Technical Support Document for the Proposed Small Spark Ignition (SI) and Marine SI Emissions Standards:

Ozone Air Quality Modeling

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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711
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I. Introduction

This document was prepared to describe the ozone air quality modeling performed by EPA in support of the proposed rule. Two basic types of modeling were completed. First, source apportionment modeling was conducted with the Comprehensive Air Quality Model with Extensions (CAMx) to gauge the potential impacts of emissions from the entire sector subject to the proposed rule[1] on future levels of ozone. Second, CAMx was used to simulate the effects of the proposed emissions reductions on ozone air quality in the future. The methodology and results of both modeling approaches will be summarized below.

II. Methodology

A. CAMx Inputs and Model Configuration

The foundation for these ozone modeling analyses that estimate the impacts from Small/Marine spark ignition (SI) engines, vessels and equipment was the CAMx modeling that was done in support of the final Clean Air Interstate Rule (CAIR). The CAIR modeling is fully described in the CAIR air quality modeling technical support document (TSD)[2], but a condensed description is provided below. The modeling procedures used in this analysis (e.g., domain, episodes, meteorology) have been used for several EPA rulemaking analyses over the past five years and are well-established.

1. Model version: The modeling simulations that comprised the Small/Marine SI analyses were conducted using CAMx, version 3.10[3]. CAMx is a non-proprietary computer model that simulates the formation and fate of photochemical oxidants, including ozone, for given input sets of meteorological conditions and emissions. CAMx also contains a source apportionment tool which is designed to attribute ozone concentrations predicted at a user-selected set of receptors to emissions from individual source areas, as also specified by the user.

2. Model domain and grid resolution: The CAMx modeling analyses were performed for a domain covering a large portion of the eastern United States, as shown in Figure II-1. This domain has nested horizontal grids of 36 km and 12 km. The model was configured such that only the lowest 4 km of the atmosphere was part of the simulation. Table II-1 provides the remainder of the basic geographic information regarding the simulations.

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[1] The proposed rule addresses emission standards for small land-based spark-ignition engines and equipment as well as for marine spark-ignition engines and vessels.

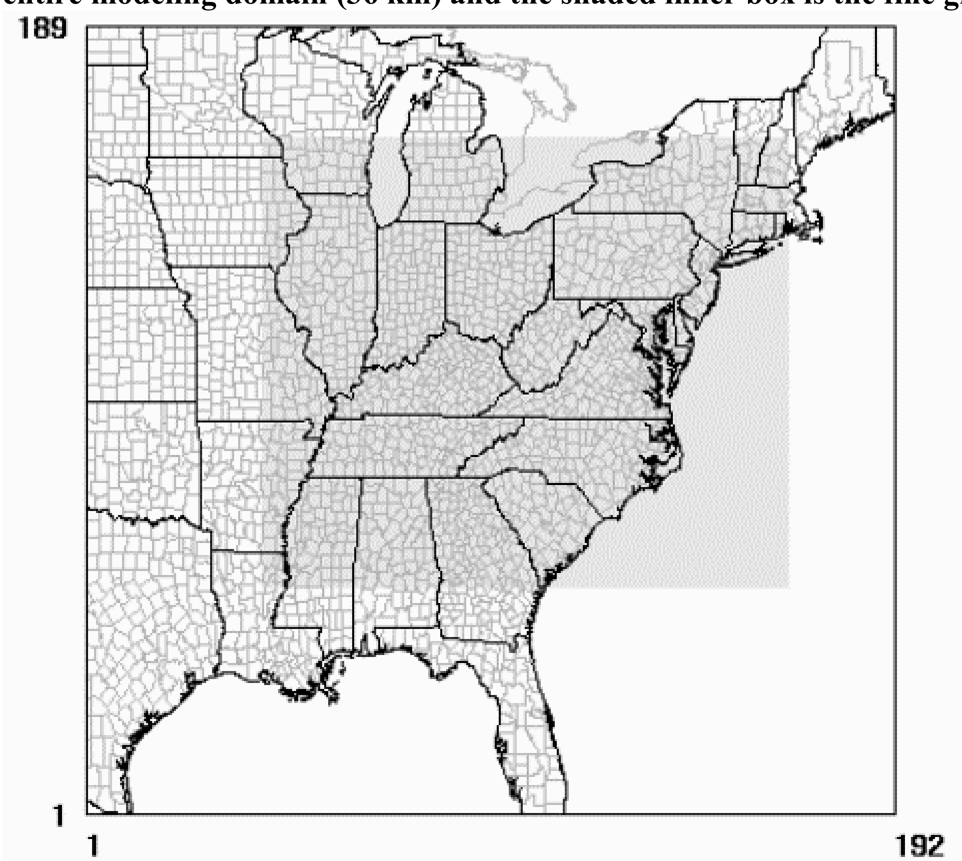
[2] U.S. Environmental Protection Agency; Technical Support Document for the Final Clean Air Interstate Rule: Air Quality Modeling; Office of Air Quality Planning and Standards; Research Triangle Park, NC; March 2005.

