United States
Environmental Protection
Agency

Air and Radiation

EPA420-R-99-031
December 1999

Technical Support Document for the Tier 2/Gasoline Sulfur Ozone Modeling Analyses

Printed on Recycled Paper

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Emissions Analysis and Monitoring Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency

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I. Introduction

This document describes the ozone modeling performed as part of the Tier 2/Sulfur final rulemaking. The ozone modeling was conducted to support several components of the rulemaking including (a) the determination of need for the Tier 2/Sulfur program, (b) the benefits/cost analysis, (c) an assessment of the expected impacts of the program on future ozone concentrations, and (d) the preparation of responses to comments on the proposed rulemaking. The modeling involved simulations of the Urban Airshed Model-Variable Grid (UAM-V), (SAI 1996) in a regional mode for two modeling domains (eastern U.S. and western U.S.) which together cover nearly all of the 48 contiguous States. Model runs were made for a 1996 Base Year and four future-year emissions scenarios: a 2007 Base Case, a 2007 Tier 2/Sulfur Control Case, a 2030 Base Case and a 2030 Control Case. These scenarios, along with the procedures followed to develop the emissions inventories for modeling, and the impacts of the control scenarios on emissions are described elsewhere (Pechan, 1999). For the eastern U.S., model simulations were made for all five emissions scenarios. However, since modeling for the West was intended mainly to support the benefit/cost analysis which was performed for 2030, only the 1996 base year and 2030 base case and control scenarios were modeled for the West. As described below, for both the East and West, emissions scenarios were modeled using meteorological conditions for several multi-day episodes when ambient measurements recorded high ozone concentrations. The remainder of this report includes a description of the modeling system, the modeling episodes, the base year model performance over the eastern and western U.S., and a discussion of the results of these simulations.

II. Ozone Modeling over the Eastern United States

A. Episode Selection

There are several considerations involved in selecting episodes for an ozone modeling analysis (EPA, 1999). In general, the goal should be to model several differing sets of meteorological conditions leading to ambient ozone levels similar to an area's design value[1]. Ideally, the modeling time periods would be supported by large amounts of ambient data to be used in input development and model evaluation. The issue, in terms of regional modeling, is how to meet these episode selection goals over a large number of individual ozone non-attainment areas without having to model several entire ozone seasons (impossibly time consuming and resource-intensive). It is inevitable that the chosen episodes will feature observed ozone lower than the design value in some areas and greater than the design value in other areas. For the Tier 2/Sulfur analyses, we focused on the summer of 1995 for selecting the

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[1] Typically defined as the fourth-highest 1-hour daily maximum ozone observed over a three year period at a specific monitor.

episodes to model in the East because 1995 is a recent time period for which we had model-ready meteorological inputs and the summer of 1995 contained one of the four episodes used by the Ozone Transport Assessment Group (OTAG) for modeling regional ozone over the eastern U.S.

Based on a review of observed daily maximum ozone concentrations across the eastern U.S. during June through August, three episodes were selected for ozone modeling: June 12-24, July 5-15, and August 10-21. The start of each episode was picked to correspond to days with no ozone exceedances. Thirty episode days were modeled in all, not including the three ramp-up days used in each episode to minimize the effects of initial conditions. The meteorological conditions and ozone levels during each episode are described below.

1. Episodic Meteorological Conditions and Ozone Levels

Warm temperatures, light winds, cloud-free skies, and stable boundary layers are some of the typical characteristics of ozone episodes. On a synoptic scale, these conditions usually result from a combination of high pressure aloft (500 millibars) and at the surface. At a smaller scale, the conditions that lead to local ozone exceedances can vary from location to location (based on factors such as wind direction, sea/lake breezes, etc.) The meteorological and resultant ozone patterns for the three Tier 2 modeling episodes are discussed in more detail below.

June 12-24, 1995

The initial stages of this episode were fairly typical from the standpoint of regional meteorology. A 500-millibar ridge propagated into the eastern U.S. from the west. The ridge was associated with a surface high that migrated south from Canada. A cold front passed completely through the region by June 13 (Wednesday) allowing the modeling to start with a clean set of initial conditions. Maximum temperatures during the June 15 - 17-period were generally in the 80s and little precipitation was measured. By June 17, a strong (1028 mb) surface high was anchored over the region.

The observed ozone fields in the early part of the episode were high (e.g., 125-130 ppb) only in locations such as Houston, Beaumont, and Lake Michigan. It was not until June 17 that concentrations exceeded 100 ppb over large parts of the domain (i.e., Midwest and Northeast Corridor).

However, as the aloft pattern amplified, a cut off low developed over the southeastern U.S. On the 19th and 20th, cooler temperatures and occasional rain prevailed in the Southeast. This resulted in a temperature pattern that featured maximums of 90-100 degrees F over the northern tier of States and 75-85 degrees F in the south. Additionally, the strong cyclonic circulation around this low resulted in aloft flow from east to west over the mid-Atlantic and Ohio Valley States. Ozone continued to build throughout this period in the Northeast, peaking on the 19th and 20th with values greater than 125 ppb common from Washington, D.C. to Boston.

The last four days of the episode were relatively clean in the Northeast due to the combination of a "backdoor" cold front and the northward migration of the cut off low. Meanwhile ozone conducive conditions returned to the Texas Gulf Coast and Lake Michigan areas. The highest value over the entire summer of 1995 (210 ppb) was recorded near Houston on the 22nd. The episode came to an end on the 25th as a long-wave trough replaced the 500-mb ridge over the eastern U.S.

Table II-1 shows a State-by-State listing of daily exceedance counts during the June 1995 Tier 2 episode. There were 85 exceedances of the ozone NAAQS during this period. The peak day of the episode was June 19. Texas had the most exceedances (28).

Table II-1. Summary of exceedance days, by State/day, for the June 1995 Tier 2 episode.

	AL	AR	CT	DE	DC	FL	GA	IL	IN	KY	LA	ME	MD	MA	MI	M	NH	NJ	NY	NC	OH	OK	PA	RI	SC	TN	TX	VA	W	WI	TOT
6/12/95																															0
6/13/95																											1				1
6/14/95																											1				1
6/15/95									**1**																		**1**				**2**
6/16/95																											**1**			**1**	**2**
6/17/95			**1**												**4**															**2**	**7**
6/18/95			**2**		**1**				**1**				**1**															**1**			**6**
6/19/95			**3**	**3**	**1**								**7**	**2**				**4**	**2**		**1**		**8**	**1**							**32**
6/20/95			**2**	**2**							**2**		**1**					**3**									**3**				**13**
6/21/95																											**7**				**7**
6/22/95																											**7**				**7**
6/23/95											**2**																**4**				**6**
6/24/95								**4**	**2**							**2**											**3**				**11**

July 5-15, 1995

The mid-July episode, which covered most of the Ozone Transport Assessment Group (OTAG) July 1995 episode, is much easier to characterize from a meteorological perspective. A strong 500-mb ridge progressed from west to east across the eastern U.S. over the period. This feature was centered over Colorado on the 8th, over Kansas on the 11th, over Illinois on the 13th, and over Pennsylvania on the 15th. The ridge finally flattened out on the 16th allowing a surface cold front to clean out the northern portions of the domain and less stable conditions to prevail over the southern portions.

Excessively hot temperatures accompanied the core of this strong ridge. Temperatures in the 90s and 100s were common throughout the episode. Rainfall was confined primarily to the coastal regions in the south and southeast. Wind speeds were moderate and the mean transport direction was southwest to northeast, especially over the northern half of the domain.

From the 8th through the 10th, the airmass over the eastern U.S. was gradually becoming hazy. Ozone hot spots occurred in urban areas like Houston, Dallas, and Atlanta. By the 11th, the area of regional haze (roughly defined as the area where peak ozone was greater than 75 ppb) had expanded to encompass most of the domain. On top of that “background,” local contributions from urban emissions yielded ozone exceedances in places like Kansas City, St. Louis, Birmingham, Dallas, Memphis, Atlanta, Baton Rouge, Evansville, Louisville, Cincinnati, Chicago, Milwaukee, Columbus, and Baltimore/Washington on the 11th and 12th.

July 13 and 14 marked the highest regional ozone levels of the summer as most sites, with the exception of those in the Southeast, exceeded 100 ppb. Almost all major metropolitan areas in the northern two-thirds of the domain measured values greater than 125 ppb on this day. For the 14th and 15th, most of the ozone problem shifted east and south due to both transport and the location of the aloft core of warm air. The Northeast Corridor, Charlotte, Greensboro, Birmingham, and Atlanta all had exceedances of the standard on this day. The episode ended abruptly on the 16th (Sunday) for most of the domain, although elevated ozone lingered over the southern regions into the early part of the next week.

Table II-2 shows a State-by-State listing of daily exceedance counts during the July 1995 Tier 2 episode. There were 199 exceedances of the ozone NAAQS during this period. The peak day of the episode, in terms of exceedance monitors was July 14. Texas had the most exceedances (26).

Table II-2. Summary of exceedance days, by State/day, for the July 1995 Tier 2 episode.

	AL	AR	CT	DE	DC	FL	GA	IL	IN	KY	LA	ME	MD	MA	MI	M	NH	NJ	NY	NC	OH	OK	PA	RI	SC	TN	TX	VA	W	WI	TOT
7/05/95																															0
7/06/95																															0
7/07/95																											2				2
7/08/95																											2				2
7/09/95							1																				4				5
7/10/95							4									1											1				6
7/11/95	1	1					3				1					3										1	5				15
7/12/95	1								1	1	1		5			4		1			3					1	5			7	30
7/13/95		1	5					8	1				2	3	7	6			1		4		1				6		1		46
7/14/95			7	3				2	2			1	4	2	6			7	5	3	3		3	3		1	1				53
7/15/95	1		3	3				2	2				10		1			6	3				5					4			40

<u>August 7-21, 1995</u>

A one-day ozone event occurred over New England on August 10, and a separate one-day event occurred in the Lake Michigan region on the 12th. By the 14th, high pressure aloft and at the surface dominated the eastern half of the U.S. Temperatures ranged from 90 to 100 degrees F over most of the domain throughout this period. Ozone was highest over Georgia, Tennessee, Kentucky, North Carolina, and Virginia during this period. Hurricane Felix brushed the East Coast from the 16th – 18th, but appeared to have little effect on ozone or ozone transport away from the immediate eastern seaboard.

A weak cold front, draped across the Great Lakes over most of the episode, moved slowly southward over the eastern half of the Appalachians during the August 18-21 period. This front initiated precipitation that helped keep ozone concentrations low in the upper Midwest. The 18th featured high ozone across the South in cities such as: Atlanta, Charlotte, Birmingham, Augusta, as well as St. Louis. On the 19th and 20th, as the front slid further south, ozone air quality improved over this region as well. Only sites in Texas and Louisiana remain above 125 ppb. The 21st marked the fourth day that the same airmass has resided over the Northeast and it had become fairly polluted by that point.

Table II-3 shows a State-by-State listing of daily exceedance[2] counts during the August 1995 Tier 2 episode. There were 90 exceedances of the ozone NAAQS during this period. The peak day of the episode, in terms of exceedance monitors was August 21st. Texas had the most exceedances (15).

Table II-3. Summary of exceedance days, by State/day, for the August 1995 Tier 2 episode.

	AL	AR	CT	DE	DC	FL	GA	IL	IN	KY	LA	ME	MD	MA	MI	M	NH	NJ	NY	NC	OH	OK	PA	RI	SC	TN	TX	VA	W	WI	TOT
8/07/95																															0
8/08/95																															0
8/09/95																															0
8/10/95	**1**											**1**		**2**			**1**														**5**
8/11/95	**1**						**1**																				**1**				**3**
8/12/95	**1**							**4**	**1**		**1**				**1**																**8**
8/13/95															**1**																**1**
8/14/95	**1**												**3**					**1**		**1**								**1**			**7**
8/15/95	**1**						**3**		**1**														**1**					**2**			**8**
8/16/95							**2**			**3**																					**5**
8/17/95							**2**			**2**										**1**						**1**	**1**				**7**
8/18/95	**4**						**5**	**1**								**1**									**1**						**12**
8/19/95							**1**				**2**																**6**				**9**
8/20/95																											**6**				**6**
8/21/95			**3**	**3**							**1**		**3**	**2**				**2**	**2**				**1**	**1**			**1**				**19**

2. General Representativeness of Episodic Ozone as Compared to Design Values

In order to examine the representativeness of ozone levels during the episodes selected for modeling, a comparison was made between the daily maximum observed values to recent

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[2] An exceedance is a daily maximum 1-hour ozone concentration >=125 ppb.

design values. In this analysis, the magnitude of county-specific design values for 1996-1998 were compared to the highest through 5th highest concentrations measured in the county during the three episodes. Counties with design values (DV) >120 ppb were selected for analysis in order to focus on concentrations approaching and exceeding the NAAQS. As can be seen in Table II-4, 64 percent of the 110 counties examined have design values within 15 ppb of the highest observed ozone in the Tier 2 episodes. Additionally, the second-high observed value yields more values below the design value than above it. The results indicate that the selected episodes contain measured ozone concentrations that are generally representative of recent design values over a large portion of the eastern U.S.

Table II-4. Summary of Comparing the Five Highest Daily Maxima to Recent Design Values.

Ranking of Observation within Tier 2 Days	# of cases in which the observed was greater than the design value by 15 ppb	# of cases in which the observed was within 15 ppb of the design value	# of cases in which the observed was less than the design value by 15 ppb
Highest ozone	32	70	8
2nd high ozone	10	80	20
3rd high ozone	2	71	37
4th high ozone	0	57	53
5th high ozone	0	45	65

B. Domain and Grid Configuration

As with episode selection, there are also several considerations involved in selecting the domain and grid configuration to be used in the ozone modeling analysis. The modeling domain should encompass the area of intended analysis with an additional buffer of grid cells to minimize the effects of uncertain boundary condition inputs. Grid resolution should be equivalent to the resolution of the primary model inputs (emissions, winds, etc.) and equivalent to the scale of the air quality issue being addressed. For the eastern U.S., the regional/national Tier 2 analyses used the previously established OTAG domain to model regional ozone. The western U.S. domain is discussed in Section III.

The Tier 2 UAM-V modeling was completed using two grids of varying extent (shown in Figure II-1) and resolution as described below.

Main Grid: Resolution: 1/2° longitude, 1/3° latitude (approximately 36 km)
East-West extent: -99 W to -67 W
North-South extent: 26 N to 47 N
Vertical extent: Surface to 4 km
Dimensions: 64 by 63 by 9

Nested Grid[3]: Resolution: 1/6° longitude, 1/9° latitude (approximately 12 km)
East-West extent: -92 W to -69.5 W
North-South extent: 32 N to 44 N
Vertical extent: Surface to 4 km
Dimensions: 137 by 110 by 9

The vertical layers were consistent between the two grids: 0-50, 50-100, 100-300, 300-600, 600-1000, 1000-1500, 1500-2000, 2000-2500, 2500-4000. All model heights are in meters above ground level. The number of vertical layers is greater than past regional-scale modeling applications (e.g., OTAG) and was intended to better capture the depth of the planetary boundary layer.

This modeling domain allows for the consideration of future residual ozone exceedances and the effects of Tier 2 emissions reductions over most major metropolitan areas in the eastern U.S. (The Dallas-Fort Worth area may be the exception given its proximity to the western boundary.)

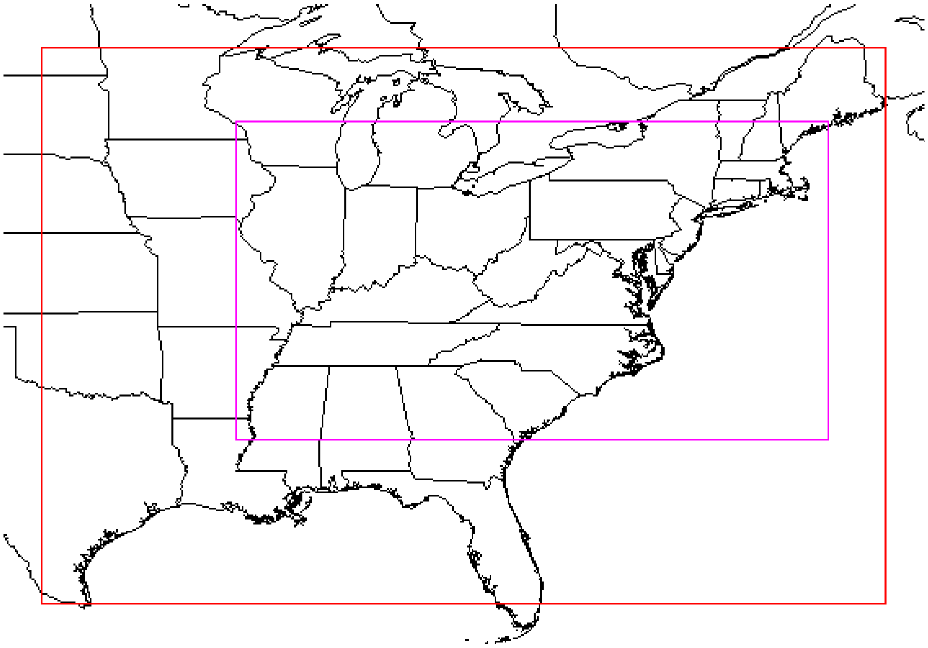

Figure II-1. Map of the Tier 2 Eastern modeling domain. The outer box denotes the entire modeling domain (36 km) and the inner box indicates the fine grid location (12 km).

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[3] Model concentrations are not calculated for the outer periphery of the nested grid. Two buffer rows and columns are needed to solve the advection portion of the mass balance equation.

C. Meteorological Modeling

In order to solve for the change in pollutant concentrations over time and space, the air quality model requires certain meteorological inputs that, in part, govern the formation, transport, and destruction of pollutant material. In particular, the UAM-V model used in the Tier 2 analyses requires five meteorological input files: wind (u- and v-vector wind components), temperature, water vapor mixing ratio, atmospheric air pressure, and vertical diffusion coefficient. Fine grid values of wind and vertical diffusivity are used; the other fine grid meteorological inputs are interpolated from the coarse grid files.

The gridded meteorological data for the three historical 1995 episodes were developed by the New York Department of Environment and Conservation (NYDEC) using the Regional Atmospheric Modeling System (RAMS), version 3b. RAMS (Pielke *et. al.*, 1992) 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 then mapped to the UAM-V grid. Two separate meteorological UAM-V inputs, cloud fractions and rainfall rates, were developed based on observed data.

RAMS was run in a nested-grid mode with three levels of resolution: 108 km, 36 km, and 12 km with 28-34[4] vertical layers. The top of the surface layer was 16.7 m in the 36 and 12km grids. The two finer grids were at least as large as their UAM-V counterparts. In order to keep the model results in line with reality, the simulated fields were nudged to an European Center for Medium-Range Weather Forecasting (ECMWF) analysis field every six hours. This assimilation data set was bolstered by every four-hourly special soundings regularly collected as part of the North American Research Strategy on Tropospheric Ozone (NARSTO) field study in the northeast U.S.

A summary of the settings and assorted input files employed in this RAMS application are listed below in Table II-5. For more detail on the meteorological model configuration, see Lagouvardos *et al.* (1997).

A limited model performance evaluation (Sistla, 1999) was completed for a portion of the 1995 meteorological modeling (July 12-15). Observed data not used in the assimilation procedure were compared against modeled data at the surface and aloft. In general, there were no widespread biases in temperatures and winds. Furthermore, the meteorological fields were compared before and after being processed into UAM-V inputs. It was concluded that this preprocessing did not distort the meteorological fields.

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[4] 34 layers were used in the inner nested grids. 28 layers were modeled in the outer 108 km grid.

Table II-5. Summary of RAMS model settings and inputs.

Model Setting/Input File	**Description**
Input- Topography	30 arc-second data from EROS Data Center.
Input - Sea-surface temperature	Mean monthly climatological data from NCAR.
Input - Vegetation type	10 arc-minute data from NOAA/NGDC.
Input - Initial conditions	The model was initialized with gridded one-degree ECMWF data sets prepared by the isentropic analysis package. Surface observations provided by SUNY were blended into the initialization fields.
Input - Soil moisture	Six layer soil model. Assumed deeper layers were more moist than near-surface layers.
Setting	Non-hydrostatic
Setting - Lateral boundary conditions	Klemp-Wilhelmson
Setting - Horizontal diffusivity	Smagorinsky
Setting - Vertical diffusivity	Mellor and Yamada parameterization scheme
Setting - Shortwave/Longwave radiation	Mahrer and Pielke

D. Development of Other UAM-V Input Files

The manmade emissions inventories for the five modeling scenarios were processed through EMS-95 (Alpine Geophysics, 1994) in order to develop the UAM-V-ready, day-specific emissions. Biogenic emissions were developed using the BEIS-2 model (Birth and Geron, 1995). In addition, the photochemical grid model requires several other types of data. In general, most of these miscellaneous model files were taken from existing regional modeling applications. Clean conditions were used to initialize the model and as lateral and top boundary conditions as in OTAG (OTAG, 1997).

