US EPA Heavy Duty Engines and Fuel Standards, 2000

This document described the procedures and results of the air quality modeling analyses used to support the Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel (HDE) final rulemaking. The air quality modeling was conducted to support several components of the rulemaking. Included in this document were assessments of the impact of the new standards on existing monitoring locations in the eastern United States. Among these were the two monitors located in LaPorte County. In Appendix D, there is a spreadsheet of relative reduction factors, which includes these two sites. The information below is taken from that spreadsheet. The column of interest is the "RRF 2007 Base." The 2007 Base scenario contains controls "on the books" for that year, such as the NOx SIP Call, and calculates the RRF from implementation of these programs.

APPENDIX D
8-Hour Relative Reduction Factors

Site Id.	State	County	Area name	RRF 2007 Base	RRF 2020 Base	RRF 2020 Control	RRF 2030 Base	RRF 2030 Control
180910005	IN	LA PORTE CO	LA PORTE CO, IN	0.9180	0.9026	0.8855	0.9207	0.8974
180910010	IN	LA PORTE CO	LA PORTE CO, IN	0.9104	0.8892	0.8677	0.9070	0.8781

The Michigan City site, 180910005, has the higher design value for LaPorte County. This modeling, which was based upon the design value at that time (1995-1997) of 91 ppb, projected the 2007 design value to be 84 ppb . The current design value is 93 ppb. Applying the RRF to that design value results in a 2007 projected design value of 85 ppb.

LADCO White Paper, 2002

The purpose of this report was to begin to assess what it will take to attain the new 8-hour standard in the Lake Michigan area. It took modeling which was performed to support the 1-hour attainment demonstration for the Lake Michigan area, and applied 8-hour metrics. This modeling was conducted for the future year of 2007, the attainment year for the Chicago-Gary-Milwaukee non-attainment area. It included a total of four episodes, two of which were also used by US EPA in their HDE modeling. The control scenario used for the LADCO modeling also included all known controls to be effective in 2007. Since this modeling was performed before the Heavy Duty Engine rule was proposed, it is similar to the HDE 2007 Base run. The modeling results, performed to conform to US EPA's "Draft Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS", May 1999, modeled a base design value for the Michigan City site of 101 ppb. From that base, the projected design value for 2007 with controls in place was modeled at 89 ppb. The resulting RRF (89 ppb/101 ppb) is 0.8811. Applying the RRF to the current design value of 93 ppb results in a projected value in 2007 of 82 ppb.

May 2, 2001

8-Hour Ozone Assessment

The purpose of this document is to summarize the results of USEPA's modeled 8-hour ozone attainment test for the recent LADCO subregional modeling. These results provide information about the amount of control needed to provide for attainment of the 8-hour ozone NAAQS in the Lake Michigan region and in other cities in the modeling domain (i.e., Indianapolis, Evansville, Louisville, St. Louis, and Detroit).

> *Comment: The LADCO subregional modeling was designed to assess 1-hour ozone and, as such, there are some limitations with using it to assess 8-hour ozone. For example, the episodes and modeling domain were selected for the Lake Michigan region and may not accurately represent other cities in the modeling domain, such as St. Louis and Detroit. On the other hand, it should be noted that three of the four modeled episodes are representative periods for high 8-hour ozone and basecase model performance for 8-hour ozone was found to be as good as (or better than) that for 1-hour ozone.*

Modeling Runs

The subregional modeling consisted of applying UAM-V for four episodes over Grid M (see "Midwest Subregional Modeling: 1-Hour Attainment Demonstration for Lake Michigan Area", September 27, 2000). The four episodes are as follows:

June 22 - 28, 1991	June 13 - 25, 1995
July 14 - 21, 1991	July 7 - 18, 1995

The following modeling runs were examined here:

SR1a	CAA controls
SR8[1]	CAA controls + 0.25 utilities + 0.25 utilities + Tier II/Low S (IL,IN,WI) (KY,MO,TN)
SR12(SIP Call)	CAA controls + 0.15 utilities + SIP Call non-utilities + Tier II/Low S
SR12a	SR12 w/ -25% utility NOx
SR12b	SR12 w/ -25% VOC (Lake Michigan area)
SR16	SR12 w/ some new changes[2]
SR16voc	SR16 w/ -30% anthropogenic (elevated and low-level) VOC domainwide

[1] MI @ final State rule for utilities (0.25) and non-utilities

[2] WI @ final State rule (0.28 utilities in 8 counties), CO credits, 13 TVA units @ 0.15, IC engines @ CAA, higher VMT growth for WI, diesel S rule, NOx I/M cut-points in WI, corrected VMT for IL, updated MOBILE5b inputs for IL and WI, and updated CAA boundary conditions.

