750 horsepower. None of the passive-regenerating VDECS can work with engines that produce more than 0.2 grams of PM per brake horsepower-hour.

Active regeneration systems supply extra energy in the form of diesel fuel or electricity to clean DPFs. Electronic systems in on-road trucks, for example, monitor exhaust back pressure and begin injecting fuel as necessary. Small amounts of diesel (3 to 10 ounces per regeneration) mist a catalyst, which heats up to burn off PM accumulated on the filter.

Active systems have no minimum-temperature requirements, but they do not dramatically extend the range of engine families for which there are compatible exhaust retrofits. And they add complexity to the machine. Concerns about proper installation, durability, and being caught between the engine manufacturer and the VDECS maker in service and warranty disputes can be discouraging.

Three of the four active-regeneration VDECS for mobile off-road equipment apply only to engines of up to 12 or 15 liters of displacement — two of those are suitable only for engines made after 1995. The ECS Combifilter specifies no engine-model-year limits, and



DCL holds a conditional Level-3+ verification with CARB for use of its **MINE-X SOOTFILTER DPF** as a passive-regeneration system on rubber-tired mobile equipment. On completion of the remaining two-thirds of its durability testing, it will be eligible for full verification. The MINE-X SOOTFILTER DPF is verified for use with engines model years 1996 through 2008 rated between 175 and 300 horsepower, and certified to particulate-matter emissions levels of 0.15 grams per brake horsepower-hour or less. Engines in this size range were not required to certify PM emissions that low until 2003, when Tier 2 went into effect. Some engines certified at 0.2 g/bhp-hr. early, though, and they're listed in the CARB-Approved Engine Families List attached to the verification executive order. Buyers looking to consolidate purchasing with fewer retrofit dealers might look into the MINE-X SOOTFILTER DPF because the passive DPF is also Level-3+ verified for use with stationary prime and emergency standby generators, pumps, and compressors up to 300 horsepower.

applies to engines up to 12 liters displacement. The HUSS FS-MK filters — active-regeneration diesel burners — are verified for engines with no size or age limits.

Independent Construction, from Concord, Calif., has fit scrapers with banks of three or more HUSS VDECS. The active-regenerating filters are verified for multiple installations in series with virtually any diesel engine. Of

course, there are practical limits to how many filters an owner wants to maintain. To keep the scrapers' PM production down to manageable levels, and to upgrade the machines' reliability, Independent has repowered most of these scrapers with Tier 2 engines (supported by state grant funding).

Fuel-burning active VDECS can work without interrupting the machine's productivity. They are attractive for rental fleets that demand reliability with no operator intervention in a wide range of operating conditions.

Electrical active-regeneration systems must be attached to shore power to regenerate. The vehicle can't work while it is plugged in, so the option is primarily for equipment operating in central locations such as in quarries, refuse transfer, airports and warehouses or material yards.

Model years mentioned in verification documents are guidelines rather than rules. Each VDECS is actually verified to work with engines certified to specific maximum PM rates. With every verification, there is a document that lists acceptable engine families for use with the device.

Successfully using VDECS inevitably comes down to making educated choices and working with reliable vendors. There are some obvious choices. Caterpillar, for example, has verified its own passive DPF for mobile off-road applications. Cat products come with Cat dealer support and one-stop warranty accountability.

The **ECS Purifilter** is conditionally verified for use with off-road diesel engines with maximum power output ratings from 50 horsepower to 750 horsepower, making it the passively regenerated VDECS capable of handling the most powerful off-road engines. It is verified for use with engine model years ranging from 1996 to 2008, but compatible engines must be certified to produce no more than



0.2 grams of particulate matter per brake horsepower-hour. Some diesels certified at that PM level ahead of time, but the first off-road diesels were not required to meet that limit until 2001. Purifilter will be eligible for full verification on completion of the remaining two-thirds of its durability testing. The **Combifilter** from ECS is an actively regenerated (plug-in electric) DPF that works with diesels up to 12 liters displacement in rubber-tired off-road equipment. ECS is also seeking off-road verification of its **Purifilter Plus**, which is currently verified for on-road heavy-duty diesels. Purifilter Plus employs a passive Purifilter DPF plus a Combifilter element for active regeneration at intervals scheduled suitably (weekly, biweekly, at engine-maintenance intervals, for example) to meet specific engines' soot-loading rate under actual operating conditions.

