Air Quality Impact Analysis Review
Sunflower Electric Power Corporation
Holcomb Expansion
Air Quality Construction Permit Application

Kansas Department of Health and Environment
Bureau of Air
Air Permitting Section

DRAFT, 2010

Table of Contents

Tables

Attachments

I. Introduction

Sunflower submitted a prevention of significant deterioration (PSD) construction permit application for construction of an 895 megawatt (MW) coal fired electric generating unit and associated equipment at the facility's existing electric generating station located in Finney County. An Air Quality Impact Analysis (AQIA) is required as part of a PSD construction permit application to show the impact of the proposed project on the National Ambient Air Quality Standards (NAAQS) and air quality related values. This document summarizes the KDHE review and evaluation of Sunflower's AQIA.

The original permit application was submitted to the Kansas Department of Health and Environment (KDHE) in February 2006. The application was originally for three 700 MW coal fired generating units, and subsequently was reduced to two 700 MW coal fired generating units. The original permit was denied October 18, 2007. An agreement between Governor Mark Parkinson and Sunflower Electric Power Corporation was signed on May 4, 2009. The agreement was for the purpose of facilitating the timely issuance of a final PSD permit for the construction of one 895 MW pulverized coal super critical generating unit. Since there were significant design changes, additional application material was submitted December 16, 2009, with additional updates submitted through June 2010.

Dispersion modeling for this project includes a demonstration of compliance with NAAQS published very recently by the Environmental Protection Agency (EPA). The NAAQS for 1-hour NO_2 was published on February 9, 2010, with an effective date of April 12, 2010. The NAAQS for 1-hour SO_2 was published in the Federal Register on June 22, 2010, with an effective date 60 days after publication. With these new final rules, EPA does not have in place significant impact levels, significant monitoring concentrations, increment, post processors and other implementation guidance and tools that are needed for a dispersion modeling analysis. In addition to the new standards, a NAAQS for $PM_{2.5}$ has existed for some time, also without significant impact levels, significant monitoring concentrations, increment, and other implementation guidance and tools from EPA needed for a dispersion modeling analysis. Recent guidance from EPA has modified recommendations for $PM_{2.5}$ NAAQS compliance demonstrations. KDHE has developed interim tools until EPA develops appropriate tools needed for dispersion modeling. Kansas has not adopted $PM_{2.5}$, NO_2 1-hour, or SO_2 1-hour NAAQS standards into K.A.R. 28-19-350. These NAAQS standards have not been adopted into K.A.R. 28-19-200(nn), which defines National Ambient Air Quality Standard as those standards promulgated at 40 CFR Part 50, revised July 1, 1995. The facility conducted modeling for these new standards based on recommendations from KDHE and EPA.

II. Facility Description

The existing facility is a coal fired electric generating station. The facility is proposing to add an 895 megawatt (MW) nominal capacity coal fired generating unit, including one steam generator (H2), one companion cooling tower, one auxiliary boiler, one emergency diesel power generator, one diesel fire pump booster pump and associated coal, lime, powdered activated carbon, and waste powder handling equipment, at the existing coal fired electric generating unit site. A detailed description of sources of emissions is included in the permit application, Part 1.0 Air Emissions, p. 1-26, Appendix D, and in Part 5.0 Air Dispersion Modeling Analysis, Section 1.5.7 through 1.7. For additional information about the proposed facility and production processes, refer to Part 1.0 of the permit application, and permit application supplemental information submissions.

The existing Holcomb Generating Station is located near Holcomb in Finney County, Kansas. Finney County is designated as an attainment area for all criteria pollutants.

In addition to normal operating conditions, alternate operating scenarios are considered in the modeling analysis.

For sulfur dioxide, emission rates from scrubber atomizer replacements and scrubber feed loop swaps were considered for modeling steam generator scrubber maintenance conditions. For a complete description, see Part 5.0, Section 1.5.7.2 Sulfur Dioxide of the permit application.

For particulate matter, two potential operational scenarios were considered: active coal storage pile utilization, and reserve coal storage pile utilization.

PM_{10} and $PM_{2.5}$ emission rates from the steam generator were modeled at 0.035 lb/MMBtu, but the final BACT emission limit is 0.025 lb/MMBtu. Modeling conducted at the higher emission rate conservatively predicts higher impacts than would be expected from the lower emission rate condition.

For a complete description of particulate matter operating scenarios, refer to the Part 5.0, Section 1.6 Particulate Matter Point Sources of the permit application.

Emissions were modeled at steam generator load capacities of 25%, 50%, 75%, and 100%.

III. Air Quality Impact Analysis (AQIA) Applicability

The proposed facility is a major source as defined by K.A.R. 28-19-350, Prevention of Significant Deterioration. Therefore, the owner or operator must demonstrate that allowable emission increases from the proposed facility would not cause or contribute to air pollution in violation of:

1) any NAAQS in any air quality control region; or
2) any applicable maximum allowable increase of PM_{10}, SO_2, or NO_2 over the baseline concentration in any area (increment).

Emissions from the proposed project and significant emission thresholds are listed in Table 1 below. New major stationary sources with pollutant emissions exceeding significant emission rates must undergo PSD review.