[3] Environ International Corporation; User's Guide: Comprehensive Air Quality Model with Extensions (CAMx), Version 3.10; Novato, CA; April 2002.

Table II-1. Configuration of ozone modeling domain.

	CAMx Modeling Configuration	
	Coarse Grid	**Fine Grid**
Map Projection	latitude/longitude	latitude/longitude
Grid Resolution	1/2/longitude, 1/3/latitude (~ 36 km)	1/6/longitude, 1/9/latitude (~ 12 km)
East/West extent	-99 W to -67 W	-92 W to -69.5 W
North/South extent	26 N to 47 N	32 N to 44 N
Dimensions	64 x 63 x 9	137 x 110 x 9
Vertical extent	9 Layers: surface to 4 km	
Layer structure (m)	0-50, 50-100, 100-300, 300-600, 600-1000, 1000-1500, 1500-2000, 2000-2500, 2500-4000	

Figure II-1. Map of the Eastern U.S. modeling domain. The outer box denotes the entire modeling domain (36 km) and the shaded inner box is the fine grid (12 km).



3. Modeling period / Ozone episodes: There are several considerations involved in selecting episodes for an ozone modeling analysis[4]. In general, the goal is to model several differing types of meteorological conditions leading to ambient ozone levels similar to an area's design value. The same 30 episode days that were modeled for CAIR were used in this analysis. For more detail on the synoptic meteorological patterns during these episodes, please see the CAIR TSD. These ozone episodes are listed in Table II-2. The first three days of each period are called the "ramp-up" days. These days are used to minimize the effects of initial conditions and are not considered as part of the output analyses.

Table II-2. Dates of CAMx ozone modeling episodes.

Episode 1	June 12-24, 1995
Episode 2	July 5-15, 1995
Episode 3	August 7-21, 1995

4. Model emissions estimates: The Small/Marine SI modeling analyses considered a base year (2001) and three future years (2015, 2020, and 2030). The base and future-year base emissions inventories used in this modeling analysis are the same as 2001 NEI-based (National Emission Inventory) estimates used in the CAIR analyses for the CAIR-relevant years (i.e., 2001, 2015, & 2020). The CAIR control case emissions were used in the Small/Marine SI future-year base modeling. Details on the development of the CAIR base and control scenario emissions, the emissions processing needed to create model-ready inputs, and summaries of the emissions data for each scenario can be found in the CAIR Emissions Inventory Technical Support Document[5]. The 2030 emissions were assumed to equal the 2020 CAIR control case emissions for all sectors except for on-road and non-road sources, which were generated via an updated National Mobile Inventory Model (NMIM) run. In the Small/Marine SI control case scenario, we used percentage reductions estimated by NMIM for the proposed new standards to adjust the future-year base levels to reflect the effects of controls. Details on the development of the base and control scenario emissions for this proposal can be found in the docket.[6]

5. Model meteorological inputs: In order to solve for the change in pollutant concentrations over time and space, the CAMx model requires certain meteorological inputs that, in part, govern the formation, transport, and destruction of pollutant material. In particular, the model requires seven meteorological input files: wind (u- and v-vector components), temperature, water vapor mixing ratio, atmospheric air pressure, cloud cover, rainfall, and vertical diffusion coefficient. The gridded meteorological data for the three 1995 historical episodes were developed using the Regional Atmospheric Modeling

[4] U.S. EPA, Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8 hour Ozone NAAQS; EPA-454/R-05-002; Research Triangle Park, NC; October 2005.

[5] U.S. EPA, CAIR Emissions Inventory Technical Support Document; Office of Air Quality Planning and Standards; Research Triangle Park, NC, March 2005.

[6] Memo to the docket – Harvey Michaels, 2005: How NONROAD inventories were prepared for AQ modeling for the Bond Rule NPRM.

System (RAMS), version 3b[7]. RAMS is a numerical meteorological model that solves the full set of physical and thermodynamic equations which govern atmospheric motions. The output data from RAMS, which is run in a polar stereographic projection and a sigma-p coordinate system, are mapped to the CAMx grid via an existing preprocessor.

