Air Quality Community of Practice
Short Term Impacts from Construction Equipment and Operations
State-of-the-Practice

Requested by:

American Association of State Highway
and Transportation Officials (AASHTO)

Center for Environmental Excellence

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March 2010

Acknowledgements

This State-of-the-Practice Report was requested by the Center for Environmental Excellence by the American Association of State Highway and Transportation Officials (AASHTO) as part of an Air Quality Community of Practice. The report was developed by James M. Shrouds who serves as a consultant to the AASHTO Center. The work was guided by the air quality community of practice members consisting of Mike Brady and Pete Conn from CALTRANS; Brad Beckham and Jill Schlaefer from CDOT; Mark Glaze, DelDOT; Phil Peevy from GADOT; Walt Zyznieuski from IDOT; Howard Simons and Gary Green from MDOT; Marilyn Jordahl-Larson from MNDOT; John Zamurs and Jonathan Bass from NYSDOT; Mike Baker from PennDOT; Jackie Ploch from TxDOT; Chris Voigt from VDOT; Tim Sexton from WSDOT; Patricia Trainer from WISDOT; Cecilia Ho, Mike Koontz, Bob O'Loughlin, and Kevin Black from FHWA; Antoinette Quagliata and Faith Cole from FTA; and Kate Kurgan from AASHTO.

Disclaimer

This State-of-the-Practice Report summarizes the discussions of Air Quality Community of Practice members who spoke as individual members of the community and did not necessarily represent their agency's views or positions. In addition, the contents of the report do not necessarily represent the views or positions of AASHTO or the Center for Environmental Excellence.

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INTRODUCTION

The Center for Environmental Excellence by AASHTO (Center) established an Air Quality Community of Practice (COP) in 2008. The purpose of the Air Quality COP is to assemble a group of State DOT practitioners to have a focused discussion on the state of the practice, emerging issues, and research data needs on particular issues, as well as on other air quality issues of interest. This effort has essentially two goals, the first of which is to extend the State DOT's networks and contacts, enabling them to share experiences and learn from each other. In this regard, this effort expands and supplements a November 2008 Air Quality Practitioner's Conference that was held in Albany, New York[1], and Phase I of this Air Quality COP effort which produced a State-of-the-Practice Report on Mobile Source Air Toxics in May 2009[2]. The second goal is to develop State-of-the-Practice Reports on several selected focus areas. The Air Quality COP consists of representatives from thirteen State DOTs, FHWA, and FTA. The Air Quality COP members considered a range of possible topic areas but agreed that Short Term Impacts from Construction Equipment and Operations should be the next focus area for discussion. This topic was chosen because a number of State DOTs are starting to be challenged by State and local resource agencies and environmental groups to look at the short term impacts from construction activities as well as impacts from the emissions from construction equipment.

Heavy construction activities can result in fugitive dust emissions from earth moving activities such as cut and fill operations, use of unpaved haul roads, sand blasting of lead paint from bridges, etc. In addition, construction equipment is normally powered by diesel engines which are high emitters of nitrogen oxide (NOx) and particulate matter (PM) emissions. NOx emissions are also a precursor to the formation of ozone and PM concentrations in the air. According to EPA's National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data[3], NOx emissions from highway vehicles decreased by 59 percent from 1970 to 2008, while off-highway vehicle NOx emissions increased by 38 percent during this time period. For PM2.5 emissions, the NEI shows a 66 percent decrease for highway vehicles during this time period while off-highway vehicles decreased by only 6 percent. EPA estimates that diesel equipment accounts for 49 percent of total nonroad mobile source NOx emissions[4], and 57 percent of total nonroad mobile source PM2.5 emissions[5].

This State-of-the-Practice Report discusses United States Environmental Protection Agency (EPA) programs to reduce impacts from construction activities, mainly in the control of diesel emissions from construction equipment; FHWA eligibility guidelines for diesel retrofits; the current state-of-the-practice of selected State DOTs in this COP for analyzing and mitigating construction impacts; and future research needs for developing more effective analysis tools, and identifying cost-effective mitigation strategies, for construction-related impacts.

EPA REGULATIONS/PROGRAMS

National Clean Diesel Campaign: According to EPA, nonroad diesel engines continue to emit large amounts of NOx and PM emissions, and contribute to public health problems. Consequently, reducing these emissions is part of a Federal, State, and local effort to reduce their adverse affects.[6] As part of this effort, EPA initiated the National Clean Diesel Campaign (NCDC) which is a high priority program to reduce diesel emissions using a variety of control strategies with the continued involvement of national, state, and local partners. The NCDC uses a three part approach which includes: 1) implementing the existing 2007 Heavy-Duty Highway Engine Rule and the Clean Nonroad Diesel Rule; 2) developing new rules for reducing emissions from trains, and marine diesels; and 3) addressing diesel engines already in use. EPA has a goal to reduce emissions from more than 11 million diesel engines in the existing fleet by 2014. To accomplish this, the EPA has targeted five main sectors that provide the best opportunity to produce significant reductions. They include: school buses, ports, construction, freight, and agriculture. EPA will work with these sectors through Partnerships and Regional Collaboratives[7] to provide information on technologies and strategies for reducing diesel emissions and by providing funding incentives[8].

Nonroad Diesel –Tier IV Final Rule: In 2004, as part of its National Clean Diesel Programs, EPA finalized a comprehensive nonroad diesel –Tier 4 final rule to reduce emissions from nonroad diesel engines. This rule was part of a three step approach for reducing emission standards for nonroad diesel engines. In 1994, EPA adopted Tier I emissions standards for all new nonroad diesel engines over 50 horsepower. These standards were phased in, depending on horsepower, between 1996 and 2000. Then in 1998, EPA adopted more stringent Tier II standards which were phased in from 2001 to 2006, and Tier III standards for engines over 50 horsepower from 2006 to 2008.

