Appendix 4a. Description of Mobile Source Control Measures

4a.1 Diesel Retrofits and Engine Rebuilds

Retrofitting heavy-duty diesel vehicles and equipment manufactured before stricter standards are in place—in 2007–2010 for highway engines and in 2011–2014 for most nonroad equipment—can provide NO_X and HC benefits. The retrofit strategies included in the RIA retrofit measure are:

- Installation of emissions after-treatment devices called selective catalytic reduction ("SCRs")
- Rebuilding nonroad engines ("rebuild/upgrade kit")

We chose to focus on these strategies due to their high NOx emissions reduction potential and widespread application. Additional retrofit strategies include, but are not limited to, lean NOx catalyst systems—which are another type of after-treatment device—and alternative fuels. Additionally, SCRs are currently the most likely type of control technology to be used to meet EPA's NOx 2007–2010 requirements for HD diesel trucks and 2008–2011 requirements for nonroad equipment. Actual emissions reductions may vary significantly by strategy and by the type and age of the engine and its application.

To estimate the potential emissions reductions from this measure, we applied a mix of two retrofit strategies (SCRs and rebuild/upgrade kits) for the 2020 inventory of:

- Heavy-duty highway trucks class 6 & above, Model Year 1995–2009
- All diesel nonroad engines, Model Year 1991–2007, except for locomotive, marine, pleasure craft, & aircraft engines

Class 6 and above trucks comprise the bulk of the NOx emissions inventory from heavy-duty highway vehicles, so we did not include trucks below class 6. We chose not to include locomotive and marine engines in our analysis since EPA has proposed regulations to address these engines, which will significantly impact the emissions inventory and emission reduction potential from retrofits in 2020. There was also not enough data available to assess retrofit strategies for existing aircraft and pleasure craft engines, so we did not include them in this analysis. In addition, EPA is in the process of negotiating standards for new aircraft engines. The lower bound in the model year range—1995 for highway vehicles and 1991 for nonroad engines—reflects the first model year in which emissions after-treatment devices can be reliably applied to the engines. Due to a variety of factors, devices are at a higher risk of failure for earlier model years. We expect the engines manufactured before the lower bound year that are still in existence in 2020 to be retired quickly due to natural turnover, therefore, we have not included strategies for pre-1995/1991 engines because of the strategies' relatively small impact on emissions. The upper bound in the model year range reflects the last year before more stringent emissions standards will be fully phased-in.

We chose the type of strategy to apply to each model year of highway vehicles and nonroad equipment based on our technical assessment of which strategies would achieve reliable results at the lowest cost. After-treatment devices can be more cost-effective than rebuild and vice versa depending on the emissions rate, application, usage rates, and expected life of the engine. The performance of after-treatment devices, for example, depends heavily upon the model year of the engine; some older engines may not be suitable for after-treatment devices and would be better candidates for rebuild/upgrade kit. In certain cases, nonroad engines may not be suitable for either after-treatment devices or rebuild, which is why we estimate that retrofits are not suitable for 5% of the nonroad fleet. The mix of strategies employed in this RIA for highway vehicles and nonroad engines are presented in Table 4a.1 and Table 4a.2, respectively. The groupings of model years for highway vehicles reflect changes in EPA's published emissions standards for new engines.

Table 4a.1: Application of Retrofit Strategy for Highway Vehicles by Percentage of Fleet

Model Year	SCR
<1995	0%
1995–2006	100%
2007–2009	50%
>2009	0%

Table 4a.2: Application of Retrofit Strategy for Nonroad Equipment by Percentage of Fleet

Model Year	Rebuild/Upgrade kit	SCR
1991–2007	50%	50%

The expected emissions reductions from SCR's are based on data derived from EPA regulations (Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-duty Highway Engines and Vehicles published October 2000), interviews with component manufacturers, and EPA's Summary of Potential Retrofit Technologies. This information is available at www.epa.gov/otaq/retrofit/retropotentialtech.htm. The estimates for highway vehicles and nonroad engines are presented in Table 4a.3 and Table 4a.4, respectively.