RAMS was run in a nested-grid mode with three levels of resolution: 108 km, 36 km, and 12 km with 28-34 vertical layers. The top of the surface layer was approximately 17 meters in the 36 and 12km grids. These two finer grids were at least as large as their CAMx counterparts. In order to keep the model results in line with reality, the simulated fields were nudged to an observation-based analysis field every six hours. A model performance evaluation generally showed that the model accurately reproduced the synoptic meteorological conditions of the episode days.[8,9]

In addition to the RAMS-based meteorological data, the photochemical grid model requires several other types of data. In general, most of these miscellaneous model files have been taken from existing regional modeling applications. Clean conditions were used to initialize the model and were also used as lateral and top boundary conditions as in previous regional modeling applications (e.g., CAIR). The model also requires information regarding land use type and surface albedo for all layer 1 grid cells in the domain. Existing regional data were used for these non-day-specific files. Photolysis rates were developed using a preprocessor that comes with the CAMx code (JCALC). Turbidity values were set equal to a constant thought to be representative of regional conditions. Two separate meteorological CAMx inputs, cloud fractions and rainfall rates, were developed based on observed data. Finally, a value of 1.0 m^2/sec was chosen for the minimum-allowed vertical diffusivity (Kv).

6. Model performance evaluation: A performance evaluation of CAMx for the 1995 base year episodes was completed as part of the modeling analysis for the Nonroad Land-based Diesel Engines Standards. The base year (evaluation year) modeling configuration used in these analyses is identical to that simulation, thus that ozone performance evaluation is still valid. For more detail, see the TSD for that rulemaking[10].

As with most regional photochemical modeling studies, the degree that model predictions replicate observed concentrations varies by day and by location over the large

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[7] Pielke, R.A., W.R. Cotton, R.L. Walko, C.J. Tremback, W.A. Lyons, L.D. Grasso, M.E. Nicholls, M.D. Moran, D.A. Wesley, T.J. Lee, and J.H. Copeland, 1992: A Comprehensive Meteorological Modeling System - RAMS, Meteor. Atmos. Phys., Vol. 49, pp. 69-91.

[8] Lagouvardos, K., G. Kallos, V. Kotroni, and S.T. Rao, 2000: "An Analysis of the Meteorological and Air Quality Conditions during an Extreme Ozone Episode over the Northeastern USA." Int. J. Environment and Pollution, Vol. 14, Nos. 1-6, pp. 581-587.

[9] Hogrefe, C. et. al. "Evaluating the performance of regional-scale photochemical modeling systems: Part 1-meteorological predictions". Atmospherics Environment 35 (2001) 4159-4174.

[10] U.S. EPA, Technical Support Document for the Nonroad Land-based Diesel Engines Standards Air Quality Modeling Analyses; Office of Air Quality Planning and Standards; Research Triangle Park, NC, April 2003.

eastern U.S. modeling domain. From a qualitative standpoint, there appears to be considerable similarity on most days between the observed and simulated ozone patterns. Additionally, where possible to discern, the model appears to follow the day-to-day variations in synoptic-scale ozone closely. More quantitative comparisons of the model predictions and ambient data are provided below. When all hourly observed ozone values (greater than 60 ppb) are compared to their model counterparts for the 30 episode modeling days, the mean normalized bias is near-zero (-1.1 percent) and the mean normalized gross error is a low 20.5 percent. As shown in Table II-3, the model generally underestimates observed ozone values for the June and July episodes, but predicts higher than observed amounts for the August episode.

Table II-3. Performance statistics for hourly ozone in the CAMx simulations.

	Average Accuracy of the Peak	Mean Normalized Bias	Mean Normalized Gross Error
Episode 1	-7.3	-8.8	19.6
Episode 2	-3.3	-5.0	19.1
Episode 3	9.6	8.6	23.3

