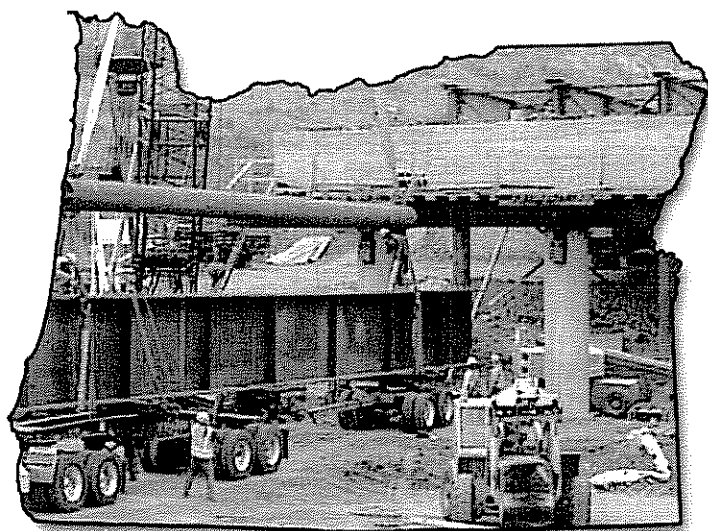


# Clean Diesel for Oregon Bridges

## Final Report

### EPA National Clean Diesel Campaign Demonstration Assistance Project

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U.S. 97 over California Avenue

**Summary:** The project funded an engine upgrade and diesel exhaust controls retrofitted on equipment used in highway bridge replacement projects as part of an ongoing campaign to promote adoption of clean diesel technology. The state of Oregon is underway with a program to build and repair over 300 aging highway bridges over an eight year period. Four contractors involved in bridge reconstruction and highway projects were recruited to participate. Twenty three pieces of equipment were identified for exhaust control retrofits. All of the devices were verified for emission reduction effectiveness on highway engines and equipment but not for nonroad engines. Devices included actively regenerating diesel particulate filters, partial flow filters and diesel oxidation catalysts. This began as the first effort in the Pacific Northwest to demonstrate the effectiveness of retrofitting exhaust controls on nonhighway equipment and will serve as a resource for widespread fleet operator acceptance elsewhere in the region.

## Project Background

In 2004 the state of Oregon, under the supervision of the Oregon Department of Transportation (ODOT), began the building and repairing of 366 aging highway bridges. The overall project, with a total project cost of over \$1.3 billion, is expected to take eight years to complete. ODOT has contracted with a private sector firm, Oregon Bridge Development Partners, to directly manage the state bridge replacement program.

The program has five project goals, (stimulate the economy, employ efficient and cost effective delivery practices, maintain freight mobility and keep traffic moving, build projects sensitive to their communities and landscapes, capitalize on funding opportunities) each evaluated within the Context Sensitive and Sustainable Solutions model developed for this effort. This approach was designed for the bridge project so that construction and completion could be done in a way that is responsive to the communities and environment of Oregon. To meet the goal to build projects sensitive to their communities and landscape ODOT initiated a collaborative effort with 11 state and federal agencies, crafting a set of environmental performance standards for all the bridges that will be repaired or replaced. The resulting Bridge Replacement Stewardship Program was recognized as a unique environmental management system by the Federal Highway Administration, receiving the prestigious "Environmental Excellence Award for Environmental Streamlining." Among the elements of this environmental management system (EMS) are several air quality related requirements like reducing idling at bridge construction sites, staging vehicles away from sensitive populations and using highway grade fuel in all equipment used on the project. In addition the EMS encourages the use of clean diesel equipment either retrofitted with exhaust controls or upgraded with engine rebuild kits. This project was designed to support this latter element and to also serve as a demonstration to contractors working on this and other highway and building projects in Oregon and other western states that clean diesel technology can work on their existing equipment inventory.

## Recruitment of Construction Company Partners

Staff from Associated General Contractors (AGC) initially recruited members of the chapter's highway council to attend a recruitment meeting co-hosted by AGC, the Oregon Department of Environmental Quality (DEQ) and the Lane Regional Air Protection Agency (LRAPA). LRAPA had recently received a federal grant to promote and underwrite the use of ultra low sulfur diesel in construction equipment focused as well on the state bridge replacement program. The invitation from AGC played a critical role in building credibility for the project. The goal was to engage the participation of at least four companies. AGC staff also made a recruitment presentation to the AGC Construction Industry Opportunity Council, a group of companies that are minority, women owned or emerging small businesses.

Based on the initial meeting, one company, Mowat Construction committed to the project but others, while interested, were skeptical about the level of their involvement as participants as well as the impact of the exhaust controls on the operational status of their equipment. To resolve these concerns, DEQ staff worked with consultants retained by the Western Regional Air Partnership on their project to promote clean diesel in nonroad engines in the western states. DEQ also reached out to vendors who had early expressed an interest in working on this project to ask them to identify contractors anywhere

in the country who have had experience with emission retrofits on construction equipment. A conference call was organized with interested Oregon companies and a construction company operator and municipal fleet manager who had participated in retrofit projects in other parts of the country. As a result three other companies, Staton Companies, Hamilton Construction and LTM, Inc. committed to participation. During the course of the project, LTM was purchased by Knife River Corporation and they decided to decline participation as they were moving towards acquisition of newer equipment. DEQ staff recruited Kerr Contractors instead, a large earthmoving, underground utility and road construction contractor.