Table 1. Emissions From the Proposed Project and PSD Significant Emission Rates

Pollutant	Project Emissions (tpy)	Significant Emission Rate (tpy)	PSD Review Required
NO_x	1914	40	Yes
SO_2	3240	40	Yes
PM	512	25	Yes
PM_{10}	742	15	Yes
$PM_{2.5}$	722	10	Yes
CO	4579	100	Yes
VOC	119	40	Yes
H_2SO_4	141	7	Yes
Lead	0.53	0.6	No

IV. Model Selection

A dispersion model is a computer simulation that uses mathematical equations to predict air pollution concentrations based on weather, topography, and emissions data. AERMOD is the current model preferred by EPA for use in nearfield regulatory applications, per 40 CFR Part 51 Appendix W, Section 3.1.2, and Appendix A to Appendix W:

> *"AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple sources based on an up-to-date characterization of the atmospheric boundary layer. AERMOD is appropriate for: point, volume, and area sources; surface, near-surface, and elevated releases; rural or urban areas; simple and complex terrain; transport distances over which steady-state assumptions are appropriate, up to 50 km; 1-hour to annual averaging times; and continuous toxic air emissions."*

Based on the proposed facility emissions, the following pollutants must be evaluated as part of the AQIA: nitrogen oxides (NO_x) as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter less than or equal to ten microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and carbon monoxide (CO). The AQIA does not evaluate VOCs as there is currently no EPA approved methodology for evaluating the 8-hour ozone standard.

The AERMOD modeling system, Version 09292, was used to evaluate the impacts of the following emissions that will result from the proposed Sunflower Electric facility:

- 1-hour, annual NO_x;
- 1-hour, 3-hour, 24-hour (expect to be revoked with final 1-hour rule), and annual (expect to be revoked with final 1-hour rule) SO_2;
- 24-hour and annual (revoked by EPA) PM_{10};
- 24-hour and annual $PM_{2.5}$;
- 1-hour and 8-hour CO,

Unless otherwise noted, regulatory default options in the AERMOD model were utilized for this air quality impact analysis.

V. Model Inputs

A. Source Data

The emission rates, point locations, and stack parameters for the emission sources used in the model were based on the data presented in the permit application. Facility point, area, and volume source information is included in the permit application Supplemental Information Submission #11, BACT Update Materials, dated January 13, 2010, Section 5.0, Air Dispersion Modeling Analysis, pages 5-11 through 5-47, and in Appendix D.

B. Urban or Rural

After a review of the appropriate 7.5-minute quadrangle, it was concluded that the area is “rural” for air modeling purposes.

C. Terrain

The proposed project was modeled using the Elevated Terrain Mode. Elevations for the project were obtained using National Elevation Data (NED) files from U.S. Geological Survey 1/3 arc second for a 100 km radius around the facility. The AERMAP processor was used to process the NED files and generate source, building, and receptor heights and hill height scales as applicable. Comparison of the submitted project elevations with the KDHE generated data indicated good correspondence between the two datasets.

D. Meteorological Data

Five years of meteorological (met) data inputs spanning the years of 2004-2008 were created for the AERMOD dispersion model. Meteorological data were prepared by Shaw Environmental. AERMET, the meteorological data pre-processor for the AERMOD modeling system, extracts and processes data in order to calculate the boundary layer parameters that are ultimately necessary for the calculation of pollutant concentrations within the atmosphere. The surface air meteorological data were obtained from the Garden City, Kansas National Weather Service (NWS) station for the years 2004 through 2008. The upper air data were obtained from the Dodge City, Kansas airport NWS station. Information on these stations is shown in Table 2.

Table 2. Meteorological Data Sites					
	Station Name	WBAN #	Latitude/Longitude	Elevation [m]	Years of Data
Surface Air Station	Garden City (GCK)	WBAN#23064	37.933 / -100.733	878.4	2004-2008
Upper Air Station	Dodge City (DDC)	WBAN#13985	37.767 / -99.967	787.0	2004-2008

The surface characteristics for use with the AERMET program were determined using AERSURFACE. Evaluation of a comparison of the surface characteristics surrounding the Garden City Airport and the Sunflower site indicates that the Garden City Airport data are representative of the application site. The Albedo and Bowen ratio, which are evaluated for a 3 kilometer radius around the area, correspond well for the airport and proposed site. Both sites are predominately characterized as grasslands and/or cultivated land (pasture/hay, row crops, small grains) – 93% of the 3 km area surrounding the Garden City Airport and 98% for the Sunflower site.

The surface roughness is evaluated for a 1 kilometer radius around the area of interest. Using AERSURFACE, the 1 km area surrounding the Garden City Airport met station is predominately characterized as commercial/ industrial/ transportation, grasslands/ herbaceous, and urban/ recreational grasses (each accounting for about 30% of the area). The 1 km area surrounding the Sunflower site is predominately characterized as grasslands/ herbaceous (about 83%), about 8% of the area is characterized as transitional – which represents the area of the existing Sunflower power plant which should be characterized as commercial/industrial/transportation. Evaluation of these parameters using AERSURFACE indicates a strong correspondence with the surface roughness values.

After a review of all information, it was concluded that the surface characteristics surrounding the Garden City Airport and the proposed project site indicates that the Garden City Airport data are representative of the proposed project site.

E. Building Downwash

Good Engineering Practice (GEP) stack height for stacks constructed after January 12, 1979 is defined as the greater of

- 65 meters, measured from the base of the stack and

- Stack height calculated from the following formula:

  Hg = H + 1.5L

  Where
  Hg = the GEP stack height
  H = the height of the nearby structure
  L = the lesser of the building height or the greatest crosswind distance of the building also known as maximum projected width.

The proposed steam generating unit stack height exceeds 65 meters. The release heights of all other emissions sources are below the GEP stack heights. For emissions released below GEP height, it is necessary to include the potential effect of plant buildings on the dispersion of emissions. Building downwash was calculated using the Building Profile Input Program (BPIP) with plume rise model enhancements (PRIME).