The model requires information regarding land use type and surface albedo for all Layer 1 grid cells in the domain. Existing OTAG data were used for these non-day-specific files. Photolysis rates were developed using the JCALC portion of the UAM-V modeling system. Turbidity values were set equal to a constant thought to be representative of regional conditions.

E. Model Performance Evaluation

The goal of the base year modeling was to reproduce the atmospheric processes resulting in high ozone concentrations over the eastern United States during the three 1995 episodes selected for modeling. Note that the base year of the emissions was 1996 while the episodes are in 1995. The effects on model performance of using 1996 base year emissions for the 1995 episodes are expected to be small.

An operational model performance evaluation for surface ozone for the 1995 episodes was performed in order to estimate the ability of the modeling system to replicate base year ozone concentrations. This evaluation is comprised principally of statistical assessments of model versus observed pairs. The robustness of an operational evaluation is directly proportional to the amount and quality of the ambient data available for comparison.

1. Statistical Definitions

Below are the definitions of statistics used for the evaluation. The format of all the statistics is such that negative values indicate model ozone predictions that were less than their observed counterparts. Positive statistics indicate model overestimation of surface ozone. Statistics were not generated for the first three days of an episode to avoid the initialization period. The operational statistics were generated on a regional basis in accordance with the primary purpose of the modeling which is to assess the need for, and impacts of, a national mobile source emissions control program. The statistics were calculated for (a) the entire Tier 2 domain and (b) four quadrants (Midwest, Northeast, Southeast, Southwest). The statistics calculated for each of these areas are:

Domainwide unpaired peak prediction accuracy: This metric simply compares the peak concentration modeled anywhere in the selected area against the peak ambient concentration anywhere in the same area. The difference of the peaks (model - observed) is then normalized by the peak observed concentration.

Peak prediction accuracy: This metric averages the paired peak prediction accuracy calculated for each monitor in the subregion. It characterizes the capacity of the model to replicate peak (afternoon) ozone over a subregion. The daily peak model versus daily peak observed residuals are paired in space but not in time.

Mean normalized bias: This performance statistic averages the normalized (by observation) difference (model - observed) over all pairs in which the observed values were greater than 60 ppb. A value of zero would indicate that the model over predictions and model under predictions exactly cancel each other out.

Mean normalized gross error: The last metric used to assess the performance of the Tier 2/Sulfur base cases is similar to the above statistic, except in this case it is the absolute value of the residual which is normalized by the observation, and then averaged over all sites. A zero gross error value would indicate that all model concentrations (in which their observed counterpart was greater than 60 ppb) exactly matched the ambient values.

2. Evaluation Results

As with previous regional photochemical modeling studies, the Tier 2 base year simulations are accurate representations of the historical ozone patterns at certain times and locations and poor representations at other times and locations over this large 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 fairly closely. Other relevant observations, in terms of model performance, are listed below.

- Mean normalized bias and mean normalized gross error values are similar to OTAG performance statistics for the entire domain and the four quadrants as summarized in Table II-6.

Table II-6. Tier 2 Base Year model performance for the entire grid and by quadrant.

Mean Normalized Bias	OTAG 1988	OTAG 1991	OTAG 1993	OTAG 1995	Tier 2 June 95	Tier 2 July 95	Tier 2 August 95
Domain	-8	-4	+1	+4	-10	-6 (-4)[5]	+2
Midwest	-15	-8	-8	-5	-11	-13 (-8)	+7
Northeast	-3	-6	-8	+8	-17	-9 (-9)	-9
Southeast	+2	+15	+21	+9	-4	+4 (+5)	+7
Southwest	-6	+6	+2	+12	+2	+8 (+8)	+6

Mean Normalized Gross Error	OTAG 1988	OTAG 1991	OTAG 1993	OTAG 1995	Tier 2 June 95	Tier 2 July 95	Tier 2 August 95
Domain	28	25	27	25	24	24 (24)	23
Midwest	27	26	25	24	24	26 (25)	22
Northeast	29	23	23	26	27	22 (21)	24
Southeast	28	25	32	27	20	24 (24)	22
Southwest	22	24	23	29	24	27 (26)	24

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[5] Values in parentheses are for the 10-15th only. These dates correspond with OTAG 1995 episode days.

- In general, the model under predicts ozone for the June and July episodes (-10 and -6 percent, respectively). This underestimation bias generally occurs over the first half of an episode. The latter portions of these episodes are generally unbiased. Model performance is best over the southern portions of the domain.

- Mean normalized gross error ranges from 22 to 23 percent. Bias and errors are generally lowest in the Southwest region (fewest number of observed sites).

- The model typically underestimates the peaks as well as the mean ozone, but not as severely.

- Although the overall tendency (June/July episodes) is to underestimate the observed ozone, there are several instances in which large overestimations occurred.

- The model is slightly biased toward overestimation in the August episode (2.1 percent). Only the Northeast quadrant is underestimated (-9.1 percent) in this episode.

- While there are no established statistical criteria for evaluating the adequacy of regional modeling applications, the relatively low values of bias and error plus the OTAG-equivalent performance indicate the modeling is sufficient for a national assessment of the need for (and impact of) Tier 2/Sulfur controls.

III. Ozone Modeling over the Western United States

A. Episode Selection

For the western modeling, there were no existing meteorological data sets suitable for regional ozone modeling. Measured ozone concentrations were examined for several recent years to find representative ozone episodes over the western U.S. As with the East, the ambient data were analyzed in order to identify time periods which captured episodic conditions in as many areas as possible. As a result of this analysis, two episodes from the summer of 1996 were selected for the western U.S. modeling: July 5-15 and July 18-31. An additional advantage associated with the selection of 1996 episodes is the meteorological inputs and emissions inputs are both from the same year. Nineteen episode days were modeled in all, not including the three ramp-up days used in both episodes to minimize the effects of initial conditions.

1. Episodic Meteorological Conditions and Ozone Levels

<u>July 5-15, 1996</u>

July 6 marked the beginning of the development of a large 500 millibar ridge over the western U.S. A thermal low was located over the California desert and average summertime conditions (light winds, warm temperatures, and little to no precipitation) existed over much of the region. Ozone was high (i.e., greater than 125 ppb) in the Sacramento, San Joaquin Valley, and Los Angeles basins over the first five days of the episode. Most of the rest of the region did not experience elevated amounts of ozone, with the exception of the Salt Lake City region on July 7 and 8 (as high as 117 ppb).

Over the period from July 11 to July 14, the ridge strengthened along the Pacific Coast displacing the jet stream north into Canada. Wind speeds aloft were quite low during this period along the West Coast resulting in little pollution advection or dispersion. Observed ozone values greater than 100 ppb were monitored in urban areas all along the Pacific Coast (Redding = 110 ppb, Eugene = 117 ppb, Portland = 145 ppb, Seattle/Tacoma = 118 ppb). Elevated levels of ozone continued throughout this period in the Sacramento, the San Joaquin Valley, and Los Angeles airsheds.

Further east, the highest ambient ozone of the summer in Albuquerque (111 ppb) and El Paso (112 ppb) were recorded on July 11. Vigorous northwest flow aloft which was associated with a trough over the central U.S. prevented ozone buildup in Denver (until July 15 when a 107 ppb value was recorded).

Monsoonal rains kept ambient ozone relatively low in Arizona cities such as Phoenix and Tucson. The episode ended (even in Los Angeles and other California cities) when a strong 500 millibar trough progressed through the region from July 15-17. This period of reduced ozone conveniently allowed the modeling for the second July 1996 episode to be initialized with clean conditions (ozone and ozone precursors).

July 18-31, 1996

Like the early July 1996 episode, this scenario began with a developing ridge over the western U.S. on July 21. Ozone was confined to the major cities of California until the July 23-28 period, by which time the anticyclone aloft had strengthened and dominated the Pacific States and the Desert Southwest. Temperatures rose into the 100s in Oregon and Washington. No precipitation was recorded anywhere west of the Rocky Mountains; cloud cover was limited as well over this region.

As a result, ozone levels rose as well in areas such as Portland (149 ppb on 7/26), Phoenix (127 ppb on 7/23), Seattle (112 ppb on 7/26) and Salt Lake City (110 ppb on 7/26). The ridge flattened out somewhat by July 29, but ozone values remained high in California and the Arizona cities (Phoenix) through the end of the episode.

2. General Representativeness of Episodic Ozone to Design Values

Ozone in the western U.S. tends to be much less regionally pervasive than in the eastern U.S. In general, ozone non-attainment conditions are more local in nature. This makes it more difficult to capture in a few episodes all of the conditions that lead to individual design-value levels of ozone in western areas. Table III-1 compares 1996-1998 ambient design values against the highest observed ozone levels in the Tier 2 episodes for the major non-California metropolitan areas in the West[6]. The results indicate that the peak ozone levels during the episodes modeled are generally in the range of the design values. For example, only in Portland, OR is the measured peak not within 15 ppb of the recent design value.

Table III-1. Comparison of 1996-1998 design values for major metropolitan areas in the western U.S. against the highest observed ozone value in those same areas recorded during the periods July 8-15, 1996 and July 21-31, 1996.

Area	1996-1998 Design Value	Highest ozone recorded in the Tier 2 episode days
Albuquerque	97	111
Denver	112	107
El Paso	123	112
Phoenix	120	127
Portland	133	149
Salt Lake City	123	117
Seattle	121	118

B. Domain and Grid Configuration

The Tier 2 UAM-V modeling for the western U.S. was completed using a domain containing two nested grids of varying extent and resolution as described below and shown in Figure III-1. The modeling used a latitude-longitude coordinate system as indicated below.

Main Grid:
Resolution: 1/2° longitude, 1/3° latitude (approximately 36 km)
East-West extent: -127 W to -99 W
North-South extent: 26 N to 52 N
Vertical extent: Surface to 4800 meters
Dimensions: 56 by 78 by 11

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[6] Capturing representative ozone levels in California is less important in this analysis because the equivalent of the Tier 2/Sulfur standards have been adopted there.

Nested Grid[7]:	Resolution: 1/6° longitude, 1/9° latitude (approximately 12 km) East-West extent: -125 W to -103 W North-South extent: 31 N to 49 N Vertical extent: Surface to 4800 meters Dimensions: 132 by 162 by 11

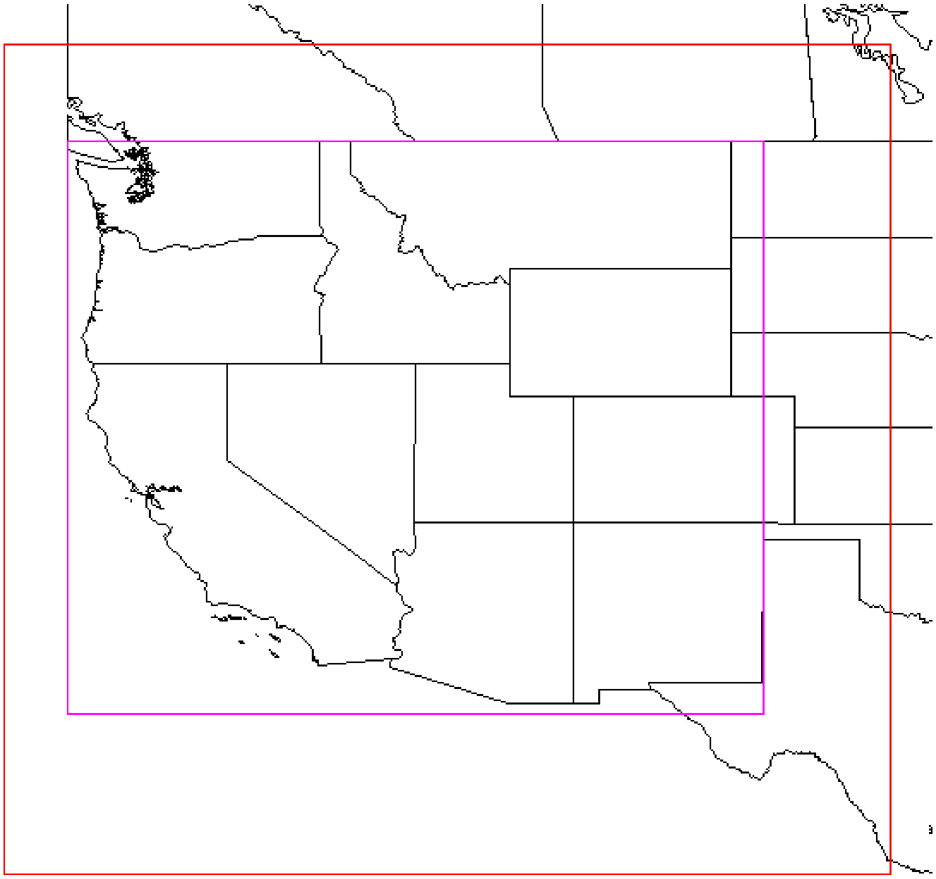

Figure III-1. Map of the Tier 2 modeling domain. The outer box denotes the entire modeling domain (36 km) and the inner box indicates the fine grid location (12 km).

The vertical layers were consistent between the two grids: 0-50, 50-100, 100-300, 300-600, 600-1000, 1000-1500, 1500-2000, 2000-2500, 2500-3100, 3100-3800, 3800-4800. All model heights are in meters above ground level.

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[7] Model concentrations are not calculated for the outer periphery of the nested grid. Two buffer rows and columns are needed to solve the advection portion of the mass balance equation.

C. Meteorological Modeling

The gridded meteorological data for the two historical 1996 episodes were developed using the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5). MM5 (Grell *et. al.*, 1995) is a numerical meteorological model that solves the full set of physical and thermodynamic equations which govern atmospheric motions.

MM5 was run in a nested-grid mode with three levels of resolution: 108 km, 36km, and 12 km with 23 vertical layers. The model was simulated in five day segments with an eight hour ramp-up period. The MM5 runs were started at 0Z, which is 4PM PST. The first eight hours of each five day period were removed before being input into UAM-V. The UAM-V runs start at midnight, and each day runs from midnight to midnight (PST).

MM5 is a terrain-following sigma-pressure coordinate model and was run using a Lambert conformal map projection, therefore the data were processed to match the UAM-V grid structure. There was also an issue in that several of the UAM-V grid boundaries extended slightly beyond their counterpart MM5 12 km and 36 km domain boundaries (mostly over the Pacific Ocean). In these cases, data from the next outer grid were mapped to these areas. A preprocessor (MM52UAMV) generates model-ready UAM-V files for wind, temperature, water vapor, pressure, and vertical diffusion from the MM5 output. For more information on the preparation of non-emissions-related inputs, see SAI (1999).

The standard version of MM5 was revised for this project to output the internally-calculated vertical diffusivities (K_v) generated as part of the Medium Range Forecast (MRF) model boundary layer scheme. When the MRF boundary layer option is employed these K_v values represent non-local vertical exchanges. This approach should provide the most representative mixing field; one that captures both large- and small-scale vertical diffusive fluxes.

Unlike the eastern UAM-V modeling, the cloud fraction and rainfall rate inputs were derived from the meteorological model as opposed to interpolating observed data to the model grid. This alternative procedure was used because of the relatively sparse meteorological observation network in the western U.S. Cloud fractions were diagnosed from the MM5 results based on the assignment of a critical relative humidity, which if exceeded, indicated the presence of a cloud. The fractional extent of the cloud was a function of the amount the model humidity exceeds the threshold value. Rainfall rates are extracted directly from MM5.

D. Development of Other UAM-V Input Files

The manmade emissions for the three scenarios were processed through the Sparse Matrix Operator Kernal Emissions (SMOKE) modeling system (Houyoux and Vukovich, 1999) for stationary sources and EMS-95 for mobile sources in order to develop the model-ready, day-specific emissions. Biogenic emissions were developed using BEIS-2. The initial, lateral boundary, and top boundary species concentrations were set to clean values intended to represent background-like concentrations. All species were set to values prescribed in EPA (1991), except CO (200 ppb), VOC (25 ppb)[8], ozone (30 ppb), NO (0 ppb), and NO2 (1 ppb). Model land use characteristics (as percentages of specified 11 categories) were derived from a 200 meter resolution U.S. Geological Survey data base. Albedo values (needed in the calculation of photolysis rates) were taken from this same data base. The aerosol optical depth which governs the amount of UV scattering due to airborne particulates was set to a nominal value (0.094) indicative of rural conditions. The photolysis rate lookup table required for the UAM-V runs was developed, as in the eastern U.S. simulations, via the JCALC preprocessor program.

E. Model Performance Evaluation

An operational evaluation was performed for the western modeling using the same procedures and statistics discussed in section II-E. Model performance measures were calculated over the entire modeling domain, the 12 km fine grid, and 10 individual areas (Albuquerque, Denver, El Paso, Phoenix, Portland, Salt Lake City, the San Joaquin Valley, Seattle, San Francisco, and Southern California). Table III-2 contains the operational evaluation statistics.

Table III-2. Model performance statistics for individual areas in the western U.S.

Region	Unpaired Peak Prediction Accuracy	Average Peak Prediction Accuracy	Mean Normalized Bias	Mean Normalized Gross Error
Albuquerque	-0.287	-0.313	-0.331	0.331
Denver	-0.190	-0.287	-0.318	0.319
El Paso	-0.356	-0.400	-0.443	0.443
Phoenix	-0.292	-0.326	-0.361	0.362
Portland	-0.041	-0.180	-0.227	0.263
Salt Lake City	-0.225	-0.308	-0.343	0.348
San Joaquin Valley	-0.309	-0.390	-0.404	0.406
Seattle	0.017	-0.200	-0.211	0.284
San Francisco	-0.404	-0.375	-0.395	0.396
Southern California	-0.436	-0.505	-0.524	0.530

Model performance for the 1996 base year episodes was characterized by underestimates

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[8] Divided across CB-IV VOC species as specified in EPA guidance.

of observed ozone as summarized in Table III-3. The model underestimated mean ozone by about 30 ppb on average. On an individual area basis, the model did somewhat better in the northwest portion of the domain (Portland and Seattle) where negative biases were about 15-25 percent. In the end, the modeling was determined to be sufficient for the intended purpose, that is, to be used in a relative sense to assess the impacts of the Tier 2/Sulfur controls as part of the economic benefits calculations.

Table III-3. Summary model performance statistics for surface ozone in the western U.S. fine grid.

(Units in percent)	Episode 1 (July 5 -15, 1996)	Episode 2 (July 21-31, 1996)
Peak prediction accuracy	-39.0	-37.5
Mean normalized bias	-40.6	-38.6
Mean normalized gross error	40.8	39.1

IV. Results of the Tier 2/Gasoline Sulfur Modeling for Ozone

The results of the Tier-2 modeling were further analyzed to provide information to (a) support the determination of the need for Tier 2, (b) examine the air quality impacts of the program, and (c) support the preparation of responses to comments on the proposed rulemaking. The analyses for each of these purposes are described below.

A. Analysis of Need

To support the determination of the need for Tier 2, the modeling results were examined to identify those CMSA and MSAs that have predicted exceedances of the 1-hour NAAQS in the 2007 and/or in the 2030 baseline scenarios. Model predicted exceedances are defined as daily 1-hour maximum concentrations >=125 ppb. A CMSA/MSA is determined to contain an exceedance if at least one of the model grid cells assigned to the area has at least one exceedance during the episodes modeled. The procedures for assigning grid cells to areas are defined below. The CMSA/MSAs with predicted 2007 base case and/or 2030 base case exceedances are listed in Appendix IV-1.

B. Impacts of the Tier 2/Sulfur Program on Ozone Levels

The forecasted impacts on ozone concentrations as a result of the Tier 2 program were analyzed by comparing model predictions from the 2007 and 2030 Tier 2 control cases to those in the corresponding 2007 and 2030 base case scenarios. For 2007, the impacts of Tier 2 are derived from model simulations for the three episodes in June, July, and August 1995. For 2030, model runs were made for the June and July 1995 episodes only. Thus, the 2030 impacts are based on predictions from these two episodes. As indicated above, the first 3 days of each episode are considered as initialization or “ramp up” days and are, therefore, excluded from the analysis of results.