The 2004 rule treats engine and fuel controls as a system to achieve the greatest emission reductions.[9] The rule sets emission standards for different sizes of nonroad engines, and builds on the Tier II program from cars and light trucks, and the 2007 highway diesel program for on highway diesel trucks. The new emission standards apply to nonroad diesel engines used in most construction activities. The standards took effect for new engines beginning in 2008 and will be fully phased in for most engines by 2014. Larger nonroad diesel engines (greater than 750 horsepower) have one additional year to meet their emission standards[10]. EPA predicts the new engine standards will reduce PM and NOx emissions by 95 percent and 90 percent, respectively, by 2030. This final rule is one of a number of interrelated rules which address nonroad diesel emissions.

The new fuel requirements will decrease the allowable levels of sulfur in fuel used in nonroad diesel engines by more than 99 percent by 2010 in two steps. Starting in 2007, fuel sulfur levels in nonroad diesel fuel were capped at 500 ppm. Then starting in 2010, fuel sulfur levels in most nonroad diesel fuel will be reduced to 15 ppm. These fuel improvements will significantly reduce both PM and NOx emissions, and result in public health benefits. The ultra-low sulfur fuel will also make it possible for manufacturers to incorporate advanced emission-control systems to nonroad diesel engines.

Clean Construction USA: This program is part of the NCDC and is designed to promote the reduction of diesel emissions from construction equipment and vehicles.[11] While EPA has set emissions standards for engines used in most new construction equipment, existing construction equipment can last for 25 to 30 years. Consequently, it will take many years for existing construction equipment to be replaced with newer and cleaner engines. Since EPA's regulations only apply to newly manufactured diesel engines, EPA developed the Clean Construction USA program to assist owners and operators of construction equipment to reduce emissions from the older engines that are currently in operation. The Clean Construction USA program encourages contractors, owners, and operators of construction equipment to: 1) properly maintain their equipment, 2) reduce idling, 3) retrofit diesel engines by installing emissions reduction technologies on an engine, such as particulate filters and oxidation catalysts, 4) replace older equipment, 5) use cleaner fuels such as ultra-low sulfur diesel, biodiesel, liquid petroleum gas, and compressed natural gas, and 6) repower equipment (i.e. replace older engines with newer, cleaner engines).

***Diesel Retrofits: Quantifying and Using Their Benefits in SIPs and Conformity*:** Retrofitting construction equipment with cleaner engines can provide a cost-effective approach for reducing emissions from such equipment and help obtain the National Ambient Air Quality Standards (NAAQS) and establish conformity in nonattainment and maintenance areas. To assist in this effort, EPA issued guidance in June 2006 on quantifying emission reductions from highway and nonroad diesel vehicles, engines, and equipment that have been retrofitted with emission reduction technology.[12]

Transportation Conformity Provisions: Section 93.123(c)(5) of EPA's Transportation Conformity regulation does not require CO, PM10 and PM2.5 hot-spot analyses for construction-related activities for temporary increases in emissions if such increases occur for less than five years at any individual site. This provision recognizes the temporary and self correcting nature of short term construction impacts on air quality.

FHWA GUIDANCE

Congestion Mitigation and Air Quality Improvement (CMAQ) Program: In 1991, Congress adopted the Intermodal Surface Transportation Efficiency Act (ISTEA) and authorized the CMAQ program to help fund transportation programs and projects that contribute to attainment of a NAAQS. The CMAQ program is jointly administered by FHWA and FTA and was reauthorized in 2005 under the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). SAFETEA-LU recognizes the importance of nonroad diesel retrofit projects and expands CMAQ eligibility to include many of them, including construction vehicles and equipment deployed in Title 23 projects. It also requires states and metropolitan planning organizations (MPOs) to give priority to funding diesel retrofits and other cost-effective mobile source emission reduction strategies.

FHWA released its revised CMAQ guidance on November 17, 2008 to incorporate the SAFETEA-LU provisions. [13] The new guidance indicates that CMAQ funds are eligible for "diesel engine replacement; full engine rebuilding and reconditioning; and purchase and installation of after-treatment hardware, including particulate matter traps and oxidation catalysts, and other technologies; and support for heavy-duty vehicle retirement programs", assuming that other CMAQ criteria are met. The guidance further states that refueling is not a stand-alone CMAQ eligible project, but it is eligible if "required to support the installation of emissions control equipment, repowering, rebuilding, or other retrofits of nonroad engines".

OVERVIEW OF THE STATE-OF-THE-PRACTICE FOR ANALYZING AND MITIGATING SHORT TERM CONSTRUCTION IMPACTS

This section contains an overview of selected State practices to control dust and nonroad vehicle emissions from construction projects in order reduce the air quality impacts associated with these projects.

California DOT

California has Standard Specifications that require the contractor to control dust from construction activities. The contractor's approved water pollution control plan must include methods to control dust in general, and anticipate the necessity for dust control for temporary traffic changes on any unpaved roadways.[14] Typical measures to control dust include watering and applying dust palliatives.