F. Receptors

AERMOD estimates ambient concentrations using a network of points, called receptors, throughout the region of interest. The model uses emissions and weather information to estimate ambient pollutant concentrations at each receptor location. Model receptors are typically placed at locations that reflect the public's exposure to the pollutant. Receptors were placed at 50 meter spacing along the proposed facility's property boundary. The remaining receptors for significant impact modeling for the proposed facility consisted of a multi-tiered grid as shown in Table 3.

Table 3. Receptor Spacing for Significant Impact Modeling for the Proposed Facility

Distance From Project Center	Receptor Spacing
Fenceline to 500m	50 meters
500m to 2,000m	100 meters
2,000m to 5,000m	500 meters
5,000m to 10,000m	1,000 meters
Beyond 10,000 m	1,000 meters
Additional Grids	50 meters (500 meter hot spots surrounding any receptors with concentrations within 10% of the maximum predicted concentrations that were not already within the 500 meter grid)

Receptors were placed following the spacing in the table above up to 10 kilometers. If significant concentrations of criteria pollutants extended beyond the 10 kilometer initial grid, the grid was expanded outwards up to 50 kilometers.

Screening modeling resulting in a significant impact for any receptors at or beyond the facility fenceline requires a full impact analysis. The screening model area of impact (AOI) was determined by first finding the distance to the farthest receptor showing a concentration greater than the SIL. This distance is then added to 50 kilometers and the area within this radius from the center of the facility is considered to be the AOI. The methodology for determining receptor grids for the full impact analysis is described below.

The receptor grid for SO_2 was expanded to 50 km from the facility fence line. Runs were completed, and any receptors that indicated an impact from the project sources greater than the SIL were identified. Any receptors that were below the threshold were removed, indicating 10,130 receptors needed to be included in the refined analysis for compliance with 3-hour and 24-hour averaging periods. The farthest receptor exceeding the SIL was determined to be a distance of 37 kilometers from the center of the Holcomb Generating Station.

The PM_{10} screening model indicated that concentrations dropped below the SIL well within the initial 10 kilometer receptor grid. Any receptors that were identified in the 24-hour or annual averaging period that had recorded impacts exceeding the SIL were used in the refined analysis. Any receptors that did not record impacts greater than the SIL were removed from the analysis. The results of the analysis indicated that 915 receptors needed to be included in the refined analysis for compliance with the 24-hour and annual averaging periods. This receptor field included the receptors that were significant in both the active pile utilization and the reserve pile utilization scenarios. The farthest receptor exceeding the SIL was determined to be a distance of 5.3 kilometers from the center of Holcomb station.

The $PM_{2.5}$ screening model indicated that concentrations dropped below the SIL well within the initial 10 kilometer receptor grid. Any receptors that were identified in the 24-hour averaging period that had recorded impacts exceeding the interim SIL established by KDHE were used in the refined analysis. Any receptors that did not record impacts greater than the SIL were removed from the analysis. The results of the analysis indicated that 2 receptors needed to be analyzed for compliance with the 24-hour averaging period. This receptor field included the receptors that were significant in both the active pile utilization and the reserve pile utilization scenarios. The farthest receptor exceeding the SIL was determined to be a distance of 2.1 kilometers from the center of Holcomb station. The facility also used a 50 meter receptor grid that was generated in the significant impact modeling runs as a more conservative modeling estimate. This receptor grid included the fence line receptors at 50 meter spacing as well as receptors spaced 50 meters apart out to a distance of 500 meters. This receptor field consisted of 4,041 discrete receptors that were used in the refined model.

VI. Significance Determination

A facility that proposes to emit any pollutant above the PSD significant emission rate thresholds must submit an ambient air quality impact analysis. In order to determine if a full impact model analysis and/or ambient air monitoring is necessary, a facility must complete a preliminary modeling analysis. The preliminary analysis includes only the proposed source or modification so it can be determined if a significant modeled impact will take place. For each pollutant that the model predicts the high first high concentration to be below the significant impact level (SIL) threshold, no further analysis is necessary for that pollutant. The SILs and pre-application monitoring thresholds for applicable pollutants and Sunflower results from the preliminary analysis are shown in Table 4.

Table 4. Significance Determination Table

Pollutant	Averaging Period	Operating Scenario	Maximum Predicted Concentration (μg/m^3)	Modeling Significant Impact Level (SIL) (μg/m^3)	Exceeds SIL?	Pre-application Monitoring Threshold Concentration (μg/m^3)	Exceeds Monitoring Threshold?
NO_2	Annual	100% Load	0.24	1	No	14	No
	1-hour	100% Load	29.24	10[1]	**Yes**	N/A	N/A
CO	8-hour	100% Load	24.42	500	No	575	No
	1-hour	100% Load	80.24	2000	No	N/A	N/A
SO_2	Annual	100% Load	0.55	1	No	N/A	N/A
	24-hour	100% Load	15.19	5	**Yes**	13	**Yes**
	3-hour	100% Load	182.76	25	**Yes**	N/A	N/A
	1-hour	100% Load	106.66	10[1]	**Yes**	N/A	N/A
PM_{10}	Annual (standard revoked by EPA)	Active Pile	1.05	1	Yes (standard revoked by EPA)	N/A	N/A
	24-hour	Active Pile	13.87	5	**Yes**	10	**Yes**
$PM_{2.5}$	Annual	Active Pile	0.41	1[1]	No	N/A	N/A
	24-hour	Active Pile	5.17	5[1]	**Yes**	N/A	N/A

[1] Interim SIL established by KDHE until EPA publishes a final SIL.