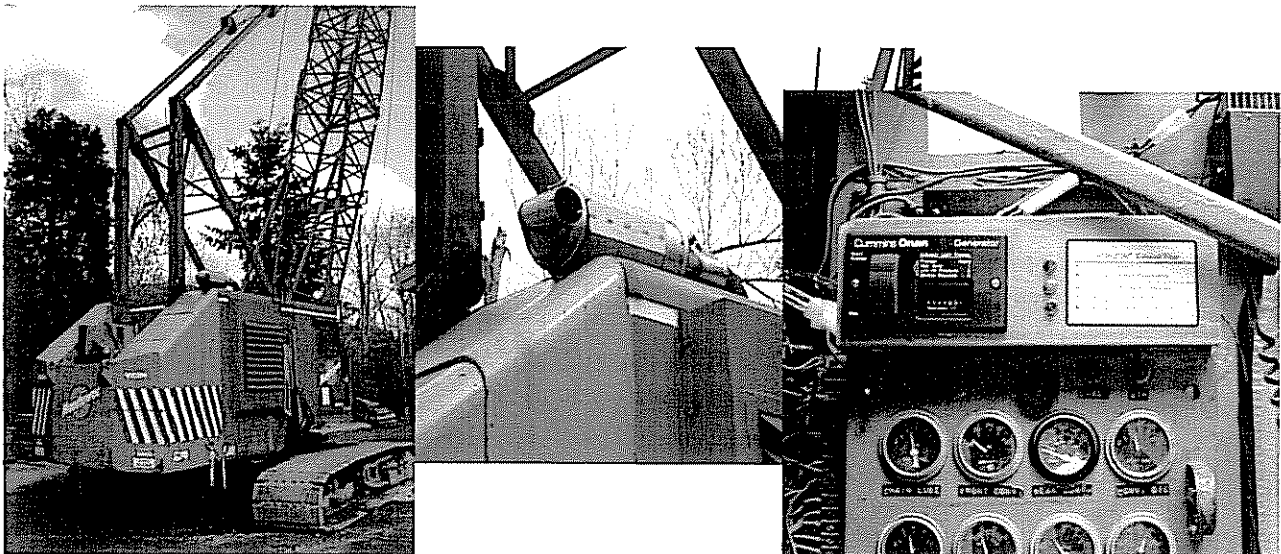
A Request for Proposals to identify a vendor for exhaust controls and engine upgrades was developed in consultation with the Environmental Protection Agency and other jurisdictions including the state of Washington. After evaluation of competitive proposals, Cummins Northwest was selected as the partner vendor for the project.

### Company Participants

#### **Hamilton Construction Company**

<http://www.hamil.com/index.php> The initial effort focused on a repower project for a Manitowoc 3900 crane. The original engine was an unregulated emission level Cummins 855 "Small Cam" engine. A Tier I emission level Cummins N14 served as the repower unit.

Equipment availability and customer application preferences eliminated current tier level engine options. Hamilton Construction personnel preferred a mechanical control configuration for the new engine. Additionally, the company had little time to complete the repower and return the crane to service for a long term project. The N14 closely approximates the dimensions of the original 855 Small Cam unit. It was an obvious candidate to minimize equipment modifications and expedite the new engine installation. While a higher tier engine was desirable from an environmental protection point of view, the N14 engine will consume 10% less fuel under similar operating conditions. When fuel savings are combined with Tier I emission reductions, relative to unregulated levels, a significant positive environmental impact should result.

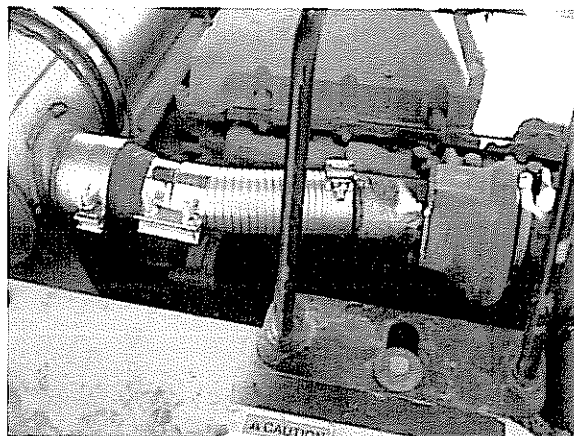


After the repower was complete, the new Cummins N14 installation was evaluated for the additional exhaust controls appropriate to the application. Exhaust temperature data logging was conducted but the data did not support use of a passively regenerated exhaust filter. Hamilton was approached about application of an active aftertreatment system. An electrically regenerated diesel particulate filter, Horizon DPF manufactured by Cleaire Advanced Emission Controls, was proposed and accepted for demonstration on the crane. The device is CARB verified as a Level III technology for off-road use with a minimum 85% particulate matter reduction. Since the crane operates in remote locations away from grid-supplied electricity, an electric generator was installed on board to provide power during periodic regeneration events. An onboard monitoring system tells the operator if regeneration is needed that can be commenced with one button operation. The generator is configured to operate only as long as needed and will shut down when the process is complete. The generator is configured as a Tier II engine and would draw 0.5 gallon of fuel per hour at normal loads.

The package was designed for easy installation and removal through the incorporation of modular systems - i.e. fuel and electrical connections are made with quick disconnect hoses / harnesses. The unit is configured for placement on the top of the crane engine housing. Fork tubes and lifting eyes facilitate the easy placement of the unit to insure the system is not damaged during transport. Mounting lugs affix the unit to the crane housing during operation. Transportation of the crane via a truck and trailer necessitate removal of the exhaust due to road clearance issues.

#### **Staton Companies**

<http://www.statonco.com/welcome.html> Staton offers demolition services particularly for large and difficult structures. Cummins NW and AGC staff met with the owner and the head of equipment maintenance met to discuss participation in the demonstration project. At that time, lead maintenance personnel were concerned about potential problems associated with aftertreatment devices. They were hesitant to participate in the demonstration project regardless of ownership interest.



Due to the nature of the company's work specialty, the majority of equipment in the fleet are excavators equipped with hydraulic crusher attachments. According to Staton personnel, these units heavily tax their hydraulic and engine cooling systems due to the severe duty cycle of the equipment's demolition operations. They expressed concern that additional ambient heat generated by aftertreatment devices would compromise operation of the excavator cooling systems. Following data logging of exhaust temperatures on the excavators they agreed to the installation of Level II partial flow filters on two units initially and then to evaluate performance issues. Four more units were identified

for exhaust control upgrades after a positive experience was reported for the equipment retrofitted initially.

#### **Mowat Construction Company**

<http://www.mowatco.com/> Mowat is a heavy/highway construction company that works throughout Alaska, Oregon, Idaho and Washington. Discussions began with consideration of a Level III device on a crane but Mowat decided instead to participate instead with diesel oxidation catalysts on ten units including forklifts, cranes, water barrel and dump trucks. This is a fairly straightforward technology even for nonroad applications. The greatest difficulty in this portion of the project proved to be scheduling as equipment moved readily from one project site to another, especially problematic when the vendor is scheduling work orders. Attention to these details can be as critical a component for project success as hardware functionality.

#### **Kerr Contractors**

<http://www.kerrcontractors.com/> Kerr Contractors Inc. is a heavy civil contractor in Oregon and Southwest Washington with over 400 pieces of equipment in its fleet. The company specializes in mass earthmoving, highway construction and road building and underground utility work. Following the retirement of LTM, Inc. from the project, DEQ staff was able to recruit Kerr to participate in retrofitting nonroad construction equipment. They had been considering repowering as a strategy for upgrading operational and environmental performance of their equipment but agreed to consider exhaust control retrofitting for this project. Following data logging, Level II devices were installed on six compactors.