The focus of the analysis is on ozone levels in the eastern U.S. since this region contains most of the areas with 1-hour nonattainment. In particular, the impacts were quantified for CMSA/MSAs with predicted future-year exceedances of the 1-hour ozone NAAQS. As indicated above, predicted exceedances are modeled 1-hour daily maximum concentrations >=125 ppb. The methods for determining which areas have forecasted exceedances are described below. For the eastern U.S. modeling there were 48 such areas in 2007 while for 2030 there were 38 areas with base case exceedances[9]. Note that the 2030 scenario had a different number of areas for analysis compared to 2007 in part because some areas only had exceedances predicted in the August episode which was not modeled for 2030 (i.e., Charleston, Cincinnati, Huntington, Indianapolis, Lakeland, Macon, Melbourne, Norfolk, Orlando, Pensacola, and Wheeling) and because one area (i.e., York) had predicted exceedances in the 2030 base case but not the 2007 base case.

1. Methods for Quantifying Impacts

a. Definition of Areas for Analysis

In order to analyze the impacts of the Tier 2/Sulfur emissions reductions, it was necessary to "link" or assign the model’s grid cells to individual CMSA/MSAs. The rules for assigning grid cells to CMSA/MSAs (i.e., areas) is as follows. The first step was to assign grid cells to States based on the fraction of the grid cells’ area in a State. A grid cell was assigned to the State which contains most of the cells’ area. Next, grid cells were assigned to an individual CMSA/MSAs if (1) the grid is wholly contained within the CMSA/MSA or (2) partially within (i.e., overlapping) the area, but *not* also partially within another CMSA/MSA. Grid cells that partially overlap two or more CMSA/MSAs are assigned to the county, and thereby the corresponding CMSA/MSA, which contains the largest portion of the grid cell. Each grid cell in the "coarse" or 36 km grid portion of the domain was divided into nine 12 km grids before applying the preceding methodology. The number of grid cells assigned to each area is listed in Appendix IV-2.

b. Description of Ozone Metrics

The impacts of Tier 2 on ozone were quantified using a number of metrics (i.e., measures of ozone concentrations). These metrics include:

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[9] These areas are listed in Appendix IV-1. Portland, OR is on the list of areas with predicted future exceedances, but was not included in this analysis which focused only on areas in the eastern U.S.

(1) the peak 1-hour ozone concentrations,
(2) the number of exceedances,
(3) the total amount of ozone >= 125 ppb,
(4) the decrease in ozone, on average, and
(5) the increase in ozone, on average.

(1) The peak 1-hour ozone represents the highest ozone prediction within the area (i.e., CMSA or MSA) across all episodes modeled.

(2) The number of exceedances is the total number of grid cells with predicted exceedances in the area across all days. This exceedance metric counts each grid cell every day there is a predicted exceedance in that grid. Thus, an individual grid cell can be counted more than once if there are multiple days with predicted exceedances in that grid.

(3) The total amount of ozone above 125 ppb in an area is determined by taking the difference between the predicted daily maximum ozone concentration and 125 ppb (i.e., daily maximum - 125 ppb) in each grid cell and then summing this amount across all grid cells in the area and days modeled. This metric is referred to as “the amount of nonattainment”.

(4) The decrease, on average is determined by first summing all the reductions predicted in those grid cells with daily maximum ozone >=125 ppb in the base case (i.e., base case exceedances). This total reduction is then divided by the number of base case exceedances in the area to yield the "ppb" decrease that occurs, on average, for the exceedances predicted in the area.

(5) The increase, on average is determined by summing any increases in ozone that occur in values already >= 125 ppb in the base case together with any increases that cause a value below 125 ppb in the base case to go above 125 ppb in the control case. This total increase is then divided by the number of exceedances in the base case.

The impacts of Tier 2 on ozone were examined for the individual CMSA/MSAs as well as by aggregating the metrics across all areas (i.e., 48 in 2007 and 38 in 2030) to obtain the overall impact expected from the program. The values of the metrics are provided in Appendix IV-3 for 2007 and Appendix IV-4 for 2030.

2. Impacts on Ozone in 2007 and 2030

a. Impacts in 2007

The ozone modeling results for 2007 show that Tier 2 will provide nearly a 10% reduction in the total number of exceedances predicted across all 48 CMSA/MSAs combined. Overall, the total amount of nonattainment is predicted to decline by about 15%. Looking at the results for individual areas, over half (i.e., 31 of the 48) areas have fewer exceedances with Tier 2 in 2007. In five of these 31 areas, the exceedances are eliminated by Tier 2 (i.e., Macon, Melbourne, Norfolk, Pittsburgh, and Rochester). Of the 48 areas, 14 are expected to have no change in the total number of exceedances. Only 3 areas (i.e., Chicago, Detroit, and New London) are predicted to have an increase in exceedances. In each of these areas the increase occurs in only one grid cell on one day, which is a small impact considering the total number of grid cells in these area.

In the vast majority of areas (i.e., 45 out of 48), the decrease in ozone, on average is greater than any predicted increase, on average. In fact, only two areas (i.e., Chicago and Detroit) are predicted to have an increase, on average of more than a half ppb (6 other areas had an increase, on average of between one tenth and a half ppb). However, even these two areas are predicted to have a reduction in the peak ozone concentration.

b. Impacts in 2030

In the 2030 base case the number of exceedances increases relative to the amount of 125 ppb or greater cells in the 2007 base case in most areas, when looking at a consistent set of episode days. This reflects the increase in emissions as growth outpaces the effects of controls. Meanwhile, the overall number of exceedances is reduced 32% due to the Tier 2/Sulfur controls in 2030 while the amount of nonattainment is predicted to decline by 36%. Of the 38 areas, nearly all (i.e., 32) are predicted to have a decrease in the number of exceedances while the remaining six areas are predicted to have no change. None of the areas are predicted to have an increase in exceedances. However, in two of the 38 areas (i.e., Chicago and Detroit) the amount of ozone nonattainment is predicted to be larger in the control case than in the 2030 base case.

C. Additional Analyses to Support Responses to Comments

Several additional analyses were performed to support the responses to comments on the proposed rule. These analyses include (a) an evaluation of the Tier 2 regional model performance analogous to EPA's urban ("local") scale model performance recommendations (EPA, 1991), (b) a determination of "alternative attainment targets" for individual areas considering the episodes modeled, and (c) an estimation of attainment/nonattainment based on relative reduction factors.

1. "Local" Scale Model Performance

Several comments were received on the Tier 2 notice of proposed rulemaking to the effect that model over predictions could be leading to overestimates of residual non-attainment areas. To support the response to this comment, a local-scale evaluation was conducted on the final modeling to ensure that the determination of Tier 2/Sulfur need was not significantly biased due to model performance. Statistics were calculated for 36 "local" subregions[10] using the procedures described in Section II. Generally speaking, model performance will typically appear poorer for individual local subregions than when the performance statistics are averaged over larger regions. This results due to the heightened sensitivity of local-scale model results to local input uncertainties. Table IV-1 contains the area-wide unpaired peak prediction accuracy, the average peak prediction accuracy, mean normalized bias and mean normalized gross error values for the 36 local-scale subdomains averaged over the 30 episode days. Some conclusions regarding model performance at the local scale are listed below.

Table IV-1. Tier 2 Base Case model performance for 36 local subregions.

Region	Unpaired Peak Prediction Accuracy	Average Peak Prediction Accuracy	Mean Normalized Bias	Mean Normalized Gross Error
Dallas	-0.140	-0.102	0.192	-0.085
Houston-Galveston	-0.098	0.059	0.248	0.006
Beaumont-Port Arthur	-0.023	0.103	0.202	0.052
Baton Rouge	0.070	0.223	0.289	0.178
New Orleans	0.285	0.143	0.222	0.141
St. Louis	-0.008	-0.037	0.193	-0.029
Memphis	0.133	-0.128	0.215	-0.108
Birmingham	0.140	0.073	0.171	0.034
Atlanta	0.151	0.014	0.225	-0.008
Nashville	0.163	0.050	0.262	0.096
Knoxville	-0.031	-0.217	0.271	-0.188
Charlotte	0.153	0.010	0.173	0.001
Greensboro	0.099	-0.015	0.174	-0.007
Raleigh-Durham	0.039	-0.090	0.176	-0.098
Evansville-Owensboro	0.170	0.004	0.230	0.037
Indianapolis	0.011	-0.113	0.206	-0.056
Louisville	0.143	0.068	0.271	0.096
Cincinnati-Dayton	0.005	-0.053	0.225	-0.034
Columbus	0.005	-0.109	0.196	-0.095
Huntington-Ashland	0.167	0.123	0.235	0.070
Chicago	0.217	-0.227	0.288	-0.058
Milwaukee	0.333	-0.187	0.234	-0.026
Muskegon-Grand Rapids	0.124	-0.142	0.221	-0.090
Gary-South Bend	0.022	-0.236	0.286	-0.128
Detroit	0.095	-0.190	0.270	-0.115
Pittsburgh	0.010	-0.101	0.228	-0.056
Central PA	0.094	-0.083	0.218	-0.048
Norfolk	0.149	-0.078	0.221	-0.064
Richmond	0.203	0.007	0.183	-0.013
Baltimore-Washington	0.022	-0.067	0.199	-0.068
Delaware	0.080	-0.071	0.150	-0.072
Philadelphia	-0.013	-0.166	0.251	-0.135

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[10] For evaluation purposes, these local areas were defined by simple boxes of grid cells around a given area. They do not correspond to non-attainment areas or CMSA/MSAs.

New York City	0.130	-0.190	0.281	-0.120
Hartford	0.054	-0.125	0.220	-0.102
Boston	0.186	-0.147	0.238	-0.076
Maine	0.189	-0.147	0.224	-0.042

- The model is, on average, biased toward underestimations of observed ozone, especially in the Midwest and Northeast.

- The few regions which exhibit overestimated base year ozone are in the southern portion of the domain. Baton Rouge, New Orleans, Birmingham, and Houston all have positive biases of at least 5 percent.

- Model performance is generally poorest in the Lake Michigan area probably due to the preponderance of shoreline monitors (where the highest ozone levels are often confined to within 1-3 km inland from the cool lake, that is, below the resolution of this analysis). Gross errors in this region approach 30 percent.

2. Determination of Alternative Attainment Targets

As indicated above, one of the primary purposes of the Tier 2 modeling was to determine the number of areas projected to experience exceedances of the 1-hour standard in 2007. These areas were identified based on whether the highest daily maximum 1-hour value in the 2007 base case was >=125 ppb. This "exceedance method" was criticized during the comment period as potentially exaggerating the extent of the future year problem. One commenter recommended that EPA follow its own guidance (EPA, 1996) regarding attainment demonstrations for ozone episode days associated with infrequent, severe meteorological conditions by allowing for alternative attainment targets (i.e., values above 124 ppb). These alternative targets are allowed for use in local attainment demonstrations to determine whether model-predicted peak ozone values > 124 ppb can be considered as showing attainment in view of the statistical form of the 1-hour NAAQS in the case of especially severe meteorological conditions.

To respond to this and similar comments we performed an analysis to identify the alternative attainment targets appropriate for the episodes modeled. This analysis was performed for those 18 areas for which the meteorological severity has been calculated and ranked. Alternative targets were not be calculated for the other areas. The projected exceedance areas for which this analysis was performed are: Atlanta, Baltimore, Baton Rouge, Birmingham, Chicago, Greater Connecticut, Cleveland, Detroit, Houston, Huntington, Louisville, Milwaukee, Muskegon, New York, Philadelphia, Pittsburgh, Providence, and St. Louis.

Table IV-2 shows the alternative targets for those days/areas thought to be representative of unusually severe meteorology. Some episode days are not shown because there are no alternative targets for those days (i.e., the target remains 124 ppb for all areas). Each residual nonattainment area (for which data was available to complete the alternate target analysis) had at least one day in which the 2007 baseline maxima exceeded the attainment target, 124 ppb or otherwise.

Table IV-2. Alternative attainment targets by non-attainment area and episode day.

	6/16	6/18	6/19	6/20	6/21	6/22	6/24	7/11	7/12	7/13	7/14	7/15	8/12	8/15	8/16	8/17	8/18	8/19	8/20
Dallas																			
Houston					130														130
Baton Rouge									150									130	
St. Louis																	130		
W. Lake Michigan	130	130	130			130	139		130	132	130	135							
Lake Michigan																			
Birmingham								137	130				130		131	130			
E. Lake Michigan									130	137	146								
Louisville										130									
Atlanta								130	130			130		153	130	130	137		
Cincinnati																			
Pittsburgh		130	130							130	130	144		130					
Washington D.C.																			
Baltimore				130								140							
Philadelphia												151							
New York City												134							
Greater CT			130	130							132	130							
Boston											130								
Providence											130								

3. Estimation of Attainment/Nonattainment Using Relative Reduction Factors

EPA received comments that recommended using relative reduction factors applied to ambient design values as an approach to estimate future nonattainment. Specifically, the commenters recommended that EPA follow draft guidance for demonstrating attainment of the 8-hour NAAQS for such an analysis (EPA, 1999). In response, we calculated relative reduction factors for the 2007 base case and control scenarios using the general methodology in this guidance. The exceptions to guidance are that: (a) relative reduction factors (RRF) were calculated for the highest design value in a county rather than for all monitoring sites in a county and (b) we used a cut-off of 80 ppb as appropriate for considering 1-hour model predictions as opposed to 70 ppb recommended in the guidance for 8-hour concentrations (see Appendix IV-5 for the rationale for selecting 80 ppb). The county-specific relative reduction factors (2007-B RRF, 2007-C RRF) were applied to both 1995-1997 and 1996-1998 design values for estimating 2007 base and 2007 control values (2007-B New DV, 2007-C New DV). The ambient design values, adjustment factors based on modeling, and the resulting 2007 values are provided in

Appendix IV-6. The areas which have estimated 2007 base case design values >=125 ppb in using either 1995-1997 and/or 1996-1998 design values are listed in Table IV-3.

Table IV-3. Areas which have estimated 2007 base case design values >=125 ppb.

Chicago, IL CMSA	Atlanta, GA CMSA	Houma, LA MSA
Dallas, TX CMSA	Baton Rouge, LA MSA	Longview, TX MSA
Houston, TX CMSA	Beaumont, TX MSA	Sheboygan, WI MSA
New York City, NY CMSA	Grand Rapids, MI MSA	Iberville Parish, LA
Philadelphia, PA CMSA	Hartford, CT MSA	La Porte County, IN
Washington, DC-Baltimore, MD CMSA	New London, CT MSA	Manitowoc County, WI

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Appendix IV-1:
Areas with Predicted Exceedances in 2007 and/or 2030 Base Case Scenarios

CMSA/MSAs	2007 Base Case Exceedance: June/July/August Episodes	2030 Base Case Exceedance: June/July Episodes
Boston, MA CMSA	Yes	Yes
Chicago, IL CMSA	Yes	Yes
Cincinnati, OH CMSA	Yes	No
Cleveland, OH CMSA	Yes	Yes
Detroit, MI CMSA	Yes	Yes
Houston, TX CMSA	Yes	Yes
Milwaukee, WI CMSA	Yes	Yes
New York City, NY CMSA	Yes	Yes
Philadelphia, PA CMSA	Yes	Yes
Washington, DC-Baltimore, MD CMSA	Yes	Yes
Atlanta, GA MSA	Yes	Yes
Barnstable, MA MSA	Yes	Yes
Baton Rouge, LA MSA	Yes	Yes
Benton Harbor, MI MSA	Yes	Yes
Biloxi, MS MSA	Yes	Yes
Birmingham, AL MSA	Yes	Yes
Buffalo, NY MSA	Yes	Yes
Canton, OH MSA	Yes	Yes
Charleston, WV MSA	Yes	No
Charlotte, NC MSA	Yes	Yes
Grand Rapids, MI MSA	Yes	Yes
Hartford, CT MSA	Yes	Yes
Houma, LA MSA	Yes	Yes
Huntington, WV MSA	Yes	No
Indianapolis, IN MSA	Yes	No
Jackson, MS MSA	Yes	Yes

Lafayette, LA MSA	Yes	Yes
Lakeland, FL MSA	Yes	No
Louisville, KY MSA	Yes	Yes
Macon, GA MSA	Yes	No
Melbourne, FL MSA	Yes	No
Memphis, TN MSA	Yes	Yes
Nashville, TN MSA	Yes	Yes
New London, CT MSA	Yes	Yes
New Orleans, LA MSA	Yes	Yes
Norfolk, VA MSA	Yes	No
Orlando, FL MSA	Yes	No
Pensacola, FL MSA	Yes	No
Pittsburgh, PA MSA	Yes	Yes
Portland, OR MSA	Not Applicable	Yes
Providence, RI MSA	Yes	Yes
Richmond, VA MSA	Yes	Yes
Rochester, NY MSA	Yes	Yes
Rockford, IL MSA	Yes	Yes
St. Louis, MO MSA	Yes	Yes
Sarasota, FL MSA	Yes	Yes
Tampa, FL MSA	Yes	Yes
Toledo, OH MSA	Yes	Yes
Wheeling, WV MSA	Yes	No
York, PA MSA	No	Yes

Appendix IV-2:
Number of 12km Grid Cells Assigned to Each CMSA/MSA

CMSA/MSAs	Total Number of Grid Cells in Area
Boston, MA CMSA	189
Chicago, IL CMSA	129
Cincinnati, OH CMSA	71
Cleveland, OH CMSA	68
Detroit, MI CMSA	126
Houston, TX CMSA	132
Milwaukee, WI CMSA	39
New York City, NY CMSA	195
Philadelphia, PA CMSA	118
Washington, DC-Baltimore, MD CMSA	187
Atlanta, GA MSA	115
Barnstable, MA MSA	19
Baton Rouge, LA MSA	30
Benton Harbor, MI MSA	15
Biloxi, MS MSA	41
Birmingham, AL MSA	64
Buffalo, NY MSA	35
Canton, OH MSA	27
Charleston, WV MSA	31
Charlotte, NC MSA	69
Grand Rapids, MI MSA	58
Hartford, CT MSA	41
Houma, LA MSA	51
Huntington, WV	47
Indianapolis, IN MSA	71
Jackson, MS MSA	48

Lafayette, LA MSA	56
Lakeland, FL MSA	21
Louisville, KY MSA	45
Macon, GA MSA	37
Melbourne, FL MSA	32
Memphis, TN MSA	58
Nashville, TN MSA	78
New London, CT MSA	12
New Orleans, LA MSA	96
Norfolk, VA MSA	60
Orlando, FL MSA	61
Pensacola, FL MSA	34
Pittsburgh, PA MSA	80
Providence, RI MSA	20
Richmond, VA MSA	66
Rochester, NY MSA	71
Rockford, IL MSA	32
St. Louis, MO MSA	127
Sarasota, FL MSA	23
Tampa, FL MSA	56
Wheeling, WV MSA	21
York, PA MSA	20

Appendix IV-3:
Ozone Metrics for 2007 Base Case and Tier 2/Sulfur Control Case[1]

June/July/August Episodes	**2007 Base Case vs 2007 Tier 2/Sulfur Control Case CMSA/MSA**									
	Composite	**Atlanta**	**Barnstable**	**Baton Rouge**	**Benton Harbor**	**Biloxi**	**Birmingham**	**Boston**	**Buffalo**	**Canton**
Peak (ppb)										
2007 Base	N/A	178	147	152	151	142	138	145	133	130
2007 Control	N/A	173	145	151	150	141	133	143	133	129
# Exceedance										
2007 Base	1170	109	5	95	9	30	12	12	3	2
2007 Control	1056	87	4	86	9	24	7	9	3	2
% Change	-9.7%	-20.2%	-20.0%	-9.5%	0.0%	-20.0%	-41.7%	-25.0%	0.0%	0.0%
Total Nonattainment (ppb)										
2007 Base	12167	1713	47	800	93	123	68	88	15	7
2007 Control	10384	1227	39	692	89	94	37	65	13	4
% Change	-14.6%	-28.4%	-17.0%	-13.5%	-4.3%	-23.6%	-45.6%	-26.1%	-13.3%	-42.9%
Total ppb Decrease	1986	535	9	116	5	32	41	24	2	3
Decrease, on Average	1.7	4.9	1.8	1.2	0.6	1.1	3.4	2.0	0.7	1.5
Total ppb Increase	76	0	0	0	0	0	1	0	0	0
Increase, on Average	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

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[1] Note that values for total non-attainment, total ppb decrease, and total ppb increase are all rounded to the nearest “ppb”.