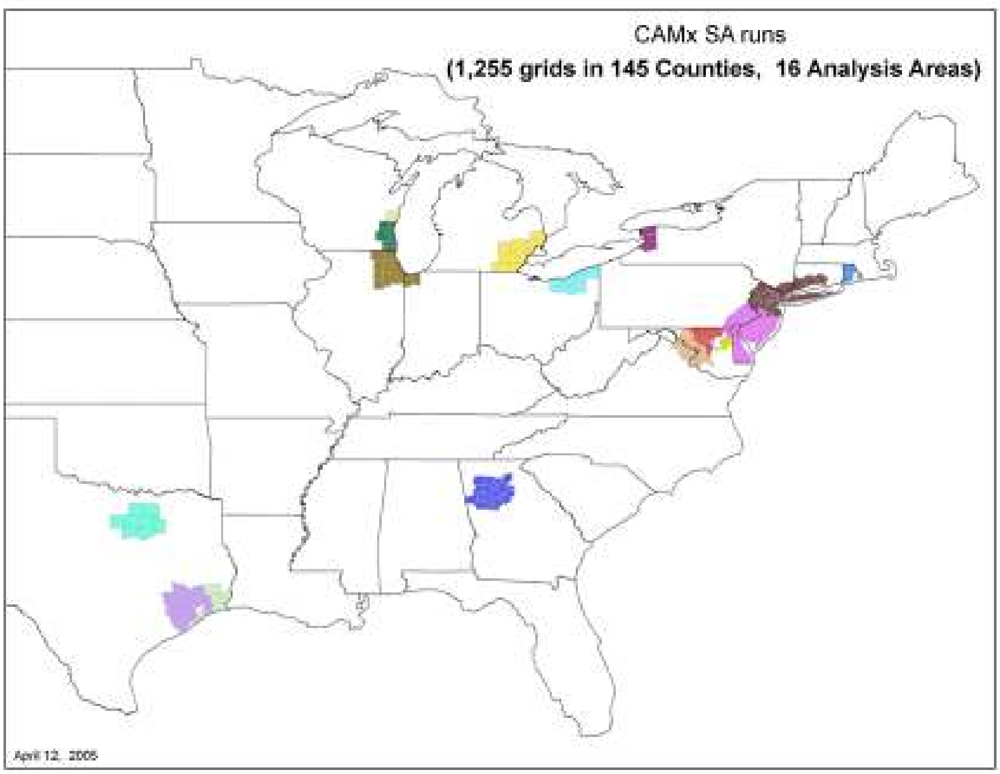
Depending on the episode and region, however, the normalized biases can range from an underestimation of 18 percent to an overestimation of 16 percent. Gross errors tend to average between 17 and 25 percent. Most of the underestimations in the June and July episodes are driven by the Northeast and Midwest quadrants (i.e., the two northern ones). Conversely, most of the overestimated ozone in the August episode is due to the Midwest, Southeast, and Southwest quadrants. In general, the model was determined to be performing acceptably, with relatively-low levels of bias and error at most space/time scales.

B. Source Apportionment Modeling

EPA used the CAMx source apportionment tool as part of the modeling analysis to determine what contribution emissions from Small SI engines and equipment and Marine SI engines and vessels would have toward residual ozone nonattainment in the future. At its simplest level, the source apportionment technique in CAMx provides a means to estimate the contributions of many individual source areas/categories to ozone formation in one single model run. This is achieved by using multiple tracer species to track the fate of ozone precursor emission (VOC and NOx) and the ozone formation caused by these emissions within a CAMx simulation. Thus, for all receptor locations and times, the ozone concentrations predicted by the CAMx are attributed to the source categories selected for analysis. EPA used the Anthropogenic Precursor Culpability Assessment (APCA) option for the Small SI and Marine SI source apportionment modeling. The key feature of APCA is that it allocates all ozone production to manmade precursor emissions, either through reactions among various manmade sources and/or through reactions between manmade emissions and biogenic emissions. The source apportionment modeling was completed for a single year (2020), using the Small/Marine SI future-year base case. Emissions from Small SI engines and equipment and Marine SI engines and vessels were analyzed separately, along with several other non-road subsectors. Appendix A shows the specific source categories that compose Small SI and Marine SI categories.

There were 16 potential ozone nonattainment receptor areas chosen, as shown in Figure II-2. There are many possible metrics to consider when investigating how a sector's emissions impact future-year ozone levels. For this analysis we focused on one of the outputs used in CAIR, the total average contribution metric. There are three parts to the calculation of this metric. In step 1, the ozone values for each of the exceedance periods in a particular downwind area are summed over the episode days. In step 2, the total ozone from the previous step that is due to anthropogenic sources is calculated based on the source apportionment results. In step 3, the contributions from a given source sub-sector to this downwind area are summed over the exceedance periods. The total contribution calculated in step 3 is then divided by the total ozone resulting from manmade sources in step 2 to determine the fraction of ozone that is due to that particular emissions category. This fraction is then multiplied by 100 to express the result as a percentage.

Figure II-2. Receptor regions for 2020 CAMx source apportionment modeling.