SR16nox SR16 w/ -30% anthropogenic (elevated and low-level) NOx domainwide

The domainwide anthropogenic emissions for these scenarios are as follows:

	VOC (TPD)	*NOx (TPD)*
SR1a	10153	12993
SR8	10059	10955
SR12	10059	9381
SR12a	10059	8911
SR12b	9709	9381
SR16	10072	9626
SR16voc	7050	9626
SR16nox	10072	6738

SR16 most closely matches the final 1-hour regional control strategy. Because this run did not show attainment of the 8-hour NAAQS (as discussed below), two additional sensitivity runs were performed to assess the effect of greater emission reductions.

Attainment Test

USEPA's 8-hour ozone guidance specifies a relative attainment test which uses monitored design values in concert with model-generated data ("Draft Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS", May 1999). The modeling is used to generate site-specific "relative reduction factors" (RRFs). Future year ozone design values are estimated at existing monitoring sites by multiplying the base year observed design value at each monitor by the corresponding RRF. The resulting future year design values are then compared to the ambient standard. If all such future year design values are $\leq$ 84 ppb, then the attainment test is passed.

The base year design values were based on the average of the design values for the three 3-year periods which include the 1996 modeling inventory year (i.e., 1994-1996, 1995-1997, and 1996-1998).[3] The RRFs for each monitor location were calculated as the ratio of the model-predicted future year daily maximum 8-hour concentration (averaged over several modeling days) to the model predicted base year daily maximum 8-hour concentration (averaged over the same modeling days). In accordance with the guidance, only those modeling days with base year daily maximum 8-hour concentrations $\geq$ 70 ppb at that location were considered here. The purpose of this threshold is to avoid overestimating the future year design values by excluding those situations when "meteorological conditions may not be similar to those leading to high concentrations (i.e., near the site-specific design value) at a particular monitor".[4]

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[3] Another way of specifying the base year design value is to use the higher of the design value from the 3-year period "straddling" the 1996 modeling inventory year (1995 - 1997) or the current 3-year period (1998 - 2000). This alternative approach, which is described in USEPA's guidance, results in slightly higher base year design values for sites in the Lake Michigan region (by about 1 - 3 ppb), and, interestingly, slightly lower base year design values for sites in the other cities (by about 1 - 3 ppb). Further discussion is needed on which approach to use for specifying the base year design value.

[4] Another way of dealing with this situation is to consider only those days based on wind directions (i.e., conditions associated with source-receptor relationships responsible for higher ozone concentrations). Based on an analysis performed by Illinois EPA, the appropriate days to consider are as follows:

WI	**IN**	**MI**
6/26/91		6/26-28/91
7/20/91	7/18/91	7/16-20/91
7/12-13/95	7/12-15/95	7/12-14/95

USEPA's guidance includes an additional "improvement" requirement for unmonitored areas with substantially higher modeled ozone concentrations than in the vicinity of any monitor (e.g., over Lake Michigan). Specifically, the RRF for these high modeled, unmonitored areas multiplied by the area-wide maximum observed design value must be less than the NAAQS. In other words, the improvement at these locations must be as great as that needed to bring the highest monitoring site into attainment. To address this requirement, a "ghost" monitor over Lake Michigan was included in the analysis.

Results

Tables 1 and 2 present the future year design values for select sites (i.e., those sites with an average design value ≥ 85 ppb) in the Lake Michigan area and other cities in the modeling domain (i.e., Indianapolis, Evansville, Louisville, St. Louis, and Detroit), respectively. The number of sites above the NAAQS and the "degree of violation" violation"[5] for each strategy are summarized below:

	Base	SR1a	SR8	SR12	SR12a	SR12b	SR16	SR16voc	SR16nox
Number of Sites > NAAQS									
Lake Michigan Area	40	25	19	16	12	11	6	4	0
Indianapolis	9	6	4	3	3	3	2	0	0
Evansville	6	4	1	0	0	0	0	0	0
Louisville	7	6	3	0	0	0	0	0	0
St. Louis	13	1	1	1	1	1	1	0	0
Detroit	5	4	4	4	4	4	2	0	0
Degree of Violation									
Lake Michigan Area	241	106	66	46	35	33	15	11	0
Indianapolis	65	30	22	1	11	13	3	0	0
Evansville	46	23	1	0	0	0	0	0	0

The RRFs were recalculated for just these days for a couple of high monitors (i.e., Pleasant Prairie and Michigan City) and resulted in slightly lower future year design values. (Note, Table 1 reflects RRFs based on all modeling days ≥ 70 ppb.) Further discussion is needed on whether to use this "select day" approach or the "70 ppb threshold" approach in calculating the RRFs.