June/July/August Episodes	**2007 Base Case vs 2007 Tier 2/Sulfur Control Case**									
	CMSA/MSA									
	Charleston	**Charlotte**	**Chicago**	**Cincinnati**	**Cleveland**	**Detroit**	**Grand Rapids**	**Hartford**	**Houma**	**Houston**
Peak (ppb)										
2007 Base	139	142	152	138	136	148	154	172	146	153
2007 Control	138	139	150	137	138	147	154	170	145	153
# Exceedances										
2007 Base	2	2	13	8	4	11	43	17	68	62
2007 Control	2	2	14	7	3	12	42	17	59	58
% Change	0.0%	0.0%	7.7%	-12.5%	-25.0%	9.1%	-2.3%	0.0%	-13.2%	-6.5%
Total Nonattainment (ppb)										
2007 Base	18	25	119	44	20	106	657	345	409	471
2007 Control	15	19	123	42	19	124	619	327	356	418
% Change	-16.7%	-24.0%	3.4%	-4.5%	-5.0%	17.0%	-5.8%	-5.2%	-13.0%	-11.3%
Total ppb Decrease	2	6	5	6	4	4	40	18	58	56
Decrease, on Average (ppb)	1.0	3.0	0.4	0.8	1.0	0.4	0.9	1.1	0.9	0.9
Total ppb Increase	0	0	11	3	2	23	2	0	0	2
Increase, on Average (ppb)	0.0	0.0	0.8	0.4	0.5	2.1	0.0	0.0	0.0	0.0

June/July/August Episodes	**2007 Base Case vs 2007 Tier 2/Sulfur Control Case**									
	CMSA/MSA									
	Huntington	**Indianapolis**	**Jackson**	**Lafayette**	**Lakeland**	**Louisville**	**Macon**	**Melbourne**	**Memphis**	**Milwaukee**
Peak (ppb)										
2007 Base	148	128	130	142	130	150	127	128	150	131
2007 Control	146	126	128	141	128	149	124	124	148	129
# Exceedances										
2007 Base	6	2	4	34	2	21	1	1	6	4
2007 Control	6	2	3	32	1	21	0	0	5	4
% Change	0.0%	0.0%	-25.0%	-5.9%	-50.0%	0.0%	-100.0%	-100.0%	-16.7%	0.0%
Total Nonattainment (ppb)										
2007 Base	65	4	12	236	7	235	2	3	78	10
2007 Control	54	2	5	205	3	224	0	0	68	10
% Change	-16.9%	-50.0%	-58.3%	-13.1%	-57.1%	-4.7%	-100.0%	-100.0%	-12.8%	0.0%
Total ppb Decrease	10	3	7	32	5	17	4	3	12	2
Decrease, on Average (ppb)	1.7	1.5	1.8	0.9	2.5	0.8	4.0	3.0	2.0	0.5
Total ppb Increase	0	0	0	0	0	6	0	0	0	2
Increase, on Average (ppb)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.5

June/July/August Episodes	**2007 Base Case vs 2007 Tier 2/Sulfur Control Case**								
	CMSA/MSA								
	Nashville	**New London**	**New Orleans**	**New York City**	**Norfolk**	**Orlando**	**Pensacola**	**Philadelphia**	**Pittsburgh**
Peak (ppb)									
2007 Base	154	159	160	179	125	135	129	138	127
2007 Control	151	157	160	178	124	132	126	136	124
# Exceedances									
2007 Base	6	18	149	170	1	5	2	20	2
2007 Control	5	19	138	163	0	3	2	20	0
% Change	-16.7%	5.6%	-7.4%	-4.1%	-100.0%	-40.0%	0.0%	0.0%	-100.0%
Total Nonattainment (ppb)									
2007 Base	96	255	1252	2064	0	24	8	110	4
2007 Control	71	232	1135	1897	0	11	3	79	0
% Change	-26.0%	-9.0%	-9.3%	-8.1%	0.0%	-54.2%	-62.5%	-28.2%	-100.0%
Total ppb Decrease	25	23	122	194	1	15	5	32	5
Decrease, on Average (ppb)	4.2	1.3	0.8	1.1	1.0	3.0	2.5	1.6	2.5
Total ppb Increase	0	0	0	22	0	0	0	0	0
Increase, on Average (ppb)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

June/July/August Episodes	2007 Base Case vs 2007 Tier 2/Sulfur Control Case									
	CMSA/MSA									
	Providence	**Richmond**	**Rochester**	**Rockford**	**Sarasota**	**St. Louis**	**Tampa**	**Toledo**	**Washington-Baltimore**	**Wheeling**
Peak (ppb)										
2007 Base	149	151	125	129	160	145	171	132	155	128
2007 Control	147	149	124	128	155	141	167	131	154	126
# Exceedances										
2007 Base	13	11	1	1	23	8	77	1	72	2
2007 Control	11	11	0	1	17	7	69	1	67	1
% Change	-15.4%	0.0%	-100.0%	0.0%	-26.1%	-12.5%	-10.4%	0.0%	-6.9%	-50.0%
Total Nonattainment (ppb)										
2007 Base	148	193	0	4	249	66	1174	7	690	3
2007 Control	128	169	0	3	188	45	947	6	576	1
% Change	-13.5%	-12.4%	0.0%	-25.0%	-24.5%	-31.8%	-19.3%	-14.3%	-16.5%	-66.7%
Total ppb Decrease	22	24	0	1	70	23	237	0	123	3
Decrease, on Average (ppb)	1.7	2.2	0.0	1.0	3.0	2.9	3.1	0.0	1.7	1.5
Total ppb Increase	0	0	0	0	0	0	1	0	1	0
Increase, on Average (ppb)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix IV-4:
Ozone Metrics for 2030 Base Case and Tier 2/Sulfur Control Case[1]

June/July Episodes	**2030 Base Case vs 2030 Tier 2/Sulfur Control Case**									
	CMSA/MSA									
	Composite	**Atlanta**	**Barnstable**	**Baton Rouge**	**Benton Harbor**	**Biloxi**	**Birmingham**	**Boston**	**Buffalo**	**Canton**
Peak (ppb)										
2030 Base	N/A	173	153	154	154	138	139	148	134	134
2030 Control	N/A	162	146	149	152	136	131	138	131	127
# Exceedances										
2030 Base	708	52	5	70	9	23	7	15	3	3
2030 Control	479	20	4	55	9	12	2	5	2	1
% Change	-32.3%	-61.5%	-20.0%	-21.4%	0.0%	-47.8%	-71.4%	-66.7%	-33.3%	-66.7%
Total Nonattainment (ppb)										
2030 Base	8122	772	71	706	110	91	45	115	17	16
2030 Control	5165	182	37	499	91	38	11	28	10	2
% Change	-36.4%	-76.4%	-47.9%	-29.3%	-17.3%	-58.2%	-75.6%	-75.7%	-41.2%	-87.5%
Total ppb Decrease	4248	938	35	237	19	71	55	129	7	19
Decrease, on Average (ppb)	6.0	18.0	7.0	3.4	2.1	3.1	7.9	8.6	2.3	6.3
Total ppb Increase	276	0	0	0	0	0	1	0	0	0
Increase, on Average (ppb)	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
	2007 Exceedances in June/July Episodes For Comparison to 2030 Exceedance									
	Composite	**Atlanta**	**Barnstable**	**Baton Rouge**	**Benton Harbor**	**Biloxi**	**Birmingham**	**Boston**	**Buffalo**	**Canton**
# Exceedances										
2007 Base	563	42	5	57	9	17	6	12	3	2
2007 Control	514	33	4	52	9	13	3	9	3	2
% Change	-8.7%	-21.4%	-20.0%	-8.8%	0.0%	-23.5%	-50.0%	-25.0%	0.0%	0.0%

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[1] Note that values for total non-attainment, total ppb decrease, and total ppb increase are all rounded to the nearest "ppb".

June/July Episodes	**2030 Base Case vs 2030 Tier 2/Sulfur Control Case**									
	CMSA/MSA									
	Charlotte	**Chicago**	**Cleveland**	**Detroit**	**Grand Rapids**	**Hartford**	**Houma**	**Houston**	**Jackson**	**Lafayette**
Peak (ppb)										
2030 Base	148	156	138	152	156	176	133	152	132	146
2030 Control	140	150	143	150	152	168	133	152	120	144
# Exceedances										
2030 Base	2	20	6	14	33	15	10	34	1	25
2030 Control	1	20	4	14	26	13	9	24	0	17
% Change	-50.0%	0.0%	-33.3%	0.0%	-21.2%	-13.3%	-10.0%	-29.4%	-100.0%	-32.0%
Total Nonattainment (ppb)										
2030 Base	35	166	37	138	576	370	38	294	7	171
2030 Control	15	197	24	182	429	283	27	215	0	117
% Change	-57.1%	18.7%	-35.1%	31.9%	-25.5%	-23.5%	-28.9%	-26.9%	-100.0%	-31.6%
Total ppb Decrease	22	37	23	20	162	92	12	91	18	63
Decrease, on Average (ppb)	11.0	1.8	3.8	1.4	4.9	6.1	1.2	2.7	18.0	2.5
Total ppb Increase	0	81	5	69	0	0	0	1	0	0
Increase, on Average (ppb)	0.0	4.0	0.8	4.9	0.0	0.0	0.0	0.0	0.0	0.0
	2007 Exceedances in June/July Episodes For Comparison to 2030 Exceedance									
	Charlotte	**Chicago**	**Cleveland**	**Detroit**	**Grand Rapids**	**Hartford**	**Houma**	**Houston**	**Jackson**	**Lafayette**
# Exceedances										
2007 Base	2	13	4	11	30	13	6	31	1	15
2007 Control	2	14	3	12	29	13	6	30	0	15
% Change	0.0%	7.7%	-25.0%	9.1%	-3.3%	0.0%	0.0%	-3.2%	-100.0%	0.0%

June/July Episodes	**2030 Base Case vs 2030 Tier 2/Sulfur Control Case**								
	CMSA/MSA								
	Louisville	**Memphis**	**Milwaukee**	**Nashville**	**New London**	**New Orleans**	**New York City**	**Philadelphia**	**Pittsburgh**
Peak (ppb)									
2030 Base	137	155	136	157	163	155	184	140	127
2030 Control	134	148	136	142	154	154	177	131	127
# Exceedances									
2030 Base	5	5	4	3	18	43	152	27	1
2030 Control	3	4	3	1	16	31	117	10	1
% Change	-40.0%	-20.0%	-25.0%	-66.7%	-11.1%	-27.9%	-23.0%	-63.0%	0.0%
Total Nonattainment (ppb)									
2030 Base	26	95	28	43	312	358	2247	181	2
2030 Control	22	67	23	17	207	271	1695	35	2
% Change	-15.4%	-29.5%	-17.9%	-60.5%	-33.7%	-24.3%	-24.6%	-80.7%	0.0%
Total ppb Decrease	18	30	15	45	109	106	780	205	3
Decrease, on Average (ppb)	3.6	6.0	3.8	15.0	6.1	2.5	5.1	7.6	3.0
Total ppb Increase	8	0	4	0	0	0	95	0	9
Increase, on Average (ppb)	1.6	0.0	1.0	0.0	0.0	0.0	0.6	0.0	9.0

	2007 Exceedances in June/July Episodes For Comparison to 2030 Exceedance								
	Louisville	**Memphis**	**Milwaukee**	**Nashville**	**New London**	**New Orleans**	**New York City**	**Philadelphia**	**Pittsburgh**
# Exceedances									
2007 Base	2	5	3	2	16	37	123	19	0
2007 Control	2	4	3	1	16	32	118	19	0
% Change	0.0%	-20.0%	0.0%	-50.0%	0.0%	-13.5%	-4.1%	0.0%	0.0%

June/July Episodes	**2030 Base Case vs 2030 Tier 2/Sulfur Control Case**									
	CMSA/MSA									
	Providence	**Richmond**	**Rochester**	**Rockford**	**Sarasota**	**St. Louis**	**Tampa**	**Toledo**	**Washington-Baltimore**	**York**
Peak (ppb)										
2030 Base	152	126	127	133	153	139	162	133	154	125
2030 Control	142	119	125	131	142	131	153	133	146	117
# Exceedances										
2030 Base	15	2	2	2	3	11	21	1	45	1
2030 Control	11	0	2	1	2	2	11	1	25	0
% Change	-26.7%	-100.0%	0.0%	-50.0%	-33.3%	-81.8%	-47.6%	0.0%	-44.4%	-100.0%
Total Nonattainment (ppb)										
2030 Base	193	1	3	11	42	61	294	8	442	0
2030 Control	92	0	1	6	19	7	141	8	165	0
% Change	-52.3%	-100.0%	-66.7%	-45.5%	-54.8%	-88.5%	-52.0%	0.0%	-62.7%	0.0%
Total ppb Decrease	112	15	2	7	29	116	234	0	363	9
Decrease, on Average (ppb)	7.5	7.5	1.0	3.5	9.7	10.5	11.1	0.0	8.1	9.0
Total ppb Increase	0	0	0	0	0	0	0	0	3	0
Increase, on Average (ppb)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	2007 Exceedances in June/July Episodes For Comparison to 2030 Exceedance									
	Providence	**Richmond**	**Rochester**	**Rockford**	**Sarasota**	**St. Louis**	**Tampa**	**Toledo**	**Washington-Baltimore**	**York**
# Exceedances										
2007 Base	13	0	1	1	2	5	15	1	39	0
2007 Control	11	0	0	1	2	4	13	1	35	0
% Change	-15.4%	0.0%	-100.0%	0.0%	0.0%	-20.0%	-13.3%	0.0%	-10.3%	0.0%

Appendix IV-5: Limiting Modeled One-Hour Daily Maxima used in Calculation of Relative Reduction Factors

As part of the identification of the need for the proposed Tier 2 standards, EPA is planning to use a rollback approach to link future-year model ozone changes to present-day ozone design values, thereby allowing an assessment of an area's future year nonattainment status. The specific equation used in the analysis is:

$$DVF_i = RRF_i * DVC_i$$

where DVF_i = the future design value predicted for site i,
RRF_i = the relative reduction factor calculated near site i, and
DVC_i = the current design value monitored at site i.

One of the more important details in an accurate calculation of episode-average RRF_i is to ensure that the calculated factor represents ozone improvements on high ozone days. If ozone predicted near a monitor on a particular day is very much less than the design value, the model predictions for that day could be unresponsive to controls (e.g., location could be upwind of controls for a given meteorological situation). EPA draft guidance on eight-hour attainment demonstrations recommended limiting RRF calculations to those instances where the daily maximum eight-hour model concentration in a nearby grid cell exceeded 70 ppb. This threshold was set based on 90 days of modeling data (at 158 sites) investigating the relationship between the RRF and the base magnitude.

The Tier 2 modeling analyses will attempt to project future-year *one-hour* design values, therefore a separate rollback threshold will be needed. Two simple approaches were used to derive an appropriate cutoff. The first approach is based on the assumption that peak eight-hour ozone concentrations are generally 85 percent of their one-hour counterparts. Using this methodology, the 70 ppb threshold identified as part of the 8-hour analysis discussed above would translate to a 80-85 ppb value (82.4).

The second approach looked at the relationship between one-hour model response (from a preliminary Tier 2 strategy run) and base model one-hour ozone at every grid cell of the domain over the July 8th - July 15th episode. As an example, Figure 1 shows a scatterplot of the two fields for July 14th for an across-the-board NOx simulation. There is a clear relationship between RRF and base ozone up to about 70-85 ppb. The largest reductions (RRFs of approximately 0.8) appear to occur in conjunction with base ozone values greater than about 80 ppb. Figure 2 shows the same style plot for a VOC control run. Again, the relationship between base ozone and ozone response appears to hold only to about 70-85 ppb.

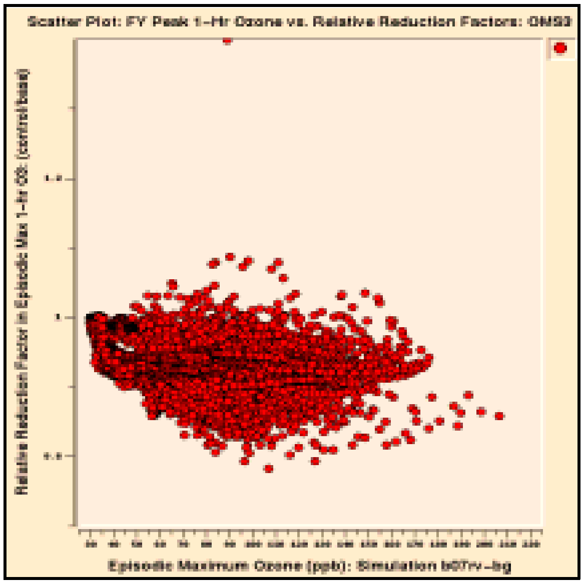

Figure 1. Scatterplot comparing base model ozone concentrations (x-axis) and relative reduction factor (y-axis) for each grid cell on July 14th, 1995. The control simulation was an across-the-board NOx simulation.

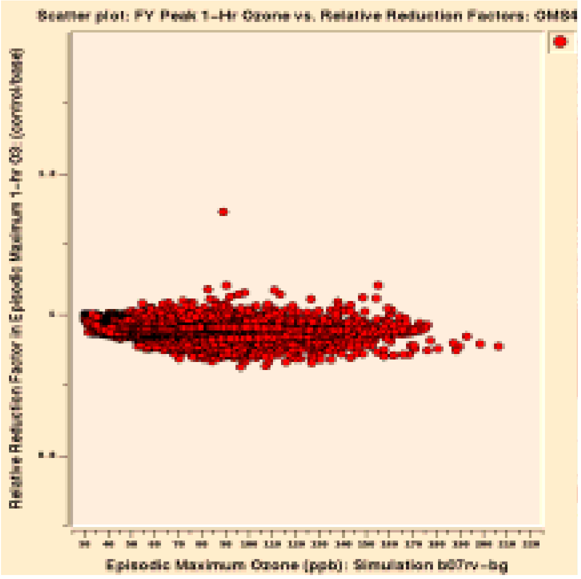

Figure 2. Scatterplot comparing base model ozone concentrations (x-axis) and relative reduction factor (y-axis) for each grid cell on July 14th, 1995. The control simulation was an across-the-board VOC simulation.

Appendix IV-6: Rollback Calculations

1995-1997 Design Values[1]

State	County	1995-97 Des Value	2007-B RRF	2007-B New DV	2007-C RRF	2007-C New DV	CMSA Name (if applicable)	MSA Name (if applicable)
Illinois	Cook	127	0.911	115	0.905	114	Chicago	CHICAGO, IL
Illinois	Du Page	103	0.928	95	0.927	95	Chicago	CHICAGO, IL
Illinois	Kane	116	0.919	106	0.925	107	Chicago	CHICAGO, IL
Illinois	Lake	116	0.915	106	0.912	105	Chicago	CHICAGO, IL
Illinois	McHenry	108	0.913	98	0.917	99	Chicago	CHICAGO, IL
Illinois	Will	108	0.919	99	0.914	98	Chicago	CHICAGO, IL
Indiana	Lake	117	0.915	107	0.910	106	Chicago	GARY, IN
Indiana	Porter	124	0.912	113	0.906	112	Chicago	GARY, IN
Wisconsin	Kenosha	129	0.921	118	0.922	118	Chicago	KENOSHA, WI
Kentucky	Boone	108	0.839	90	0.830	89	Cincinnati	CINCINNATI, OH-KY-IN
Kentucky	Campbell	115	0.895	102	0.889	102	Cincinnati	CINCINNATI, OH-KY-IN
Kentucky	Kenton	114	0.885	100	0.878	100	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Butler	125	0.876	109	0.865	108	Cincinnati	HAMILTON, OH
Ohio	Clermont	116	0.880	102	0.872	101	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Hamilton	119	0.910	108	0.905	107	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Warren	124	0.895	110	0.885	109	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Ashtabula	105	0.907	95	0.896	94	Cleveland	CLEVELAND
Ohio	Cuyahoga	108	0.916	98	0.911	98	Cleveland	CLEVELAND
Ohio	Geauga	112	0.894	100	0.883	98	Cleveland	CLEVELAND
Ohio	Lake	119	0.915	108	0.906	107	Cleveland	CLEVELAND
Ohio	Lorain	101	0.915	92	0.910	91	Cleveland	CLEVELAND
Ohio	Medina	110	0.904	99	0.892	98	Cleveland	CLEVELAND
Ohio	Portage	114	0.906	103	0.893	101	Cleveland	AKRON, OH
Ohio	Summit	113	0.916	103	0.906	102	Cleveland	AKRON, OH
Texas	Collin	132	0.941	124	0.930	122	Dallas	DALLAS, TX
Texas	Dallas	134	0.946	126	0.937	125	Dallas	DALLAS, TX
Texas	Denton	139	0.940	130	0.925	128	Dallas	DALLAS, TX
Texas	Ellis	118	0.967	114	0.946	111	Dallas	DALLAS, TX
Texas	Tarrant	133	0.945	125	0.930	123	Dallas	FORT WORTH, TX
Michigan	Genesee	99	0.902	89	0.891	88	Detroit	FLINT, MI
Michigan	Lenawee	104	0.915	95	0.907	94	Detroit	ANN ARBOR, MI
Michigan	Macomb	124	0.914	113	0.918	113	Detroit	DETROIT, MI

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[1] *** denotes county where RRF is not defined because all current 1-hr daily maximum model ozone values (for all 30 days) are below 80 ppb.