Table 4. Significance Determination Table							
Pollutant	Averaging Period	Operating Scenario	Maximum Predicted Concentration (μg/m^3)	Modeling Significant Impact Level (SIL) (μg/m^3)	Exceeds SIL?	Pre-application Monitoring Threshold Concentration (μg/m^3)	Exceeds Monitoring Threshold?
Ozone	>100 tpy VOC emissions	N/A	N/A	N/A	N/A	>100 tpy VOC emissions	**Yes**

The modeled impacts for the proposed facility fall below the modeling significant impact level (SIL) for annual NO_2, annual SO_2, 8-hour CO, 1-hour CO, and annual $PM_{2.5}$.

The new 1-hour NO_2 NAAQS standard was published on February 9, 2010, with an effective date of April 12, 2020. The facility conducted a full impact analysis to demonstrate compliance with the new NO_2 NAAQS.

A full impact analysis was conducted for 24-hour, 3-hour, and 1-hour SO_2. The 1-hour SO_2 NAAQS standard was published in the Federal Register on June 22, 2010, and will be effective 60 days after publication. The 24-hour and annual standards for SO_2 are expected to be revoked prior to issuance of this permit.

A full impact analysis was required for 24-hour PM_{10} and 24-hour $PM_{2.5}$. The facility also conducted a full impact analysis for annual PM_{10}; however, this standard was subsequently revoked by EPA.

The modeled impacts for the proposed project fall below the pre-application ambient monitoring thresholds for annual NO_2 and 8-hour CO.

The modeled impacts for the proposed project exceed the pre-application ambient monitoring thresholds for 24-hour SO_2 (this standard is expected to be revoked when the new 1-hour SO_2 NAAQS becomes effective) and 24-hour PM_{10}. Expected emissions of VOC exceeded 100 tons per year, a threshold that potentially triggers pre-application monitoring. As approved by KDHE, in lieu of pre-application ambient monitoring data, the facility will use representative monitoring data for these pollutants from state monitoring sites located at Cedar Bluff and Dodge City.

VII. Refined Analysis Results

Refined modeling was conducted to demonstrate compliance with the NAAQS for each pollutant and averaging period for which the SIL was exceeded. Evaluation of compliance with the NAAQS requires that the refined modeling accounts for the combined impact of the proposed project, nearby sources, and background concentrations.

KDHE supplied emission sources within the following distances from the facility to Sunflower for the full impact analysis as shown in Table 5.

Table 5. Radius of Impact for SIL	
Pollutant	**Radius of Impact + 50 (km)**
SO_2	90[2]
PM_{10}	60
$PM_{2.5}$	60[2]
NO_2	100[2]

KDHE prepared the nearby source inventories using information available through the KDHE emission inventory database and the facility files. 40 CFR Part 51 Appendix W procedures were followed. The list of nearby sources provided can be found in Part 5.0, Tables 5-43 (SO_2 NAAQS), 5-44 (SO_2 increment) (revised in Table 5-53), Tables 5-58 (PM_{10} NAAQS), 5-59 (PM_{10} increment), and 5-72 ($PM_{2.5}$ NAAQS) of the application. The list of nearby sources for NO_2 1-hour compliance is located in Table 13 of the Supplemental Information Submission #15B submitted May 28, 2010. The significant impact area plus 50 kilometers also extended into Colorado for some pollutants. The Colorado Department of Public Health and Environment was contacted, but there were no sources within the area.

The background concentrations were obtained by the facility through review of the EPA Air Quality System (AQS) and communication with KDHE. Background concentrations prepared by KDHE can be found in Attachment A of this document and are not identical to those obtained by the facility. However, the variations are minor and do not alter the facility's ability to comply with the NAAQS.

Table 6 summarizes the results from the refined analysis and includes the total concentration compared to the NAAQS for each pollutant for which a refined analysis was conducted.

[2] Used interim SIL established by KDHE for new standards.

Table 6. NAAQS Compliance Demonstration						
Pollutant	**Averaging Period**	**Modeled Concentration ($\mu g/m^3$)**	**Background Concentration ($\mu g/m^3$)**	**Total Concentration ($\mu g/m^3$)**	**NAAQS ($\mu g/m^3$)**	**% of NAAQS**
NO_2	1-hour	374.84	34	423.84	188.7	224.6
SO_2	24-hour	213.9	7.9	221.8	365	60.8
	3-hour	873.6	13	886.60	1,300	68.2
	1-hour	555.75	10.5	566.25	195	290.4
PM_{10}	Annual	1.66	26	27.66	50	55.3
	24-hour	10.59	85	95.59	150	63.7
$PM_{2.5}$	24-hour	3.65	18	21.65	35	61.9

NAAQS exceedances were modeled in the 1-hour NO_2 compliance demonstration. The number of receptors with modeled exceedances for each compliance period in the meteorological data utilized is listed in Table 18 of the Supplemental Information Submission #15B submitted May 28, 2010. An analysis was conducted on each receptor for which there was an exceedance. The results of the analyses indicated that for all modeled exceedances, the proposed project has impacts less than the SIL and therefore does not cause or contribute a significant amount to any modeled exceedances. Predicted NAAQS exceedances due to emissions from other sources will be reviewed and addressed separately from this document.

NAAQS exceedances were modeled in the 1-hour SO_2 compliance demonstration. The number of receptors with modeled exceedances for each compliance period in the meteorological data utilized is listed in Table 15 of the Supplemental Information Submission #17B submitted June 21, 2010. An analysis was conducted on each receptor for which there was an exceedance. The results of the analyses indicated that for all modeled exceedances, the proposed project has impacts less than the SIL and therefore does not cause or contribute a significant amount to any modeled exceedances. Predicted NAAQS exceedances due to emissions from other sources will be reviewed and addressed separately from this document.