C. Small/Marine SI Control Strategy Modeling

As discussed in Section II.A.4, the Small/Marine SI control scenario modeling looked at multiple future years. The 1995 evaluation case and the 2001 base year simulations had already been completed as part of earlier rulemaking support modeling. CAMx simulations completed as part of this analysis include:

- 2015 CAIR base case w/ Small SI / Marine SI controls
- 2015 CAIR control case w/ Small SI / Marine SI controls
- 2020 CAIR control case
- 2020 CAIR control case w/ Small SI / Marine SI controls
- 2030 CAIR control case
- 2030 CAIR control case w/ Small SI / Marine SI controls

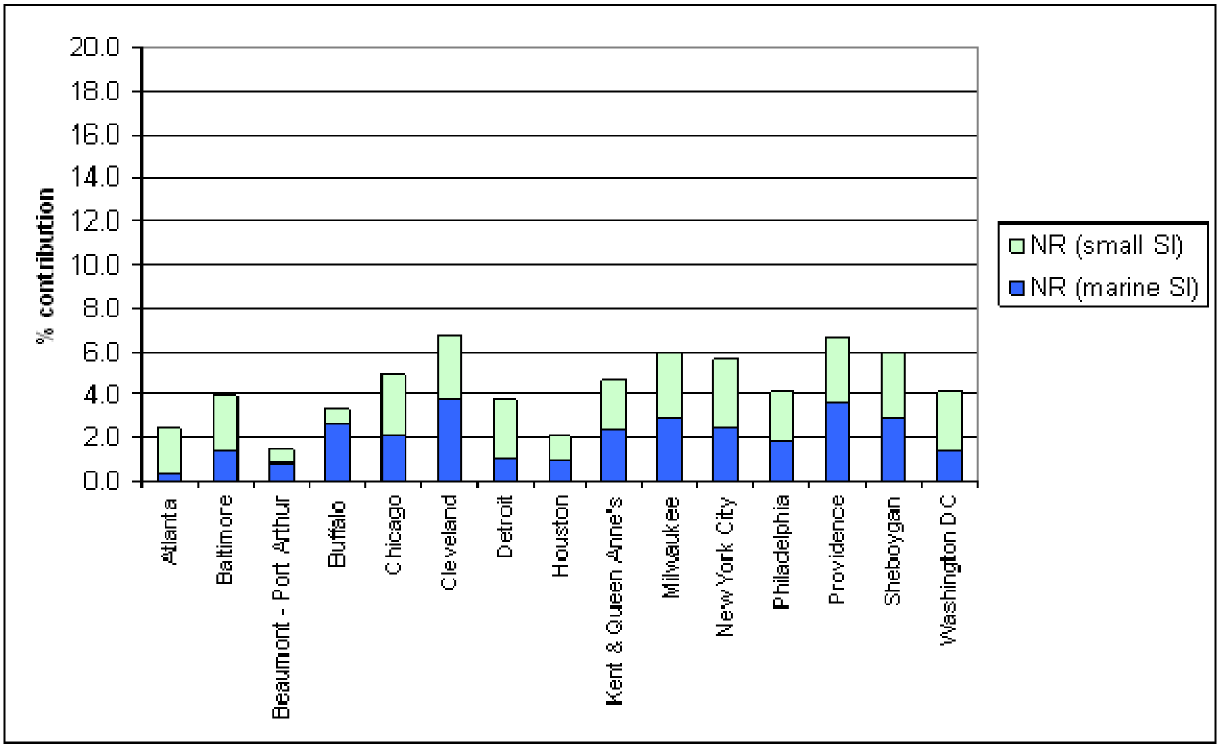
Two basic types of modeling outputs were generated as part of the Small/Marine SI CAMx modeling. The first set of outputs are model projections of future-year 8-hour ozone design values. These projections are derived by combining base year ambient design values with the relative response of the model between the model base year (2001) and the model future year. For more detail on the calculation of future-year design values, see EPA's attainment demonstration guidance (footnote #3). The second set of output metrics quantify the absolute change in certain air quality metrics (e.g., average change in exceedance counts/days, population-weighted average change in model outputs >= 85 ppb, etc.). Both sets of modeling outputs are summarized in Section III.