Michigan	Oakland	117	0.913	106	0.922	107	Detroit	DETROIT, MI
Michigan	St Clair	119	0.924	109	0.922	109	Detroit	DETROIT, MI
Michigan	Washtenaw	104	0.924	96	0.917	95	Detroit	ANN ARBOR, MI
Michigan	Wayne	114	0.923	105	0.925	105	Detroit	DETROIT, MI
Texas	Brazoria	148	0.975	144	0.968	143	Houston	BRAZORIA, TX
Texas	Galveston	182	0.968	176	0.961	174	Houston	GALVESTON, TX
Texas	Harris	189	0.944	178	0.944	178	Houston	HOUSTON, TX
Wisconsin	Milwaukee	126	0.918	115	0.914	115	Milwaukee	MILWAUKEE, WI
Wisconsin	Ozaukee	127	0.919	116	0.915	116	Milwaukee	MILWAUKEE, WI
Wisconsin	Racine	119	0.921	109	0.921	109	Milwaukee	RACINE, WI
Wisconsin	Washington	106	0.895	94	0.892	94	Milwaukee	MILWAUKEE, WI
Wisconsin	Waukesha	109	0.900	98	0.897	97	Milwaukee	MILWAUKEE, WI
Connecticut	Fairfield	138	0.937	129	0.934	128	New York City	NEW HAVEN, CT
Connecticut	New Haven	157	0.935	146	0.930	146	New York City	NEW HAVEN, CT
New Jersey	Bergen	122	0.954	116	0.954	116	New York City	BERGEN, NJ
New Jersey	Essex	114	0.938	106	0.934	106	New York City	NEWARK, NJ
New Jersey	Hudson	120	0.938	112	0.934	112	New York City	JERSEY CITY, NJ
New Jersey	Hunterdon	119	0.921	109	0.913	108	New York City	MIDDLESEX, NJ
New Jersey	Mercer	131	0.917	120	0.911	119	New York City	TRENTON, NJ
New Jersey	Middlesex	139	0.921	128	0.916	127	New York City	MIDDLESEX, NJ
New Jersey	Monmouth	138	0.934	128	0.927	127	New York City	MONMOUTH, NJ
New Jersey	Morris	124	0.898	111	0.889	110	New York City	NEWARK, NJ
New Jersey	Ocean	149	0.908	135	0.899	133	New York City	MONMOUTH, NJ
New Jersey	Union	109	0.924	100	0.920	100	New York City	NEWARK, NJ
New York	Bronx	123	0.954	117	0.954	117	New York City	NEW YORK, NY
New York	Dutchess	113	0.799	90	0.794	89	New York City	DUTCHESS COUNTY, NY
New York	Kings	124	0.926	114	0.921	114	New York City	NEW YORK, NY
New York	New York	121	0.926	112	0.921	111	New York City	NEW YORK, NY
New York	Orange	115	0.860	98	0.858	98	New York City	NEWBURGH, NY-PA
New York	Putnam	122	0.893	108	0.891	108	New York City	NEW YORK, NY
New York	Queens	125	0.924	115	0.917	114	New York City	NEW YORK, NY
New York	Richmond	137	0.934	127	0.932	127	New York City	NEW YORK, NY
New York	Suffolk	138	0.923	127	0.918	126	New York City	NASSAU-SUFFOLK, NY
New York	Westchester	121	0.941	113	0.938	113	New York City	NEW YORK, NY
Delaware	New Castle	139	0.849	118	0.838	116	Philadelphia	WILMINGTON, DE-MD
Maryland	Cecil	152	0.842	127	0.831	126	Philadelphia	WILMINGTON, DE-MD
New Jersey	Atlantic	124	0.909	112	0.899	111	Philadelphia	ATLANTIC-CAPE MAY, NJ
New Jersey	Camden	137	0.912	124	0.901	123	Philadelphia	PHILADELPHIA, PA-NJ
New Jersey	Cumberland	115	0.869	99	0.859	98	Philadelphia	VINELAND, NJ
New Jersey	Gloucester	128	0.885	113	0.877	112	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Bucks	137	0.910	124	0.904	123	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Delaware	126	0.882	111	0.874	110	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Montgomery	122	0.890	108	0.886	108	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Philadelphia	130	0.903	117	0.899	116	Philadelphia	PHILADELPHIA, PA-NJ
D.C.	Washington	125	0.906	113	0.902	112	Washington-Baltimore	WASHINGTON, DC

Maryland	Anne Arundel	142	0.892	126	0.883	125	Washington-Baltimore	BALTIMORE,MD
Maryland	Baltimore	130	0.890	115	0.880	114	Washington-Baltimore	BALTIMORE,MD
Maryland	Baltimore City	137	0.899	123	0.892	122	Washington-Baltimore	BALTIMORE,MD
Maryland	Calvert	105	0.848	89	0.835	87	Washington-Baltimore	WASHINGTON, DC
Maryland	Carroll	115	0.882	101	0.871	100	Washington-Baltimore	BALTIMORE,MD
Maryland	Charles	118	0.857	101	0.844	99	Washington-Baltimore	WASHINGTON, DC
Maryland	Harford	145	0.881	127	0.871	126	Washington-Baltimore	BALTIMORE,MD
Maryland	Montgomery	118	0.892	105	0.884	104	Washington-Baltimore	WASHINGTON, DC
Maryland	Prince Georges	132	0.892	117	0.883	116	Washington-Baltimore	WASHINGTON, DC
Virginia	Alexandria City	124	0.909	112	0.906	112	Washington-Baltimore	WASHINGTON, DC
Virginia	Arlington	123	0.909	111	0.906	111	Washington-Baltimore	WASHINGTON, DC
Virginia	Fairfax	124	0.904	112	0.896	111	Washington-Baltimore	WASHINGTON, DC
Virginia	Fauquier	97	0.871	84	0.860	83	Washington-Baltimore	WASHINGTON, DC
Virginia	Prince William	110	0.877	96	0.867	95	Washington-Baltimore	WASHINGTON, DC
Virginia	Stafford	110	0.879	96	0.867	95	Washington-Baltimore	WASHINGTON, DC
New York	Albany	105	0.833	87	0.819	86		ALBANY, NY
New York	Saratoga	101	0.846	85	0.829	83		ALBANY, NY
New York	Schenectady	94	0.815	76	0.808	75		ALBANY, NY
Pennsylvania	Lehigh	114	0.884	100	0.877	99		ALLENTOWN, PA
Pennsylvania	Northampton	109	0.893	97	0.883	96		ALLENTOWN, PA
Pennsylvania	Blair	114	0.851	97	0.839	95		ALTOONA, PA
Wisconsin	Outagamie	98	0.864	84	0.854	83		APPLETON, WI
Wisconsin	Winnebago	98	0.902	88	0.892	87		APPLETON, WI
North Carolina	Buncombe	86	0.825	70	0.803	69		ASHEVILLE, NC
Georgia	De Kalb	136	0.894	121	0.872	118		ATLANTA, GA
Georgia	Douglas	140	0.902	126	0.882	123		ATLANTA, GA
Georgia	Fulton	143	0.899	128	0.876	125		ATLANTA, GA
Georgia	Gwinnett	121	0.894	108	0.860	104		ATLANTA, GA
Georgia	Paulding	112	0.849	95	0.826	92		ATLANTA, GA
Georgia	Rockdale	145	0.875	126	0.839	121		ATLANTA, GA
Georgia	Richmond	118	0.886	104	0.857	101		AUGUSTA, GA-SC
South Carolina	Aiken	104	0.861	89	0.841	87		AUGUSTA, GA-SC

South Carolina	Edgefield	93	0.851	79	0.827	76		AUGUSTA, GA-SC
Texas	Travis	104	0.936	97	0.919	95		AUSTIN, TX
Maine	Penobscot	95	0.942	89	0.932	88		BANGOR, ME
Massachusetts	Barnstable	131	0.911	119	0.900	117		BARNSTABLE, MA
Louisiana	Ascension	121	0.990	119	0.982	118		BATON ROUGE, LA
Louisiana	East Baton Rouge	131	0.981	128	0.970	127		BATON ROUGE, LA
Louisiana	Livingston	127	0.988	125	0.981	124		BATON ROUGE, LA
Louisiana	West Baton Rouge	114	0.979	111	0.965	110		BATON ROUGE, LA
Texas	Jefferson	139	0.981	136	0.975	135		BEAUMONT, TX
Texas	Orange	121	0.987	119	0.979	118		BEAUMONT, TX
Michigan	Berrien	119	0.907	107	0.897	106		BENTON HARBOR, MI
Mississippi	Hancock	105	0.985	103	0.975	102		BILOXI, MS
Mississippi	Jackson	109	0.998	108	0.988	107		BILOXI, MS
Alabama	Jefferson	132	0.879	116	0.857	113		BIRMINGHAM, AL
Alabama	Shelby	127	0.882	112	0.860	109		BIRMINGHAM, AL
Massachusetts	Bristol	138	0.883	121	0.872	120		BOSTON, MA-NH
Massachusetts	Essex	113	0.954	107	0.945	106		BOSTON, MA-NH
Massachusetts	Middlesex	109	0.917	99	0.908	98		BOSTON, MA-NH
Massachusetts	Plymouth	102	0.909	92	0.897	91		BOSTON, MA-NH
Massachusetts	Suffolk	95	0.912	86	0.902	85		BOSTON, MA-NH
Massachusetts	Worcester	108	0.910	98	0.900	97		BOSTON, MA-NH
New Hampshire	Rockingham	130	0.959	124	0.951	123		BOSTON, MA-NH
New York	Erie	91	0.922	83	0.916	83		BUFFALO, NY
New York	Niagara	102	0.920	93	0.911	92		BUFFALO, NY
Vermont	Chittenden	85	***	***	***	***		BURLINGTON, VT
Ohio	Stark	107	0.908	97	0.893	95		CANTON, OH
Iowa	Linn	74	0.936	69	0.927	68		CEDAR RAPIDS, IA
Illinois	Champaign	94	0.869	81	0.857	80		CHAMPAIGN, IL
West Virginia	Kanawha	110	0.891	97	0.882	96		CHARLESTON, WV
South Carolina	Berkeley	94	0.900	84	0.876	82		CHARLESTON, SC
South Carolina	Charleston	102	0.873	89	0.852	86		CHARLESTON, SC
North Carolina	Lincoln	105	0.872	91	0.851	89		CHARLOTTE, NC-SC
North Carolina	Mecklenburg	123	0.876	107	0.855	105		CHARLOTTE, NC-SC
North Carolina	Rowan	119	0.846	100	0.826	98		CHARLOTTE, NC-SC
South Carolina	York	114	0.874	99	0.852	97		CHARLOTTE, NC-SC
Tennessee	Hamilton	113	0.862	97	0.829	93		CHATTANOOGA, TN-GA
Kentucky	Christian	101	0.751	75	0.742	74		CLARKSVILLE, TN-KY
South Carolina	Richland	107	0.893	95	0.861	92		COLUMBIA, SC
Georgia	Muscogee	108	0.900	97	0.867	93		COLUMBUS, GA-AL
Ohio	Delaware	99	0.881	87	0.869	86		COLUMBUS, OH
Ohio	Franklin	107	0.897	95	0.894	95		COLUMBUS, OH
Ohio	Licking	115	0.878	100	0.864	99		COLUMBUS, OH
Ohio	Madison	112	0.872	97	0.861	96		COLUMBUS, OH
Texas	Nueces	115	***	***	***	***		CORPUS CHRISTI, TX
Illinois	Rock Island	83	0.924	76	0.920	76		DAVENPORT, IA-IL
Iowa	Scott	95	0.920	87	0.915	86		DAVENPORT, IA-IL

Florida	Volusia	89	0.955	85	0.928	82		DAYTONA BEACH, FL
Ohio	Clark	118	0.876	103	0.863	101		DAYTON, OH
Ohio	Greene	111	0.865	95	0.852	94		DAYTON, OH
Ohio	Miami	110	0.875	96	0.860	94		DAYTON, OH
Ohio	Montgomery	112	0.874	97	0.864	96		DAYTON, OH
Alabama	Lawrence	98	0.813	79	0.797	78		DECATUR, AL
Alabama	Morgan	114	0.876	99	0.861	98		DECATUR, AL
Illinois	Macon	100	0.859	85	0.846	84		DECATUR, IL
Iowa	Polk	82	0.889	72	0.874	71		DES MOINES, IA
Iowa	Warren	74	0.881	65	0.867	64		DES MOINES, IA
Delaware	Kent	124	0.901	111	0.887	110		DOVER, DE
Indiana	Elkhart	113	0.884	99	0.873	98		ELKHART, IN
New York	Chemung	88	0.900	79	0.884	77		ELMIRA, NY
Pennsylvania	Erie	105	0.908	95	0.897	94		ERIE, PA
Indiana	Posey	99	0.875	86	0.865	85		EVANSVILLE, IN-KY
Indiana	Vanderburgh	114	0.873	99	0.862	98		EVANSVILLE, IN-KY
Indiana	Warrick	113	0.865	97	0.855	96		EVANSVILLE, IN-KY
Kentucky	Henderson	108	0.865	93	0.856	92		EVANSVILLE, IN-KY
North Carolina	Cumberland	106	0.878	93	0.851	90		FAYETTEVILLE, NC
Alabama	Colbert	83	0.812	67	0.796	66		FLORENCE, AL
Florida	Lee	83	0.989	82	0.966	80		FORT MEYERS, FL
Florida	St Lucie	82	0.997	81	0.975	79		FORT PIERCE-, FL
Indiana	Allen	106	0.906	96	0.893	94		FORT WAYNE, IN
Indiana	De Kalb	82	0.904	74	0.890	72		FORT WAYNE, IN
Florida	Alachua	101	0.923	93	0.900	90		GAINESVILLE, FL
Michigan	Allegan	137	0.917	125	0.911	124		GRAND RAPIDS-MUSKEGON, MI
Michigan	Kent	124	0.910	112	0.904	112		GRAND RAPIDS-MUSKEGON, MI
Michigan	Muskegon	136	0.919	124	0.912	124		GRAND RAPIDS-MUSKEGON, MI
Michigan	Ottawa	113	0.919	103	0.913	103		GRAND RAPIDS-MUSKEGON, MI
Wisconsin	Brown	108	0.898	97	0.889	95		GREEN BAY, WI
North Carolina	Davie	105	0.809	84	0.790	82		GREENSBORO, NC
North Carolina	Forsyth	115	0.839	96	0.815	93		GREENSBORO, NC
North Carolina	Guilford	109	0.864	94	0.840	91		GREENSBORO, NC
North Carolina	Pitt	104	0.900	93	0.882	91		GREENVILLE, NC
South Carolina	Anderson	114	0.870	99	0.846	96		GREENVILLE, SC
South Carolina	Cherokee	106	0.860	91	0.840	89		GREENVILLE, SC
South Carolina	Pickens	107	0.847	90	0.823	88		GREENVILLE, SC
South Carolina	Spartanburg	117	0.853	99	0.829	96		GREENVILLE, SC
Pennsylvania	Dauphin	113	0.901	101	0.881	99		HARRISBURG, PA
Pennsylvania	Perry	103	0.844	86	0.825	85		HARRISBURG, PA
Connecticut	Hartford	138	0.923	127	0.917	126		HARTFORD, CT
Connecticut	Litchfield	120	0.897	107	0.888	106		HARTFORD, CT
Connecticut	Middlesex	135	0.939	126	0.933	126		HARTFORD, CT
Connecticut	Tolland	127	0.919	116	0.910	115		HARTFORD, CT
North Carolina	Alexander	94	0.822	77	0.807	75		HICKORY, NC
North Carolina	Caldwell	97	0.869	84	0.847	82		HICKORY, NC
Louisiana	Lafourche	127	0.987	125	0.980	124		HOUMA, LA

Kentucky	Boyd	122	0.858	104	0.847	103		HUNTINGTON, WV-KY-OH
Kentucky	Greenup	114	0.842	95	0.832	94		HUNTINGTON, WV-KY-OH
Ohio	Lawrence	113	0.837	94	0.826	93		HUNTINGTON, WV-KY-OH
West Virginia	Cabell	122	0.862	105	0.851	103		HUNTINGTON, WV-KY-OH
Alabama	Madison	102	0.871	88	0.848	86		HUNTSVILLE, AL
Indiana	Hamilton	116	0.900	104	0.889	103		INDIANAPOLIS, IN
Indiana	Hancock	120	0.902	108	0.890	106		INDIANAPOLIS, IN
Indiana	Johnson	102	0.863	88	0.853	87		INDIANAPOLIS, IN
Indiana	Madison	112	0.901	100	0.888	99		INDIANAPOLIS, IN
Indiana	Marion	115	0.904	103	0.896	103		INDIANAPOLIS, IN
Indiana	Morgan	103	0.887	91	0.881	90		INDIANAPOLIS, IN
Mississippi	Hinds	97	0.944	91	0.921	89		JACKSON, MS
Mississippi	Madison	89	0.968	86	0.960	85		JACKSON, MS
Tennessee	Madison	64	0.826	52	0.811	51		JACKSON, TN
Florida	Duval	116	0.965	111	0.936	108		JACKSONVILLE, FL
Florida	St Johns	91	0.953	86	0.925	84		JACKSONVILLE, FL
New York	Chautauqua	104	0.910	94	0.899	93		JAMESTOWN,NY
Wisconsin	Rock	103	0.898	92	0.890	91		JANESVILLE-BELOIT, WI
Tennessee	Sullivan	111	0.861	95	0.847	94		JOHNSON CITY, TN-VA
Pennsylvania	Cambria	102	0.875	89	0.864	88		JOHNSTOWN, PA
Michigan	Kalamazoo	106	0.897	95	0.886	93		KALAMAZOO, MI
Kansas	Wyandotte	113	0.950	107	0.941	106		KANSAS CITY, MO-KS
Missouri	Clay	128	0.947	121	0.935	119		KANSAS CITY, MO-KS
Missouri	Jackson	88	0.933	82	0.923	81		KANSAS CITY, MO-KS
Missouri	Platte	116	0.946	109	0.937	108		KANSAS CITY, MO-KS
Tennessee	Anderson	110	0.834	91	0.813	89		KNOXVILLE, TN
Tennessee	Blount	117	0.840	98	0.816	95		KNOXVILLE, TN
Tennessee	Knox	120	0.866	103	0.844	101		KNOXVILLE, TN
Tennessee	Loudon	112	0.846	94	0.824	92		KNOXVILLE, TN
Tennessee	Sevier	111	0.796	88	0.778	86		KNOXVILLE, TN
Indiana	Tippecanoe	104	0.891	92	0.879	91		LAFAYETTE, IN
Louisiana	Lafayette	109	0.974	106	0.964	105		LAFAYETTE, LA
Louisiana	Calcasieu	116	0.987	114	0.979	113		LAKE CHARLES, LA
Florida	Polk	99	0.972	96	0.947	93		LAKELAND, FL
Pennsylvania	Lancaster	125	0.895	111	0.882	110		LANCASTER, PA
Michigan	Clinton	88	0.914	80	0.904	79		LANSING, MI
Michigan	Ingham	97	0.916	88	0.907	87		LANSING, MI
Kentucky	Fayette	101	0.885	89	0.872	88		LEXINGTON, KY
Kentucky	Jessamine	98	0.878	86	0.866	84		LEXINGTON, KY
Kentucky	Scott	101	0.831	83	0.819	82		LEXINGTON, KY
Ohio	Allen	106	0.892	94	0.880	93		LIMA, OH
Nebraska	Lancaster	68	0.938	63	0.925	62		LINCOLN, NE
Arkansas	Pulaski	108	0.952	102	0.927	100		LITTLE ROCK, AR
Texas	Gregg	139	0.977	135	0.960	133		LONGVIEW, TX
Indiana	Clark	125	0.889	111	0.883	110		LOUISVILLE, KY-IN
Indiana	Floyd	125	0.895	111	0.891	111		LOUISVILLE, KY-IN
Kentucky	Bullitt	116	0.874	101	0.868	100		LOUISVILLE, KY-IN