The analyses indicated that concentration levels of all pollutants resulting from the proposed project, when combined with other sources, would not significantly contribute to an exceedance of the NAAQS.

Model runs were conducted to demonstrate that the allowable increments were not exceeded for each pollutant and averaging period. The contributions from the proposed project were modeled, as well as total increment consumed by all sources that received a permit after the minor source baseline date. The highest second high concentration was used for the short term averaging periods (1-hour, 3-hour, and 24-hour) and the highest first high concentrations were used for comparison with the annual averaging period. The results are summarized in Tables 7 and 8:

Table 7. Holcomb Expansion Project Increment Consumption				
Pollutant	**Averaging Period**	**Modeled Concentration ($\mu g/m^3$)**	**Class II Increment ($\mu g/m^3$)**	**% of Increment**
NO_2	Annual	0.24	25	1.0
SO_2	Annual	0.55	20	2.8
	24-hour	11.73	91	12.9
	3-hour	88.92	512	17.4
PM_{10}	Annual	1.05	17	6.2
	24-hour	7.45	30	24.8

Table 8. All Source Cumulative Increment Consumption				
Pollutant	**Averaging Period**	**Modeled Concentration ($\mu g/m^3$)**	**Increment ($\mu g/m^3$)**	**% of Increment**
SO_2	24-hour	16.28	91	17.9
	3-hour	106.96	512	20.9
PM_{10}	Annual	2.39	17	14.1
	24-hour	11.95	30	39.8

The annual NO_2 concentration modeled was below the significance threshold, so no cumulative analysis was conducted for annual NO_2. No Class II increment has been published by EPA for 1-hour NO_2.

Cumulative increment consumption for SO_2 was done for 3-hour and 24-hour only, since the annual modeled concentration was below the significance threshold.

The analyses indicated that concentration levels of all pollutants resulting from the proposed project, alone and when combined with other increment consuming sources, would comply with PSD Class II increments.

VIII. Visibility Impacts

The PSD regulations require the applicant to provide an analysis of impairment to visibility that will occur as a result of the source and growth associated with the source [40 CFR 52.21(o)(1)]. There are no Federal Class I areas located within 100 km of the proposed facility. The nearest Federal Class I Area is the Great Sand Dunes National Monument, nearly 400 km west of the proposed facility. Wichita Mountains National Wildlife Refuge is slightly more than 400 km southeast of the proposed facility.

At the request of KDHE and US Fish and Wildlife Services (FWS), the applicant completed a Class I Visibility Impact Analysis using the CALPUFF modeling system. This analysis was conducted in consultation with KDHE, EPA Region 7, and FWS. This analysis was done when the application contained two 700 MW steam generating units. The visibility impacts of the project, now reduced to 895 MW, will be lower than those previously determined. The analysis included Great Sand Dunes and Wichita Mountains Class I areas.

Two different methods were used to evaluate background visibility, Method 2 (all values expressed in % light extinction), and Method 6 (all values expressed in deciviews). The Method 2 results did indicate visibility impacts exceeding 5%. Method 6 assesses data on a 98th percentile basis, and predicted impacts to be below 0.5 deciviews.

CALPUFF was used beyond the normally recommended maximum source receptor distance of 300 km, which can cause overestimation of visibility impacts. To address this problem, KDHE completed a Class I Visibility Impact Analysis using the CAMx modeling system, which does not have this distance limitation. The CAMx results indicated no visibility impacts exceeding 0.5 deciviews for any Class I area. This analysis is more representative than the CALPUFF analysis because of the large source receptor distance from Sunflower to surrounding Class I areas (> 400 km). The Alternative Visibility Analysis Using the CAMx Modeling System report is included in Attachment B of this document.

The 2007 CAMx modeling analysis described above was conducted for three 700 MW units. Impacts will be less for the single 895 MW unit currently proposed at the same location.

Per direction from KDHE, an analysis of the Scott Lake Class II area, located approximately 80 km to the north of the facility was performed. The visibility analysis was performed in accordance with the guidelines set forth in EPA-450/4-88-015, *Workbook for Plume Visual Impact Screening and Analysis*. Refer to Part 7.0 Additional Impacts Analysis of the permit application for a detailed discussion of inputs to the VISCREEN model. The screening analysis indicated that some of the Class I screening criteria were exceeded. No criteria have been established for Class II areas.

Analysis of the City of Holcomb was also performed, using a distance of 7 km to the edge of the city and 8 km for the far side of the city. Procedures and inputs used in the Scott Lake analysis were followed. The screening analysis indicates that some of the Class I screening criteria were exceeded. No criteria have been established for Class II areas.

IX. Conclusions

The Ambient Air Quality Analysis is summarized in Part 5.0 Air Dispersion Modeling of the permit application. Evaluation of the facility potential emissions indicated that emissions of NO_2, SO_2, CO, $PM_{2.5}$, and PM_{10} are expected. The AQIA does not evaluate VOCs as there is currently no EPA approved methodology for evaluating the 8-hour ozone standard.

The AERMOD Modeling System was used to determine predicted ground level concentrations.

The results of the initial significant impact modeling indicated that refined modeling was required for 24-hour SO_2, 3-hour SO_2, 1-hour SO_2, 1-hour NO_2, 24-hour PM_{10}, and 24-hour $PM_{2.5}$. The facility also conducted a full impact analysis for annual PM_{10}; however, this standard was subsequently revoked by EPA.

The analyses indicated that concentration levels of all pollutants resulting from the proposed project, when combined with other sources, would not significantly contribute to an exceedance of the NAAQS.

The analyses indicated that concentration levels of all pollutants resulting from the proposed project, when combined with other increment consuming sources, would comply with PSD Class II increments.

