4.0 NO_x ANALYSIS METHODS

5 Nonroad Diesel Equipment Anti-Idling

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Emission control standards for diesel engines, and nonroad diesel engines, have lagged behind standards for other mobile sources such as passenger cars. Because of this, diesel engines contribute disproportionately to the overall mobile source pollutant emissions inventory. Over the last ten years, EPA has introduced a series of highway and nonroad diesel fuel quality and emission standards that when fully implemented will reduce diesel emissions from newer emissions more than 90 percent (Figure 1, Figure 2). Emissions from existing engines, however, will continue to emit high levels of pollution for many years. To begin to address this problem, states and EPA have introduced measures to reduce emissions from existing engines such as retrofit and anti-idling programs.

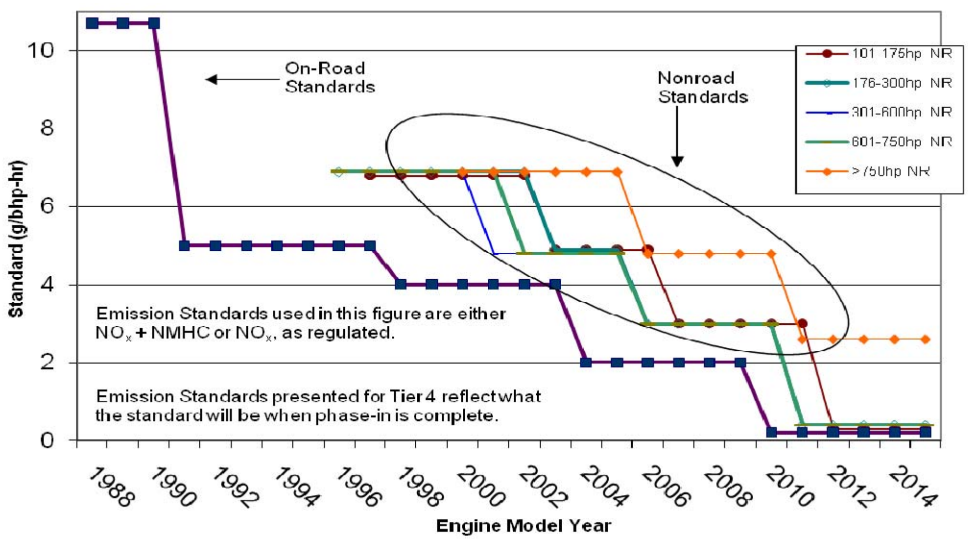

Figure 1: Diesel NOx Emissions Standards (g/bhp-hr)

There are numerous reasons why nonroad construction equipment is left idling for extended periods: to perform work, to keep the operator warm, to keep the machine ready for work while waiting for supplies and equipment to be moved, union rules, and common practice. Increasing amounts of data are available to assist in the development of an emissions inventory for nonroad engine idling. Although in-use hours and emissions from nonroad equipment are estimated by EPA's NONROAD model, the model does not provide an explicit estimate of time spent or emissions resulting from nonroad idling. Anecdotal data and some in-use testing data are available. Some of the in-use testing data indicate that nonroad construction equipment may spend as much as half of in-use hours idling.

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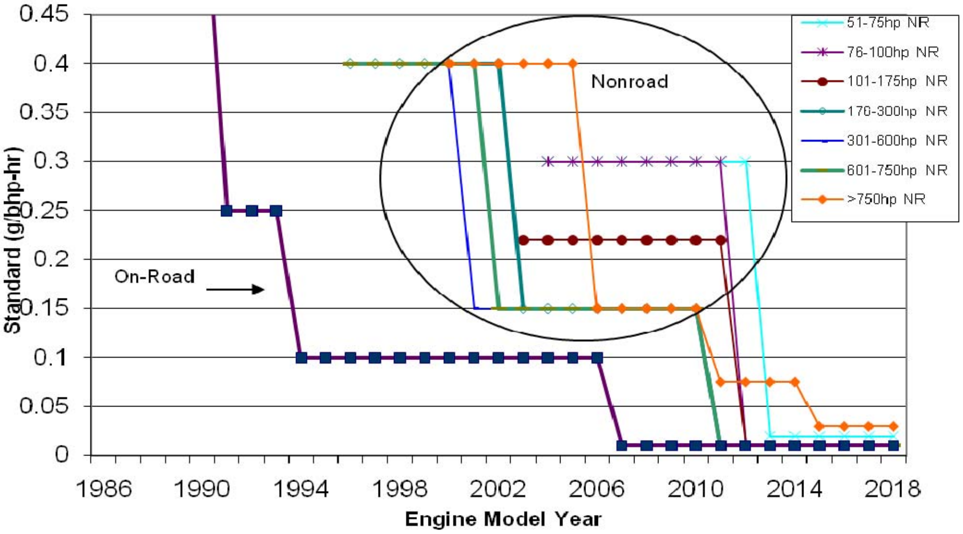