#### **Participant Reactions/Observations**

The project partners circulated a survey to participants at the close of the project to gauge their reaction to the project as well as their willingness to participate in future clean diesel projects. See Appendix A for the survey and a summary of those comments.

Given the time it took to recruit company participation, it is remarkable how uniformly pleased the participants are with their involvement in the project and their willingness to proceed with further work. Initially there was a great deal of skepticism regarding involvement in a government funded project that might compromise or alter some form of their business practices. In addition there were other concerns related to the technology itself, e.g., adverse impacts to power, fuel consumption, operator visibility and ongoing maintenance. The partnership between AGC and DEQ proved crucial in overcoming these barriers by providing credible and respected partners who could offer assurances about the scope of

project involvement and reliable information about the operational and technical implications of the technologies to be deployed. More than one company has already inquired as to the availability of further funding to continue with the remainder of the vehicles in their fleet. These companies now have a greater respect for government assistance programs as well as knowledge and acceptance of clean diesel technologies on construction equipment. These companies are well placed and prominent within the construction industry in Oregon and the Pacific Northwest and can serve as respected proponents and advisors to other companies considering clean diesel as a ongoing part of their business strategy.

#### **Preventive Maintenance Strategy**

The project proposal also included an element to partner with the Washington Department of Ecology to take advantage of their effort to develop and evaluate a screening program for maintenance and repair options for highway and nonhighway engines. Well maintained equipment has been shown in other mining operations to result in lowered emissions. Engine repowers and exhaust retrofitting can be the primary strategies in a clean diesel campaign but are often either too expensive or cannot deliver a return on investment from a traditional business point of view. Offering a lower cost and more readily accessible alternative to securing air quality improvements, through a preventive maintenance program, can be a way to build and reinforce interest in a fleet operator's desire to contribute to healthier air quality in any way they can. An effective preventive maintenance program can deliver direct return to a fleet, extend the life of equipment, result in cleaner air but can also establish partnerships that lead to greater efforts when the circumstances permit. Unfortunately, the Washington state program did not get off the ground and so without a program effort to build on, this element was not completed.

This element still retains value as a complete approach towards promoting clean diesel and DEQ will be establishing meetings with diesel engine dealers and repair facilities to develop a program and campaign that can be used for highway and non highway vehicles and equipment. In fact one of the offshoots of this project is that a fleet participant from this project has already offered to develop a heavy duty equipment operators training to demonstrate safe and fuel efficient operation of heavy equipment.

#### **Clean Construction Rental Equipment**

Not all of the equipment used on a construction project is owned by the contractor. Specialized equipment for a particular application may not warrant the investment to purchase. Upgrading exhaust systems on rented or leased equipment represents another way for contractors to experience clean diesel equipment in a low risk setting, possibly leading to upgrading their own equipment.

EnviroFunding is a privately funded business that offers a revolving funding program, in this case that would support the emission upgrades on equipment used in construction and offered for long term lease or short term rental. The proposal was to meet with construction equipment rental companies to build interest and participation in their program. EnviroFunding was to establish a low level fee that is mutually acceptable between EnviroFunding and the rental/leasing companies, to be paid by the rental/leasing company on a monthly basis, e.g. in the form of an "environmental benefit fee", of a few percent of the rental or lease rate. A portion of the fee was to be used to acquire additional exhaust controls for installation on further equipment. Representatives from EnviroFunding and DEQ were able to secure meetings with two construction equipment rental companies. Neither was interested in participating in the project. One company regarded the program as being more attractive for their offices in California, presumably because of the prospects of California regulatory programs driving customer interest. The other company, also in the business of selling new and used equipment, was not interested because their rental equipment was purchased new and used for only three to four years

before being sold as used equipment. They saw the value of emission upgrades only to the extent that the vehicles remained in their fleet.

Installing exhaust upgrades on equipment available for lease or rent remains a viable and important strategy to support the industry's movement towards lower emitting vehicles. Unfortunately this was not able to be accomplished as part of this project. AGC and DEQ will continue to look for opportunities to engage rental companies as part of the overall clean diesel effort.

#### **Lessons Learned and Recommendations**

This project took a long time to complete. Staff turnover at AGC was unavoidable but contributed in part to the delay. Ongoing participation by DEQ staff offered continuity and enhanced the opportunity for a successful outcome. Delays were also attributable to the difficulty in recruiting participation including needing to overcome skepticism about being involved in a federally funded project with technology that little was known about. Delays also occurred in the actual delivery and installation of exhaust controls. On all projects of this nature there can be breakdowns in communication and delays attributable to product orders and delivery. These certainly occurred here but with this project, more so than with other retrofit project the DEQ has been involved in, scheduling of equipment for installation proved to be especially challenging. One of the advantages with the selected vendor was their widespread network of shops through the Pacific Northwest from which installers could be deployed. However, these contractors, especially during the relatively short construction season in the Pacific Northwest for highway and "dirt" contractors, move their equipment from one location to another with very short notice. In some cases, the vendor was required to "chase" the equipment down in order to install the exhaust controls. The installations proceeded well once the exhaust controls and parts got to the site but scheduling during the off season would reduce this delay.

Historically the evolution of exhaust controls on diesel engines has proceeded from highway engines to nonhighway engines. There are a number of good reasons as to why this has occurred, the relative diversity of engines and differential usage patterns for nonhighway engines being one element, but it has resulted in a smaller number of options for exhaust controls for those interested in installing proven and verified technology in nonhighway equipment. This project was authorized as a demonstration project and was able to succeed with the installation of exhaust controls on nonroad engines that had been verified on highway engines. However, interested contractors nowadays, almost five years after this project initiated, still face a relative scarcity of verified technologies that can be installed on their nonhighway equipment. Nonhighway equipment in Oregon, in particular, constitutes a significant portion of total diesel exhaust emissions. A shortened list of verified exhaust controls limits the opportunities to make progress that a clean diesel program must achieve in order to sustain credibility. EPA should be making every effort to support verification of exhaust control technologies for nonhighway engines.

Exhaust controls on diesel engines, while very cost effective from a social and public health perspective, cannot be justified from a standard business case point of view. Therefore there remains a very strong argument to be made, if clean diesel technology is to make a difference, for public financial support to be made accessible for projects similar to this. This could be in the form of grants, tax credits and possibly loans. Expanding the list of verified technologies for nonhighway engines also increases the chances for applicants for federal or state funding to participate in opportunities for funding increasingly becoming available. To the extent that access to funding support is competitive EPA priorities for awarding grant funding, both nationally and regionally, should support construction companies'

participation. There is a strong emphasis towards projects in involving freight movement, a sector, while important, does not necessarily represent the same opportunity for emission reductions. EPA should ensure that otherwise well developed projects from the construction industry are also able to compete well for funding opportunities and be reflected in award decision priorities.