The analyses indicated that visibility impacts were within allowable criteria.

X. Recommendations

In addition to control equipment outlined in the permit application, the following requirements were relied on in the modeling analysis and should be included as permit conditions:

- A NO_x hourly emission limit of 3.0 g/HP-hr for the replacement H1 fire pump;
- A requirement to conduct operational and maintenance testing between the hours of 9:00 AM and 6:00 PM only for H2 emergency diesel generator, H2 DFP booster pump, and H1 replacement fire pump;
- Limit sulfur in the fuel oil burned at the Garden City plant to less than 0.5%.

Attachment A

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
Division of Environment
Bureau of Air

MEMORANDUM

Date: June 15, 2010

To: Mindy Bowman
Marian Massoth, Chief, Air Permitting

From: Tom Gross, Chief, Air Monitoring and Planning

Subject: Background Concentrations for Sunflower Electric Power Corporation

Per your recent request, I am attaching recommended background concentrations for the proposed Sunflower Electric Power Corporation Prevention of Significant Deterioration (PSD) construction permit to be located in Holcomb, Kansas.

The table includes five years of historical monitored data from calendar years 2005 through 2009 from sites we consider to be representative of the expected concentrations in Holcomb. The data was pulled from the federal AQS monitoring database.

It also includes our recommended background concentrations for PM2.5, PM10, NOx, and SO2. Please let me know if you have questions about the data or the recommendations.

Attachment: Sunflower background table

C Michael Martin
Douglas Watson

Recommended Background Concentrations - Sunflower

Pollutant	NAAQS PPM	NAAQS ug/m3	Avg Period	Form of Std	Site	Year	Conc. PPM	Conc. ug/m3
NO_2	0.100	188.3	**1-hour**	3 yr avg of 98^{th} %tile of the daily max 1-hour avg	Peck	2005	0.026	49.0
						2006	0.029	54.6
						2007	0.028	52.7
						2008	0.025	47.1
						2009	0.024	45.2
						5 year avg.	**0.026**	**49.0**
Recommended 1-hour NO_2 Background Concentration: 49.0 ug/m3								
SO_2	0.140	366.8	**24-hour**	Not to be exceeded more than once per year	Cedar Bluff	2005	0.005	13.1
						2006	0.002	5.2
						2007	0.003	7.9
						2008	0.003	7.9
						2009	0.001	2.6
						5 year avg.	**0.003**	**7.3**
Recommended 24-hour SO_2 Background Concentration: 7.3 ug/m3								
SO_2	0.500	1300.0	**3-hour**	Not to be exceeded more than once per year	Cedar Bluff	2005	0.006	15.7
						2006	0.002	5.2
						2007	0.003	7.9
						2008	0.003	7.9
						2009	0.002	5.2
						5 year avg.	**0.003**	**8.4**
Recommended 3-hour SO_2 Background Concentration: 8.4 ug/m3								
SO_2	0.075	N/A	**1-hour**	3 yr avg of 99th %tile of the daily max 1-hour avg	Cedar Bluff	2005	0.006	15.7
						2006	0.003	7.9
						2007	0.004	10.5
						2008	0.004	10.5
						2009	0.003	7.9
						5 year avg.	**0.004**	**10.5**
Recommended 1-hour SO_2 Background Concentration: 10.5 ug/m3								

06/04/2010

Recommended Background Concentrations - Sunflower

Pollutant	NAAQS PPM	NAAQS ug/m3	Avg Period	Form of Std	Site	Year	Conc. PPM	Conc. ug/m3
PM_{10}		150	**24-hour Max**	Not to be exceeded more than once per year on avg over 3 years	Dodge City	2005	N/A	57 (6-day)
						2006	N/A	85 (6-day)
						2007	N/A	< 75% capture
						2008	N/A	129 (Cont.)
						2009	N/A	85 (Cont.)
						4 year avg.		**89**
Recommended 24-hour PM_{10} Background Concentration: 89 ug/m3								
PM_{10}		50	**Annual Mean**	N/A	Dodge City	2005	N/A	19
						2006	N/A	27
						2007	N/A	< 75% capture
						2008	N/A	22
						2009	N/A	21
						4 year avg.		**22**
Recommended Annual Mean PM_{10} Background Concentration: 22 ug/m3								
$PM_{2.5}$		35	**24-hour**	3 year avg of 98^{th} %tile of 24 hour conc.	Cedar Bluff	2005	N/A	20
						2006	N/A	18
						2007	N/A	15
						2008	N/A	19
						2009	N/A	15
						5 year avg.		**17**
Recommended 24-hour $PM_{2.5}$ Background Concentration: 17 ug/m3								
$PM_{2.5}$		15	**Annual Mean**	3 year avg of weighted annual mean	Cedar Bluff	2005	N/A	7
						2006	N/A	8
						2007	N/A	7
						2008	N/A	7
						2009	N/A	7
						5 year avg.		**7**
Recommended Annual Mean $PM_{2.5}$ Background Concentration: 7 ug/m3								

06/04/2010

Attachment B

Sunflower Expansion – Alternative Visibility Analysis using the CAMx modeling system

Prepared by:
Kansas Department of Health and Environment
1000 SW Jackson Street, Suite 310
Topeka, KS 66610

June 19, 2007

Introduction

On December 15, 2006 the KDHE received comments from the US Department of the Interior, Fish and Wildlife Service (FWS) concerning the potential visibility impact on the Wichita Mountains Wilderness Class I area from a proposed expansion of the Sunflower Holcomb plant. To address these visibility concerns, the Department and permit applicant representatives worked with the FWS and EPA in establishing a protocol to evaluate the impacts of this expansion on visibility in the Wichita Mountains. This protocol followed Environmental Protection Agency (EPA) and federal land manager (FLM) guidance in choosing CALPUFF as the tool to do this analysis. Unfortunately for this application, CALPUFF is being exercised beyond the normally recommended maximum source receptor distance of 300 km. Knowing that this potential problem could cause an overestimation of the visibility impacts, the KDHE did an additional alternative analysis using the Comprehensive Air Quality Model with Extensions (CAMx) model, which does not have this distance limitation.