Figure 2: Diesel PM Emissions Standards (g/bhp-hr)

4.5.1 Existing Standards

To date, four states (Connecticut, Massachusetts, New Jersey, and Rhode Island) in the Ozone Transport Region (OTR) place restrictions on nonroad idling. The idling restrictions of Connecticut, Massachusetts, and Rhode Island apply respectively to "mobile sources" and "diesel engines," both of which include nonroad construction equipment. Connecticut explicitly exempts from its idling regulation nonroad diesel engines in marine and locomotive applications. Conversely, Massachusetts and Rhode Island's regulations include marine vessels and locomotives. New Jersey's regulation applies to nonroad construction equipment and marine engines, but not to locomotives. Additionally, California places restrictions on nonroad idling. California Air Resources Board (CARB)'s nonroad idling provision, like Connecticut's does not cover marine or locomotive engines.

Table 1: Application of existing nonroad idling rules in the OTR

	Non Road Application		
	Construction Equipment	Marine	Locomotive
CT	A	\	\
MA	A	A	A
NJ	A	A	\
RI	A	A	A
CARB	A	\	\

A = Rule applies to the engine application.

4.5.2 The OTC Measure

Specifically, the OTC model rule would apply to all nonroad diesel engines, except for engines used in locomotives; as generator sets used on locomotives; marine engines; recreational vehicles; farming equipment; military equipment when it is being used during training exercises; emergency or public safety situations; or any use of a nonroad diesel engine that is not for compensation. This model rule was developed as a framework for each state to consider in developing rules for that individual state, based on state-specific statutory and regulatory authority. Each state would then follow the specific rulemaking proposal and adoption processes required for their agency.

Nonroad diesel equipment is often used in processes that require the engine idle in order to perform a function. Examples of this include cement agitation, operation of a boom lift, and operating hydraulic systems. To allow this necessary flexibility to operators in order for the operators to perform their tasks and clarify situations where idling is not considered unnecessary, several exemptions are provided for in the model rule:

- To ensure the safe operation of the equipment, including idling to verify that the equipment is in good working order, or other conditions specified by the equipment manufacturer in the manual or other technical document accompanying the nonroad diesel engine;
- For testing, servicing, repairing, or diagnostic purposes, including regeneration of a diesel particulate filter;
- For less than fifteen (15) minutes when queuing, i.e., when nonroad diesel equipment, situated in a queue of other vehicles, must intermittently move forward to perform work or a service. This does not include the time an operator may wait motionless in line in anticipation of the start of a workday or opening of a location where work or a service will be performed. Idling will be limited to fifteen (15) minutes when queuing;
- When used in an emergency or public safety capacity; and
- For inspection to verify that all equipment is in good working order, if idling is required as part of the inspection.

To clarify these exemptions, and other aspects of the model rule, an accompanying guidance document was produced to help members of industry more clearly understand the exemptions. Additionally, the guidance document will aid enforcement officers so that violations can be properly addressed.

To ensure compliance with the rule the model rule is structured to allow enforcement to be conducted by a municipal or local government, or state agents that are granted the right to enter a property or location where a nonroad diesel engine is located. This provides the flexibility for each state to alter the model rule in order to match their existing enforcement authority. Also, depending on specific state statutory authority/regulations, the enforcement officer that has jurisdiction can penalize any person, entity, owner, or operator of a property or location where a nonroad diesel engine is operated, owners and operators of a nonroad diesel engine, or the holder of the permit for the activity for which the nonroad diesel engine is being operated, for an infraction.

4.5.3 Emissions Reduction Benefit

Data on idling activity as compared to total usage time are scarce. Three sources of data were relied on for this estimation: CARB, John Deere, and EPA. To estimate the emissions benefit for its nonroad idling rule, CARB asked individuals with significant experience in the industry to estimate the time off-road construction equipment spends idling unnecessarily. Their inquiry resulted in two estimates: 1) publicly owned fleets idle for 1.8% of the hours they are in use, and 2) privately-owned fleets idle 7.5% of the time. CARB further assumes that 95% of nonroad equipment is privately owned, giving an average idle rate of 7.2%.

Information obtained from John Deere distributors in the Northeast, who collected data from telematic devices installed on 19 construction machines. These devices allow equipment owners to monitor, in real-time, exactly how the machine is operating, including whether it is idling. The average idling rate from the John Deere survey is 42%, considerably higher than CARB's estimate. Data collected from EPA correspond to the data obtained from John Deere and because of this, and because the data were only for a very small number of equipment it was not included in further analysis.