Kentucky	Jefferson	120	0.892	107	0.888	106		LOUISVILLE, KY-IN
Kentucky	Oldham	112	0.871	97	0.864	96		LOUISVILLE, KY-IN
New Hampshire	Hillsborough	111	0.902	100	0.895	99		LOWELL, MA-NH
Georgia	Bibb	122	0.808	98	0.783	95		MACON, GA
Wisconsin	Dane	97	0.921	89	0.909	88		MADISON, WI
New Hampshire	Merrimack	98	0.864	84	0.858	84		MANCHESTER, NH
Florida	Brevard	86	0.986	84	0.960	82		MELBOURNE, FL
Arkansas	Crittenden	122	0.914	111	0.904	110		MEMPHIS, TN-AR-MS
Mississippi	De Soto	131	0.941	123	0.928	121		MEMPHIS, TN-AR-MS
Tennessee	Shelby	128	0.943	120	0.935	119		MEMPHIS, TN-AR-MS
Minnesota	Anoka	106	0.913	96	0.912	96		MINNEAPOLIS, MN-WI
Minnesota	Dakota	91	0.918	83	0.915	83		MINNEAPOLIS, MN-WI
Minnesota	Washington	103	0.948	97	0.938	96		MINNEAPOLIS, MN-WI
Wisconsin	St Croix	88	0.938	82	0.924	81		MINNEAPOLIS, MN-WI
Alabama	Mobile	111	0.920	102	0.904	100		MOBILE, AL
Louisiana	Ouachita	94	0.976	91	0.965	90		MONROE, LA
Alabama	Elmore	102	0.894	91	0.871	88		MONTGOMERY, AL
Alabama	Montgomery	92	0.891	81	0.867	79		MONTGOMERY, AL
Tennessee	Davidson	110	0.908	99	0.889	97		NASHVILLE, TN
Tennessee	Dickson	120	0.691	82	0.681	81		NASHVILLE, TN
Tennessee	Rutherford	95	0.870	82	0.846	80		NASHVILLE, TN
Tennessee	Sumner	124	0.887	110	0.869	107		NASHVILLE, TN
Tennessee	Williamson	110	0.813	89	0.795	87		NASHVILLE, TN
Tennessee	Wilson	108	0.858	92	0.841	90		NASHVILLE, TN
Connecticut	New London	144	0.930	133	0.924	133		NEW LONDON, CT
Louisiana	Jefferson	107	0.970	103	0.962	102		NEW ORLEANS, LA
Louisiana	Orleans	96	0.969	93	0.963	92		NEW ORLEANS, LA
Louisiana	St Bernard	98	0.982	96	0.975	95		NEW ORLEANS, LA
Louisiana	St Charles	115	0.978	112	0.972	111		NEW ORLEANS, LA
Louisiana	St James	119	0.990	117	0.982	116		NEW ORLEANS, LA
Louisiana	St John The Baptis	114	0.982	111	0.975	111		NEW ORLEANS, LA
Virginia	Hampton City	109	0.912	99	0.904	98		NORFOLK, VA
Virginia	Suffolk City	108	0.908	98	0.900	97		NORFOLK, VA
Oklahoma	Cleveland	102	0.972	99	0.952	97		OKLAHOMA CITY, OK
Oklahoma	Mc Clain	95	0.993	94	0.972	92		OKLAHOMA CITY, OK
Oklahoma	Oklahoma	110	0.977	107	0.959	105		OKLAHOMA CITY, OK
Nebraska	Douglas	88	0.926	81	0.915	80		OMAHA, NE-IA
Florida	Orange	106	0.985	104	0.956	101		ORLANDO, FL
Florida	Osceola	96	0.983	94	0.955	91		ORLANDO, FL
Florida	Seminole	95	0.975	92	0.945	89		ORLANDO, FL
Kentucky	Daviess	108	0.846	91	0.838	90		OWENSBORO, KY
Ohio	Washington	110	0.843	92	0.833	91		PARKERSBURG, WV-OH
West Virginia	Wood	116	0.830	96	0.821	95		PARKERSBURG, WV-OH
Florida	Escambia	113	0.967	109	0.949	107		PENSACOLA, FL
Illinois	Peoria	95	0.899	85	0.890	84		PEORIA-PEKIN, IL
Pennsylvania	Allegheny	133	0.895	119	0.885	117		PITTSBURGH, PA
Pennsylvania	Beaver	105	0.932	97	0.921	96		PITTSBURGH, PA

Pennsylvania	Washington	117	0.876	102	0.866	101		PITTSBURGH, PA
Pennsylvania	Westmoreland	125	0.897	112	0.887	110		PITTSBURGH, PA
Massachusetts	Berkshire	89	0.880	78	0.869	77		PITTSFIELD, MA
Maine	Cumberland	121	0.931	112	0.923	111		PORTLAND, ME
Maine	York	126	0.959	120	0.951	119		PORTLAND, ME
New Hampshire	Strafford	101	0.917	92	0.911	91		PORTSMOUTH, NH-ME
Rhode Island	Kent	133	0.918	122	0.911	121		PROVIDENCE, RI-MA
Rhode Island	Providence	117	0.926	108	0.917	107		PROVIDENCE, RI-MA
Rhode Island	Washington	113	0.909	102	0.900	101		PROVIDENCE, RI-MA
North Carolina	Chatham	103	0.856	88	0.835	85		RALEIGH, NC
North Carolina	Durham	103	0.883	90	0.862	88		RALEIGH, NC
North Carolina	Franklin	110	0.868	95	0.846	93		RALEIGH, NC
North Carolina	Johnston	107	0.890	95	0.866	92		RALEIGH, NC
North Carolina	Wake	114	0.913	104	0.891	101		RALEIGH, NC
Pennsylvania	Berks	118	0.876	103	0.864	101		READING, PA
Virginia	Charles City	119	0.872	103	0.859	102		RICHMOND, VA
Virginia	Chesterfield	114	0.881	100	0.868	98		RICHMOND, VA
Virginia	Hanover	124	0.882	109	0.866	107		RICHMOND, VA
Virginia	Henrico	115	0.892	102	0.877	100		RICHMOND, VA
Virginia	Roanoke	94	0.846	79	0.828	77		ROANOKE, VA
New York	Monroe	102	0.923	94	0.913	93		ROCHESTER, NY
New York	Wayne	102	0.927	94	0.918	93		ROCHESTER, NY
Illinois	Winnebago	93	0.905	84	0.898	83		ROCKFORD, IL
North Carolina	Edgecombe	102	0.908	92	0.893	91		ROCKY MOUNT, NC
Florida	Manatee	96	0.974	93	0.952	91		SARASOTA, FL
Florida	Sarasota	99	0.968	95	0.944	93		SARASOTA, FL
Georgia	Chatham	85	0.924	78	0.905	76		SAVANNAH, GA
Pennsylvania	Lackawanna	110	0.853	93	0.838	92		SCRANTON, PA
Pennsylvania	Luzerne	110	0.840	92	0.825	90		SCRANTON, PA
Pennsylvania	Mercer	111	0.885	98	0.868	96		SHARON, PA
Wisconsin	Sheboygan	123	0.927	114	0.923	113		SHEBOYGAN, WI
Louisiana	Bossier	98	0.967	94	0.950	93		SHREVEPORT, LA
Louisiana	Caddo	101	0.967	97	0.950	95		SHREVEPORT, LA
Indiana	St Joseph	114	0.896	102	0.886	100		SOUTH BEND, IN
Illinois	Sangamon	98	0.857	84	0.842	82		SPRINGFIELD, IL
Massachusetts	Hampden	126	0.906	114	0.898	113		SPRINGFIELD, MA
Massachusetts	Hampshire	132	0.897	118	0.890	117		SPRINGFIELD, MA
Missouri	Greene	101	0.815	82	0.792	80		SPRINGFIELD, MO
Illinois	Jersey	112	0.896	100	0.875	98		ST. LOUIS, MO-IL
Illinois	Madison	128	0.922	118	0.902	115		ST. LOUIS, MO-IL
Illinois	St Clair	108	0.930	100	0.912	98		ST. LOUIS, MO-IL
Missouri	Jefferson	125	0.915	114	0.896	112		ST. LOUIS, MO-IL
Missouri	St Charles	131	0.922	120	0.900	117		ST. LOUIS, MO-IL
Missouri	St Louis	119	0.924	109	0.905	107		ST. LOUIS, MO-IL
Missouri	St Louis City	108	0.927	100	0.911	98		ST. LOUIS, MO-IL
Pennsylvania	Centre	118	0.861	101	0.845	99		STATE COLLEGE, PA
Ohio	Jefferson	111	0.902	100	0.892	98		STEUBENVILLE, OH-WV

West Virginia	Hancock	106	0.902	95	0.892	94		STEUBENVILLE, OH-WV
New York	Madison	89	0.938	83	0.925	82		SYRACUSE, NY
New York	Onondaga	102	0.911	92	0.899	91		SYRACUSE, NY
Florida	Leon	96	0.928	89	0.900	86		TALLAHASSEE, FL
Florida	Hillsborough	112	0.967	108	0.953	106		TAMPA, FL
Florida	Pasco	92	0.965	88	0.942	86		TAMPA, FL
Florida	Pinellas	93	0.962	89	0.950	88		TAMPA, FL
Indiana	Vigo	107	0.889	95	0.878	93		TERRE HAUTE, IN
Ohio	Lucas	111	0.915	101	0.910	100		TOLEDO, OH
Ohio	Wood	94	0.914	85	0.905	85		TOLEDO, OH
Oklahoma	Tulsa	121	0.977	118	0.964	116		TULSA, OK
Texas	Smith	109	0.955	104	0.938	102		TYLER, TX
New York	Herkimer	88	0.954	83	0.949	83		UTICA-ROME, NY
New York	Oneida	95	0.906	86	0.892	84		UTICA-ROME, NY
Texas	Victoria	95	***	***	***	***		VICTORIA, TX
Wisconsin	Marathon	84	0.893	75	0.883	74		WAUSAU, WI
Florida	Palm Beach	89	0.979	87	0.947	84		WEST PALM BEACH, FL
West Virginia	Ohio	107	0.869	92	0.858	91		WHEELING, WV-OH
Kansas	Sedgwick	96	0.961	92	0.948	91		WICHITA, KS
Pennsylvania	Lycoming	91	0.880	80	0.863	78		WILLIAMSPORT, PA
North Carolina	New Hanover	102	0.921	93	0.905	92		WILMINGTON, NC
Pennsylvania	York	109	0.889	96	0.875	95		YORK, PA
Ohio	Mahoning	109	0.891	97	0.875	95		YOUNGSTOWN, OH
Ohio	Trumbull	109	0.884	96	0.870	94		YOUNGSTOWN, OH
Alabama	Clay	110	0.817	89	0.797	87		
Alabama	Geneva	84	0.893	74	0.869	73		
Alabama	Sumter	83	0.813	67	0.801	66		
Arkansas	Montgomery	79	***	***	***	***		
Arkansas	Newton	83	***	***	***	***		
Delaware	Sussex	123	0.880	108	0.867	106		
Georgia	Dawson	97	0.862	83	0.832	80		
Georgia	Fannin	92	0.855	78	0.823	75		
Georgia	Glynn	89	0.920	81	0.901	80		
Georgia	Sumter	98	0.881	86	0.856	83		
Illinois	Adams	89	0.895	79	0.887	78		
Illinois	Effingham	97	0.838	81	0.825	80		
Illinois	Hamilton	89	0.830	73	0.821	73		
Illinois	Macoupin	102	0.856	87	0.837	85		
Illinois	Randolph	94	0.841	79	0.830	77		
Indiana	Kosciusko	100	0.900	89	0.888	88		
Indiana	La Porte	146	0.924	134	0.919	134		
Indiana	Lawrence	100	0.823	82	0.811	81		
Iowa	Harrison	79	0.924	73	0.913	72		
Iowa	Palo Alto	70	***	***	***	***		
Iowa	Story	87	0.887	77	0.873	75		
Iowa	Van Buren	82	0.899	73	0.890	72		
Kentucky	Bell	92	0.795	73	0.776	71		

Kentucky	Edmonson	113	0.792	89	0.781	88		
Kentucky	Graves	92	0.861	79	0.853	78		
Kentucky	Hancock	114	0.820	93	0.811	92		
Kentucky	Hardin	113	0.827	93	0.818	92		
Kentucky	Lawrence	95	0.798	75	0.789	74		
Kentucky	Livingston	108	0.841	90	0.833	89		
Kentucky	McCracken	100	0.855	85	0.847	84		
Kentucky	McLean	103	0.856	88	0.847	87		
Kentucky	Perry	90	0.766	68	0.754	67		
Kentucky	Pike	98	0.782	76	0.768	75		
Kentucky	Pulaski	94	0.832	78	0.818	76		
Kentucky	Simpson	101	0.817	82	0.805	81		
Kentucky	Trigg	106	0.805	85	0.796	84		
Louisiana	Beauregard	117	0.978	114	0.969	113		
Louisiana	Grant	91	0.974	88	0.961	87		
Louisiana	Iberville	139	0.990	137	0.983	136		
Louisiana	Pointe Coupee	111	0.976	108	0.963	106		
Louisiana	St Mary	104	0.990	102	0.984	102		
Maine	Hancock	121	0.916	110	0.906	109		
Maine	Kennebec	98	0.950	93	0.942	92		
Maine	Knox	119	0.916	108	0.906	107		
Maine	Oxford	79	0.911	71	0.905	71		
Maine	Piscataquis	80	***	***	***	***		
Maine	Sagadahoc	125	0.933	116	0.924	115		
Maine	Somerset	92	0.958	88	0.946	87		
Maryland	Kent	129	0.874	112	0.862	111		
Michigan	Benzie	108	0.933	100	0.924	99		
Michigan	Cass	115	0.890	102	0.879	101		
Michigan	Huron	110	0.931	102	0.923	101		
Michigan	Mason	125	0.919	114	0.912	113		
Michigan	Mecosta	110	0.911	100	0.901	99		
Michigan	Roscommon	99	0.916	90	0.907	89		
Mississippi	Adams	97	0.968	93	0.957	92		
Mississippi	Choctaw	81	0.858	69	0.842	68		
Mississippi	Franklin	94	0.965	90	0.954	89		
Mississippi	Lauderdale	92	0.848	78	0.828	76		
Mississippi	Lee	96	0.828	79	0.812	77		
Mississippi	Sharkey	95	0.954	90	0.945	89		
Mississippi	Warren	97	0.977	94	0.968	93		
Missouri	Monroe	96	0.870	83	0.859	82		
Missouri	Ste Genevieve	108	0.875	94	0.860	92		
New Hampshire	Belknap	89	0.814	72	0.809	71		
New Hampshire	Carroll	88	0.858	75	0.855	75		
New Hampshire	Cheshire	91	0.921	83	0.910	82		
New Hampshire	Coos	93	0.847	78	0.842	78		
New Hampshire	Grafton	77	0.831	63	0.824	63		
New Hampshire	Sullivan	90	0.906	81	0.897	80		

New York	Essex	101	0.951	96	0.945	95		
New York	Hamilton	97	0.813	78	0.804	78		
New York	Jefferson	110	0.928	102	0.922	101		
New York	Ulster	97	0.834	80	0.825	80		
North Carolina	Camden	93	0.920	85	0.910	84		
North Carolina	Caswell	111	0.854	94	0.835	92		
North Carolina	Duplin	89	0.862	76	0.843	75		
North Carolina	Granville	116	0.875	101	0.854	99		
North Carolina	Haywood	103	0.803	82	0.784	80		
North Carolina	Martin	90	0.913	82	0.898	80		
North Carolina	Northampton	100	0.846	84	0.832	83		
North Carolina	Person	100	0.871	87	0.853	85		
North Carolina	Rockingham	113	0.860	97	0.837	94		
North Carolina	Swain	78	0.790	61	0.771	60		
North Carolina	Yancey	108	0.867	93	0.845	91		
Ohio	Clinton	121	0.846	102	0.833	100		
Ohio	Knox	113	0.893	100	0.881	99		
Ohio	Logan	100	0.886	88	0.872	87		
Ohio	Preble	110	0.867	95	0.852	93		
Ohio	Union	75	0.875	65	0.862	64		
Oklahoma	Latimer	100	0.960	96	0.949	94		
Oklahoma	Okmulgee	94	0.975	91	0.961	90		
Pennsylvania	Armstrong	90	0.890	80	0.879	79		
Pennsylvania	Clearfield	116	0.872	101	0.860	99		
Pennsylvania	Franklin	113	0.835	94	0.820	92		
Pennsylvania	Greene	123	0.796	97	0.785	96		
Pennsylvania	Lawrence	101	0.901	90	0.885	89		
Pennsylvania	Monroe	117	0.881	103	0.873	102		
South Carolina	Abbeville	93	0.883	82	0.862	80		
South Carolina	Barnwell	99	0.838	82	0.819	81		
South Carolina	Chester	107	0.878	93	0.856	91		
South Carolina	Colleton	91	0.862	78	0.843	76		
South Carolina	Darlington	94	0.886	83	0.861	80		
South Carolina	Oconee	92	0.838	77	0.809	74		
South Carolina	Union	98	0.816	79	0.797	78		
South Carolina	Williamsburg	85	0.823	69	0.808	68		
Tennessee	Bradley	106	0.771	81	0.751	79		
Tennessee	Coffee	105	0.836	87	0.817	85		
Tennessee	Dyer	112	0.844	94	0.833	93		
Tennessee	Giles	104	0.752	78	0.737	76		
Tennessee	Hamblen	96	0.798	76	0.784	75		
Tennessee	Haywood	97	0.881	85	0.869	84		
Tennessee	Humphreys	102	0.777	79	0.769	78		
Tennessee	Jefferson	125	0.803	100	0.785	98		
Tennessee	Lawrence	93	0.713	66	0.699	65		
Tennessee	Putnam	99	0.822	81	0.804	79		
Vermont	Bennington	99	0.911	90	0.901	89		

Virginia	Caroline	109	0.873	95	0.858	93		
Virginia	Frederick	102	0.824	84	0.811	82		
Virginia	Henry	101	0.813	82	0.796	80		
Virginia	Madison	99	0.790	78	0.777	76		
Virginia	Wythe	94	0.774	72	0.760	71		
West Virginia	Greenbrier	99	0.731	72	0.719	71		
Wisconsin	Columbia	104	0.918	95	0.906	94		
Wisconsin	Dodge	93	0.877	81	0.869	80		
Wisconsin	Door	127	0.945	120	0.936	118		
Wisconsin	Florence	80	***	***	***	***		
Wisconsin	Fond Du Lac	96	0.886	85	0.878	84		
Wisconsin	Jefferson	94	0.893	83	0.884	83		
Wisconsin	Kewaunee	121	0.920	111	0.911	110		
Wisconsin	Manitowoc	145	0.919	133	0.915	132		
Wisconsin	Oneida	78	***	***	***	***		
Wisconsin	Polk	85	0.929	78	0.915	77		
Wisconsin	Sauk	90	0.883	79	0.872	78		
Wisconsin	Vernon	85	0.920	78	0.909	77		
Wisconsin	Walworth	100	0.894	89	0.888	88		

