Chapter 3: Emissions Controls Analysis – Design and Analytical Results

Synopsis

The revised NO2 standard is 100 parts per billion (ppb), calculated from the average of the 98th percentile of 1-hour daily maximum concentrations from three consecutive years. OMB Circular A-4 requires the RIA to contain, in addition to analysis of the impacts of the revised NAAQS of 100 ppb, analysis of a level more stringent and a level less stringent than the NAAQS. For this analysis, we chose a more stringent level of 80 ppb and a less stringent level of 125 ppb.

This chapter documents the illustrative emission control strategy we applied to simulate attainment with the revised NO_2 NAAQS and the two additional levels being analyzed. Section 3.1 describes the approach we followed to select emission controls to simulate attainment. Section 3.2 describes the emission control measures identified as appropriate for this illustrative control strategy. Section 3.3 summarizes the emission reductions estimated as necessary to meet the revised NAAQS and the two additional levels included in the analysis. Section 3.4 includes the estimated costs of controls for each area projected to exceed one or more of the levels of the analysis. Section 3.5 discusses key limitations in the approach we used to estimate the control strategies for each alternative standard.

3.1 Designing the Control Strategy Analysis

It is important to note that this analysis does not attempt to estimate attainment or nonattainment for any areas of the country other than those counties currently served by one of the 409 monitors in the current network. Chapter 2 explains that the current network is focused on community-wide ambient levels of NO_2, and not near-roadway levels, which may be significantly higher. The revised standard contains requirements for an NO_2 monitoring network that will include monitors near major roadways. We recognize that once a network of near-roadway monitors is in place, more areas could find themselves exceeding the new hourly NO_2 NAAQS. However for this RIA analysis, we lack sufficient data to predict which counties beyond the current network might exceed the revised NAAQS after implementation of a near-roadway monitoring network. Therefore we lack a credible analytic path to estimating costs and benefits for counties outside of the current NO2 monitoring network. This analysis relies on current and future estimated air quality concentrations at area-wide monitors, making adjustments to future year projections using derived estimates of the relationship between future year area-wide air quality peaks and current near-roadway peaks.

As part of our economic analysis of the revised NO_2 standard, our 2020 analysis baseline assumes that States will put in place the necessary control strategies to attain the previous $PM_{2.5}$ and ozone standards. The cost of these control strategies was included in the RIAs for those rulemakings. We do not include the cost of those controls in this analysis, in order to prevent counting the cost of installing and operating the controls twice. Of course, the health and environmental benefits resulting from installation of those controls were attributed to attaining those standards and are not counted again for the analysis of this NO_2 standard.

The first step in the control strategy analysis was to identify the geographic areas projected to exceed the revised standard or one of the additional levels in the time period for which attainment is required. We based this assessment on monitor design values projected to the year 2020 and adjusted to simulate levels for a near-road monitoring network, as discussed in Chapter 2. (Prior to near-roadway adjustment, all the monitor design values in the current network were below the alternative NAAQS levels). After identifying the geographic areas, we estimated the amount of NOx emission reductions necessary to bring the areas into attainment with the three levels being analyzed. The process for estimating the necessary emission reductions is described in Chapter 2. Because of the focus of the revised NAAQS on near-road issues, we chose to apply mobile source control measures to achieve the necessary emission reductions. The types of measures appropriate for such an analysis are described in the next section. Finally, we determined the cost of control, as discussed in Section 3.4.

3.2 Control Measures

Because this analysis primarily concerns meeting the requirements for the near-road monitoring network, the control strategy is focused on control measures that reduce emissions from onroad and nonroad mobile sources. Onroad mobile sources are mobile sources that travel on roadways. These sources include automobiles, buses, trucks, and motorcycles traveling on roads and highways. Nonroad mobile sources are any combustion engine that travels by other means than roadways. These sources include railroad locomotives; marine vessels; aircraft; off-road motorcycles; snowmobiles; pleasure craft; and farm, construction, industrial and lawn/garden equipment.

Local onroad and nonroad mobile source control measures that are effective in reducing emissions of NOx include:

- Diesel Retrofits (Onroad)
- Diesel Retrofits and Engine Rebuilds (Nonroad)
- Elimination of Long Duration Idling (Onroad)
- Continuous Inspection and Maintenance (Onroad)

Information describing these measures, the effectiveness of each, and the role of EPA's National Mobile Inventory Model (NMIM) in calculating reductions for the diesel retrofit measures, is contained in Chapter 3 of the document "Final Ozone NAAQS Regulatory Impact Analysis"[1]. Each of these measures reduces emissions of NOx which has the co-benefit of reducing secondary formation of PM2.5. In addition, diesel retrofits and elimination of long duration idling reduce direct emissions of PM2.5.