Companies participating in clean diesel technology projects take on a certain level of risk. They are not typically required to purchase and install this technology, that even though it has become more widespread is still not the norm in any industry sector. Financial support for those willing to take that risk is one way environmental agencies can promote more widespread adoption of clean diesel technology. Recognizing the leadership role that individuals and companies are making in taking this step is also another way to show support and encourage others to follow. Recently the Oregon DEQ completed development of a recognition program for any fleet that takes scaled steps towards reducing diesel emissions either by using alternative fuels, adopting fuel economy measures and/or by upgrading exhaust controls on their diesel powered equipment. This program, marketed as Fleet Forward, is designed to be accessible to any business sector. Companies participating in this particular project will be evaluated and encouraged to participate. A program like Fleet Forward should be part of a complete effort to highlight and encourage and reward those individuals willing to take steps above and beyond.

#### **Project Partners**

The Associated General Contractors, Oregon-Columbia Chapter Foundation is a charitable, non-profit, 501 (c) (3) organization dedicated to promoting construction training and education. The mission of the Foundation is to exclusively carry out charitable purposes related to and in support of construction industry promotion, construction training and education and construction-related efforts. The Foundation is affiliated with the Associated General Contractors, Oregon-Columbia Chapter (AGC), a full service trade association serving 1,100 members in Oregon and southwest Washington, the third largest chapter among the 101 AGC chapters nationwide.

For more information contact John Rakowitz, [johnr@agc-oregon.org](mailto:johnr@agc-oregon.org), 503.686.3363.

The Oregon Department of Environmental Quality (DEQ) is a state agency whose responsibility is to protect the quality of Oregon's environment. DEQ is responsible for protecting and enhancing Oregon's water and air quality, for cleaning up spills and releases of hazardous materials, and for managing the proper disposal of hazardous and solid wastes. The Department completes this work through a mix federally delegated programs, state originated programs and voluntary initiatives. The Oregon Clean Diesel Initiative is an example of the latter type of environmental protection measure. Starting in 2001, the Department has led efforts in the state to promote cleaner burning fuel, exhaust control upgrades and fuel efficiency measures in heavy duty vehicles typically powered by diesel fuel. The Department provided technical and outreach assistance to this project as part of its clean diesel demonstration and promotion efforts.

For more information contact Kevin Downing, [downing.kevin@deq.state.or.us](mailto:downing.kevin@deq.state.or.us), 503.229.6549

The project partners would like to thank Cummins Northwest in general and Tom Gardiner in particular for their dedication to meeting the project goals and their prowess in developing engineering solutions to the challenges encountered in installing exhaust controls on construction equipment. The project partners would also like to thank Monica Beard-Raymond and Connie Ruth, the EPA project officers, for their patience, responsiveness to our questions and concerns and their unfailing support that helped us complete this project.

## Appendix A Equipment List

### Mowat Construction

| Equip # | Model Year | Equipment Description   | Model    | HP  | Annual Usage – Miles | Annual Usage – Hours | Fuel Consumption |
|---------|------------|-------------------------|----------|-----|----------------------|----------------------|------------------|
| 589     | 1998       | IHC Flatbed Dump        | 4700     | 230 | 3000                 | NA                   | 16 mpg           |
| 645     | 1998       | IHC Barrel Truck        |          | 215 | 550                  | 150                  | 15 mpg           |
| 662     | 1996       | Manitowac Crawler Crane | 222HD    | 350 | NA                   | 650                  | 3.5 gph          |
| 664     | 1997       | Manitowac Crawler       | 222HD    | 350 | NA                   | 850                  | 3.5 gph          |
| 665     | 2002       | Terex Crane             | 665 65T  | 215 | NA                   | 475                  | 2.5 gph          |
| 700     | 2004       | I/R Forklift            | VR1044   | 110 | NA                   | 1000                 | 2 gph            |
| 707     | 2002       | I/R Forklift            | VR1044   | 110 | NA                   | 650                  | 2 gph            |
| 7002    | 2005       | I/R Forklift            | VR1044   | 110 | NA                   | 800                  | 2 gph            |
| 9991    | 2000       | Pettibone               | Super 20 | 185 | NA                   | 500                  | 3 gph            |
| 9994    | 2001       | Pettibone               | Super 20 | 185 | NA                   | 500                  | 3 gph            |

### Hamilton Construction

| Description          | Engine Model | Model Year | HP | Activity (hr/yr) |
|----------------------|--------------|------------|----|------------------|
| Manitowac 3900 Crane | Cummins N14  |            |    |                  |

### Kerr Contractors

| Equip # | Description                  | VIN         | Equipment Type   | Engine Year | HP  | Activity (hr/yr) |
|---------|------------------------------|-------------|------------------|-------------|-----|------------------|
| CR846   | IR SD180D VIB Soil Compactor | 10715       | Roller/Compactor | 1994        | 230 | 500              |
| CR855   | Sakai SV510D Roller          | VSV16-30165 | Roller/Compactor | 2004        | 138 | 500              |
| CR856   | Sakai SV510D Roller          | VSV16-30161 | Roller/Compactor | 2002        | 138 | 500              |
| CR858   | Sakai SV510D Roller          | VSV1630155  | Roller/Compactor | 2005        | 138 | 500              |
| CR865   | Sakai SV700D Soil Compactor  | 10112       | Roller/Compactor | 2006        | 166 | 500              |
| CR876   | Sakai SV510D Roller          | VSV16-30161 | Roller/Compactor | 2002        | 138 | 500              |

### Staton Companies

| Equip # | Description        | VIN       | Equipment Type | Engine Year | HP  | Activity (hr/yr) |
|---------|--------------------|-----------|----------------|-------------|-----|------------------|
| 236     | 370 Linkbelt LX    | K6J3-7138 | Excavator      | 2003        | 230 | 1,500            |
| 237     | 370 Linkbelt LX    | K6J4-8692 | Excavator      | 2004        | 138 | 1,500            |
| 238     | 330 Linkbelt LX    | K6J4-8662 | Excavator      | 2004        |     | 1,500            |
| 239     | 370 RB Linkbelt LX | K6J5-9688 | Excavator      | 2005        |     | 1,500            |
| 240     | 370 Linkbelt LX    | K6J5-9879 | Excavator      | 2006        | 230 | 1,500            |
| 244     | 330 Linkbelt LX    | K6J4-7269 | Excavator      | 2004        | 138 | 1,500            |

## Appendix B Participant Follow-up Survey

AGC Oregon/Columbia Chapter Clean Construction Equipment project

### Participant follow-up survey

Thank you for participating in the EPA funded demonstration project to reduce emissions from construction equipment. Please help us improve future projects with your feedback about your experiences in this project. Please respond to the queries below in writing or, if it is more convenient, we will call you. Let us know if you would prefer to debrief by phone. If you have any questions, contact Kevin Downing at DEQ, 503.229.6549, [downing.kevin@deq.state.or.us](mailto:downing.kevin@deq.state.or.us).