California has extensive specifications and special provisions for sand blasting paint from bridges that help reduce dust and lead emissions. For example, the Contractor must submit a debris containment and collection program to the Project Engineer before sand blasting work starts. The program must identify materials, equipment, and methods to be used and include, among other things, working drawings of containment systems. The Contractor must verify the effectiveness of the containment system by monitoring the ambient air around the bridge site. The monitoring process must consist of collecting, analyzing, and reporting air test results and recommending corrective action when specified exposure levels are exceeded. The specifications indicate that the containment system shall consist of either: (1) a ventilated containment structure; (2) vacuum shrouded surface preparation equipment and drapes, tarps, or other materials; or (3) an equivalent containment system.[15]

California has PM monitoring requirements for construction activities in specific issue areas - mainly for operations in soil with aerially deposited lead or in areas with naturally occurring asbestos. The requirements for handling aerially deposit lead varies with the concentration levels of the lead.[16] Generally, the material containing hazardous waste concentrations of aerially deposit lead must be placed as shown on the construction plans, and covered with a nonhazardous soil or pavement. In addition the contractor must submit

a Lead Compliance Plan which includes perimeter air monitoring incorporating upwind and downwind locations as shown on the plans or as approved by the Project Engineer. Monitoring must be accomplished with personal air samplers and achieve a detection limit of 0.05 $\mu g/m^3$ of air per day. The specifications also indicate that no visible dust is permitted from excavation, transportation, placement, and handling of material containing aerially deposited lead.

California defines material containing naturally occurring asbestos (NOA) as having asbestos content of 0.25 percent or greater.[17] Contractors are required to notify the Project Engineer and the local Air Pollution Control District at least 15 days before starting work that disturbs material containing NOA. The contractor must also prepare and implement a dust control plan for the project. The plan must control dust from material containing NOA and include measures such as, watering, chemical dust palliatives, speed controls on unpaved areas, stabilizing stockpiles and disturbed areas, and preventing mud tracking on to paved roadways.

NOx emissions from construction equipment are controlled by State and local air district rules that are enforceable under Caltrans Standard Specifications. The State air board has on- and off-road vehicle/equipment fleet and portable engine rules that require various State and local air district registrations and have specific schedules for implementing emission controls.[18] Contractors have to follow those rules and file suitable paperwork to document they have met the requirements. State air board regulations also limit idling to five minutes statewide for off- and on-road diesels (30 seconds within 100' of schools), with some local regulations and ordinances further restricting idling times to as little as two to three minutes. State air board regulations also require that off-road diesel fuel meet on-road fuel formulation requirements (i.e. sulfur content <15 ppm and other limits, effective 2006).

California uses a local Air District spreadsheet to predict PM emissions from construction equipment.[19] The spreadsheet can be used to predict both fugitive dust and exhaust emissions from construction activities and equipment. The spreadsheet uses a simplified methodology, involving estimates of acres of land disturbed daily by construction operations, to predict fugitive emissions. Detailed estimates of fugitive emissions for individual vehicles and construction activities are not feasible for most studies due to lack of detailed information about the number, types, and usage of equipment at the environmental review stage of the project. The spreadsheet is the Sacramento Air Quality Management District's Road Construction Emissions Model, Version 6.3.2, which includes EMFAC2007 and OFFROAD2007 emissions factors to calculate emissions from construction equipment. The spreadsheet is based on Sacramento-area vehicle fleet composite emission data, which may differ in other areas, so it's an approximation when used outside Sacramento County; however, it's close enough that other air districts require or suggest its use.

Local air pollution control or air quality management district regulations require permits, mandatory dust control plan submittal, and various specific work activities with recordkeeping in many areas. In general, the contractor must follow these rules as

applicable based on the Caltrans Standard Specifications Section 14-9.02[20] (formerly Section 7-1.01F). Some key areas with special regulations beyond "visible dust" and "nuisance" controls are San Joaquin Valley and Imperial Valley (extensive and detailed prohibitory rules and dust control plan requirements - "Regulation VIII" in both areas[21]); San Joaquin Valley indirect source review regulations (calculation of emissions and mitigation measures from most development and road construction activities; mitigation fee if listed measures aren't sufficient)[22]; South Coast and nearby areas (Los Angeles and desert areas - extensive prohibitory rules, and dust control plans for major projects)[23].

California at this time does not perform greenhouse gas analysis for construction activities. However, the Sacramento spreadsheet in its most recent revision can produce CO2 estimates based on EMFAC 2007 and OFFROAD 2007 emission factors. The California Air Resources Board at this time does not recommend use of EMFAC and OFFROAD for greenhouse gas analysis[24], but if needed CO2 estimates can be prepared.

Colorado DOT

The CDOT, like most States, have standard specifications for erosion and dust control. CDOT typically uses water as a dust control measure if the surface is not paved or there is a chance of fugitive dust issues. The State specifications require that sprinkling equipment deliver a uniform and controlled distribution so as not to cause ponding of water or washing away of materials.[25] Prewetting of material in excavation areas is permitted to reduce dust levels once the Project Engineer has approved the contractor's "prewetting layout" which describes the equipment and process that will be used. The specifications also include requirements for the chemical constituents and application procedures for a magnesium chloride dust palliative. If borrow pit operations are located on the project site, dust control measures will be employed on them as well.

The specifications include a section on Heavy Metal Based Paint Management, in the event paint removal contains lead, chromium or other heavy metals. This section requires, among other things, that the contractor contact the Air Pollution Control Division (APCD) of the Colorado Department of Public Health and Environment to determine if an air pollution permit is required, and obtain such permit if required, before cleaning or demolition work begins. The contractor is also required to contain the paint chips, corrosion residues and spent abrasives. CDOT reports that an application of ECCOBOND (a special epoxy adhesive product) can be placed on top of the lead based paint to encapsulate the lead, so that it can be removed later either mechanically or by sand blasting. Sand blasting is typically controlled via plastic enclosures.

Typical NEPA mitigation measures include:

- Use of water or chemical inhibitors for dust control
- Covering trucks hauling soil and other materials
- Stabilizing and covering stockpile areas
- Minimizing off-site tracking of mud and debris by washing construction equipment in contained areas and by temporary access stabilization techniques.