III. Summary of Ozone Modeling Results

A. Source Apportionment Modeling

In the 16 potential residual ozone nonattainment areas, the source apportionment modeling estimated that Small SI and Marine SI emissions were responsible for between one and seven percent of all ozone concentrations above 85 ppb. Figure III-1 shows the percentage contributions for each sector to each of the 16 receptor areas. Not surprisingly, gasoline-fueled pleasure craft contribute most in areas with access to waterways (e.g., Cleveland and Providence). In these locations, Marine SI sources can be responsible for as much as four percent of the overall ozone exceedance problem. The average contribution of these sources is 2.0 percent. In general, the Small SI sources (e.g., turf equipment, lawn tractors, and commercial generators) are a larger contributor; the average is 2.3 percent. The impacts from the Small SI sources range from a low of 0.6 percent (Beaumont – Port Arthur) to a high of 3.2 percent (New York City). Compared to other non-road sectors, these emissions were concluded to have larger impacts than aircraft or large SI sources; comparable impacts to Category 3 marine vessels; but smaller impacts than Category 1 and 2 marine vessels, locomotives, and miscellaneous non-road diesel equipment. Overall, the non-road sector is projected, according to the CAMx modeling, to be responsible for 25-40 percent of the 2020 ozone problem in the residual nonattainment locations barring additional control of the sector.

Figure III-1. Percent Contribution to 2020 8-Hour Ozone Exceedances from the Small/Marine SI sectors, as determined by CAMx Source Apportionment



B. Small/Marine SI Control Strategy Modeling

As indicated in the RIA document, the control scenario modeling indicates that the reductions from this proposed rule will contribute to reducing ambient ozone concentrations and potential exposures in future years. Table III-1 shows the average change in projected, future-year, eight-hour ozone design values (DV) in various years as a result of the Small/Marine SI control scenario. Average DV changes are shown for:

1) all counties with ambient 8-hour ozone design values for the base year period,

2) those counties with baseline design values >= 85 ppb ("violating" counties), and

3) those counties with baseline design values within 10 percent of the 8-hour ozone standard, i.e., between 76.5 and 85 ppb ("near-violating" counties).

Figures III-2 and III-3 display the projected county-level ozone air quality changes expected from this rule. Not surprisingly, the largest impacts are in areas near water, where Marine SI source contributions can be large.

As seen in Table III-1, the average effect of the proposed rule is a 0.5 ppb reduction in 2020 and a 0.7 ppb reduction in 2030. The impact of the proposed reductions has also been analyzed with respect to those areas that have the highest projected design values. The impacts of the proposed rule tend to be greater for those counties with higher design values (e.g. violating counties). We project that there will be 13 counties in the eastern U.S. with design values at or above 85 ppb in 2030. After implementation of this proposed action, we project that 7 of these 13 counties will be at least 40% closer to a design value of less than 85 ppb, and on average the 13 counties will be approximately 35% closer to a design value of less than 85 ppb.

Table III-1. Change in projected 2020 and 2030 8-hour ozone design values as a result of the Small/Marine SI control strategy.

	County Count	2020 projected	2030 projected
All counties	525	-0.5 ppb	-0.7 ppb
Violating counties	270	-0.6 ppb	-0.8 ppb
Near-violating counties	185	-0.4 ppb	-0.5 ppb

Table III-2 is identical to Table III-1, except the modeled air quality changes have been normalized by future-year population projections on a county-by-county basis. The impacts of the rule tend to be largest in counties in which many people live. On a population-weighted basis, the average change in future year design values for all 525 counties with monitors over the Eastern U.S. would be a decrease of 0.7 ppb in 2020 and a decrease of 0.8 ppb in 2030. Considering only those counties with present-day design values over the national standard, the population-weighted average county change is projected to be -0.8 ppb in 2020 and -1.0 ppb in 2030.

Table III-2. Population-weighted change in projected 2020 and 2030 8-hour ozone design values as a result of the Small/Marine SI control strategy.

	County Count	2020 projected	2030 projected
All counties	525	-0.7 ppb	-0.8 ppb
Violating counties	270	-0.8 ppb	-1.0 ppb
Near-violating counties	185	-0.5 ppb	-0.7 ppb

Figure III-2. Change in projected 2020 8-hour ozone design values as a result of the Small/Marine SI control strategy.