Level 3 Off-Road-Vehicle VDECS

		Engine Compatibility		Applications	Regeneration	Exhaust Temp Required
		Size	Model Years			
Caterpillar	Diesel Particulate Filter	175 - 600 hp	1996 - 2005	Off-road: rubber-tired and tracked	passive	240°C — 40% of the time
Cleaire	Lonestar	150 - 350 hp	1996 - 2009	Off-road: rubber-tired	passive	260°C — 70% of the time
Cleaire	Phoenix	up to 12 liters	1996 - 2009	Off-road: rubber-tired (conditionally verified)	active (diesel burner)	none
Cleaire	Skyline	<=15 liters	1996 - 2007	Off-road: rubber-tired	active (electric plug-in)	none
DCL Int'l	Mine-X SootFilter DPF	175 - 300 hp	1996 - 2008	Off-road: rubber-tired (conditionally verified)	passive	350°C — 30% of the time
ECS	Purifilter	50 - 750 hp	1996 - 2008	Off-road: rubber-tired (conditionally verified)	passive	320°C — 25% of the time
ECS	Combifilter	<=12 liters	pre 2008	Off-road: rubber-tired	active (electric plug-in)	none
ESW	ThermaCat	175 - 300 hp	1996 - 2009	Off-road: rubber-tired and tracked	active (diesel burner)	210°C — 15% of the time
HUSS	FS-MK DPFs	no limit	pre 2009	Off-road: rubber-tired and tracked	active (diesel burner)	none

CARB verifies that Level 3 verified diesel emissions control strategies (VDECS) reduce exhaust particulates by 85 percent or more, and that they will continue to do so reliably for reasonable the life of the device. Conditionally verified technologies have proven to reduce PM by 85 percent and have consistently performed for at least one-third of the required test hours. They're considered the same as Level 3 devices, but must achieve full verification within three years.

STRATEGY GUIDE FOR EMISSIONS MANAGEMENT

The **ThermaCat** from **ESW Canada** is the first mobile, off-road Level 3+ VDEC to combine a passive diesel particulate filter (DPF) with an active-regenerating diesel fuel burner (Purifilter Plus, from ECS, is a competitor still seeking CARB verification). It's verified for engines up to 15 liters. The hybrid system is intended for vehicles working severe-duty cycles,

where exhaust temperatures are low. As long as the vehicle is operated at exhaust temperatures above 500 degrees Fahrenheit (260 deg. C), ThermaCat will regenerate passively fast enough that active regeneration is not necessary. When the vehicle runs long periods with exhaust temperatures below 500 deg. F, backpressure will increase as the filter accumulates soot. Once the exhaust-gas backpressure reaches a preset value, diesel injection activates automatically during normal vehicle operation to raise the filter's internal temperature and burn more diesel PM off the element. ThermaCat is verified to work with engines whose exhaust temperature reaches 210 deg. C just 15 percent of the time.



ThermaCat is verified to work with engines whose exhaust temperature reaches 210 deg. C just 15 percent of the time.

The CARB verified **HUSS FS-MK** diesel particulate filters as Level 3+ diesel emission control systems for use with most on-road engines through 2006 model year, and most off-road diesel engines through the 2008 model year. HUSS proved to CARB that multiple FS-MK filters can be mounted in series on vehicles to accommodate diesel engines of any size and PM output level. The company claims to have applied the active, diesel-burning filters on engines up to 800 horsepower. Volvo Construction Equipment entered a strategic partnership with the Swiss aftertreatment maker, to provide diesel-exhaust retrofits for Volvo construction equipment. Various configurations of the FS-MK filters are available as Volvo-approved products through Volvo CE dealers. HUSS systems are available in a similar way for Volvo's other heavy-duty diesel brands, Volvo Trucks, Mack Trucks, Volvo Penta, and Volvo Bus for retrofits globally.



Other indications of VDECS-maker staying power include OEM partnerships. For example, in 2008 Cat named CleanAIR an allied vendor of exhaust retrofit products specifically for stationary diesel engines. This kind of partnership is likely to give the maker volume and experience that will help them meet the demands of many applications.

Similarly, Volvo has named the HUSS FS-MK Series a Volvo-approved product. Volvo has worked with HUSS to match engines and applications — both off-road and on — to HUSS products. The VDECS can be purchased through Volvo CE and the various Volvo truck brands' (Volvo, Volvo Penta, Mack) dealers.