On a multimodal corridor project, referred to as TREX, located on I-25 between Broadway and Lincoln Avenue in the Denver metropolitan area, including I-225 between I-25 and Parker Road, CDOT included a requirement for the contractor to provide a PM10 Monitoring Plan to characterize PM10 concentration levels along the construction corridor.[26] The PM10 Plan must describe the monitoring network in terms of the number and location of the monitors, and provide for daily sampling. The contractor is also required to maintain a daily log of air quality observations and any mitigation measures that are implemented. Any monitored PM10 concentration level over 150 micrograms per cubic meter (ug/m^3) must be reported to the APCD. CDOT indicates that they are planning to incorporate this procedure in new large and prolonged projects.

Illinois DOT

IDOT includes the following standard construction-related PM language in their NEPA documents:

> *"Demolition and construction activities can result in short-term increases in fugitive dust and equipment-related particulate emissions in and around the project area. Equipment-related particulate emissions can be minimized if the equipment is well maintained. The potential air quality impacts will be short-term, occurring only while demolition and construction work is in progress and local conditions are appropriate.*
>
> *The potential for fugitive dust emissions typically is associated with building demolition, ground clearing, site preparation, grading, stockpiling of materials, on-site movement of equipment, and transportation of materials. The potential is greatest during dry periods, periods of intense construction activity, and during high wind conditions.*
>
> *The Department's Standard Specifications for Road and Bridge Construction include provisions on dust control.[27] Under these provisions, dust and airborne dirt generated by construction activities will be controlled through dust control procedures or a specific dust control plan, when warranted. The contractor and the Department will meet to review the nature and extent of dust-generating activities and will cooperatively develop specific types of control techniques appropriate to the specific situation. Techniques that may warrant consideration include measures such as minimizing track-out of soil onto nearby publicly-traveled roads, reducing speed on unpaved roads, covering haul vehicles, and applying chemical dust suppressants or water to exposed surfaces, particularly those on which construction vehicles travel. With the application of appropriate measures to limit dust emissions during construction, this project will not cause any significant, short-term particulate matter air quality impacts."*[28]

The Department's Standard Specifications (Section 280) also include provisions for erosion control.[29] These provisions include such items as straw and hay bales, temporary mulch material, temporary erosion control seeding, etc. These measures, while used to prevent erosion and sediment, also reduce fugitive dust emissions.

IDOT has a Special Provision for Containment and Disposal of Lead Paint Cleaning.[30] Among other things, these provisions require the contractor to submit the following for approval: 1) Containment Plans for the containment materials and equipment that will be used to accomplish containment and ventilation, 2) Environmental Monitoring Plan to address the observations and equipment used to ensure that project dust and debris are not escaping the containment into the surrounding environment (air, soil, and water), 3) Waste Management Plan to address waste handling, storage, testing, hauling, and disposal, and 4) Contingency Plan for emergencies, such as in the event of a failure of the dust collection system.

Illinois also has an anti-idling law[31] for air quality nonattainment areas. In addition, IDOT has Special Provisions on idling restrictions[32] and diesel vehicle emissions control[33] that are included in all construction projects receiving funds from the American Recovery and Reinvestment Act of 2009. The idling restrictions include: 1) a requirement for the contractor to establish truck staging areas in locations that will have a minor impact on adjacent sensitive receptors, and 2) idling restrictions for diesel powered vehicles, when not in motion, of not more that ten minutes within any 60 minute period, except under certain circumstances. The diesel vehicle emission control provisions require all 50 horsepower engines and above to use ultra low sulfur fuel (i.e. 15 ppm sulfur content or less).

Maryland DOT

MDOT includes the following standard language in all of their air quality technical reports and EIS documents:

> *"The construction phase of the proposed project has the potential to impact the local ambient air quality by generating fugitive dust through activities such as demolition and materials handling. The SHA has addressed this possibility by establishing "Specifics for Construction and Materials" which specifies procedures to be followed by contractors involved in the site work.*
>
> *The Maryland Air and Radiation Management Administration was consulted to determine the adequacy of the "specifications" in terms of satisfying the requirements of the "Regulations Governing the Control of Air Pollution in the State of Maryland." The Maryland Air and Radiation Management Administration found the specifications to be consistent with the requirements of these regulations. Therefore, during the construction period, all appropriate measures (Code of Maryland Regulations 26.11.06.03D)[34] would be incorporated to minimize the impact of the proposed transportation improvements on the air quality of the area.*

> *Specifically, applying water or appropriate liquids during demolition, land clearing, grading, and construction operations can minimize fugitive dust. Water can be applied on dirt roads, material stockpiles and other surfaces capable of producing airborne dust. At all times when in motion, open-body trucks for transporting materials should be covered, and all excavated material should be removed promptly.*
>
> *Mobile source emissions can be minimized during construction by not permitting idling delivery trucks or other equipment during periods of unloading or other non-active use. The existing number of traffic lanes should be maintained, to the maximum extent possible, and construction schedules should be planned in a manner that will not create traffic disruption and increase air pollutants. Applications of these measures will ensure that construction impact of the project is insignificant."*

The Intercounty Connector (ICC) project, which is an 18-mile long controlled access, toll facility in Montgomery and Prince George's Counties, Maryland, includes the above standard language. But in addition, the contracts for this major project require the monitoring and control of dust. The contract documents indicate that fugitive dust beyond the project limits is prohibited and must be immediately corrected if it should occur. The Contractors monitor the air opacity in active construction areas and dust control measures are implemented when needed. Water sprayed on work areas is the usual method of control, but other operations may need additional methods, including minimization of soil disturbance, applying mulch and establishing vegetation, applying polymers barriers, and blading off loose material from haul roads.