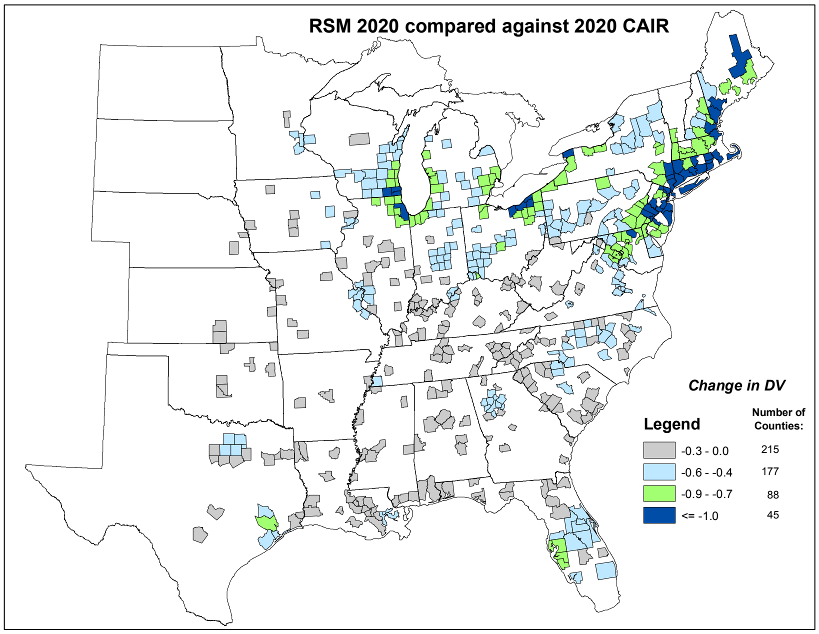


Figure III-3. Change in projected 2030 8-hour ozone design values as a result of the Small/Marine SI control strategy

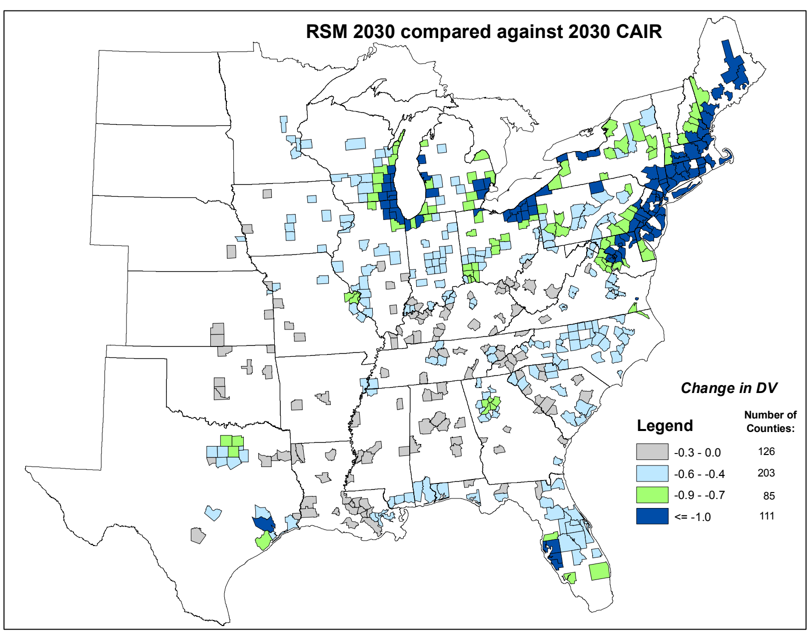


Table III-3 summarizes some of the absolute model metrics. Again, the modeling indicates that the reductions from this proposed rule will contribute to reducing ambient ozone concentrations and potential exposures in future years.

Table III-3. Absolute model metrics of projected air quality change in 2020 and 2030 as a result of the Small/Marine SI control strategy.

	2020 projected	2030 projected
Average change in total nonattainment	-8.7%	-10.9%
Population-weighted change in total nonattainment	-10.3%	-12.6%
Change in number of exceedances	-8.1%	-10.3%
Change in number of exceedance days	-5.7%	-7.5%
Change in average maximum 8-hour ozone in nonattainment areas	-0.7 ppb	-1.1 ppb

Appendix A: Source Classification Codes (SCCs) that comprise the Small SI and Marine SI sectors.