<u>1996-1998 Design Values</u>

State	County	1996-98 Des Value	2007-B RRF	2007-B New DV	2007-C RRF	2007-C New DV	CMSA Name (if applicable)	MSA Name (if applicable)
Illinois	Cook	125	0.920	114	0.921	115	Chicago	CHICAGO, IL
Illinois	Du Page	97	0.928	90	0.927	89	Chicago	CHICAGO, IL
Illinois	Kane	92	0.919	84	0.925	85	Chicago	CHICAGO, IL
Illinois	Lake	124	0.921	114	0.922	114	Chicago	CHICAGO, IL
Illinois	McHenry	94	0.913	85	0.917	86	Chicago	CHICAGO, IL
Illinois	Will	95	0.891	84	0.883	83	Chicago	CHICAGO, IL
Indiana	Lake	113	0.912	103	0.906	102	Chicago	GARY, IN
Indiana	Porter	124	0.912	113	0.906	112	Chicago	GARY, IN
Wisconsin	Kenosha	136	0.921	125	0.922	125	Chicago	KENOSHA, WI
Kentucky	Boone	108	0.839	90	0.830	89	Cincinnati	CINCINNATI, OH-KY-IN
Kentucky	Campbell	115	0.895	102	0.889	102	Cincinnati	CINCINNATI, OH-KY-IN
Kentucky	Kenton	120	0.885	106	0.878	105	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Butler	118	0.876	103	0.865	102	Cincinnati	HAMILTON, OH
Ohio	Clermont	116	0.880	102	0.872	101	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Hamilton	124	0.910	112	0.905	112	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Warren	124	0.895	110	0.885	109	Cincinnati	CINCINNATI, OH-KY-IN
Ohio	Ashtabula	108	0.907	97	0.896	96	Cleveland	CLEVELAND
Ohio	Cuyahoga	106	0.901	95	0.892	94	Cleveland	CLEVELAND
Ohio	Geauga	116	0.894	103	0.883	102	Cleveland	CLEVELAND
Ohio	Lake	123	0.915	112	0.906	111	Cleveland	CLEVELAND
Ohio	Lorain	101	0.915	92	0.910	91	Cleveland	CLEVELAND
Ohio	Medina	105	0.904	94	0.892	93	Cleveland	CLEVELAND
Ohio	Portage	110	0.906	99	0.893	98	Cleveland	AKRON, OH
Ohio	Summit	112	0.916	102	0.906	101	Cleveland	AKRON, OH
Texas	Collin	128	0.941	120	0.930	119	Dallas	DALLAS, TX
Texas	Dallas	135	0.947	127	0.937	126	Dallas	DALLAS, TX
Texas	Denton	135	0.940	126	0.925	124	Dallas	DALLAS, TX
Texas	Ellis	130	0.967	125	0.946	122	Dallas	DALLAS, TX
Texas	Tarrant	128	0.945	120	0.932	119	Dallas	FORT WORTH, TX
Michigan	Genesee	104	0.913	94	0.901	93	Detroit	FLINT, MI
Michigan	Lenawee	99	0.915	90	0.907	89	Detroit	ANN ARBOR, MI
Michigan	Macomb	123	0.914	112	0.918	112	Detroit	DETROIT, MI
Michigan	Oakland	100	0.913	91	0.922	92	Detroit	DETROIT, MI
Michigan	St Clair	118	0.913	107	0.908	107	Detroit	DETROIT, MI
Michigan	Washtenaw	99	0.924	91	0.917	90	Detroit	ANN ARBOR, MI
Michigan	Wayne	114	0.923	105	0.925	105	Detroit	DETROIT, MI
Texas	Brazoria	134	0.975	130	0.968	129	Houston	BRAZORIA, TX
Texas	Galveston	170	0.971	165	0.964	163	Houston	GALVESTON, TX
Texas	Harris	196	0.946	185	0.946	185	Houston	HOUSTON, TX
Wisconsin	Milwaukee	129	0.918	118	0.914	117	Milwaukee	MILWAUKEE, WI
Wisconsin	Ozaukee	129	0.919	118	0.915	118	Milwaukee	MILWAUKEE, WI

Wisconsin	Racine	129	0.921	118	0.921	118	Milwaukee	RACINE, WI
Wisconsin	Washington	106	0.895	94	0.892	94	Milwaukee	MILWAUKEE, WI
Wisconsin	Waukesha	103	0.900	92	0.897	92	Milwaukee	MILWAUKEE, WI
Connecticut	Fairfield	134	0.937	125	0.934	125	New York City	NEW HAVEN, CT
Connecticut	New Haven	139	0.935	129	0.930	129	New York City	NEW HAVEN, CT
New Jersey	Bergen	116	0.954	110	0.954	110	New York City	BERGEN, NJ
New Jersey	Essex	112	0.938	105	0.934	104	New York City	NEWARK, NJ
New Jersey	Hudson	120	0.938	112	0.934	112	New York City	JERSEY CITY, NJ
New Jersey	Hunterdon	119	0.921	109	0.913	108	New York City	MIDDLESEX, NJ
New Jersey	Mercer	121	0.917	110	0.911	110	New York City	TRENTON, NJ
New Jersey	Middlesex	132	0.921	121	0.916	120	New York City	MIDDLESEX, NJ
New Jersey	Monmouth	129	0.934	120	0.927	119	New York City	MONMOUTH, NJ
New Jersey	Morris	116	0.898	104	0.889	103	New York City	NEWARK, NJ
New Jersey	Ocean	139	0.908	126	0.899	124	New York City	MONMOUTH, NJ
New Jersey	Passaic	120	0.918	110	0.913	109	New York City	BERGEN, NJ
New Jersey	Union	109	0.924	100	0.920	100	New York City	NEWARK, NJ
New York	Bronx	122	0.954	116	0.954	116	New York City	NEW YORK, NY
New York	Dutchess	111	0.799	88	0.794	88	New York City	DUTCHESS CO, NY
New York	Kings	114	0.926	105	0.921	104	New York City	NEW YORK, NY
New York	New York	121	0.926	112	0.921	111	New York City	NEW YORK, NY
New York	Orange	115	0.860	98	0.858	98	New York City	NEWBURGH, NY-PA
New York	Putnam	121	0.893	108	0.891	107	New York City	NEW YORK, NY
New York	Queens	141	0.924	130	0.917	129	New York City	NEW YORK, NY
New York	Richmond	138	0.934	128	0.932	128	New York City	NEW YORK, NY
New York	Suffolk	137	0.923	126	0.918	125	New York City	NASSAU, NY
New York	Westchester	115	0.941	108	0.938	107	New York City	NEW YORK, NY
Delaware	New Castle	127	0.849	107	0.838	106	Philadelphia	WILMINGTON, DE-MD
Maryland	Cecil	152	0.842	127	0.831	126	Philadelphia	WILMINGTON, DE-MD
New Jersey	Atlantic	124	0.909	112	0.899	111	Philadelphia	Atlantic City, NJ
New Jersey	Camden	129	0.912	117	0.902	116	Philadelphia	PHILADELPHIA, PA-NJ
New Jersey	Cumberland	115	0.869	99	0.859	98	Philadelphia	VINELAND, NJ
New Jersey	Gloucester	122	0.885	107	0.877	107	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Bucks	119	0.910	108	0.904	107	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Delaware	126	0.882	111	0.874	110	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Montgomery	126	0.890	112	0.886	111	Philadelphia	PHILADELPHIA, PA-NJ
Pennsylvania	Philadelphia	125	0.903	112	0.899	112	Philadelphia	PHILADELPHIA, PA-NJ
D.C.	Washington	118	0.906	106	0.902	106	Washington-Baltimore	WASHINGTON, DC
Maryland	Anne Arundel	138	0.892	123	0.883	121	Washington-Baltimore	BALTIMORE,MD
Maryland	Baltimore	126	0.906	114	0.899	113	Washington-Baltimore	BALTIMORE,MD
Maryland	Baltimore City	137	0.899	123	0.892	122	Washington-Baltimore	BALTIMORE,MD
Maryland	Calvert	112	0.848	94	0.835	93	Washington-Baltimore	WASHINGTON, DC
Maryland	Carroll	115	0.882	101	0.871	100	Washington-	BALTIMORE,MD

							Baltimore	
Maryland	Charles	123	0.857	105	0.844	103	Washington-Baltimore	WASHINGTON, DC
Maryland	Frederick	108	0.880	95	0.869	93	Washington-Baltimore	WASHINGTON, DC
Maryland	Harford	141	0.881	124	0.871	122	Washington-Baltimore	BALTIMORE,MD
Maryland	Montgomery	117	0.892	104	0.884	103	Washington-Baltimore	WASHINGTON, DC
Maryland	Prince Georges	129	0.892	115	0.883	113	Washington-Baltimore	WASHINGTON, DC
Virginia	Alexandria City	119	0.909	108	0.906	107	Washington-Baltimore	WASHINGTON, DC
Virginia	Arlington	119	0.909	108	0.906	107	Washington-Baltimore	WASHINGTON, DC
Virginia	Fairfax	125	0.904	112	0.896	112	Washington-Baltimore	WASHINGTON, DC
Virginia	Fauquier	107	0.871	93	0.860	91	Washington-Baltimore	WASHINGTON, DC
Virginia	Loudoun	116	0.888	102	0.880	102	Washington-Baltimore	WASHINGTON, DC
Virginia	Prince William	115	0.877	100	0.867	99	Washington-Baltimore	WASHINGTON, DC
Virginia	Stafford	112	0.879	98	0.867	97	Washington-Baltimore	WASHINGTON, DC
New York	Albany	105	0.833	87	0.819	86		ALBANY, NY
New York	Saratoga	99	0.846	83	0.829	82		ALBANY, NY
New York	Schenectady	90	0.815	73	0.808	72		ALBANY, NY
Pennsylvania	Lehigh	114	0.884	100	0.877	99		ALLENTOWN, PA
Pennsylvania	Northampton	111	0.893	99	0.883	97		ALLENTOWN, PA
Pennsylvania	Blair	114	0.851	97	0.839	95		ALTOONA, PA
Wisconsin	Outagamie	94	0.864	81	0.854	80		APPLETON, WI
Wisconsin	Winnebago	94	0.902	84	0.892	83		APPLETON, WI
North Carolina	Buncombe	108	0.825	89	0.803	86		ASHEVILLE, NC
Georgia	De Kalb	133	0.905	120	0.886	117		ATLANTA, GA
Georgia	Douglas	133	0.896	119	0.866	115		ATLANTA, GA
Georgia	Fayette	141	0.883	124	0.850	119		ATLANTA, GA
Georgia	Fulton	146	0.899	131	0.876	127		ATLANTA, GA
Georgia	Gwinnett	134	0.894	119	0.860	115		ATLANTA, GA
Georgia	Paulding	124	0.849	105	0.826	102		ATLANTA, GA
Georgia	Rockdale	134	0.875	117	0.839	112		ATLANTA, GA
Georgia	Richmond	118	0.886	104	0.857	101		AUGUSTA, GA-SC
South Carolina	Aiken	109	0.861	93	0.841	91		AUGUSTA, GA-SC
South Carolina	Edgefield	111	0.851	94	0.827	91		AUGUSTA, GA-SC
Texas	Travis	110	0.936	102	0.919	101		AUSTIN, TX
Maine	Penobscot	94	0.942	88	0.932	87		BANGOR, ME
Massachusetts	Barnstable	124	0.911	112	0.900	111		BARNSTABLE, MA

Louisiana	Ascension	123	0.990	121	0.982	120		BATON ROUGE, LA
Louisiana	East Baton Rouge	126	0.981	123	0.970	122		BATON ROUGE, LA
Louisiana	Livingston	127	0.988	125	0.981	124		BATON ROUGE, LA
Louisiana	West Baton Rouge	119	0.979	116	0.965	114		BATON ROUGE, LA
Texas	Jefferson	130	0.984	127	0.974	126		BEAUMONT, TX
Texas	Orange	122	0.987	120	0.979	119		BEAUMONT, TX
Michigan	Berrien	125	0.907	113	0.897	112		BENTON HARBOR, MI
Mississippi	Hancock	105	0.985	103	0.975	102		BILOXI, MS
Mississippi	Jackson	115	0.998	114	0.988	113		BILOXI, MS
Alabama	Jefferson	126	0.893	112	0.871	109		BIRMINGHAM, AL
Alabama	Shelby	128	0.882	112	0.860	110		BIRMINGHAM, AL
Massachusetts	Bristol	118	0.883	104	0.872	102		BOSTON, MA-NH
Massachusetts	Essex	113	0.954	107	0.945	106		BOSTON, MA-NH
Massachusetts	Middlesex	113	0.923	104	0.914	103		BOSTON, MA-NH
Massachusetts	Plymouth	102	0.909	92	0.897	91		BOSTON, MA-NH
Massachusetts	Suffolk	95	0.912	86	0.902	85		BOSTON, MA-NH
Massachusetts	Worcester	115	0.910	104	0.900	103		BOSTON, MA-NH
New Hampshire	Rockingham	120	0.959	115	0.951	114		BOSTON, MA-NH
New York	Erie	107	0.922	98	0.916	97		BUFFALO, NY
New York	Niagara	101	0.920	92	0.911	91		BUFFALO, NY
Vermont	Chittenden	82	***	***	***	***		BURLINGTON, VT
Ohio	Stark	108	0.904	97	0.890	96		CANTON, OH
Iowa	Linn	78	0.934	72	0.925	72		CEDAR RAPIDS, IA
Illinois	Champaign	100	0.869	86	0.857	85		CHAMPAIGN, IL
West Virginia	Kanawha	111	0.891	98	0.882	97		CHARLESTON, WV
South Carolina	Berkeley	101	0.900	90	0.876	88		CHARLESTON, SC
South Carolina	Charleston	99	0.873	86	0.852	84		CHARLESTON, SC
North Carolina	Lincoln	105	0.872	91	0.851	89		CHARLOTTE, NC-SC
North Carolina	Mecklenburg	131	0.897	117	0.877	114		CHARLOTTE, NC-SC
North Carolina	Rowan	126	0.818	103	0.795	100		CHARLOTTE, NC-SC
South Carolina	York	108	0.874	94	0.852	92		CHARLOTTE, NC-SC
Tennessee	Hamilton	125	0.862	107	0.829	103		CHATTANOOGA, TN-GA
Kentucky	Christian	101	0.751	75	0.742	74		CLARKSVILLE, TN-KY
South Carolina	Richland	113	0.896	101	0.864	97		COLUMBIA, SC
Georgia	Muscogee	103	0.900	92	0.867	89		COLUMBUS, GA-AL
Ohio	Delaware	116	0.882	102	0.869	100		COLUMBUS, OH
Ohio	Franklin	109	0.897	97	0.894	97		COLUMBUS, OH
Ohio	Licking	112	0.878	98	0.864	96		COLUMBUS, OH
Ohio	Madison	112	0.872	97	0.861	96		COLUMBUS, OH
Texas	Nueces	102	***	***	***	***		CORPUS CHRISTI, TX
Illinois	Rock Island	83	0.924	76	0.920	76		DAVENPORT, IA-IL
Iowa	Scott	94	0.921	86	0.915	86		DAVENPORT, IA-IL
Florida	Volusia	94	0.955	89	0.928	87		DAYTONA BEACH, FL
Ohio	Clark	119	0.877	104	0.863	102		DAYTON, OH
Ohio	Greene	116	0.865	100	0.852	98		DAYTON, OH
Ohio	Miami	110	0.875	96	0.860	94		DAYTON, OH

Ohio	Montgomery	112	0.874	97	0.864	96		DAYTON, OH
Alabama	Lawrence	101	0.813	82	0.797	80		DECATUR, AL
Alabama	Morgan	114	0.876	99	0.861	98		DECATUR, AL
Illinois	Macon	100	0.859	85	0.846	84		DECATUR, IL
Iowa	Polk	76	0.889	67	0.874	66		DES MOINES, IA
Iowa	Warren	79	0.881	69	0.867	68		DES MOINES, IA
Delaware	Kent	128	0.901	115	0.887	113		DOVER, DE
Indiana	Elkhart	113	0.884	99	0.873	98		ELKHART, IN
New York	Chemung	93	0.900	83	0.884	82		ELMIRA, NY
Pennsylvania	Erie	117	0.908	106	0.897	105		ERIE, PA
Indiana	Posey	105	0.875	91	0.865	90		EVANSVILLE, IN-KY
Indiana	Vanderburgh	114	0.873	99	0.862	98		EVANSVILLE, IN-KY
Indiana	Warrick	115	0.853	98	0.844	97		EVANSVILLE, IN-KY
Kentucky	Henderson	108	0.865	93	0.856	92		EVANSVILLE, IN-KY
North Carolina	Cumberland	108	0.905	97	0.878	94		FAYETTEVILLE, NC
Florida	Lee	98	0.989	96	0.966	94		FORT MEYERS, FL
Florida	St Lucie	88	0.997	87	0.975	85		FORT PIERCE, FL
Indiana	Allen	101	0.904	91	0.890	89		FORT WAYNE, IN
Indiana	De Kalb	82	0.904	74	0.890	72		FORT WAYNE, IN
Florida	Alachua	105	0.923	96	0.900	94		GAINESVILLE, FL
Michigan	Allegan	123	0.917	112	0.911	111		GRAND RAPIDS-MUSKEGON, MI
Michigan	Kent	106	0.897	95	0.887	94		GRAND RAPIDS-MUSKEGON, MI
Michigan	Muskegon	121	0.919	111	0.912	110		GRAND RAPIDS-MUSKEGON, MI
Michigan	Ottawa	106	0.919	97	0.913	96		GRAND RAPIDS-MUSKEGON, MI
Wisconsin	Brown	105	0.898	94	0.889	93		GREEN BAY, WI
North Carolina	Davie	113	0.809	91	0.790	89		GREENSBORO, NC
North Carolina	Forsyth	120	0.862	103	0.836	100		GREENSBORO, NC
North Carolina	Guilford	112	0.864	96	0.840	94		GREENSBORO, NC
North Carolina	Pitt	109	0.900	98	0.882	96		GREENVILLE, NC
South Carolina	Anderson	118	0.870	102	0.846	99		GREENVILLE, SC
South Carolina	Cherokee	116	0.860	99	0.840	97		GREENVILLE, SC
South Carolina	Pickens	109	0.847	92	0.823	89		GREENVILLE, SC
South Carolina	Spartanburg	112	0.853	95	0.829	92		GREENVILLE, SC
Pennsylvania	Dauphin	112	0.887	99	0.866	97		HARRISBURG, PA
Pennsylvania	Perry	103	0.844	86	0.825	85		HARRISBURG, PA
Connecticut	Hartford	139	0.923	128	0.917	127		HARTFORD, CT
Connecticut	Litchfield	120	0.897	107	0.888	106		HARTFORD, CT
Connecticut	Middlesex	135	0.939	126	0.933	126		HARTFORD, CT
Connecticut	Tolland	132	0.919	121	0.910	120		HARTFORD, CT
North Carolina	Alexander	110	0.822	90	0.807	88		HICKORY, NC
North Carolina	Caldwell	111	0.869	96	0.847	93		HICKORY NC
Louisiana	Lafourche	110	0.987	108	0.980	107		HOUMA, LA
Kentucky	Boyd	107	0.858	91	0.847	90		HUNTINGTON, WV-KY-OH
Kentucky	Carter	118	0.824	97	0.814	96		HUNTINGTON, WV-KY-OH
Kentucky	Greenup	118	0.842	99	0.832	98		HUNTINGTON, WV-KY-OH
Ohio	Lawrence	123	0.837	102	0.826	101		HUNTINGTON, WV-KY-OH
West Virginia	Cabell	129	0.862	111	0.851	109		HUNTINGTON, WV-KY-OH

Alabama	Madison	104	0.899	93	0.878	91		HUNTSVILLE, AL
Indiana	Hamilton	125	0.900	112	0.889	111		INDIANAPOLIS, IN
Indiana	Hancock	120	0.902	108	0.890	106		INDIANAPOLIS, IN
Indiana	Johnson	102	0.863	88	0.853	87		INDIANAPOLIS, IN
Indiana	Madison	112	0.901	100	0.888	99		INDIANAPOLIS, IN
Indiana	Marion	118	0.904	106	0.896	105		INDIANAPOLIS, IN
Indiana	Morgan	103	0.887	91	0.881	90		INDIANAPOLIS, IN
Mississippi	Hinds	104	0.944	98	0.921	95		JACKSON, MS
Mississippi	Madison	101	0.968	97	0.960	96		JACKSON, MS
Florida	Duval	111	0.965	107	0.936	103		JACKSONVILLE, FL
Florida	St Johns	91	0.953	86	0.925	84		JACKSONVILLE, FL
New York	Chautauqua	106	0.910	96	0.899	95		JAMESTOWN,NY
Wisconsin	Rock	100	0.898	89	0.890	88		JANESVILLE-BELOIT, WI
Tennessee	Sullivan	113	0.861	97	0.847	95		JOHNSON CITY, TN-VA
Pennsylvania	Cambria	112	0.875	98	0.864	96		JOHNSTOWN, PA
Michigan	Kalamazoo	105	0.897	94	0.886	93		KALAMAZOO, MI
Kansas	Miami	114	0.944	107	0.933	106		KANSAS CITY, MO-KS
Kansas	Wyandotte	113	0.950	107	0.941	106		KANSAS CITY, MO-KS
Missouri	Clay	124	0.947	117	0.935	115		KANSAS CITY, MO-KS
Missouri	Jackson	94	0.933	87	0.923	86		KANSAS CITY, MO-KS
Missouri	Platte	122	0.946	115	0.937	114		KANSAS CITY, MO-KS
Tennessee	Anderson	107	0.834	89	0.813	86		KNOXVILLE, TN
Tennessee	Blount	118	0.840	99	0.816	96		KNOXVILLE, TN
Tennessee	Knox	134	0.860	115	0.838	112		KNOXVILLE, TN
Tennessee	Loudon	112	0.846	94	0.824	92		KNOXVILLE, TN
Tennessee	Sevier	119	0.796	94	0.778	92		KNOXVILLE, TN
Louisiana	Lafayette	101	0.974	98	0.964	97		LAFAYETTE, LA
Louisiana	Calcasieu	122	0.987	120	0.979	119		LAKE CHARLES, LA
Florida	Polk	102	0.970	98	0.946	96		LAKELAND, FL
Pennsylvania	Lancaster	121	0.895	108	0.882	106		LANCASTER, PA
Michigan	Clinton	93	0.914	84	0.904	84		LANSING, MI
Michigan	Ingham	97	0.916	88	0.907	87		LANSING, MI
Kentucky	Fayette	101	0.885	89	0.872	88		LEXINGTON, KY
Kentucky	Jessamine	102	0.878	89	0.866	88		LEXINGTON, KY
Kentucky	Scott	103	0.831	85	0.819	84		LEXINGTON, KY
Ohio	Allen	102	0.892	91	0.880	89		LIMA, OH
Nebraska	Lancaster	64	0.938	60	0.925	59		LINCOLN, NE
Arkansas	Pulaski	102	0.952	97	0.927	94		LITTLE ROCK, AR
Texas	Gregg	128	0.977	125	0.960	122		LONGVIEW, TX
Indiana	Clark	130	0.889	115	0.883	114		LOUISVILLE, KY-IN
Indiana	Floyd	127	0.895	113	0.891	113		LOUISVILLE, KY-IN
Kentucky	Bullitt	111	0.874	96	0.868	96		LOUISVILLE, KY-IN
Kentucky	Jefferson	121	0.892	107	0.888	107		LOUISVILLE, KY-IN
Kentucky	Oldham	120	0.871	104	0.864	103		LOUISVILLE, KY-IN
New Hampshire	Hillsborough	110	0.902	99	0.895	98		LOWELL, MA-NH
Georgia	Bibb	134	0.808	108	0.783	104		MACON, GA
Wisconsin	Dane	94	0.921	86	0.909	85		MADISON, WI