The ICC project does not contribute to violation of a NAAQS; therefore no specific mitigation measures are required. Nevertheless a commitment was made to implement a Diesel Emissions Reduction Program to minimize air emissions during construction. The contact requirements[35] for this project states this program will require:

- Diesel powered construction equipment with 60 horsepower ratings and above that are assigned to the contract for a period in excess of 30 days must meet minimum emissions reduction requirements by engine manufacturer, or by being properly retrofitted with emissions control devices, or that clean fuels be used if necessary to meet the emissions reduction requirements; and
- All pertinent Federal and State regulations relative to exhaust emission controls and safety to be complied with; and
- Retrofit equipment that is used to consist of oxidation catalysts, or similar retrofit equipment control technology, that is included in the EPA Verified Retrofit Technology List[36]; and
- Delivery vehicles to reduce their idling times when unloading construction material.

These requirements were included in the Request for Proposals for all ICC construction contracts. To satisfy these requirements, the contractor is required to submit and adhere to

a Diesel Emissions Reduction Plan to demonstrate his compliance with the contract requirements. Non compliance requires the contractor to submit a plan to regain compliance. Failure to submit or implement the plan within five working days results in discontinuance of the equipment that is necessary to regain compliance.

Minnesota DOT

Minnesota Administrative Rule 7011.0150 entitled "Preventing Particulate Matter From Becoming Airborne" directs that no person shall cause or permit a building or its appurtenances or a road, or a driveway, or an open area to be constructed, used, repaired, or demolished without applying all reasonable precautions to prevent the discharge of visible fugitive dust emissions.[37] MNDOT also has Construction Specifications that require the contractor to minimize fugitive dust emissions within the project limits through the specified application of water and other dust suppressants as directed by the Project Engineer or stipulated in the contract.[38] Additional proposed construction specifications requiring a Dust Control Plan, etc. are currently being reviewed.

An extensive Air Quality and Waste Management Manual for the removal of paint on steel bridge structures is also in place.[39] The manual requires a preconstruction overview to determine if lead or non-lead paint exists on the bridge. (Lead paint is defined as having a lead content equal to or greater than 0.5 percent (5,000ppm) by weight, or 0.5 mg/cm^2 by x-ray fluorescence.) A decision must also be made to determine if the abrasive blasting residue is hazardous or nonhazardous waste. The manual indicates that all blasting residues used to remove lead paint, must be managed as a hazardous waste, except for the mineral aggregate abrasives mixed with Blastox (which is a granular chemical abrasive additive that is blended with slags, sands, or other media for use in the removal of lead based paint). Any residue from aggregate abrasives mixed with Blastox must remain on site until laboratory test results determine that the residue is non-hazardous.

The manual has detailed construction requirements for both the removal of non-lead and lead based paints. For non-lead based paints, the manual indicates, among other things, that the contractor's containment must be sufficient enough to stop blasting residue from being released into the environment, and that there be no visible emissions of particulate matter or visible deposits on the ground outside the containment area. For lead based paints, the containment provisions are much more detailed and depend on the bridge classification as determined by its proximity to water and sensitive receptors. Also for lead based paints the contractor is required to provide a completed written notice to the Minnesota Pollution Control Agency, the Project Engineer, and local residences at least ten working days prior to its removal from the project.

New York State DOT

NYSDOT is pursuing the implementation of "green construction practices[40]." Under these practices, all new construction contracts will:

- Require the use of ultra-low sulfur diesel fuel in construction equipment.

- Include provisions banning the idling of diesel equipment for longer than three minutes, with certain exceptions, if the diesel exhaust is within 15 meters of a sensitive receptor (i.e. hospitals, schools, daycare facilities, building fresh air or ventilation intakes, elderly housing or convalescent facilities).

- Include provisions to protect air intakes for buildings and/or facilities from the impacts of diesel exhaust fumes.

- Include additional requirements for dust control. For areas not subject to traffic this could include applying a vegetative cover, mulch, or spray adhesives on soil surfaces to prevent airborne migration of soil particles. On areas subject to traffic this could include water sprinkling, applying polymer additives to the water, providing barriers such as woven geotextiles or stone on the driving surface, providing windbreaks such as a silt fence to control air currents, and wheel washing to ensure on-road construction vehicle tires are clean before leaving the construction site.

NYSDOT's standard specifications include requirements for Class A Containment, which is a limited access and sealed tarpaulin containment with high efficiency particulate air vacuum filtration**,** for abrasive-blast cleaning associated with paint removal work from structural steel.[41] These specifications include, among other things, a requirement to submit working drawings of the containment system, and requirements for containment operations, waste collection, ventilation, lighting, and containment performance. Realtime air quality monitoring is required for Class A Containment bridge paint removal projects to ensure that aerosol levels do not exceed specified levels. If an aerosol level exceeds 150 ug/m^3 over a 15 minute time interval, operational or mechanical difficulties need to be identified and corrected. Multiple exceedances of 150 ug/m^3 or an exceedance of 450 ug/m^3 requires suspension of abrasive blasting operations until deficiencies are corrected.[42]