SCC	Subsector	SCC Descriptor
2282005010	Marine SI	Mobile Sources: Pleasure Craft: Gasoline 2-Stroke: Outboard
2282005015	Marine SI	Mobile Sources: Pleasure Craft: Gasoline 2-Stroke: Personal Water Craft
2282010005	Marine SI	Mobile Sources: Pleasure Craft: Gasoline 4-Stroke: Inboard/Sterndrive
2260001060	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Recreational Equipment: Specialty Vehicles/Carts
2260002006	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Tampers/Rammers
2260002009	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Plate Compactors
2260002021	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Paving Equipment
2260002027	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Signal Boards/Light Plants
2260002039	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Concrete/Industrial Saws
2260002054	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Construction and Mining Equipment: Crushing/Processing Equipment
2260003030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Industrial Equipment: Sweepers/Scrubbers
2260003040	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Industrial Equipment: Other General Industrial Equipment
2260004015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Rotary Tillers < 6 HP (Residential)
2260004016	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Rotary Tillers < 6 HP (Commercial)
2260004020	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Chain Saws < 6 HP (Residential)
2260004021	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Chain Saws < 6 HP (Commercial)
2260004025	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Trimmers/Edgers/Brush Cutters (Residential)
2260004026	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Trimmers/Edgers/Brush Cutters (Commercial)
2260004030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Leafblowers/Vacuums (Residential)
2260004031	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Leafblowers/Vacuums (Commercial)
2260004035	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Snowblowers (Residential)
2260004036	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Snowblowers (Commercial)
2260004071	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Lawn and Garden Equipment: Turf Equipment (Commercial)
2260005035	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Agricultural Equipment: Sprayers
2260005050	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Agricultural Equipment: Hydro-power Units
2260006005	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Commercial Equipment: Generator Sets
2260006010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Commercial Equipment: Pumps
2260006015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Commercial Equipment: Air Compressors
2260007005	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 2-Stroke: Logging Equipment: Chain Saws > 6 HP
2265001050	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Recreational Equipment: Golf Carts
2265001060	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Recreational Equipment: Specialty Vehicles/Carts

2265002003	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Pavers
2265002006	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Tampers/Rammers
2265002009	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Plate Compactors
2265002015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Rollers
2265002021	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Paving Equipment
2265002024	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Surfacing Equipment
2265002027	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Signal Boards/Light Plants
2265002030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Trenchers
2265002033	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Bore/Drill Rigs
2265002039	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Concrete/Industrial Saws
2265002042	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Cement and Mortar Mixers
2265002054	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Crushing/Processing Equipment
2265002066	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Tractors/Loaders/Backhoes
2265002072	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Skid Steer Loaders
2265002078	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Construction and Mining Equipment: Dumpers/Tenders
2265003030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Industrial Equipment: Sweepers/Scrubbers
2265003040	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Industrial Equipment: Other General Industrial Equipment
2265003050	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Industrial Equipment: Other Material Handling Equipment
2265003060	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Industrial Equipment: AC\Refrigeration
2265004010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Lawn Mowers (Residential)
2265004011	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Lawn Mowers (Commercial)
2265004015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Rotary Tillers < 6 HP (Residential)
2265004016	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Rotary Tillers < 6 HP (Commercial)
2265004025	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Trimmers/Edgers/Brush Cutters (Residential)
2265004026	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Trimmers/Edgers/Brush Cutters (Commercial)
2265004030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Leafblowers/Vacuums (Residential)
2265004031	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Leafblowers/Vacuums (Commercial)
2265004035	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Snowblowers (Residential)
2265004036	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Snowblowers (Commercial)
2265004040	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Rear Engine Riding Mowers (Residential)
2265004041	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Rear Engine Riding Mowers (Commercial)
2265004046	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Front Mowers (Commercial)

2265004051	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Shredders < 6 HP (Commercial)
2265004055	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Lawn and Garden Tractors (Residential)
2265004056	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Lawn and Garden Tractors (Commercial)
2265004066	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Chippers/Stump Grinders (Commercial)
2265004071	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Turf Equipment (Commercial)
2265004075	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Other Lawn and Garden Equipment (Residential)
2265004076	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Lawn and Garden Equipment: Other Lawn and Garden Equipment (Commercial)
2265005010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: 2-Wheel Tractors
2265005015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: Agricultural Tractors
2265005030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: Agricultural Mowers
2265005035	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: Sprayers
2265005040	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: Tillers > 6 HP
2265005050	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Agricultural Equipment: Hydro-power Units
2265006005	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Commercial Equipment: Generator Sets
2265006010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Commercial Equipment: Pumps
2265006015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Commercial Equipment: Air Compressors
2265006025	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Commercial Equipment: Welders
2265006030	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Commercial Equipment: Pressure Washers
2265007010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Logging Equipment: Shredders > 6 HP
2265007015	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Logging Equipment: Forest Eqp - Feller/Bunch/Skidder
2265008005	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Airport Ground Support Equipment: Airport Ground Support Equipment
2265010010	Small SI	Mobile Sources: Off-highway Vehicle Gasoline, 4-Stroke: Industrial Equipment: Other Oil Field Equipment
2285004015	Small SI	Mobile Sources: Railroad Equipment: Gasoline, 4-Stroke: Railway Maintenance

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