#### Operational Experience

Have you or your employees noticed any change in the functionality or operation of the equipment that has been retrofitted, e.g., fuel consumption, power, visible smoke or odor, noise, operator visibility, maintenance, handling, etc?

- We believe there has been a positive result but nothing specific yet.
- There seems to be less smoke, engine runs with less noise, fuel consumption is better
- The machines we retrofitted are used on numerous projects and operated by different people on each project so comparison before and after is not likely to be obvious. The equipment functions well and we have not noticed any difference in fuel consumption. We believe this equipment has less visible smoke and odors.

In some circumstances in the aftermath of clean diesel projects employees may report enhanced well being, or experience fewer sick days and respiratory illness. Do you have any comparable experiences to share?

- Here again the retrofitted machines do not have assigned operators so comparison before and after is not likely.
- Nothing noted at this time
- Any impacts have not been reported.

#### Participation in the program

Tell us about your experience in working with the various partners in this project. Have they been helpful, responsive, supportive, difficult to get an answer, etc..

What has been your experience working on this project with AGC?

Very positive    Positive    Neutral    Negative    Very negative

Comment:

- Very positive, Bev was enthusiastic and very helpful.
- Positive (2)
- Disappointed with overall administration, changes in personnel have been disruptive. Also did not appreciate how billing was done in that charges appeared on his account that were

difficult to reconcile with work otherwise ordered directly by company employees.  
Reimbursement didn't always match up with invoice paperwork.

What has been your experience working on this project with Cummins Northwest ?

Very positive   Positive          Neutral          Negative          Very negative

Comment:

- Positive (3)
- Did a great job in retrofitting and actual installation; long time to get it done however. There was a push to get it done but then a lapse in time; when working did a good job to minimize equipment downtime.
- Positive, although timing and scheduling of work were our greatest concern. This was our first such project so we did not know what to expect from the vendor.

What has been your experience working on this project with DEQ?

Very positive   Positive          Neutral          Negative          Very negative

Comment:

- Positive (2)
- Very positive, Kevin Downing is remarkable to work with. He is our primary contact and facilitates communication between all parties in a way that focuses on results.
- Very apprehensive originally; actually enjoyed this aspect to demonstrate the right thing and to work with the government; saw this as an opportunity rather than a concern.

Federally funded projects require a competitive selection process for the technology provider. Do you have any advice for criteria or other considerations in selecting a vendor for future projects?

- Try to match delivery and service levels with recipient's organizational style
- Proximity of service locations
- Qualifications to do the work and other similar criteria as long as price is not allowed to get out of hand

What was your original motivation for participation in the program?

- To become compliant before it is required
- Our customers wanted cleaner exhaust from the equipment
- Our initial motivation was to learn as much as we can about how such programs impact the largest category of capital investment in our company. This led to a better understanding of what can be done, what is available to address the issue, trends in changes to equipment, and some understanding of what to expect in the future.
- An opportunity to learn about clean diesel. This project reduced the downside risk. We would not have done this on our own. This has been beneficial to get people on board.

What are the concerns that keep you, or have kept you, from doing clean diesel upgrades on your equipment?

- The cost of retrofitting all of our bigger pieces of equipment.
- Concerns about warranty interactions, how retrofits may increase downtime

- Awareness to begin with. Not really a concern but largest reason. Now that we are better informed one of our largest concerns is lack of retrofit equipment for large horsepower and older machines. The nature of the climate in the Pacific Northwest limits the number of months and hours each year that we run our equipment. For this reason we have a greater mix of older equipment in our fleet than you would find with a contractor in southern California. The retrofit equipment is also limited to the largest populations of machine makes and models. The verification requirement to qualify for financial incentives limits the population of machines likely to be retrofitted.
- Too much heat thrown off, loss of power and performance

What would it take to for you to do additional clean diesel upgrades, e.g., low interest loans, tax credits, grant funds, recognition, reduced costs, etc.?

- Tax credits would be great
- In our case all these incentives, with the exception of low interest loans, are of interest to us.
- Every little bit helps but grant funds would be great
- Any of these would be helpful. Definitely should not undervalue recognition

Based on your experience, would you otherwise do this again?

- Yes, we would
- Definitely
- Based on what we know about the system, yes we would. Thank you for asking us.
- Yes, absolutely

Would you recommend clean diesel upgrades to others in the construction industry?

- Yes, we would
- Yes, under programs like we have been involved in. It is not quite to the point where the direct and indirect financial benefits are enough without these programs.
- Yes
- I would. It is a hard sell to spend money to do this. It was a great opportunity for us.

Federal grant opportunities are available on an ongoing basis. Would you be interested in being among a group of companies working to apply for these opportunities when they arise?

- Yes, we would
- Yes, definitely
- Yes, we have done available equipment in Oregon. We would look at equipment in other states.
- Very much so

The state of Oregon offers tax credits on an ongoing basis for exhaust retrofits and engine repowers. Are you aware of these incentives? If not, would you like to find out more?

- Yes we would
- Not aware of incentives, we would like to know more.
- Would be useful to know for future equipment
- Yes, we are aware

**Additional comment**

By participating in this program we developed a greater understanding of the current and future trends toward cleaner diesel equipment used in our industry. It is not easy to quantify at the moment but this knowledge has already impacted purchase decisions for additional heavy equipment for our company. The expectation and anticipation of clean diesel operational regulation is factored into the cost and future value of any machine we purchase. This leads us to focus on; machines that we know can be retrofitted and the general cost to do it, machines that have already been retrofitted, and machines manufactured to meet emission standards.

## Appendix C Press Coverage

### *Daily Journal of Commerce* Portland, Oregon

#### **Fueling change**

*POSTED: Thursday, December 1, 2005 at 01:00 AM PT*

The Associated General Contractors Oregon-Columbia chapter last month became the first trade association - and the only construction industry organization - to receive a grant to promote clean diesel technology from the Environmental Protection Agency.

The AGC secured a \$120,000 grant, in partnership with the Oregon Department of Environmental Quality, to fund engine upgrades and retrofit exhaust controls to help cut air pollution emissions from heavy duty construction equipment.