NYSDOT requires a project level PM10 and PM2.5 analysis for nonroad construction equipment exhaust for all projects that do not meet initial screening criteria and that have an estimated construction period of more than three years. The initial screening criteria include NEPA and State Environmental Quality Review (SEQR) project classification(s) and traffic volume increases. NEPA Categorical Exclusion and SEQR Type II projects screen out. In addition, all projects that result in no traffic volume increases screen out. The procedures for the projects that do not screen out include look up tables for PM10 and PM2.5 that provide coefficients for the various regions in New York and for various years ranging from 2004 to 2014. The coefficients are based on a ratio of NYSDOT Regional Nonroad Construction PM2.5 or PM10 emissions in tons/year (RCPM) to NYSDOT Region Construction Value in dollars/years (RCV$). These coefficients are used because in a given area the guidance indicates that "the dollar value of construction projects provides a good refection of construction equipment emissions because of the proportional relationship between the dollar value of construction and the amount of construction activity". The Project Level Nonroad Construction PM10 or PM2.5 emissions in tons/year (PLCPM) Value is then determined by multiplying the coefficient for the specific region

and date by the Project Level Construction Value in dollars/year (PLCV$).[43] The formula is as follows:

PLCPM = RCPM/RCV$ x PLCV$

If the analysis shows that the emissions for PM10 and PM 2.5 are at or below 15 tons/year for the analysis year--the year with the highest emissions during the construction period--no further assessment is required. If the emissions exceed 15 tons/year, the project must be advanced by means of an Environmental Impact Statement (EIS) and must perform an advanced PM construction emission analysis using the NONROAD model. If the emissions still exceed 15 tons/year, the contracts need to incorporate PM mitigation measures for nonroad construction equipment.

Virginia DOT

VDOT includes standard language in environmental documents, modified as appropriate for the project location and applicable regulations including the Virginia Administrative Code (VAC).[44] For example:

> *"The project is located within an ozone maintenance area as well as an emissions control area for volatile organic compounds (VOC) and nitrogen oxides (NOx). As such, all reasonable precautions should be taken to limit emissions of VOC and NOx. In addition, the following Virginia Department of Environmental Quality (VDEQ) air pollution regulations must be adhered to during the construction of this project: 9 VAC 5-130, Open Burning restrictions[45]; 9 VAC 5-40-5490, Cutback Asphalt restrictions[46]; and 9 VAC 5-50-60, Fugitive Dust precautions[47].*
>
> *Emissions may be produced in the construction of this project from heavy equipment and vehicle travel to and from the site, as well as from fugitive sources. Construction emissions are short term or temporary in nature. In order to mitigate these emissions, all construction activities are to be performed in accordance with VDOT Road and Bridge Specifications[48]."*

Standards for asphalt paving operations are detailed under Article 39 of 9 VAC 40 (Existing Stationary Sources).[49] Similarly, standards for visible emissions and fugitive dust are detailed under Article 1 of 9 VAC 5-50 (New and Modified Stationary Sources).[50]

VDOT Road and Bridge Specifications include the following general requirements under Section 107.16(b) (2):

> *"The Contractor shall comply with the provisions of Section 107.01 and the State Air Pollution Control Law and Rules of the State Air Pollution Control Board, including notifications required therein.*

> *Burning shall be performed in accordance with all applicable local laws and ordinances and under the constant surveillance of watchpersons. Care shall be taken so that the burning of materials does not destroy or damage property or cause excessive air pollution. The Contractor shall not burn rubber tires, asphalt, used crankcase oil, or other materials that produce dense smoke. Burning shall not be initiated when atmospheric conditions are such that smoke will create a hazard to the motoring public or airport operations. Provisions shall be made for flagging vehicular traffic if visibility is obstructed or impaired by smoke. At no time shall a fire be left unattended.*
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> *Asphalt mixing plants shall be designed, equipped, and operated so that the amount and quality of air pollutants emitted will conform to the rules of the State Air Pollution Control Board.*
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> *Emission standards for asbestos incorporated in the EPA's National Emission Standards for Hazardous Air Pollutants apply to the demolition or renovation of any institutional, commercial, or industrial building, structure, facility, installation, or portion thereof that contains friable asbestos or where the Contractor's methods for such actions will produce friable asbestos."*

VDOT specifications include requirements for the protection of the public and the environment from leaded paint and hazardous material resulting from coating preparation, cleaning, removal operations, blast abrasives, rust, and paint overspray. For work in these categories, continuous visual monitoring of the containment structures, dust collectors, and recycling equipment is required to ensure that there are no visible emissions outside the containment system. Perimeter monitoring is conducted using high-volume air samplers equipped for the collection of total suspended particulate samples; the filters are analyzed for lead. If monitored levels exceed the NAAQS for lead (or waste materials otherwise reach the ground or water surfaces), the operations are halted until corrective action is taken. VDOT specifications for allaying dust consist primarily of watering, applying calcium chloride or both.

Additional restrictions apply for the emission control areas identified in State Air Board Regulations. In VOC emissions control areas, open burning is prohibited during the months of May through September, and the use of cutback asphalts--asphalts blended with a petroleum solvent--is prohibited during the months of April through October, except when it is used for a penetrating prime coat or tack coat.

Wisconsin DOT

WISDOT has Standard Specifications[51], a Construction and Materials Manual[52], and a Facilities Development Manual[53] for controlling and mitigating dust from construction activities. These documents require dust control measures to be available for use on all construction projects. Measures can include such items as watering and applying dust

control chemicals such as magnesium chloride and calcium chloride. The magnesium chloride and calcium chloride can be applied in dry or in a liquid form; the Specifications contain specific chemical requirements for both forms. The contractor must consult with the Project Engineer before applying any dust control chemicals. Other dust control measures include vegetative cover, mulch, tackifiers and soil stabilizers which include polymers. WISDOT's erosion control specifications include a wide range of control measures such as erosion mates, turf reinforcement mats, silt fences, ditch checks or dikes, and sediment traps and basins. While many of the erosion control measures are for mitigating water quality impacts they can also help reduce fugitive air quality emissions.