Table 4a.3: Percentage Emissions Reduction by Highway Vehicle Retrofit Strategy

	PM	CO	HC	NOx
SCR (+DPF)	90%	90%	90%	70%

Table 4a.4: Percentage Emissions Reduction by Nonroad Equipment Retrofit Strategy

Strategy	PM	CO	HC	NOx
SCR (+DPF)	90%	90%	90%	70%
Rebuild/Upgrade Kit	30%	15%	70%	40%

It is important to note that there is a great deal of variability among types of engines (especially nonroad), the applicability of retrofit strategies, and the associated emissions reductions. We applied the retrofit emissions reduction estimates to engines across the board (e.g., retrofits for bulldozers are estimated to produce the same percentage reduction in emissions as for agricultural mowers). We did this in order to simplify model runs, and, in some cases, where we did not have enough data to differentiate emissions reductions for different types of highway vehicles and nonroad equipment. We believe the estimates used in the RIA, however, reflect the best available estimates of emissions reductions that can be expected from retrofitting the heavy-duty diesel fleet.

Using the retrofit module in EPA's National Mobile Inventory Model (NMIM) available at http://www.epa.gov/otaq/nmim.htm, we calculated the total percentage reduction in emissions (PM, NOx, HC, and CO) from the retrofit measure for each relevant engine category (source category code, or SCC) for each county in 2020. To evaluate this change in the emissions inventory, we conducted both a baseline and control analysis. Both analyses were based on NMIM 2005 (version NMIM20060310), NONROAD2005 (February 2006), and MOBILE6.2.03 which included the updated diesel PM file PMDZML.csv dated March 17, 2006. For the control analysis, we applied the retrofit measure corresponding to the percent reductions of the specified pollutants in Tables 3a.12 and 3a.13 to the specified model years in Tables 3a.10 and 3a.11 of the relevant SCCs. Fleet turnover rates are modeled in the NMIM, so we applied the retrofit measure to the 2007 fleet inventory, and then evaluated the resulting emissions inventory in 2020. The timing of the application of the retrofit measure is not a factor; retrofits only need to take place prior to the attainment date target (2020 for this RIA). For example, if retrofit devices are installed on 1995 model year bulldozers in 2007, the only impact on emissions in 2020 will be from the expected inventory of 1995 model year bulldozer emissions in 2020.

We then compared the baseline and control analyses to determine the percent reduction in emissions we estimate from this measure for the relevant SCC codes in the targeted nonattainment areas.

4a.2 Implement Continuous Inspection and Maintenance Using Remote Onboard Diagnostics (OBD)

Continuous Inspection and Maintenance (I/M) is a new way to check the status of OBD systems on light-duty OBD-equipped vehicles. It involves equipping subject vehicles with some type of transmitter that attaches to the OBD port. The device transmits the status of the OBD system to receivers distributed around the I/M area. Transmission may be through radio-frequency, cellular or wi-fi means. Radio frequency and cellular technologies are currently being used in the states of Oregon, California and Maryland.

Current I/M programs test light-duty vehicles on a periodic basis—either annually or biennially. Emission reduction credit is assigned based on test frequency. Using Continuous I/M, vehicles are continuously monitored as they are operated throughout the non-attainment area. When a vehicle experiences an OBD failure, the motorist is notified and is required to get repairs within the normal grace period—typically about a month. Thus, Continuous I/M will result in repairs happening essentially whenever a malfunction occurs that would cause the check engine light to illuminate. The continuous I/M program is applied to the same fleet of vehicles as the current periodic I/M programs. Currently, MOBILE6 provides an increment of benefit when going from a biennial program to an annual program. The same increment of credit applies going from an annual program to a continuous program.
Source Categories Affected by Measure:

- All 1996 and newer light-duty gasoline vehicles and trucks:
- All 1996 and newer (SCC 2201001000) Light Duty Gasoline Vehicles (LDGV), Total: All Road Types
- All 1996 and newer (SCC 2201020000) Light Duty Gasoline Trucks 1 (LDGT1), Total: All Road Types
- All 1996 and newer (SCC 2201040000) Light Duty Gasoline Trucks 2 (LDGT2), Total: All Road Types

OBD systems on light duty vehicles are required to illuminate the malfunction indicator lamp whenever emissions of HC, CO or NOx would exceed 1.5 times the vehicle's certification standard. Thus, the benefits of this measure will affect all three criteria pollutants. MOBILE6 was used to estimate the emission reduction benefits of Continuous I/M, using the methodology discussed above.

4a.3 Eliminating Long Duration Truck Idling

Virtually all long duration truck idling—idling that lasts for longer than 15 minutes—from heavy-duty diesel class 8a and 8b trucks can be eliminated with two strategies:

- truck stop & terminal electrification (TSE)
- mobile idle reduction technologies (MIRTs) such as auxiliary power units, generator sets, and direct-fired heaters

TSE can eliminate idling when trucks are resting at truck stops or public rest areas and while trucks are waiting to perform a task at private distribution terminals. When truck spaces are electrified, truck drivers can shut down their engines and use electricity to power equipment which supplies air conditioning, heat, and electrical power for on-board appliances. MIRTs can eliminate long duration idling from trucks that are stopped away from these central sites. For a more complete list of MIRTs see EPA's Idle Reduction Technology page at http://www.epa.gov/otaq/smartway/idlingtechnologies.htm.

This measure demonstrates the potential emissions reductions if every class 8a and 8b truck is equipped with a MIRT or has dependable access to sites with TSE in 2020.
To estimate the potential emissions reduction from this measure, we applied a reduction equal to the full amount of the emissions attributed to long duration idling in the MOBILE model, which is estimated to be 3.4% of the total NOx emissions from class 8a and 8b heavy duty diesel trucks. Since the MOBILE model does not distinguish between idling and operating emissions, EPA estimates idling emissions in the inventory based on fuel conversion factors. The inventory in the MOBILE model, however, does not fully capture long duration idling emissions. There is evidence that idling may represent a much greater share than 3.4% of the real world inventory, based on engine control module data from long haul trucking companies. As such, we believe the emissions reductions demonstrated from this measure in the RIA represent ambitious but realistic targets. For more information on determining baseline idling activity see EPA's "Guidance for Quantifying and Using Long-Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity" available at http://www.epa.gov/smartway/idle-guid.htm.

Pollutants and Source Categories Affected by Measure: NO_x

Table 4a.5: Class 8a and 8b Heavy Duty Diesel Trucks (decrease NOx for all SCCs)

SCC	Note: All SCC Descriptions below begin with "Mobile Sources; Highway Vehicles—Diesel"
2230074110	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Interstate: Total
2230074130	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Other Principal Arterial: Total
2230074150	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Minor Arterial: Total
2230074170	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Major Collector: Total
2230074190	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Minor Collector: Total
2230074210	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Rural Local: Total
2230074230	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Interstate: Total
2230074250	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Other Freeways and Expressways: Total
2230074270	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Other Principal Arterial: Total
2230074290	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Minor Arterial: Total
2230074310	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Collector: Total
2230074330	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B; Urban Local: Total

Estimated Emissions Reduction from Measure (%): 3.4 % decrease in NOx for all SCCs affected by measure

4a.4 Commuter Programs

Commuter programs recognize and support employers who provide incentives to employees to reduce light-duty vehicle emissions. Employers implement a wide range of incentives to affect change in employee commuting habits including transit subsidies, bike-friendly facilities, telecommuting policies, and preferred parking for vanpools and carpools. The commuter measure in this RIA reflects a mixed package of incentives.