[5] The "degree of violation" is the sum over all monitors of the difference between the design value and 84 ppb.

Louisville	40	19	8	0	0	0	0	0	0
St. Louis	62	8	6	5	4	5	1	0	0
Detroit	27	11	8	6	5	5	2	0	0

Summary
Based on the results of this analysis, several findings should be noted:

- CAA controls are not sufficient to demonstrate attainment of the 8-hour ozone NAAQS in the Lake Michigan area and other Midwestern cities (i.e., Indianapolis, Evansville, Louisville, St. Louis, and Detroit)
- In the Lake Michigan area, the final 1-hour regional control strategy (i.e., SR16, which includes the NOx SIP Call) will get us close to compliance with the 8-hour NAAQS, but additional control will be needed. In some other Midwestern cities (i.e., Indianapolis, St. Louis, and Detroit), SIP Call controls also will not be enough to provide for attainment of the 8-hour NAAQS. (These controls may, however, be sufficient in Evansville and Louisville.)
- An additional reduction in anthropogenic NOx emissions (on the order of 30% beyond SR16) appears to be sufficient to provide for attainment of the 8-hour NAAQS in the Lake Michigan area and other Midwestern cities (i.e., Indianapolis, St. Louis, and Detroit).

Note: Consistent with the "comment" noted above, these findings should be considered preliminary and subject to change. Further analyses (with, possibly, a different photochemical model, different or additional episodes, and improved emissions inventories) are needed to establish a formal attainment demonstration for the 8-hour ozone NAAQS.

Table 1. Future Year Design Values for Lake Michigan Area

SITE	Base	SR1a	SR8	SR12	SR12a	SR12b	SR16	SR16voc	SR16nox
Pleasant Prairie	**95**	**94**	**91**	**90**	**90**	**89**	**88**	**86**	82
Kenosha	**85**	83	81	81	80	80	79	77	73
Racine	**90**	**87**	**86**	**85**	**85**	84	83	81	77
S. Milwaukee	**91**	**87**	**85**	84	84	84	82	80	74
Milwaukee-Alverno	**85**	81	80	79	78	78	76	75	69
Milwaukee-UWMN	**85**	81	81	80	80	79	77	75	71
Milwaukee-Bayside	**93**	**89**	**88**	**87**	**86**	**86**	84	83	77
Grafton	**92**	**88**	**87**	**86**	**85**	**85**	83	82	75
Harrington Beach	**93**	**90**	**89**	**87**	**87**	**86**	**85**	84	78
Sheboygan	**91**	**88**	**86**	**85**	84	84	83	81	76
Manitowoc	**95**	**91**	**89**	**88**	**88**	**87**	**86**	84	78
Kewaunee	**91**	**87**	**85**	84	83	83	81	80	73
Newport Beach	**92**	**87**	**85**	84	83	83	81	80	73
Waukegan	**85**	82	81	80	80	80	78	77	72
Northbrook	**85**	**85**	84	84	84	83	81	80	76
Des Plaines	**85**	**86**	**85**	**85**	84	84	81	80	78
Evanston	**87**	**85**	84	84	83	83	81	80	77
Chicago-SWFP	**88**	84	82	82	82	82	79	78	73
Chicago-Jardine	**86**	83	82	81	81	80	79	77	73
Hammond	**93**	**87**	**85**	**85**	84	84	82	81	74
Gary-IITRI	**92**	**86**	84	84	83	83	81	80	73
Ogden Dunes	**94**	**88**	**86**	**85**	**85**	**85**	83	82	74
National Lakeshore	**90**	**85**	83	82	81	82	79	78	71
Michigan City	**101**	**95**	**93**	**92**	**90**	**91**	**89**	**88**	80
Laporte	**89**	83	82	81	80	80	78	77	70
Lowell	**87**	81	80	79	78	79	76	76	69
Valparaiso	**86**	81	79	78	77	78	76	75	68
Potato Creek	**90**	**86**	84	82	81	82	78	78	68
South Bend	**88**	84	81	79	79	79	77	76	70
Granger	**90**	**86**	84	82	81	82	78	78	69
Bristol	**87**	83	81	80	79	79	76	76	67
Frankfort	**87**	84	82	81	81	80	79	78	73
Scottville	**93**	**89**	**88**	**86**	**86**	**85**	84	82	77
Muskegon	**97**	**92**	**90**	**89**	**88**	**88**	**86**	**85**	79
Holland	**96**	**90**	**89**	**87**	**86**	**87**	84	83	76
Grand Rapids	**85**	80	79	78	77	77	74	73	68
Evans	**87**	83	81	80	80	80	77	76	69
Coloma	**96**	**90**	**88**	**87**	**86**	**87**	83	82	74
Cassopolis	**93**	**88**	**86**	**85**	84	84	81	80	71
Kalamazoo	**85**	81	79	78	77	77	73	72	65
Over Lake	**101**	**96**	**94**	**93**	**93**	**92**	**90**	**88**	83