All the makers of VDECS, because they've gone to the trouble and expense of having technologies verified, are committed to the market for the long haul.

New emissions-retrofit devices continue to be added to the verified list. If you don't have to retrofit machines now, it may be worth waiting to see what new products are verified in the coming months. Don't hold out false hope, though — it is unlikely that a simple retrofit solution for engines made long before 1996 is forthcoming.

Most pre-Tier-2 engines (2002 or earlier, up to 299 horsepower) will have to be gone from California in the next seven or eight years. The BACT ordinances — like those in New York City and the Chicago area's Cook County — will effectively start pushing pre-2003 off-road diesels out of their jurisdictions.

The Big Apple requires emissions-retrofits now, and Cook County's diesel pollution ordinance will start requiring them soon. Keep an eye on the CARB Level 3 Verified Technology list, and start planning fleet investments now. Waiting until the last minute to try to comply will be devastating for most construction equipment users.

MORE ONLINE

Level 3 Stationary VDECS

www.constructionequipment.com/articleDetail/CA6668097.html

Level 3 On-Road VDECS

www.constructionequipment.com/articleDetail/CA6668098.html

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By LARRY STEWART, Executive Editor

CARB Demands Update of On-Road Diesels

Truck owners will have to start replacing pre-2007 engines or retrofitting them with DPFs by 2011, but the best (known) compliance deals are going on right now

California contractors, mired in the initial compliance with the Air Resources Board's In-Use Off-Road Diesel Emissions Regulation, are paying scant attention to the sister rule regulating in-use on-road diesel emissions. The off-road rule's shifting requirements have demanded some strategy adjustments and the on-road rule, known as the statewide truck and bus rule or, officially, the Diesel Particulate Matter and Oxides of Nitrogen and Greenhouse Gases Control Measure for On-Road Heavy-Duty Diesel-Fueled Vehicles, appears to be no less time consuming.

"I've been up to my

ears in the off-road regulation for six years, and frankly, I'm not nearly as up to speed on the on-road reg.," says Michael Shaw with Perry & Shaw, an El Cajon contractor that fields about 60 diesel machines. "I lost any personal interest I had in trying to keep up with the on-road regulation when I spent countless hours and resources following the off-road regulation through its workshops and public comment to completion, only to have it continue to be a moving target. I just have no faith in the process.

"I'm going to try to stay informed as to what the requirements of the on-road regulation are," he adds. "And when I decide CARB [the California



Trucks with engines certified to EPA 2007 or later emissions standards could be compliant until 2021, and they are likely to be gradually more expensive in California over the coming years.

Air Resources Board] thinks they know what they're doing, then I'll get serious about what we have to do to comply."

The in-use diesel truck regulation requires engine upgrades or replacements to trucks of 14,000 pounds gross vehicle weight (GVW) or heavier, so that by 2023 all of California's trucks will have emissions equivalent to 2010-model-year engines or better. The first performance deadline, requiring particulate matter (PM) filters on some engines on Jan. 1, 2011, is followed by engine or truck replacement requirements to reduce emissions of oxides of nitrogen (NOx) starting the first of January 2013. Fleets with three or fewer affected vehicles don't begin to meet performance requirements until 2015.

Potential for the on-road diesel regulation's finer points to shift, combined with the dearth of retrofit technologies available to bring existing trucks into compliance, has many contractors in the wait-and-see mode. Of course, a lack of cash to spend on trucks is discouraging investments as well.

But inaction will likely inflate compliance cost. Scant early-action incentives in the on-road measure expire by 2010. And while the cynical sit on the sidelines, the proactive are likely driving up prices for one key option – trucks with 2007-certified engines.