The State DOT has Special Provisions[54] for removing paint from bridges using steel grit. These provisions prescribe a containment system consisting of tarpaulins or rigid materials to completely enclose the paint removal operation and to contain, collect and store the spent material. The containment system must be a completely integrated self-contained system for abrasive blasting and recovery. It must also filter all air exhausted from the enclosure to remove all hazardous and other particulate matter emissions. The Special Provisions also describe abating asbestos containing material on structures. They indicate that regulated asbestos containing material must be abated by a licensed abatement contractor. Also it indicates that if asbestos not previously identified is found or previously non-friable asbestos becomes crumbled, pulverized, or reduced to a powder, work must be stopped immediately and the Project Engineer must be notified. The Project Engineer will then notify the department's Bureau of Equity and Environmental Services for an emergency response.

On one project (Marquette Interchange), the WISDOT included Special Provisions to help reduce exhaust emissions from construction equipment. The provisions included limits on the sulfur content in diesel fuel, encouraged the contractors to establish staging zones in non-sensitive areas for trucks waiting to load and unload materials, to shut down truck engines if they were going to be queued up more than 15 minutes, and to locate stationary diesel powered equipment in locations that will minimize diesel emissions on abutting properties. WISDOT also has an EPA Diesel Emissions Reduction Act grant for repowering nonroad construction equipment to help reduce diesel emissions.

RESEARCH & REPORTS

The following is a summary of completed and ongoing research and reports that are relevant to evaluating and mitigating short term construction impacts. Also included is a list of suggested future research and data needs by the COP members to better analyze and mitigate such impacts.

REPORTS:

EPA - ***The Cost-Effectiveness of Heavy-Duty Diesel Retrofits and Other Mobile Source Emission Reduction Projects and Programs:***[55] Congress included a provision in SAFETEA-LU for EPA, in consultation with DOT, to issue guidance on the cost-

effectiveness of diesel emission control technologies that have been certified by EPA or the California Air Resources Board. EPA developed this report in response to both the SAFETEA-LU requirements and the Energy Policy Act of 2005. Among other thing, the report includes appendices containing estimates of cost-effectiveness in cost per ton of pollutant reduced for diesel retrofit scenarios.

EPA - ***Diesel Retrofit Technology: An Analysis of the Cost Effectiveness of Reducing Particulate Matter Emissions from Heavy-Duty Diesel Engines Through Retrofits:***[56] This report includes an analysis of the costs and emissions benefits of retrofitting several different types of vehicles including 250 horsepower bulldozers with diesel oxidation catalysts and catalyzed diesel particulate filters. EPA indicates that these technologies are the most common PM emissions reduction technologies for diesel engines. The report indicates that the cost-effectiveness of diesel oxidation catalysts ranges from $18,100 to $49,700 per ton of PM reduced.

EPA - ***Diesel Retrofit Technology: An Analysis of the Cost Effectiveness of Reducing Particulate Matter and Nitrogen Oxides Emissions from Heavy-Duty Nonroad Diesel Engines Through Retrofits:***[57] This report evaluates the cost effectiveness of retrofitting nonroad equipment such as tractors/loaders/backhoes, excavators, cranes, generator sets, agricultural tractors, crawler tractors/dozers and off-highway trucks with diesel oxidation catalysts and catalyzed diesel particulate filters, as well as with selective catalytic reduction systems and engine upgrade kits for NOx reduction.

Frey, Rasdorf, and Lewis, North Carolina State University - ***Results of a Comprehensive Field Study of Fuel Use and Emissions of Nonroad Diesel Construction Equipment.***[58] This paper summarizes the results of field research using a portable emission monitoring system to collect information on fuel use and emissions data from eight backhoes, six bulldozers, three excavators, four generators, six motor graders, three off-road trucks, one skid-steer loader, three track loaders, and five wheel loaders while they performed various duty cycles. The report suggests that where possible emissions inventories be based on fuel consumed, rather than time of activity, because fuel based emission rates were found to be less sensitive and have less variability to engine size and load.

Frey, Rasdorf, Kim, Pang, Lewis, North Carolina State University – ***Comparison of Real World Emissions of Backhoes, Front-End Loaders, and Motor Graders for B20 Biodiesel vs. Petroleum Diesel and for Selected Engine Tiers.***[59] This study collected data for in-use fuel consumption and emissions rates for five backhoes, four front end loaders, and six motor graders nonroad vehicles. Each of these vehicles was tested with petroleum diesel and B20 biodiesel fuels. The study found, among other things, that on average the use of B20 instead of petroleum diesel lead to an insignificant decrease in NO_x emission rates but significant decreases for opacity, HC, and CO, respectively.

Frey, Rasdorf, Pang, Kim, Lewis, North Carolina State University – ***Methodology for Activity, Fuel Use, and Emissions Data Collection and Analysis for Nonroad Construction Equipment***.[60] This paper develops standard procedures for field data

collection and analysis for nonroad construction equipment. It also makes recommendations on preferred data collection, quality assurance, and analysis procedures in order to obtain energy use and emissions data.

Lewis, Frey, and Rasdorf, North Carolina State University – *Development and Use of Emissions Inventories for Construction Vehicles*.[61] This paper includes a methodology for inventorying construction fleet emissions based on emissions measurements of selected backhoes, front-end loaders, and motor graders for various model years and engine standards. The tests were performed for B20 biodiesel and petroleum diesel fuels. The emissions inventory showed that the average emissions rates for B20 biodiesel produced significantly lower emissions of PM, CO, and HC than petroleum diesel and about the same level of NO_x emissions. It concludes that a highly effective emissions reduction strategy is to use B20 biodiesel fuels in combination with the newer, high tier engines.