Table 2. Future Year Design Values for Other Cities in Modeling Domain

	Base	SR1a	SR8	SR12	SR12a	SR12b	SR16	SR16voc	SR16nox
INDIANAPOLIS									
Marion County-Harrison	95	91	90	88	88	88	85	82	77
Marion County- MannRoad	89	84	81	78	77	78	75	74	68
Marion County- Harding	90	86	84	83	82	83	79	77	73
Marion County- NAC	89	86	84	83	82	83	80	77	72
Johnson Conty-Trafalgar	85	80	77	75	74	75	72	71	65
Morgan County-Monrovia	88	83	80	77	76	77	74	73	67
Hamilton County-Noblesville	98	93	91	90	89	90	87	84	78
Hancock County-Fortville	95	91	89	87	86	87	84	82	76
Madison County-Emporia	92	87	85	82	82	82	80	79	70
EVANSVILLE									
Posey County-St. Phillips	88	84	80	76	75	76	74	74	64
Vanderburgh County-Scott	93	89	85	80	79	80	78	78	67
Vanderburgh County-Evansville	92	88	84	80	79	80	77	77	67
Warrick County-Yankeetown	94	90	84	79	78	79	76	76	65
Warrick County - Booneville	91	88	82	77	75	77	74	74	64
Warrick County - Tecumseh	92	88	83	79	78	79	77	76	66
LOUISVILLE									
Clark County-Charlestown	93	89	87	84	84	84	81	79	72
Floyd County-New Albany	91	89	87	84	83	84	81	78	72
Bullitt County-Shepherdstown	86	80	78	75	74	75	71	71	62
Jefferson County-WLKY	91	87	86	84	83	84	80	78	73
Jefferson County - Bardstown	88	87	84	82	82	82	78	76	72
Jefferson County - Watson	90	86	84	82	80	82	77	76	68
Oldham County-Buckner	89	85	81	79	78	79	76	75	67
ST. LOUIS									
Madison County-Alton	90	82	80	80	79	80	74	73	66
Madison County - Maryville	87	82	79	78	77	78	75	74	67
Madison County - Edwardsville	88	81	80	79	78	79	75	74	67
Madison County - Wood River	88	81	80	79	78	79	75	74	67
Jefferson County-Arnold	91	84	81	79	78	79	76	75	66
St Charles County-W. Alton	100	92	90	89	88	89	85	83	76
St Charles County-Orchard	93	84	82	81	80	81	76	75	68
St Genevieve County-BonTerre	86	79	75	73	73	73	70	70	62
St.Louis County-Ferguson	88	82	81	80	79	80	76	74	70
St.Louis County - Affton	86	79	77	76	75	76	73	71	67
St.Louis County - Queeny Park	85	79	78	77	77	77	74	72	68
St.Louis County - Clayton	85	80	78	77	77	77	74	72	68
St.Louis County - St. Ann	87	81	80	79	78	79	75	73	69
DETROIT									
Wayne County-E 7mile	89	87	86	85	85	85	82	80	79
Macomb County-New Haven	92	87	87	86	86	86	85	83	81
Macomb County-Warren	88	86	85	85	85	85	81	79	77
St. Clair County-Algonac	92	87	86	86	85	85	85	83	80
St. Clair County - Port Huron	86	81	80	80	80	80	79	77	73