In general, the regulation requires truck owners to reduce fleet emissions each year for the next 12 years following one of three possible plans. The first is to install best-available control technologies (BACT) in the form of verified diesel emissions control strategies (VDECS) – which to this point are primarily diesel particulate filters (DPFs) – and replace either vehicles or engines or retrofit them to match 2010-model-year engines' emissions on a prescribed schedule. The second option is like the first in that it requires engines to be retrofitted with BACTs and/or replaced, but instead of scheduling specific ranges of engine model years to be upgraded each year, it directs that certain percentages of the total fleet be upgraded each year. The third option is to meet CARB's gradually declining fleet-average

SCHEDULING BACT RETROFITS

The BACT Schedule compliance option lists the compliance date, engine model years affected, and required actions. Fleets that comply with this schedule do not have any reporting requirements. In any given year, engines about seven years old or newer will always meet the requirements of this schedule. A fleet can meet the replacement requirement by replacing a vehicle with one that has a 2010-model-year engine or with one that has a later compliance date on the schedule. For example, a fleet owner with a 1994 engine could meet the Jan. 1, 2013, compliance requirements by replacing the existing truck with one that has a 2007-model-year engine originally equipped with a PM filter. According to the schedule, no further action would be required for that truck until 2021. By 2021, the truck would need to be replaced with one powered by a 2010-model-year engine or newer. In this way, a fleet could comply by purchasing used vehicles and would not need to purchase 2010-model-year engines until 2021.

BACT Schedule

Compliance Date January 1	Existing Engine Model Years	Required Actions
2011	Pre-1994	Install PM Filter
2012	2003 – 2004	Install PM Filter
2013	2005 – 2006	Install PM Filter
	1994 – 1999	Replace Vehicle
2014*	2000 – 2002	Replace Vehicle
2015	Pre – 1994	Replace Vehicle
2016	2003 – 2004	Replace Vehicle
2017	2005 – 2006	Replace Vehicle
2018, 2019, 2020	All pre-2007	No new requirements
2021	2007 or equivalent	Replace Vehicle
2022	2008	Replace Vehicle
2023	2009	Replace Vehicle

PM Filter – Highest level verified diesel emissions control technology to reduce PM.

* By 2014 all engines must have a PM filter regardless of engine model year.

Source: California Air Resources Board

emissions targets for PM and NOx. The three routes each reach the same place on or about 2023, having reduced California truck and bus fleets' emissions until the average matches the exhaust profile of a 2010-model-year, EPA-certified on-road diesel.

You don't have to declare which compliance option you intend to use, or stick with any one compliance option from year to year. Once the requirement of any one compliance option is met for PM, and any one option is met for NOx, the fleet is in compliance. A fleet calculator spreadsheet is available on the CARB website at www.arb.ca.gov/msprog/onrdiesel/calculators.htm to help evaluate different choices. The cal-

STRATEGY GUIDE FOR EMISSIONS MANAGEMENT



Cleaire's Longview DPF is the only on-road VDECS currently verified to reduce NOx. But its 25 percent reduction falls far short of bringing engines into parity with 2010-certified emissions.

culator determines when any of the three options are satisfied for either pollutant; and it accounts for vehicles that qualify for credits, delays and other provisions. It does not, however, help much with comparing compliance costs.

"We developed a compliance planning tool in-house that takes all three compliance options [considering the data you input] and compares and contrasts them," says Charlie Cox, with emissions-retrofit dealer, IRONMAN Parts, in Corona, Calif. "So you can see which one is going to make you spend the most money and when it's going to make you spend it. One [option] may look good for the first three years and then slaps you with a big purchase demand on the fourth year.

"The more fleets that I run through this thing, the more obvious it is that the purchase preferences and fleet makeup of each fleet have everything to do with which option makes the most sense," he says. "The BACT Schedule option has its pros and cons. It's simple – harsh, but simple. You don't even have to report under that option, so life is easier. Some people want that.

"But I also have clients who say things like, 'I like my '98s – they get great fuel economy – but my '02s aren't nearly as nice. I'd rather keep my '98s.' Well, he'd better not choose the BACT Schedule option; it's going to tell him exactly when those need to be gone."

Cox is impressed at the significance of factors other than cost driving many strategies.

"If they normally turn over a lot of trucks every year – a high percentage of the fleet – then they're likely a good candidate for the BACT Schedule," Cox says. "Whereas if they turn over a very low percentage of their fleet, then the fleet averaging option is more likely a good choice.

"Other fleet managers look at the BACT percentage option and realize the expenses there tend to be more uniform than the BACT schedule (which costs like a rollercoaster – extremely low expenses to extremely high expenses from one year to the next)," he says. "Fleet average tends to be less of a rollercoaster, but there are still years with high costs and low. The BACT percentage option allows you to blend retrofits and replacements so that you have a nice, stable expenditure each year.