New Hampshire	Merrimack	98	0.864	84	0.858	84		MANCHESTER, NH
Florida	Brevard	93	0.986	91	0.960	89		MELBOURNE, FL
Arkansas	Crittenden	118	0.914	107	0.904	106		MEMPHIS, TN-AR-MS
Mississippi	De Soto	131	0.941	123	0.928	121		MEMPHIS, TN-AR-MS
Tennessee	Shelby	123	0.943	116	0.935	114		MEMPHIS, TN-AR-MS
Minnesota	Anoka	93	0.913	84	0.912	84		MINNEAPOLIS, MN-WI
Minnesota	Dakota	87	0.918	79	0.915	79		MINNEAPOLIS, MN-WI
Minnesota	Washington	97	0.948	91	0.938	91		MINNEAPOLIS, MN-WI
Wisconsin	St Croix	88	0.938	82	0.924	81		MINNEAPOLIS, MN-WI
Alabama	Mobile	114	0.920	104	0.904	103		MOBILE, AL
Louisiana	Ouachita	94	0.976	91	0.965	90		MONROE, LA
Alabama	Elmore	109	0.894	97	0.871	94		MONTGOMERY, AL
Alabama	Montgomery	118	0.891	105	0.867	102		MONTGOMERY, AL
Tennessee	Davidson	120	0.901	108	0.882	105		NASHVILLE, TN
Tennessee	Rutherford	101	0.870	87	0.846	85		NASHVILLE, TN
Tennessee	Sumner	127	0.887	112	0.869	110		NASHVILLE, TN
Tennessee	Williamson	114	0.813	92	0.795	90		NASHVILLE, TN
Tennessee	Wilson	108	0.858	92	0.841	90		NASHVILLE, TN
Connecticut	New London	137	0.930	127	0.924	126		NEW LONDON, CT-MA
Louisiana	Jefferson	111	0.970	107	0.962	106		NEW ORLEANS, LA
Louisiana	Orleans	92	0.969	89	0.963	88		NEW ORLEANS, LA
Louisiana	St Bernard	105	0.982	103	0.975	102		NEW ORLEANS, LA
Louisiana	St Charles	108	0.978	105	0.972	104		NEW ORLEANS, LA
Louisiana	St James	108	0.990	106	0.982	106		NEW ORLEANS, LA
Louisiana	St John The Baptis	109	0.982	107	0.975	106		NEW ORLEANS, LA
Virginia	Hampton City	109	0.912	99	0.904	98		NORFOLK, VA
Virginia	Suffolk City	108	0.908	98	0.900	97		NORFOLK, VA
Florida	Marion	101	0.936	94	0.910	91		OCALA, FL
Oklahoma	Cleveland	104	0.972	101	0.952	98		OKLAHOMA CITY, OK
Oklahoma	Mc Clain	98	0.993	97	0.972	95		OKLAHOMA CITY, OK
Oklahoma	Oklahoma	109	0.979	106	0.962	104		OKLAHOMA CITY, OK
Nebraska	Douglas	82	0.928	76	0.917	75		OMAHA, NE-IA
Florida	Orange	109	0.985	107	0.956	104		ORLANDO, FL
Florida	Osceola	104	0.983	102	0.955	99		ORLANDO, FL
Florida	Seminole	100	0.975	97	0.945	94		ORLANDO, FL
Kentucky	Daviess	108	0.846	91	0.838	90		OWENSBORO, KY
Ohio	Washington	110	0.843	92	0.833	91		PARKERSBURG, WV-OH
West Virginia	Wood	111	0.830	92	0.821	91		PARKERSBURG, WV-OH
Florida	Escambia	117	0.967	113	0.949	111		PENSACOLA, FL
Illinois	Peoria	89	0.899	79	0.890	79		PEORIA-PEKIN, IL
Pennsylvania	Allegheny	122	0.895	109	0.885	107		PITTSBURGH, PA
Pennsylvania	Beaver	113	0.932	105	0.921	104		PITTSBURGH, PA
Pennsylvania	Washington	123	0.876	107	0.866	106		PITTSBURGH, PA
Pennsylvania	Westmoreland	104	0.897	93	0.887	92		PITTSBURGH, PA
Massachusetts	Berkshire	108	0.880	95	0.869	93		PITTSFIELD, MA
Maine	Cumberland	121	0.932	112	0.923	111		PORTLAND, ME
Maine	York	121	0.932	112	0.923	111		PORTLAND, ME

New Hampshire	Strafford	101	0.917	92	0.911	91		PORTSMOUTH, NH-ME
Rhode Island	Kent	114	0.918	104	0.911	103		PROVIDENCE, RI-MA
Rhode Island	Providence	108	0.926	100	0.917	99		PROVIDENCE, RI-MA
Rhode Island	Washington	111	0.909	100	0.900	99		PROVIDENCE, RI-MA
North Carolina	Chatham	106	0.856	90	0.835	88		RALEIGH, NC
North Carolina	Durham	110	0.883	97	0.862	94		RALEIGH, NC
North Carolina	Franklin	112	0.868	97	0.846	94		RALEIGH, NC
North Carolina	Johnston	110	0.890	97	0.866	95		RALEIGH, NC
North Carolina	Wake	116	0.908	105	0.885	102		RALEIGH, NC
Pennsylvania	Berks	117	0.876	102	0.864	101		READING, PA
Virginia	Charles City	123	0.872	107	0.859	105		RICHMOND, VA
Virginia	Chesterfield	114	0.881	100	0.868	98		RICHMOND, VA
Virginia	Hanover	125	0.882	110	0.866	108		RICHMOND, VA
Virginia	Henrico	116	0.892	103	0.877	101		RICHMOND, VA
Virginia	Roanoke	110	0.846	93	0.828	91		ROANOKE, VA
New York	Monroe	96	0.923	88	0.913	87		ROCHESTER, NY
New York	Wayne	101	0.927	93	0.918	92		ROCHESTER, NY
Illinois	Winnebago	86	0.905	77	0.898	77		ROCKFORD, IL
North Carolina	Edgecombe	106	0.908	96	0.893	94		ROCKY MOUNT, NC
Florida	Manatee	102	0.974	99	0.952	97		SARASOTA, FL
Florida	Sarasota	106	0.968	102	0.944	100		SARASOTA, FL
Georgia	Chatham	87	0.924	80	0.905	78		SAVANNAH, GA
Pennsylvania	Lackawanna	108	0.853	92	0.838	90		SCRANTON, PA
Pennsylvania	Luzerne	110	0.840	92	0.825	90		SCRANTON-, PA
Pennsylvania	Mercer	117	0.885	103	0.868	101		SHARON, PA
Wisconsin	Sheboygan	138	0.927	127	0.923	127		SHEBOYGAN, WI
Louisiana	Bossier	109	0.967	105	0.950	103		SHREVEPORT, LA
Louisiana	Caddo	102	0.967	98	0.950	96		SHREVEPORT, LA
Indiana	St Joseph	117	0.896	104	0.886	103		SOUTH BEND, IN
Illinois	Sangamon	96	0.857	82	0.842	80		SPRINGFIELD, IL
Massachusetts	Hampden	116	0.906	105	0.898	104		SPRINGFIELD, MA
Massachusetts	Hampshire	128	0.897	114	0.890	113		SPRINGFIELD, MA
Missouri	Greene	94	0.815	76	0.792	74		SPRINGFIELD, MO
Illinois	Jersey	122	0.896	109	0.875	106		ST. LOUIS, MO-IL
Illinois	Madison	118	0.922	108	0.902	106		ST. LOUIS, MO-IL
Illinois	St Clair	98	0.930	91	0.912	89		ST. LOUIS, MO-IL
Missouri	Jefferson	118	0.915	107	0.896	105		ST. LOUIS, MO-IL
Missouri	St Charles	131	0.922	120	0.900	117		ST. LOUIS, MO-IL
Missouri	St Louis	119	0.924	109	0.905	107		ST. LOUIS, MO-IL
Missouri	St Louis City	107	0.927	99	0.911	97		ST. LOUIS, MO-IL
Pennsylvania	Centre	113	0.861	97	0.845	95		STATE COLLEGE, PA
Ohio	Jefferson	94	0.903	84	0.892	83		STEUBENVILLE, OH-WV
West Virginia	Hancock	99	0.903	89	0.892	88		STEUBENVILLE, OH-WV
New York	Madison	90	0.938	84	0.925	83		SYRACUSE, NY
New York	Onondaga	95	0.911	86	0.899	85		SYRACUSE, NY
Florida	Leon	97	0.928	90	0.900	87		TALLAHASSEE, FL
Florida	Hillsborough	123	0.973	119	0.960	118		TAMPA, FL

Florida	Pasco	98	0.965	94	0.942	92		TAMPA, FL
Florida	Pinellas	104	0.962	100	0.954	99		TAMPA, FL
Indiana	Vigo	107	0.889	95	0.878	93		TERRE HAUTE, IN
Ohio	Lucas	108	0.920	99	0.914	98		TOLEDO, OH
Ohio	Wood	97	0.914	88	0.905	87		TOLEDO, OH
Oklahoma	Tulsa	116	0.977	113	0.965	111		TULSA, OK
Texas	Smith	107	0.955	102	0.939	100		TYLER, TX
New York	Herkimer	84	0.954	80	0.949	79		UTICA-ROME, NY
New York	Oneida	91	0.906	82	0.892	81		UTICA-ROME, NY
Texas	Victoria	92	***	***	***	***		VICTORIA, TX
Wisconsin	Marathon	83	0.893	74	0.883	73		WAUSAU, WI
Florida	Palm Beach	102	0.979	99	0.947	96		WEST PALM BEACH, FL
West Virginia	Ohio	105	0.869	91	0.858	90		WHEELING, WV-OH
Kansas	Sedgwick	97	0.961	93	0.948	91		WICHITA, KS
Pennsylvania	Lycoming	95	0.875	83	0.861	81		WILLIAMSPORT, PA
North Carolina	New Hanover	102	0.921	93	0.905	92		WILMINGTON, NC
Pennsylvania	York	109	0.889	96	0.875	95		YORK, PA
Ohio	Mahoning	111	0.891	98	0.875	97		YOUNGSTOWN, OH
Ohio	Trumbull	114	0.890	101	0.875	99		YOUNGSTOWN, OH
Alabama	Clay	110	0.817	89	0.797	87		
Alabama	Geneva	88	0.893	78	0.869	76		
Alabama	Sumter	81	0.813	65	0.801	64		
Arkansas	Montgomery	85	***	***	***	***		
Arkansas	Newton	84	***	***	***	***		
Delaware	Sussex	125	0.880	109	0.867	108		
Georgia	Dawson	108	0.862	93	0.832	89		
Georgia	Fannin	96	0.855	82	0.823	78		
Georgia	Glynn	99	0.920	91	0.901	89		
Georgia	Sumter	98	0.881	86	0.856	83		
Illinois	Adams	98	0.895	87	0.887	86		
Illinois	Effingham	96	0.838	80	0.825	79		
Illinois	Hamilton	89	0.830	73	0.821	73		
Illinois	Macoupin	107	0.856	91	0.837	89		
Illinois	Randolph	97	0.841	81	0.830	80		
Indiana	La Porte	128	0.924	118	0.919	117		
Indiana	Lawrence	100	0.823	82	0.811	81		
Indiana	Perry	114	0.820	93	0.812	92		
Iowa	Harrison	92	0.924	85	0.913	84		
Iowa	Palo Alto	81	***	***	***	***		
Iowa	Story	87	0.887	77	0.873	75		
Iowa	Van Buren	82	0.899	73	0.890	72		
Kansas	Linn	104	0.961	99	0.949	98		
Kentucky	Bell	98	0.795	77	0.776	76		
Kentucky	Edmonson	108	0.792	85	0.781	84		
Kentucky	Graves	102	0.861	87	0.853	86		
Kentucky	Hancock	111	0.820	91	0.811	90		
Kentucky	Hardin	96	0.827	79	0.818	78		

Kentucky	Lawrence	95	0.798	75	0.789	74		
Kentucky	Livingston	113	0.841	95	0.833	94		
Kentucky	McCracken	109	0.855	93	0.847	92		
Kentucky	McLean	106	0.856	90	0.847	89		
Kentucky	Perry	90	0.766	68	0.754	67		
Kentucky	Pike	100	0.782	78	0.768	76		
Kentucky	Pulaski	95	0.832	79	0.818	77		
Kentucky	Simpson	113	0.817	92	0.805	90		
Kentucky	Trigg	106	0.805	85	0.796	84		
Louisiana	Beauregard	109	0.978	106	0.969	105		
Louisiana	Grant	95	0.974	92	0.961	91		
Louisiana	Iberville	126	0.990	124	0.983	123		
Louisiana	Pointe Coupee	111	0.976	108	0.963	106		
Louisiana	St Mary	102	0.990	100	0.984	100		
Maine	Hancock	118	0.916	108	0.906	106		
Maine	Kennebec	102	0.950	96	0.942	96		
Maine	Knox	113	0.916	103	0.906	102		
Maine	Oxford	77	***	***	***	***		
Maine	Piscataquis	68	***	***	***	***		
Maine	Sagadahoc	124	0.933	115	0.924	114		
Maine	Somerset	93	0.958	89	0.946	87		
Maryland	Kent	126	0.874	110	0.862	108		
Michigan	Benzie	107	0.933	99	0.924	98		
Michigan	Cass	115	0.890	102	0.879	101		
Michigan	Huron	106	0.931	98	0.923	97		
Michigan	Mason	123	0.919	113	0.912	112		
Michigan	Mecosta	124	0.911	112	0.901	111		
Michigan	Missaukee	97	0.912	88	0.902	87		
Michigan	Roscommon	99	0.916	90	0.907	89		
Mississippi	Adams	97	0.968	93	0.957	92		
Mississippi	Choctaw	81	0.858	69	0.842	68		
Mississippi	Lauderdale	92	0.848	78	0.828	76		
Mississippi	Lee	107	0.828	88	0.812	86		
Mississippi	Panola	119	0.887	105	0.873	103		
Mississippi	Sharkey	95	0.954	90	0.945	89		
Mississippi	Warren	97	0.977	94	0.968	93		
Missouri	Cedar	96	0.946	90	0.937	89		
Missouri	Monroe	97	0.870	84	0.859	83		
Missouri	Ste Genevieve	106	0.875	92	0.860	91		
New Hampshire	Belknap	88	0.814	71	0.809	71		
New Hampshire	Carroll	79	0.858	67	0.855	67		
New Hampshire	Cheshire	91	0.921	83	0.910	82		
New Hampshire	Coos	101	0.847	85	0.842	85		
New Hampshire	Grafton	84	0.831	69	0.824	69		
New Hampshire	Sullivan	93	0.906	84	0.897	83		
New York	Essex	93	0.951	88	0.945	87		
New York	Hamilton	91	0.813	74	0.804	73		

New York	Jefferson	104	0.928	96	0.922	95		
New York	Ulster	96	0.834	80	0.825	79		
North Carolina	Avery	96	0.884	84	0.862	82		
North Carolina	Camden	93	0.920	85	0.910	84		
North Carolina	Caswell	118	0.854	100	0.835	98		
North Carolina	Duplin	99	0.862	85	0.843	83		
North Carolina	Granville	124	0.875	108	0.854	105		
North Carolina	Haywood	106	0.827	87	0.804	85		
North Carolina	Lenoir	109	0.879	95	0.860	93		
North Carolina	Martin	94	0.913	85	0.898	84		
North Carolina	Northampton	103	0.846	87	0.832	85		
North Carolina	Person	117	0.871	101	0.853	99		
North Carolina	Rockingham	123	0.860	105	0.837	103		
North Carolina	Swain	87	0.790	68	0.771	67		
North Carolina	Yancey	94	0.867	81	0.845	79		
Ohio	Clinton	118	0.846	99	0.833	98		
Ohio	Knox	108	0.893	96	0.881	95		
Ohio	Logan	99	0.886	87	0.872	86		
Ohio	Preble	111	0.867	96	0.852	94		
Ohio	Union	96	0.875	84	0.862	82		
Oklahoma	Latimer	108	0.960	103	0.949	102		
Oklahoma	Mayes	106	0.974	103	0.962	102		
Oklahoma	Muskogee	93	0.987	91	0.972	90		
Oklahoma	Okmulgee	104	0.975	101	0.961	99		
Pennsylvania	Armstrong	113	0.890	100	0.879	99		
Pennsylvania	Clearfield	117	0.872	102	0.860	100		
Pennsylvania	Franklin	115	0.835	95	0.820	94		
Pennsylvania	Greene	123	0.796	97	0.785	96		
Pennsylvania	Lawrence	98	0.901	88	0.885	86		
Pennsylvania	Monroe	116	0.881	102	0.873	101		
South Carolina	Abbeville	103	0.883	90	0.862	88		
South Carolina	Barnwell	108	0.838	90	0.819	88		
South Carolina	Chester	113	0.878	99	0.856	96		
South Carolina	Colleton	99	0.862	85	0.843	83		
South Carolina	Darlington	99	0.886	87	0.861	85		
South Carolina	Oconee	103	0.838	86	0.809	83		
South Carolina	Union	99	0.816	80	0.797	78		
South Carolina	Williamsburg	89	0.823	73	0.808	71		
Tennessee	Bradley	106	0.771	81	0.751	79		
Tennessee	Coffee	96	0.836	80	0.817	78		
Tennessee	Giles	104	0.752	78	0.737	76		
Tennessee	Hamblen	96	0.798	76	0.784	75		
Tennessee	Haywood	120	0.881	105	0.869	104		
Tennessee	Humphreys	102	0.777	79	0.769	78		
Tennessee	Jefferson	126	0.803	101	0.785	98		
Tennessee	Lawrence	100	0.713	71	0.699	69		
Tennessee	Putnam	106	0.822	87	0.804	85		

Texas	Marion	94	0.973	91	0.955	89		
Vermont	Bennington	98	0.911	89	0.901	88		
Virginia	Caroline	111	0.873	96	0.858	95		
Virginia	Frederick	109	0.824	89	0.811	88		
Virginia	Henry	101	0.813	82	0.796	80		
Virginia	Madison	115	0.790	90	0.777	89		
Virginia	Wythe	96	0.774	74	0.760	72		
West Virginia	Greenbrier	111	0.731	81	0.719	79		
Wisconsin	Columbia	91	0.918	83	0.906	82		
Wisconsin	Dodge	100	0.877	87	0.869	86		
Wisconsin	Florence	83	***	***	***	***		
Wisconsin	Fond Du Lac	96	0.886	85	0.878	84		
Wisconsin	Jefferson	93	0.893	83	0.884	82		
Wisconsin	Kewaunee	117	0.920	107	0.911	106		
Wisconsin	Manitowoc	158	0.919	145	0.915	144		
Wisconsin	Oneida	82	***	***	***	***		
Wisconsin	Polk	81	0.929	75	0.915	74		
Wisconsin	Sauk	89	0.883	78	0.872	77		
Wisconsin	Vernon	83	0.920	76	0.909	75		
Wisconsin	Walworth	100	0.894	89	0.888	88		