Table 2: Emissions from Avoidable Nonroad Idling, OTC States 2009 (tpy)

	Idling Rate	NO_X
John Deere	42%	35,146
CARB	7.2%	6,151
Total Emissions from Sector		194,831

In order to estimate idling emissions in the OTR, idling emissions rates (emission factors) and activity (hours spent idling) for different types of nonroad construction equipment were determined. Idling emissions data were analyzed for 35 engines tested as part of a study of nonroad emissions conducted by North Carolina State University[1]. Regressions were run based on Equation 1 using as the dependent variable three types of pollutants, Oxides of Nitrogen (NO_X), Particulate Matter (PM), and Total Hydrocarbons (THC), as well as diesel fuel consumption. Significant relationships were found between rated power and the level of emissions of NO_X that occur during idling, as well as between rated power and fuel consumption. The equipment's rated power displayed no effect on the level of PM and THC emissions that result during idling, essentially making it zero. Additionally, the variables of whether an engine was Tier 1 or was Tier 2 or greater were found to have significant coefficients for all species of emissions. These results provide high quality equations for estimating emissions from idling from across the sector.

Equation 1: Regression Equation for Calculating Emissions

$$\textit{Idling Emissions} = \alpha * \textit{RatedPower} + \beta * \textit{Tier1} + \gamma * \textit{Tier2Plus} + \varepsilon$$

In order to account for the likely differences in emission factors for each equipment class, they were isolated for further analysis based on their Source Classification Code (SCC). The NONROAD model was used to estimate populations of 65 nonroad engine types in each of the 13 OTC states during the 2009 baseline year. The population data were further disaggregated by emissions tier and power class, and to calculate the annual activity (hours in operation) for each equipment type and for three size classes and three emissions tiers, using default values contained in NONROAD input data files and supporting documentation.

Table 2 shows the potential emissions benefit for the OTC states, assuming that all unnecessary idling could be eliminated for both the 7.2% and 42% cases as compared to total emissions from the sector as estimated from the NONROAD model. Significant NO_X emissions could be

[1] Frey, C., W. Rasdorf, K. Kim, S. Pang, P. Lewis, and S. Abolhassani (2007). "Real-World Duty Cycles and Utilization for Construction Equipment in North Carolina," Final Report for Research Project No. HWY - 2006 – 08, North Carolina Department of Transportation, Raleigh, NC

reduced if idling beyond 5 minutes is to be eliminated in the OTR for construction equipment machines.

Emission inventories contain estimates of actual emissions to the air during the relevant time period. Factors that concern how widespread the impact of the rule is and how effective the rule is are just important as the efficiency of the control itself when estimating actual emissions. An equation to calculate how these factors impact emission can be seen in Equation 1. For the case of the nonroad idling model rule the control efficiency would be 100% since the control involves simply turning the engine off, which would result in zero emissions production in a controlled situation. Rule penetration is based on the exemptions in the model rule and should be calculated individually on a state by state basis. Rule effectiveness is largely based on how well enforcement officers are enforcing the rule, with the predominant factor being how often they find violations when visiting a site, a value which would have to be determined on a state by state basis. Another important factor impacting rule effectiveness is the degree of success of outreach efforts to the regulated community. It should be noted that existing EPA guidance for the development of emissions inventories does specify that rule effectiveness is not directly applicable to mobile sources.

Equation 2: Equation for Calculating Controlled Emissions

*Uncontrolled Emissions * (1–(Control Efficiency * Rule Penetration * Rule Effectiveness)) = Controlled Emissions*

4.5.4 Control Cost Estimate

We estimate that this regulation would provide only economic benefits due to the nature of the control. The 35 engines tests completed by North Carolina State University included data points for the amount of fuel that was consumed during engine idling. The same methodology that was employed to calculate emission factors was employed to calculate fuel usage. If one assumes that the price of diesel is $4/gallon this would result in the economic benefits listed in Table 3. Additionally, there are economic benefits associated with reductions in maintenance and replacement costs due to the reduction in the amount of time equipment engines are left running, but this cost was not estimated.

Table 3: Benefits from Avoidable Nonroad Idling, OTC States 2009

	Idling Rate	Fuel (g)	2009 $
John Deere	42%	30,327,964	121,311,854
CARB	7.2%	5,307,394	21,229,575

4.5.5 Emissions Reduction Benefits for Other Pollutants

Reducing idling from nonroad diesel engines inherently reduces other pollutants that are produced by nonroad diesel engines. The same techniques used to calculate NO_X emissions benefits from the regulation were used to determine reductions that would

Table 4: Emissions from Avoidable Nonroad Idling, OTC States 2009 (tpy)

	Idling Rate	THC	PM
John Deere	42%	4,394	253
CARB	7.2%	769	44
Total Emissions from Sector		18,464	16,711

occur from implementing the rule in the OTR for THC and PM. The potential emission benefit for the OTC states is in Table 4.