3.3 Estimated Emission Reductions

As described in Chapter 2, air quality design values from the current monitoring network were projected to the year 2020 and were adjusted to estimate the range of levels that might occur at near-road monitor locations at gradients of 30 percent, 65 percent, and 100 percent. These adjusted design values were also adjusted to reflect the change in influence from mobile source emissions projected for the year 2020. Finally, these adjusted design values were used to estimate the level of emission reductions necessary to meet the 3 levels of the standard included in this analysis.

For the revised standard of 100 ppb and the less stringent level of 125 ppb there were no projected exceedances in 2020. For the more stringent level of 80 ppb, exceedances were projected in 4 counties. The counties and their estimated emission reductions are presented in Table 3.1. For this illustrative analysis, we identified several mobile source control measures that would be appropriate for achieving the necessary emission reductions, as described in section 3.2. These measures currently are not required in the geographic areas listed in Table 3.1 and could be implemented in those areas as part of a local control strategy for reducing emissions.

Table 3-1: NOx Emission Reductions (tons/yr) by County in 2020 for More Stringent Level of 80 ppb[a]

County	ST	Tons reduced (30% Gradient)	Tons reduced (65% Gradient)	Tons reduced (100% Gradient)
Adams Co	CO		680	8,070
East Baton Rouge Par	LA			460
El Paso Co	TX			8,600
Salt Lake Co	UT			4,100

[a] All estimates rounded to two significant figures.

[1] http://www.epa.gov/ttn/ecas/regdata/RIAs/452_R_08_003.pdf (beginning on page 3a-12).

3.4 Costs of Mobile Source Controls

Because this analysis examines emissions and air quality approximating near-roadway conditions, we believe it is appropriate to focus analysis of controls on mobile sources. For the purposes of this analysis EPA reviewed existing cost effectiveness estimates for a number of federal on-road and non-road regulations that have been promulgated in the last several years. These regulations include the Tier 2 regulation for light-duty motor vehicles, the 2007 highway heavy duty rules, the Tier 4 non-road equipment rule, the locomotive/marine rule, and the small spark ignition equipment rule. EPA also reviewed the cost effectiveness estimates for the mobile source controls that were applied in the RIA for the 2008 ozone NAAQS. That RIA included cost effectiveness estimates for mobile source controls that included retrofits for on-road vehicles and non-road equipment, elimination of long duration truck idling, continuous inspection and maintenance of light-duty vehicles, the introduction of plug-in hybrid vehicles into the national vehicle fleet, more stringent requirements for aftermarket replacement catalytic converters, commuter programs to reduce vehicle miles travelled and vehicle trips, and improved emission control systems for new vehicles.

As summarized in Table 3.2 the majority of these controls have costs of between $1,000 and $5,000 per ton of NOx or NOx+non-methane hydrocarbons. There are some exceptions. Several of the measures produce fuel savings that offset the cost of the control equipment or vehicle and any operating expenses; therefore, these measures produce NOx reductions at no cost. Some non-road retrofits, particularly for agricultural equipment, are more expensive. However, this type of equipment would not be the primary focus of an attainment strategy for the NO_2 NAAQS under a near roadway monitoring scenario. Retrofits of class 6 and 7 heavy duty vehicles and commuter programs also have higher costs per ton. However, these do not provide large emission reductions. Finally, the estimated cost per ton of NOx reductions from improvements in the emissions control systems for new motor vehicles is also higher. However, as noted in the RIA for 2008 ozone NAAQS, this is a very rough estimate of the cost of these controls. Only one method for achieving the desired level of emissions was considered. A much more detailed analysis would be required to develop a representative cost for such future controls on new vehicles.

The purpose of this analysis is to develop an estimate of the average cost per ton of NOx reductions that would be needed to bring projected nonattainment areas into compliance with the revised NO_2 NAAQS. Based on the estimates in these recent RIAs it is evident that there remain mobile source control strategies that provide emissions reductions in the range of $1,000 to $5,000 per ton of NOx. However, we also recognize that the costs of controls will likely increase as additional control measures are implemented. We anticipate that nonattainment areas would employ a mixture of controls that fall within the range of $1,000 to $5,000 per ton and some additional controls that have higher costs per ton. Given the screening nature of this analysis we have estimated that the annualized average cost of controls to attain the NO_2 NAAQS would be in the range of $3,000 to $6,000 per ton. This estimate is based upon knowledge of the cost of mobile source controls included in previous analyses, especially for the control measures listed in Section 3.2, which are generally based on a three percent discount rate. A discount rate of seven percent was not available for all estimates provided in Table 3.2.