"If you want to keep trucks as long as humanly possible, then fleet averaging is probably more for you," Cox says. "If you want to be somewhere halfway in between, BACT percentage limits will also let you pick and choose which ones go where and when. All you have to do is meet the percentages."

How far some truck owners might go to simplify compliance has surprised Cox.

"I sat down with a P&D-fleet guy the other day who completely surprised me with his reac-



tion to the numbers we came up with,” Cox says. “He said, ‘Well why don’t I just go buy a boatload of ’07s [trucks with engines certified to 2007-model-year emissions standards]?’ He was talking about buying 225 2007s in the next year and a half.

“To me, that seemed like a crazy purchase, considering the cost. But he said, ‘No I’ll get a great deal on them now.’”

A fleet judiciously replaced with 2007-certified trucks could be compliant until 2021 via the BACT Schedule. But already pricey 2007-to-2009 trucks are likely to hold value, if not appreciate, in California as demand for them increases between now and 2014.

Ultimate compliance – 2010 emissions standards – is impossible at the moment, so there is no silver bullet for sale right now that guarantees a truck’s indefinite place in a fleet. Trucks with 2010-certified engines will be available on Jan. 1, but buying brand-new replacements will likely be the expensive play. Volvo Trucks will add a \$9,600 surcharge to vehicles that meet EPA 2010 emissions standards, and Daimler Trucks will levy emissions-control surcharges from \$6,700 to \$9,000 per vehicle, depending on engine choice. Navistar’s price increases will reach \$1,600 per vehicle, which is added to an average \$1,000-per-unit price hike early in 2009.

Retrofitting some trucks with VDECS will be less expensive, but these trucks will need to be replaced or fit with additional, as-yet-unverified technologies to bring them to emissions parity with 2010 engines. And today’s VDECS applications are limited. Costs range from \$10,000 to \$30,000, but average between \$15,000 and \$20,000 per engine.

The best candidates for retrofitting are 1998- to 2002-model diesels because they already have some pollution-control technologies that will limit the need for regeneration and maintenance. The ideal retrofit device is a passive one, that regenerates (burns accumulated soot off the filter element) while the truck is working. The engine must run at a specified minimum temperature for at least 25 percent of its duty cycle for passive filters to be reliable. The alternatives are active VDECS, which regenerate using electric energy or diesel fuel and

BACT PERCENTAGE CHOICES

Complying via BACT Percentage Limits offers truck-fleet owners flexibility to select which vehicles to upgrade first, but requires users to report fleet information annually. The table’s middle column lists minimum percentages of fleet engines that need Level 3-verified particulate-matter (PM) filters. The right column holds the percentage of fleet engines matching 2010-model-year emissions standards needed to satisfy NOx BACT requirements. A fleet of four trucks, for example, could meet the 25-percent PM filter requirement in 2011 by installing a PM filter on any truck. If by then the fleet already has a 2007-model-year or newer engine originally equipped with a PM filter, that truck would meet the PM-filter requirement. In 2012, two trucks would need PM filters. By 2013, the fleet would need to replace a vehicle (25 percent of the fleet) with one having a 2010 engine, or add a retrofit to bring one truck up to 2010 standards (Note: There currently are no retrofit technologies that match 2010-model-year NOx reductions). A 2010 or later model truck would have a DPF, satisfying the 75- percent PM-filter requirement. By 2014, the fourth vehicle would need to be replaced with one having a 2010 or later engine. The fleet would be set until 2017, when one of the trucks with only an aftermarket PM filter would need to be replaced. By 2020, the fourth vehicle would need replacing.

BACT Percentage Limits

Compliance Date January 1	Percent Meeting BACT PM Filter	2010 Engine*
2011	25%	N/A
2012	50%	N/A
2013	75%	25%
2014	100%	50%
2015	100%	50%
2016	100%	60%
2017, 2018, 2019	100%	80%
2020, 2021, 2022	100%	90%
2023	100%	100%

Source: California Air Resources Board

require that the truck be taken out of production during the process.

There are just three VDECS allowed on pre-1993 on-road diesels, and none are passive. Of the 14 VDECS capable of working with 1993 or later diesels, half are passive models. Two of those passive VDECS are not verified to work with original-equipment oxidation catalysts, which disqualifies them from use with many engines built in the late 1990s through 2007. Ten of the 14 on-road VDECS are not verified for use with engines that use exhaust-gas recirculation (EGR), which precludes them from being applied to most domestic diesels built since October 2002 (only one passive VDECS will work with EGR).