The grant highlights a new effort by the state agency and construction industry leaders to promote widespread use of clean diesel fuels and retrofitting technology in construction vehicles, which account for 27 percent of diesel particulate matter emissions in Oregon, according to a 2002 emissions inventory by the DEQ. Other partners on the project include Caterpillar Inc. and Cummins NW, which have agreed to in-kind contributions.

"There's a huge cost benefit," to reducing diesel emissions in the state said Kevin Downing, air quality expert with DEQ. "Based on (Environmental Protection Agency) cost benefit analysis, we've concluded there's a \$2.3 billion a year impact on the economy from exposure to diesel exhaust in the state of Oregon."

Downing acknowledged that while the brunt of the environmental and health costs falls on Oregon residents, the cost of retrofitting outdated equipment falls mostly on construction companies and other equipment owners. Many contractors are reluctant to undertake retrofitting measures for this reason. "I understand the EPA has a mandate to improve air quality, and it's hard to do with limited funds. But to ask the private industry to pay for it could push a lot of small contractors out of business," said Scott Williams, president of Hamilton construction company, who is active in representing the industry on environmental issues.

Funds from the pilot project will be available to contractors competing in the state's highway bridge replacement projects. Of 366 bridge projects outlined in the Oregon Transportation Investment Act (OTIA) state funding initiative, 140 bridges are scheduled for construction during the grant's proposal period, which ends in October of 2007.

New diesel engines run much more efficiently with less air pollution than older engines. Retrofit technology is an upgrade that traps particulate emissions from dirty engines, which contribute to poor air quality and low visibility. Companies can also reduce tailpipe emissions by switching their fleets from off-road grade diesel fuel, which contains 5,000 parts per million (ppm) of sulfur, to highway-grade diesel fuel (500 ppm), ultra-low sulfur diesel (15 ppm) or biodiesel.

Because the largest air quality benefits are seen when retrofit technology is used along with ultra-low sulfur diesel fuel, the DEQ and the AGC are also promoting the use of low-emissions and biodiesel fuels, which can be used in any diesel engine without additional equipment.

"I'm hoping that the industry will embrace what we're doing," said Greg Miller, government relations specialist at the AGC. "(The grant) is a positive step forward in working to ensure good, continued air quality in Oregon."

The environmental and health benefits of retrofitting engines are many. In addition to improved visibility due to the reduction of haze, diesel particulate emissions were identified as the No. 1 risk for excess cancer in the state in a preliminary study by the DEQ, for example.

"Folks working on a job site in construction are most affected by diesel emissions because that's what they breathe every single day," said Sharon Banks with the Lane County regional air pollution authority clean fuel project, which is partnered with DEQ in promoting clean diesel initiatives.

The Lane County project is offering a \$0.05-per-gallon rebate to construction companies that use ultra-low sulfur diesel fuel on bridge projects in the county. "Any time you can reduce your exposure to things that make you more prone to being sick, it's a good idea," Banks said.

But the cost of the engine upgrades to contractors can be prohibitive. Depending on the engine size, the technology can cost upward of \$6,000 to outfit one machine. "It's a pretty costly venture for a company to undertake on its own," said Miller. The AGC grants will help foot the bill, but only for qualified bridge projects.

Other funding sources to help offset the costly upgrades include the state of Oregon, which is offering a 35 percent business tax refund to companies that retrofit their vehicles, and the federal government, which is offering a 30 percent tax refund.

Even with financial assistance, however, the majority of the cost burden lies on the machine owners, leaving them with a cost-benefit analysis between the environmental benefits of operating clean equipment and costs that impact the bottom line. It's a difficult choice for many contractors, especially those involved in low-bid situations such as the state bridge projects.

Many contractors are also concerned that using clean diesel technology or fuel on heavy construction equipment will lower the power output and effectiveness of the machines. "We're supportive of (the state's) efforts in reducing emissions of old equipment, but our support is contingent on the performance issue being acceptable," said Steve Wildish, vice president with the Wildish construction company in Eugene, who wrote a letter of support for the DEQ grant application. Wildish has successfully bid on state bridge projects in the past.

"We are very concerned about breakout force," he said. "But heck, we're supportive of a better environment if it's possible and economically feasible."

***Statesman Journal, Salem Oregon***

**Chapter gets grant for diesel retrofits**

December 13, 2005

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The Environmental Protection Agency grant is part of a campaign to promote the widespread adoption of clean diesel technology.

"Advances in emission controls for diesel have come so far that it is possible for a diesel engine to have an exhaust profile that is better than often found with natural gas-powered engines," said Kevin Downing of the Oregon Department of Environmental Quality.

The state of Oregon is rebuilding and repairing almost 300 aging highway bridges across an eight-year period.

-- Beth Casper

## Appendix D Project Expenditures

| Project Description                                    | Charge to Grant  | Contribution     | Contribution By |
|--|------------------|------------------|-----------------|
| Hamilton - Crane repower and retrofit w/ Level III DPF | \$33,912         |                  |                 |
|  |                  | \$21,658         | Hamilton        |
|  |                  | \$28,367         | Cummins NW      |
| Kerr - Nonroad retrofit of Level II products           | \$33,160         | \$25,311         | Cummins NW      |
| Mowat - Nonroad retrofit of Level I products           | \$19,896         | \$7,690          | Cummins NW      |
| Staton – Nonroad retrofit of Level II products         | \$33,032         | \$24,824         | Cummins NW      |
| Administrative and technical assistance                |                  | \$18,836         | DEQ             |
| <b>TOTAL</b>   | <b>\$120,000</b> | <b>\$126,686</b> |                 |

For the repower portion of the project, the grant paid for half the cost of the offered price, less an estimate for typical rebuild costs for the old engine, which was paid for by the project participant. For the retrofit portion of the project, the grant paid for all offered costs.