CAMx overview and datasets used

CAMx version 4.42, available freely from Environ Corporation www.camx.com, was used in this modeling analysis. CAMx is a photochemical grid model an Eulerian photochemical dispersion model that allows for an integrated "one-atmosphere" assessment of gaseous and particulate air pollution (ozone, PM2.5, PM10, air toxics, mercury) over many scales, ranging from sub-urban to continental (Environ 2006a). CAMx simulates the emission, dispersion, chemical reaction, and removal of pollutants in the troposphere by solving the pollutant continuity equation for each chemical species modeled on a system of nested three-dimensional grids.

This version of CAMx includes the implementation of the particulate source apportionment technology (PSAT) within the full-science plume in grid (PiG). This version of CAMx uses a full-chemistry PiG module for near-source plume chemistry and dynamics and a three-dimensional grid model for plume chemistry, transport, and dispersion at further downwind distances and contains all of the scientific advantages of both CALPUFF and a photochemical grid model.

Because CAMx requires a very data and resource intensive meteorological and emissions inventory dataset, the KDHE relied on the work being done by the Central Air Planning Association (CENRAP) for the Regional Haze Rule. The Department obtained the 2002 MM5 meteorological data and 2002 base F emissions inventory from EPA Region 7. This emissions inventory data was then augmented with projected emissions from Sunflower's proposed expansion along with the new stack parameters from the proposed expansion. The data used were very similar to those being used in the Texas BART determinations. Please see Environ 2006b for addition description of the datasets used.

For the PSAT setup KDHE used the PSAT/OSAT "point source override" feature (Environ 2006b). This was done by having a source region map with one source region for the entire domain and assigning a separate source region value in the point source input file that will override the source region that the point source resides in. In addition, a negative flag was set for Sunflower stack diameters in order for this point source to receive the PiG treatment. An example of the CAMx script used is provided in Appendix B.

Emissions Rates and Stack Parameters

During the development of the CALPUFF modeling protocol KDHE, FWS, and Sunflower representatives discussed appropriate emissions rates to use in the modeling. It was determined that for visibility impacts an expected worst-case normal operating rate should be used. This worst-case normal operating rate excluded startups, shutdowns, malfunctions, and maintenance activities. It was determined that the rates would be 0.09 lbs/MMBtu for SO2 and 0.05 lbs/MMBtu for NOx for each unit. Because these two pollutants dominate the visibility impacts no other pollutants were modeled. CAMx requires emissions to be speciated and expressed in moles/hour (Environ 2006a), therefore, the emissions rates used in CAMx were NO – 5,769 moles/hour, NO2 – 641 moles/hour, and SO2 – 12,427 moles/hour (note this represents all three proposed units operating).

Additional information on the source characteristics can be found in the permit application and CALPUFF modeling protocol (Sunflower Electric Power Corporation. 2006).

Visibility Impacts - Methodology

Visibility impacts were calculated at the Wichita Mountains Class I area using the PSAT tool in CAMx to first estimate the pollutant concentrations of Sunflowers proposed expansion. Visibility impacts were then calculated following the procedures based on the Federal Land Managers' Air Quality Related Values Workgroup report (FLAG, 2000). The FLAG (2000) procedures were developed to estimate visibility impacts at Class I areas from proposed new sources as part of the Prevention of Significant Deterioration (PSD) and New Source Review (NSR) process.

The IMPROVE reconstructed mass extinction equation is used to estimate visibility at Class I areas using IMPROVE monitoring data, and has also been used for evaluating visibility impacts at Class I areas due to new sources using modeling output of a single source or group of sources. The total light extinction due to a source (bsource), in units of inverse megameters (Mm-1), is assumed to be the sum of the light extinction due to the source's individual species concentration impacts times an extinction efficiency coefficient:

bsource = bSO4 + bNO3 + bOC + bEC+ bsoil + bcoarse
bSO4 = 3 [(NH4)2SO4]f(RH)
bNO3 = 3 [NH4NO3]f(RH)
bOC = 4 [OMC]
bEC = 10 [EC]
bSoil = 1 [Soil]
bcoarse = 0.6 [Coarse Mass]

Here f(RH) are relative humidity adjustment factors. The concentrations in the square brackets are in µg/m3 and are based on the PSAT results. For Wichita Mountains the f(RH) values used are 2.75 2.55 2.35 2.35 2.74 2.51 2.2 2.37 2.67 2.5 2.59 2.78 for January through December, respectively (EPA, 2003)

The following species mappings are used to map the CAMx species to those used in the IMPROVE reconstructed mass extinction equation given above (Environ, 2006b):

[(NH4)2SO4] = 1.375 x PSO4
[NH4NO3] = 1.290 x PNO3
[OMC] = POA + SOA1 + SOA2 + SOA3 + SOA4 + SOA5
[EC] = PEC
[Soil] = FPRM + FCRS
[Coarse Mass] = CPRM + CCRS

Here PSO4 and PNO3 are the CAMx particulate sulfate and nitrate species. POA is the CAMx primary particulate organic aerosol species, whereas SOA1-5 are the five secondary organic aerosol species carried in CAMx. Primary elemental carbon is represented by PEC in CAMx. CAMx carries two species that represent the other PM2.5 components (i.e., fine particles that are not SO4, NO3, EC or OC), one for the crustal (FCRS) and the other for the remainder of the primary emitted PM2.5 species (FPRM). Similarly, CAMx carries two species to represent coarse mass (PM2.5-10), one for crustal (CCRS), and one for other coarse PM (CPRM). For the Sunflower expansion project only PSO4 and PNO3 were evaluated.