STRATEGY GUIDE FOR EMISSIONS MANAGEMENT



Electric vehicles like this 16,500-pound GVW Smith Newton bucket truck for PG&E can dramatically lower fleet emissions averages. Smith will produce vehicles up to 16,500 pounds GVW in the United States in 2010.

or build glider kits with engines certified to 2007 emissions standards.

Replacing with 2007-certified engines can only be part of a much broader strategy if cost is to be contained, though.

"It takes a real keen understanding of the rules to try to model what's going to be the cheapest legal path to compliance," says Sean Edgar, of the consultancy Clean Fleets Coalition in Sacramento. "Because in the short term people want to minimize their outlay of capital, but in the long

term CARB has a plan that by 2023 everybody's going to be using near-zero-emissions engines."

Edgar advises diesel-equipment owners in California on environmental regulatory compliance. His client list includes hundreds of dump-truck and solid-waste companies. He says the first step to lowest-cost compliance for most truck owners is to carefully inventory their engines.

"CARB's rules are all about the engine, not necessarily the year of the truck," he says. "And the year of the engine is not necessarily the same as the year of the truck. You have to absolutely have clear information about what engine model year is in your existing trucks.

"And the in-use on-road diesel rule is about diesel engines in vehicles that are greater than 14,000 pounds GVW," he adds. "That includes a lot of the smaller Class 4 and 5 equipment that is very common in construction use.

"You also have to understand the current use of the vehicle because there are some mileage-

THE FLEET-AVERAGE OPTION

Fleet averaging allows a truck owner to gradually retrofit and replace engines to meet fleet-average emissions targets for PM and NOx. Targets decline so that by 2014 all engines should have PM filters, and by 2023 all trucks should have emissions equivalent to 2010-model-year engines. The NOx and PM emissions factors and targets for each engine are based on the engine model year and vehicle weight class. Applying a VDECS reduces the emissions factor by the percent reduction for which the retrofit device is verified. Fleets may comply with some engines emitting above the target if they also have enough engines below the targets that the fleet average meets the goal. Owners complying via fleet average must report fleet information annually. Hybrid vehicles earn a credit up until 2017 that double

counts their very low emissions levels when calculating the PM and NOx indices and target rates. Alternate-fuel or heavy-duty pilot ignition engines are allowed to apply the NOx emission factor for the engine model year to which the engines are certified in calculating the NOx index and zero for the PM index.

Fleet Emissions Targets (grams/mile)

Model Year*	Greater Than 33,000 lbs		Less Than 33,001 lbs	
	PM	NOx	PM	NOx
2011	0.710	--	0.38	--
2012	0.530	--	0.29	--
2013	0.320	14.4	0.17	8.5
2014	0.110	9.8	0.06	5.8
2015	0.110	9.8	0.06	5.8
2016	0.110	7.8	0.06	4.6
2017	0.110	6.0	0.06	4.0
2018	0.110	6.0	0.06	4.0
2019	0.110	6.0	0.06	4.0
2020	0.110	4.4	0.06	3.2
2021	0.110	4.4	0.06	3.2
2022	0.110	3.0	0.06	1.6
2023	0.110	1.6	0.06	0.8