### Hamilton Construction – Manitowac 3900 Repower and Retrofit Project

| Description                                    | Qty | List Price <sup>1</sup> | Grant Charge | Participant Contribution |
|--|-----|-------------------------|--------------|--------------------------|
| Tier 1 Cummins N14C                            | 1   | \$38,700                | \$15,567     | \$21,658                 |
| 6HDKAS-11 Commercial Mobile Genset             | 1   | \$7,363                 | \$6,250      | \$0                      |
| Cleaire Skyline Active DPF (Horizon)           | 1   | \$15,100                | \$10,175     | \$0                      |
| Exhaust Temperature Data Logging               | 1   | \$125                   | \$0          | \$0                      |
| Engineering Development                        | 130 | \$16,250                | \$0          | \$0                      |
| Device Installation/training and commissioning | 52  | \$5,564                 | \$1,145      | \$0                      |
| Equipment modifications                        | 1   | \$835                   | \$775        | \$0                      |
|  |     | \$83,937                | \$33,912     | \$21,658                 |

### Kerr Contractors – Level II Retrofit Project

| Description                                  | Qty | List Price <sup>1</sup> | Grant Charge |
|--|-----|-------------------------|--------------|
| Level II Donaldson Diesel Multi-Stage Filter | 6   | \$49,146                | \$27,990     |
| Device Installation and commissioning        | 50  | \$5,350                 | \$2,620      |
| Equipment modifications                      | 1   | \$3,350                 | \$2,550      |
| Exhaust Temperature Data Logging             | 5   | \$625                   | \$0          |
|  |     | \$58,471                | \$33,160     |

### Mowat Construction – Level I Retrofit Project

| Description                           | Qty  | List Price <sup>1</sup> | Grant Charge |
|---------------------------------------|------|-------------------------|--------------|
| Level I diesel oxidation catalysts    | 10   | \$15,468                | \$11,790     |
| Device Installation and commissioning | 59.3 | \$6,345                 | \$3,973      |
| Equipment modifications               | 1    | \$5,773                 | \$4,133      |
|                                       |      | \$27,586                | \$19,896     |

<sup>1</sup> List price effective at time products were quoted or work was performed

**Staton Companies – Level II Retrofit Project**

| <b>Description</b>                           | <b>Qty</b> | <b>List Price<sup>1</sup></b> | <b>Grant Charge</b> |
|--|------------|-------------------------------|---------------------|
| Level II Donaldson Diesel Multi-Stage Filter | 6          | \$49,146                      | \$27,988            |
| Device Installation and commissioning        | 56.5       | \$6,046                       | \$2,965             |
| Equipment modifications                      | 1          | \$2,414                       | \$2,079             |
| Exhaust Temperature Data Logging             | 2          | \$250                         | \$0                 |
|  |            | \$57,856                      | \$33,032            |

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<sup>1</sup> List price effective at time products were quoted or work was performed

AGC Oregon/Columbia Chapter Clean Construction Equipment project

Participant follow-up survey

Thank you for participating in the EPA funded demonstration project to reduce emissions from construction equipment. Please help us improve future projects with your feedback about your experiences in this project. Please respond to the queries below in writing or, if it is more convenient, we will call you. Let us know if you would prefer to debrief by phone. If you have any questions, contact Kevin Downing at DEQ, 503.229.6549, [downing.kevin@deq.state.or.us](mailto:downing.kevin@deq.state.or.us).

Operational Experience

Have you or your employees noticed any change in the functionality or operation of the equipment that has been retrofitted, e.g., fuel consumption, power, visible smoke or odor, noise, operator visibility, maintenance, handling, etc?

- We believe there has been a positive result but nothing specific yet.
- There seems to be less smoke, engine runs with less noise, fuel consumption is better
- The machines we retrofitted are used on numerous projects and operated by different people on each project so comparison before and after is not likely to be obvious. The equipment functions well and we have not noticed any difference in fuel consumption. We believe this equipment has less visible smoke and odors.

In some circumstances in the aftermath of clean diesel projects employees may report enhanced well being, or experience fewer sick days and respiratory illness. Do you have any comparable experiences to share?

- Here again the retrofitted machines do not have assigned operators so comparison before and after is not likely.
- Nothing noted at this time
- Any impacts have not been reported.

Participation in the program

Tell us about your experience in working with the various partners in this project. Have they been helpful, responsive, supportive, difficult to get an answer, etc..

What has been your experience working on this project with AGC?

Very positive    Positive    Neutral    Negative    Very negative

Comment: Very positive, Bev was enthusiastic and very helpful.

- Positive (2)
- Disappointed with overall administration, changes in personnel have been disruptive. Also did not appreciate how billing was done in that charges appeared on his account that were difficult to reconcile with work otherwise ordered directly by company employees. Reimbursement didn't always match up with invoice paperwork.

What has been your experience working on this project with Cummins Northwest ?

Very positive    Positive            Neutral            Negative            Very negative

Comment: Positive (3)

- Did a great job in retrofitting and actual installation; long time to get it done however. There was a push to get it done but then a lapse in time; when working did a good job to minimize equipment downtime.
- Positive, although timing and scheduling of work were our greatest concern. This was our first such project so we did not know what to expect from the vendor.

What has been your experience working on this project with DEQ?

Very positive    Positive            Neutral            Negative            Very negative

Comment: Positive (2)

- Very positive, Kevin Downing is remarkable to work with. He is our primary contact and facilitates communication between all parties in a way that focuses on results.
- Very apprehensive originally; actually enjoyed this aspect to demonstrate the right thing and to work with the government; saw this as an opportunity rather than a concern.

Federally funded projects require a competitive selection process for the technology provider. Do you have any advice for criteria or other considerations in selecting a vendor for future projects?

- Try to match delivery and service levels with recipient's organizational style
- Proximity of service locations
- Qualifications to do the work and other similar criteria as long as price is not allowed to get out of hand

What was your original motivation for participation in the program?

- To become compliant before it is required

- Our customers wanted cleaner exhaust from the equipment
- Our initial motivation was to learn as much as we can about how such programs impact the largest category of capital investment in our company. This led to a better understanding of what can be done, what is available to address the issue, trends in changes to equipment, and some understanding of what to expect in the future.
- An opportunity to learn about clean diesel. This project reduced the downside risk. We would not have done this on our own. This has been beneficial to get people on board.

What are the concerns that keep you, or have kept you, from doing clean diesel upgrades on your equipment?

- The cost of retrofitting all of our bigger pieces of equipment.
- Concerns about warranty interactions, how retrofits may increase downtime
- Awareness to begin with. Not really a concern but largest reason. Now that we are better informed one of our largest concerns is lack of retrofit equipment for large horsepower and older machines. The nature of the climate in the Pacific Northwest limits the number of months and hours each year that we run our equipment. For this reason we have a greater mix of older equipment in our fleet than you would find with a contractor in southern California. The retrofit equipment is also limited to the largest populations of machine makes and models. The verification requirement to qualify for financial incentives limits the population of machines likely to be retrofitted.
- Too much heat thrown off, loss of power and performance

What would it take to for you to do additional clean diesel upgrades, e.g., low interest loans, tax credits, grant funds, recognition, reduced costs, etc.?

- Tax credits would be great
- In our case all these incentives, with the exception of low interest loans, are of interest to us.
- Every little bit helps but grant funds would be great
- Any of these would be helpful. Definitely should not undervalue recognition

Based on your experience, would you otherwise do this again?