NCHRP - *Determine Alternative Calculations for Fine Particulate Emission Factors Other Than AP-42 Applicable to Calculate Re-entrained Dust on Transportation Projects:*[62] The objective of this study was to identify and develop guidelines for the use of more accurate calculation methods to calculate $PM_{2.5}$ and PM_{10} emission factors for re-entrained road dust for both paved and unpaved roads.

NCHRP 25-25/Task 58 – *Methods to Address Greenhouse Gas Emissions from Transportation Construction/Maintenance/Operations Activities*:[63] The objective of this study is to look at techniques available to estimate greenhouse gas emissions from transportation activities. This research will develop a spreadsheet or other tool that will allow the user to enter information on construction, maintenance and/or operations activities and provide reliable estimates of greenhouse gas emissions. This research will also "develop a synthesis of current research on the cost-effectiveness of different strategies within these activities to reduce greenhouse gas emissions, identify the gaps in current research, and recommend needed research to more affectively address the cost-effectiveness of these strategies".

Texas Transportation Institute - *Characterization of In-Use Emissions From TxDOT's Nonroad Equipment Fleet – Phase 1 Report:*[64] This report presents preliminary findings of the study characterizing in-use TxDOT nonroad diesel equipment emissions, and literature reviews of emissions reduction technologies and emissions control measures. It also discusses selection of TxDOT nonroad equipment and emissions reduction technologies for emissions testing, and shows preliminary results of in-use emissions of TxDOT diesel equipment. Emissions measurements and data comparison and analysis tasks are still ongoing.

University of California-Davis – *Construction Equipment Retrofit and Replacement Tool Version 3.0.*[65] This document provides a spreadsheet tool to calculate emissions from six types of construction equipment used on transportation construction projects. The spread sheet estimates emissions reductions for NOx, PM, total hydrocarbons, carbon monoxide, and carbon dioxide for both regional and project scale applications of retrofits and replacements.

FUTURE RESEARCH AND DATA NEEDS:

The Air Quality COP recommends the following additional research measures to help advance the state-of-the-practice for analyzing short term construction impacts from construction equipment and operations:

- Conduct full cycle emissions analyses of construction processes, such as asphalt paving (composition, emulsion, batch plant, asphalt mix temperature, transport, application, etc) and/or concrete paving and reconstruction activities (fly ash additives, plant operations and temperature requirements, transport, pavement demolition and concrete pours, etc).

- Conduct a long-term research project to determine air quality affects from common highway construction equipment and activities. This study could be similar to the NCHRP study entitled, "Environmental Impact of Construction and Repair Materials on Surface and Ground Water (Primer)". [66]

- Review Project Engineer's logs of construction activities related to certain projects to get better information on the types of construction equipment used, and the hours and duration of use. This effort could also include collecting additional field data for in-use fuel consumption and emissions characteristics of various pieces of construction equipment. It could also include evaluating examples across the country to see if different types of construction activities, fuel consumption, and emission characteristics can be compared across States.

SUMMARY

State DOTs are starting to be challenged by State and local resource agencies and environmental groups to look at the short term impacts from construction equipment and activities. This is because heavy construction equipment and activities can result in fugitive dust emissions from earth moving activities, use of unpaved haul roads, sand blasting of lead paint from bridges, etc. In addition, construction equipment is normally powered by diesel engines which are high emitters of NOx and PM emissions.

To help reduce diesel engine emissions, EPA initiated the NCDC which is a high priority program to reduce diesel emissions from a variety of control strategies. The campaign uses a three part approach which includes: 1) implementing the existing 2007 Heavy-Duty Highway Engine Rule and the Clean Nonroad Diesel Rule; 2) developing new rules for reducing emissions from trains, and marine diesels; and 3) addressing diesel engines already in use. These programs will help to substantially reduce emissions from construction equipment used for transportation projects.

In response to SAFETEA-LU provisions, FHWA put out revised CMAQ guidance on November 17, 2008 which indicates that CMAQ funds are eligible for diesel engine

replacements, rebuilding and reconditioning; purchase and installation of after-treatment hardware, and other technologies; and to support heavy-duty vehicle retirement programs, assuming that other CMAQ criteria are met. These funds will help fund cost-effective strategies for reducing emissions from existing construction equipment.

State DOTs are using various techniques and have a number of standard specifications to lessen the impacts from both construction activities, and exhaust emissions from construction equipment. For example, controls for fugitive dust generally involve such techniques as watering and chemical stabilization of cut and fill activities and haul roads, stabilizing material stockpiles, covering open bodied trucks that are carrying materials, providing wind breaks, minimizing off-site tracking of mud and debris, etc. A number of States also require monitoring of PM levels to ensure appropriate mitigation measures are used if emissions exceed prescribed levels. Most States also have extensive specifications to control emissions from sand blasting operations for bridges.

State DOT's use a variety of techniques and requirements for controlling diesel exhaust emissions from construction equipment such as requiring: 1) the use of low sulfur diesel fuels, 2) retro-fit equipment to meet EPA certified technologies, and 3) diesel powered construction equipment to meet minimum emissions reduction requirements for manufacturers. State DOTs also often restrict the time that construction equipment is allowed to idle. These techniques will generally vary depending on the location, size and duration of the project.

In addition, several States interviewed as part of this report have started to predict emissions from construction equipment. Typically this involves using spreadsheets and look up tables. Further research will be needed to refine these predictive techniques. This research will need to gain better information on the types of construction equipment used, and the hours and duration of use. It will also need to include collecting additional field data for in-use fuel consumption and emissions characteristics of various pieces of construction equipment.

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