Source: California Air Resources Board

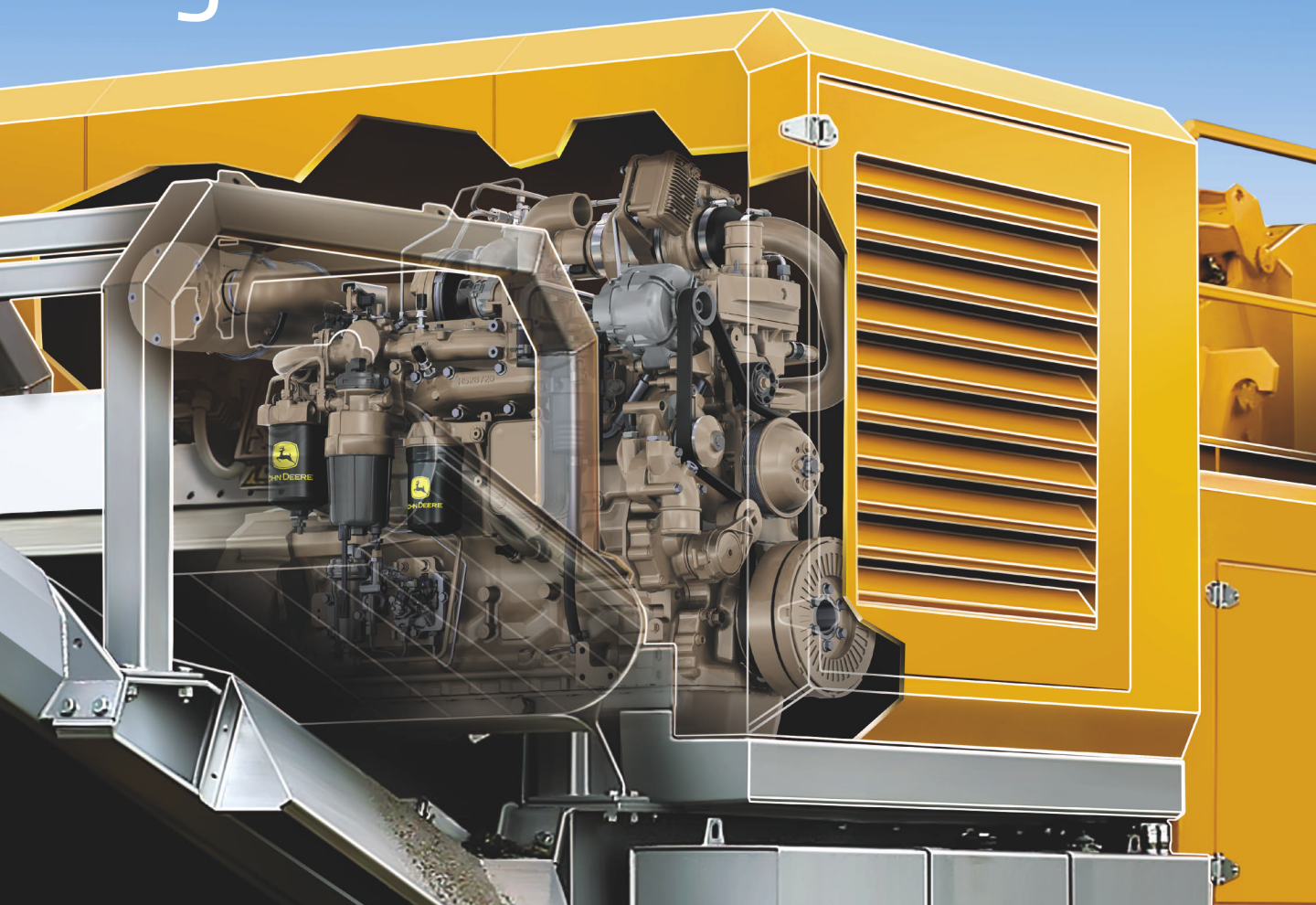
Engine Emissions Factors (grams/mile)

Model Year*	Greater Than 33,000 lbs		Less Than 33,001 lbs	
	PM	NOx	PM	NOx
1900	3.36	22.0	1.65	14.2
1991	1.25	22.0	0.84	14.2
1994	0.81	22.0	0.43	14.2
2004	0.81	12.0	0.43	6.7
2007	0.11	7.0	0.06	4.0
2010	0.11	1.6	0.06	0.8