- Yes we would
- Definitely
- Based on what we know about the system, yes we would. Thank you for asking us.
- Yes, absolutely

Would you recommend clean diesel upgrades to others in the construction industry?

- Yes we would
- Yes, under programs like we have been involved in. It is not quite to the point where the direct and indirect financial benefits are enough without these programs.
- Yes
- I would. It is a hard sell to spend money to do this. It was a great opportunity for us.

Federal grant opportunities are available on an ongoing basis. Would you be interested in being among a group of companies working to apply for these opportunities when they arise?

- Yes we would
- Yes, definitely
- Yes, we have done available equipment in Oregon. We would look at equipment in other states.
- Very much so

The state of Oregon offers tax credits on an ongoing basis for exhaust retrofits and engine repowers. Are you aware of these incentives? If not, would you like to find out more?

- Yes we would
- Not aware of incentives, we would like to know more.
- Would be useful to know for future equipment
- Yes, we are aware

#### Additional comment

By participating in this program we developed a greater understanding of the current and future trends toward cleaner diesel equipment used in our industry. It is not easy to quantify at the moment but this knowledge has already impacted purchase decisions for additional heavy equipment for our company. The expectation and anticipation of clean diesel operational regulation is factored into the cost and future value of any machine we purchase. This leads us to focus on; machines that we know can be retrofitted and the general cost to do it, machines that have already been retrofitted, and machines manufactured to meet emission standards.

Equipment List

Mowat Construction

| Equip # | Year | Manufacturer Description | Model    | Horse power | Annual Usage Mileage | Annual Usage Hours | Fuel Consumption |
|---------|------|--------------------------|----------|-------------|----------------------|--------------------|------------------|
|         |      |                          |          |             |                      |                    |                  |
| 589     | 1998 | IHC Flatbed Dump         | 4700     | 230         | 3000                 |                    | 16 mpg           |
| 645     | 1998 | IHC Barrell Truck        |          | 215         | 550                  | 150                | 15 mpg           |
| 662     | 1996 | Manitowac Crawler Crane  | 222HD    | 350         | NA                   | 650                | 3.5 gph          |
| 664     | 1997 | Manitowac Crawler        | 222HD    | 350         | NA                   | 850                | 3.5 gph          |
| 665     | 2002 | Terex Crane              | 665 65T  | 215         | NA                   | 475                | 2.5 gph          |
| 700     | 2004 | I/R Forklift             | VR 1044  | 110         | NA                   | 1000               | 2 gph            |
| 707     | 2002 | I/R Forklift             | VR1044   | 110         | NA                   | 650                | 2 gph            |
| 7002    | 2005 | I/R Forklift             | VR 1044  | 110         | NA                   | 800                | 2 gph            |
| 9991    | 2000 | Petibone                 | Super 20 | 185         | NA                   | 500                | 3 gph            |
| 9994    | 2001 | Petibone                 | Super 20 | 185         | NA                   | 500                | 3 gph            |

Hamilton Construction

Kerr Contractors

| EQ NO | DESCRIPTION                  | VIN         | Equipment Type   | Engine Year | Engine HP | Activity (hr/yr) |
|-------|------------------------------|-------------|------------------|-------------|-----------|------------------|
| CR846 | IR SD180D VIB SOIL COMPACTOR | 10715       | Roller/Compactor | 1994        | 230       | 500              |
| CR855 | SAKAI SV510D ROLLER          | VSV16-30165 | Roller/Compactor | 2004        | 138       | 500              |
| CR856 | SAKAI SV510D ROLLER          | VSV16-30161 | Roller/Compactor | 2002        | 138       | 500              |
| CR858 | SAKAI ROLLER SV510D          | VSV1630155  | Roller/Compactor | 2005        | 138       | 500              |
| CR865 | SAKAI SV700D SOIL COMPACTOR  | 10112       | Roller/Compactor | 2006        | 166       | 500              |
| CR876 | SAKAI SV510D ROLLER          | VSV16-30161 | Roller/Compactor | 2002        | 138       | 500              |

Staton Companies

| EQ NO | DESCRIPTION        | VIN       | Equipment Type | Engine Year | Engine HP | Activity (hr/yr) |
|-------|--------------------|-----------|----------------|-------------|-----------|------------------|
| 236   | 370 LINKBELT LX    | K6J3-7138 | Excavator      | 2003        | 230       | 1,500            |
| 237   | 370 LINKBELT LX    | K6J4-8692 | Excavator      | 2004        | 138       | 1,500            |
| 238   | 330 LINKBELT LX    | K6J4-8662 | Excavator      | 2004        |           | 1,500            |
| 239   | 370 RB LINKBELT LX | K6J5-9688 | Excavator      | 2005        |           | 1,500            |
| 240   | 370 LINKBELT LX    | K6J5-9879 | Excavator      | 2006        |           | 1,500            |
| 244   | 330 LINKBELT LX    | K6J4-7269 | Excavator      | 2004        | 138       | 1,500            |

# *Daily Journal of Commerce* Portland, Oregon

## Fueling change

*POSTED: Thursday, December 1, 2005 at 01:00 AM PT*

The Associated General Contractors Oregon-Columbia chapter last month became the first trade association - and the only construction industry organization - to receive a grant to promote clean diesel technology from the Environmental Protection Agency.

The AGC secured a \$120,000 grant, in partnership with the Oregon Department of Environmental Quality, to fund engine upgrades and retrofit exhaust controls to help cut air pollution emissions from heavy duty construction equipment.

The grant highlights a new effort by the state agency and construction industry leaders to promote widespread use of clean diesel fuels and retrofitting technology in construction vehicles, which account for 27 percent of diesel particulate matter emissions in Oregon, according to a 2002 emissions inventory by the DEQ. Other partners on the project include Caterpillar Inc. and Cummins NW, which have agreed to in-kind contributions.

"There's a huge cost benefit," to reducing diesel emissions in the state said Kevin Downing, air quality expert with DEQ. "Based on (Environmental Protection Agency) cost benefit analysis, we've concluded there's a \$2.3 billion a year impact on the economy from exposure to diesel exhaust in the state of Oregon."

Downing acknowledged that while the brunt of the environmental and health costs falls on Oregon residents, the cost of retrofitting outdated equipment falls mostly on construction companies and other equipment owners. Many contractors are reluctant to undertake retrofitting measures for this reason.

"I understand the EPA has a mandate to improve air quality, and it's hard to do with limited funds. But to ask the private industry to pay for it could push a lot of small contractors out of business," said Scott Williams, president of Hamilton construction company, who is active in representing the industry on environmental issues.

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From Salem *Statesman Journal*,

Oregon

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