Table 3-2: Estimated $/ton Costs of NOx Emissions Reductions from Recent RIAs

SOURCE CATEGORY[a]	NO_X COST/TON	NOTES
C3 Marine Coordinated Strategy NPRM, 2009	510	a
Nonroad Small Spark-Ignition Engines 73 FR 59034, October 8, 2008	330-1,200	a, b, c
Stationary Diesel (CI) Engines (71 FR 39154, July 11, 2006)	580 – 20,000	a
Locomotives and C1/C2 Marine (Both New and Remanufactured) (73 FR 25097, May 6, 2008)	730	a, b
Heavy Duty Nonroad Diesel Engines (69 FR 38957, June 29, 2004)	1,100	a, b
2007 Highway Heavy Duty Rule (66 FR 5001, January 18, 2001)	2,200	a, b
Tier 2 (Page VI-18 of the Tier 2 RIA)	2,047	b, d
Continuous Light-duty Vehicle Inspection and Maintenance (2008 ozone RIA Appendix 5a pages 5a-7 – 5a-9)	0	
Eliminate Long Duration Truck Idling (2008 ozone RIA Appendix 5a pages 5a-9 – 5a-10)	0	
Plug-in Hybrid Vehicles (2008 ozone RIA Appendix 7a pages 7a-4 – 7a-96)	0	
Retrofit Class 8b Trucks (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	1,100-2,500	
Retrofit Class 6 & 7 Trucks (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	5,600-14,100	
Retrofit Non-road Equipment – SCR (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	2,600-10,400	
Retrofit Non-road Equipment – Rebuild/Upgrade (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	1,000-4,900	
Improve Aftermarket Replacement Catalytic Converters (2008 ozone RIA Appendix 7a pages 7a-6 – 7a-8)	3,700	
Commuter Programs (2008 ozone RIA Appendix 5a pages 5a-10 – 5a-11)	19,200	
Improve Catalyst Efficiency for New Light-duty Vehicles (2008 ozone RIA Appendix 7a pages 7a-3 – 7a-4)	17,500	

[a] Table presents aggregate program-wide cost/ton over 30 years, discounted at a 3 percent NPV, except for Stationary CI Engines and Locomotive/Marine retrofits, for which annualized costs of control for individual sources are presented. All figures are in 2006 U.S. dollars per short ton.
[b] Includes NO_X plus non-methane hydrocarbons (NMHC). NMHC are also ozone precursors, thus some rules set combined NO_X+NMHC emissions standards. NMHC are a small fraction of the overall reductions so aggregate cost/ton comparisons are still reasonable.
[c] Low end of range represents costs for marine engines with credit for fuel savings, high end of range represents costs for other nonroad SI engines without credit for fuel savings.
[d] Discounted aggregate cost effectiveness.

To calculate the engineering costs for this screening-level near-roadway analysis we multiplied the tons needed from Section 3.3 by the lower and upper ends of the range of \$3,000 to \$6,000/ton (2006\$). Cost estimates are provided in Table 3.3. Note that due to the screening level nature of this analysis, we did not examine local conditions for each of these areas and apply known control measures.

Table 3-3: Total Costs (millions of 2006\$) by County in 2020 for More Stringent Level of 80 ppb[a]

County	ST	Tons reduced (30% Gradient)	Tons reduced (65% Gradient)	Tons reduced (100% Gradient)
Adams Co	CO		\$2.0 to \$4.1	\$24 to \$48
East Baton Rouge Par	LA			\$1.4 to \$2.7
El Paso Co	TX			\$26 to \$52
Salt Lake Co	UT			\$12 to \$25

[a] Total Cost estimates are shown as a range of annualized costs from \$3,000/ton to \$6,000/ton. Results do not include monitoring costs, estimated to be \$3.6m for the U.S. Costs estimates were only available for a 3% discount rate.

3.5 Key Limitations

The estimates of emission reductions associated with the control strategies described above are subject to important limitations and uncertainties. EPA's analysis is based on its best judgment for various input assumptions that are uncertain. As a general matter, the Agency selects the best available information from available engineering studies of air pollution controls and has set up what it believes is the most reasonable framework for analyzing the cost, emission changes, and other impacts of regulatory controls. More specifically, we note the following limitations of this analysis:

- *Current PM2.5 and Ozone Controls in Baseline*: Our 2020 analysis year baseline assumes that States will put in place the necessary control strategies to attain the current $PM_{2.5}$ and ozone standards. There is a significant level of uncertainty in the control strategies assumed to be employed in these RIAs. As States develop their plans for attaining these standards, their NOx control strategies may differ significantly from our analysis.

- *Use of Existing CMAQ Model Runs*: This analysis represents a screening level analysis. We did not conduct new regional scale modeling specifically targets to

NO_2; instead we relied upon impact ratios developed from model runs used in the analysis underlying the ozone NAAQS.

- *Analysis Year of 2020*: Data limitations necessitated the choice of an analysis year of 2020, as opposed to the presumptive implementation year of 2017. Emission inventory projections are available for 5-year increments; i.e. we have inventories for 2015 and 2020, but not 2017. In addition, the CMAQ model runs upon which we relied were also based on an analysis year of 2020.