This measure demonstrates the potential emissions reductions from providing commuter incentives to 10% and 25% of the commuter population in 2020.

We used the findings from a recent Best Workplaces for Commuters survey, which was an EPA sponsored employee trip reduction program, to estimate the potential emissions reductions from this measure.[1] The BWC survey found that, on average, employees at workplaces with comprehensive commuter programs emit 15% fewer emissions than employees at workplaces that do not offer a comprehensive commuter program.

We believe that getting 10%–25% of the workforce involved in commuter programs is realistic. For modeling purposes, we divided the commuter programs measure into two program penetration rates: 10% and 25%. This was meant to provide flexibility to model a lower penetration rate for areas that need only low levels of emissions reductions to achieve attainment.

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[1] Herzog, E., Bricka, S., Audette, L., and Rockwell, J., 2005. *Do Employee Commuter Benefits Reduce Vehicle Emissions and Fuel Consumption? Results of the Fall 2004 Best Workplaces for Commuters Survey*, Transportation Research Record, Journal of the Transportation Research Board: Forthcoming.

According to the 2001 National Household Transportation Survey (NHTS) published by DOT, commute VMT represents 27% of total VMT. Based on this information, we calculated that BWC would reduce light-duty gasoline emissions by 0.4% and 1% with a 10% and 25% program penetration rate, respectively.

Pollutants and Source Categories Affected by Measure (SCC): NO_x, and VOC

Table 4a.6: All Light-Duty Gasoline Vehicles and Trucks

SCC	Note: All SCC Descriptions below begin with "Mobile Sources; Highway Vehicles—Gasoline"
2201001110	Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Total
2201001130	Light Duty Gasoline Vehicles (LDGV); Rural Other Principal Arterial: Total
2201001150	Light Duty Gasoline Vehicles (LDGV); Rural Minor Arterial: Total
2201001170	Light Duty Gasoline Vehicles (LDGV); Rural Major Collector: Total
2201001190	Light Duty Gasoline Vehicles (LDGV); Rural Minor Collector: Total
2201001210	Light Duty Gasoline Vehicles (LDGV); Rural Local: Total
2201001230	Light Duty Gasoline Vehicles (LDGV); Urban Interstate: Total
2201001250	Light Duty Gasoline Vehicles (LDGV); Urban Other Freeways and Expressways: Total
2201001270	Light Duty Gasoline Vehicles (LDGV); Urban Other Principal Arterial: Total
2201001290	Light Duty Gasoline Vehicles (LDGV); Urban Minor Arterial: Total
2201001310	Light Duty Gasoline Vehicles (LDGV); Urban Collector: Total
2201001330	Light Duty Gasoline Vehicles (LDGV); Urban Local: Total
2201020110	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Total
2201020130	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Other Principal Arterial: Total
2201020150	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Minor Arterial: Total
2201020170	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Major Collector: Total
2201020190	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Minor Collector: Total
2201020210	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Local: Total
2201020230	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Interstate: Total
2201020250	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Other Freeways and Expressways: Total
2201020270	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Other Principal Arterial: Total
2201020290	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Minor Arterial: Total
2201020310	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Collector: Total
2201020330	Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Urban Local: Total
2201040110	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Interstate: Total
2201040130	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Other Principal Arterial: Total
2201040150	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Minor Arterial: Total
2201040170	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Major Collector: Total
2201040190	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Minor Collector: Total
2201040210	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Rural Local: Total
2201040230	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Interstate: Total
2201040250	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Other Freeways and Expressways: Total
2201040270	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Other Principal Arterial: Total
2201040290	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Minor Arterial: Total
2201040310	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Collector: Total
2201040330	Light Duty Gasoline Trucks 3 & 4 (M6) = LDGT2 (M5); Urban Local: Total

Estimated Emissions Reduction from Measure (%):

With a 10% program penetration rate:	0.4%
With a 25% program penetration rate:	1%