* Engine model year emissions standard met

Source: California Air Resources Board

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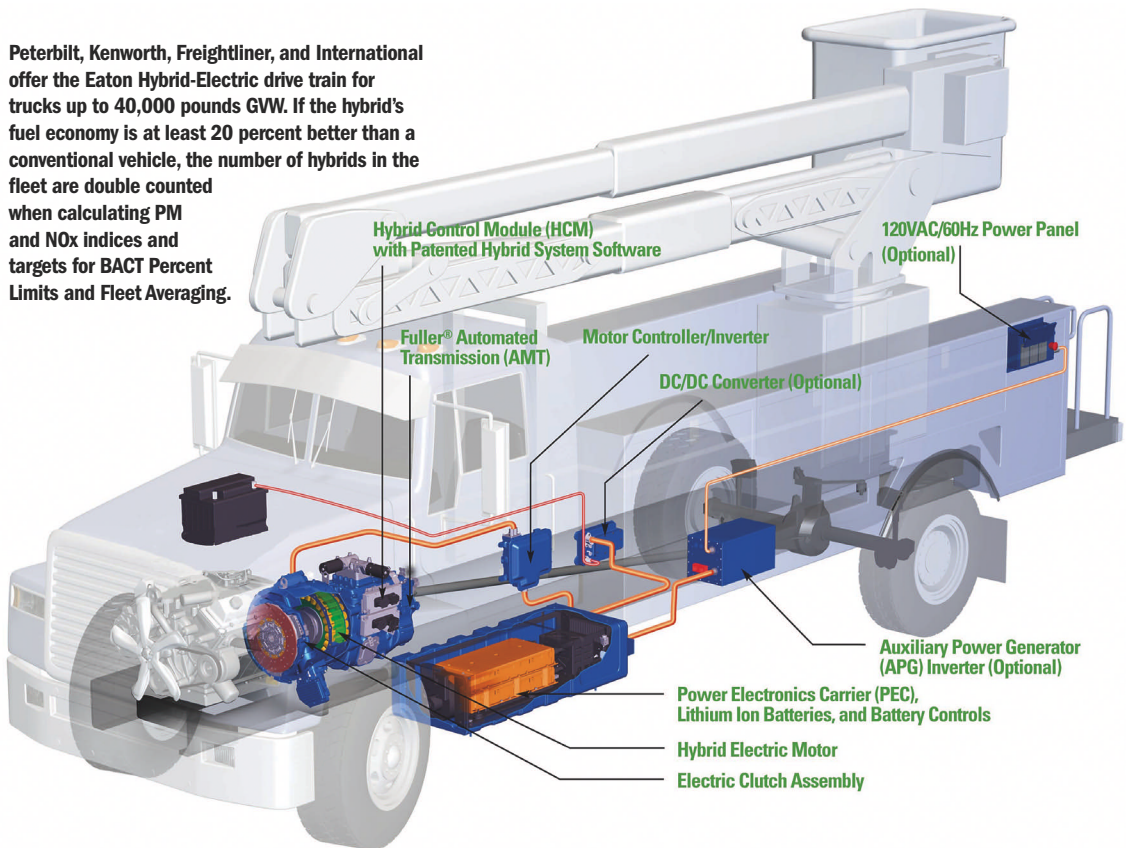
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STRATEGY GUIDE FOR EMISSIONS MANAGEMENT

Peterbilt, Kenworth, Freightliner, and International offer the Eaton Hybrid-Electric drive train for trucks up to 40,000 pounds GVW. If the hybrid's fuel economy is at least 20 percent better than a conventional vehicle, the number of hybrids in the fleet are double counted when calculating PM and NOx indices and targets for BACT Percent Limits and Fleet Averaging.



MORE ONLINE

New Verifications for Level 3 VDECS

<http://www.constructionequipment.com/articleDetail/CA6668098.html>

weighted thresholds,” Edgar says. “Lower-use vehicles may not have to comply as quickly.”

Edgar’s greatest challenge to California truck owners, though, may be to thoroughly understand their owning-and-operating costs.

“People understandably do not like the idea of taking on truck or equipment payments right now, economic conditions being what they are,” he says. “But I understand from working with a lot of equipment owners that they’re spending significant money keeping older trucks on the road.”

Neglecting to recoup all of the costs arising from owning and operating equipment – depreciation or cost of capital, for example – because of accounting practices or ownership biases gives a decision maker a false sense of a truck’s economy. Failing to accurately measure

fuel use or mileage can also make trucks appear much less expensive to operate than a newer replacement.

Underestimating truck costs makes it more difficult to decide which emissions-cleanup option – retrofit, repower, replacement – will be most cost effective in the long term. Worse yet, inaccurate or incomplete accounting can lead managers to retain trucks that might be effectively replaced by subcontractors, dramatically reducing the owner’s exposure to regulatory liability.

Properly accounting for all equipment costs is an exercise in which all construction-equipment owners in air-quality non-attainment areas should seriously engage. Because even if your state does not adopt the CARB diesel-emissions regulations to clean up their air, chances are very good that municipal and other local agencies responsible for air quality will soon impose regulations that will force diesel owners to invest in cleaner diesels.



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