The haze index (HI) for the source is calculated in deciviews (dv) from the source's extinction plus natural background using the following formula:

HIsource = 10 ln[(bsource + bnatural)/10]

Here, bnatural is the Class I area specific clean natural visibility background, and EPA's default values were used in this analysis. For Wichita Mountains the natural visibility background value used were bnatural = 20.6061 (EPA 2003).

The source's HI was compared against natural conditions to assess the significance of the source's visibility impact. EPA guidance lists natural conditions (bnatural) by Class I area in terms of Mm-1 (Environ, 2006) and assumes clean conditions with no man-made or weather interference. The visibility significance metric for evaluating visibility impact is the change in deciview (del-dv) from the source's and natural conditions haze indices:

del-dv = HIsource – HInatural = 10 ln[(bsource + bnatural)/10] - 10 ln[bnatural/10]
= 10ln[(bsource + bnatural)/bnatural]

Using CAMx PSAT, Sunflowers proposed expansion was modeled as a source group and the sulfate and nitrate species impacts were determined. Using the above methodology the species were reconstructed for visibility and the del-dv was calculated. A threshold of 0.5 del-dv maximum will be used to assess potential contribution to visibility impairment. This is the same threshold established in the Regional Haze rule. This del-dv threshold is also being considered by the FLM's as the replacement to the current Method 2 analysis in CALPUFF.

Visibility Impacts – Results

The visibility impacts from Sunflower's proposed expansion were calculated at the Wichita Mountains Class I area and only included the impacts of sulfate and nitrate formation resulting from the sources proposed expansion. Again, the sulfate and nitrate impacts are expected to represent the great majority of the visibility impairment from this source.

Using the methodology described above, the visibility impacts due to sulfate and nitrate on a daily basis (sorted by descending del-dv) were:

ClassI Area	Julian Date	bSO4	bNO3	Del-dv
WIMO1	342	6.86E-01	3.06E-01	0.47
WIMO1	340	5.54E-01	1.97E-01	0.36
WIMO1	38	4.07E-01	2.76E-01	0.33
WIMO1	4	3.86E-01	2.20E-01	0.29
WIMO1	277	5.24E-01	4.02E-02	0.27
WIMO1	360	0.175223	3.16E-01	0.24
WIMO1	39	2.58E-01	2.28E-01	0.23
WIMO1	343	3.30E-01	1.23E-01	0.22
WIMO1	317	2.21E-01	2.09E-01	0.21
WIMO1	111	0.426719	2.35E-03	0.21
WIMO1	299	3.16E-01	9.70E-02	0.20

WIMO1	341	3.29E-01	8.13E-02	0.20
WIMO1	112	3.88E-01	1.29E-02	0.19
WIMO1	359	0.108471	0.247125	0.17
WIMO1	3	2.31E-01	1.11E-01	0.16
WIMO1	361	0.182219	1.50E-01	0.16
WIMO1	347	1.43E-01	1.73E-01	0.15
WIMO1	308	2.04E-01	8.92E-02	0.14
WIMO1	325	6.88E-02	2.15E-01	0.14
WIMO1	346	2.06E-01	7.01E-02	0.13
WIMO1	309	1.71E-01	7.07E-02	0.12
WIMO1	321	8.84E-02	1.26E-01	0.10
WIMO1	20	0.0598496	1.25E-01	0.09
WIMO1	300	1.54E-01	2.81E-02	0.09
WIMO1	324	5.50E-02	1.24E-01	0.09
WIMO1	345	1.43E-01	3.53E-02	0.09
WIMO1	5	0.0870633	6.99E-02	0.08
WIMO1	51	1.25E-01	3.19E-02	0.08
WIMO1	114	1.57E-01	1.28E-06	0.08
WIMO1	258	1.49E-01	5.95E-03	0.07
WIMO1	353	3.57E-02	1.16E-01	0.07
WIMO1	279	1.48E-01	1.28E-03	0.07
WIMO1	351	0.038806	1.01E-01	0.07
WIMO1	344	1.05E-01	3.18E-02	0.07
WIMO1	278	1.14E-01	1.78E-02	0.06
WIMO1	316	8.74E-02	4.39E-02	0.06
WIMO1	12	0.0340993	9.64E-02	0.06
WIMO1	302	1.11E-01	1.73E-02	0.06
WIMO1	320	5.18E-02	7.37E-02	0.06
WIMO1	52	0.0682877	0.0536748	0.06
WIMO1	13	4.13E-02	7.87E-02	0.06
WIMO1	26	5.13E-02	6.58E-02	0.06
WIMO1	19	3.24E-02	8.31E-02	0.06
WIMO1	6	0.0227102	9.04E-02	0.05
WIMO1	348	2.94E-02	7.91E-02	0.05
WIMO1	35	3.23E-02	7.14E-02	0.05
WIMO1	326	3.40E-02	6.55E-02	0.05
WIMO1	356	0.025068	7.44E-02	0.05
WIMO1	333	5.02E-02	4.87E-02	0.05
WIMO1	332	3.27E-02	6.60E-02	0.05
WIMO1	263	8.10E-02	1.39E-02	0.05
WIMO1	14	2.04E-02	7.36E-02	0.05
WIMO1	25	0.0228009	6.99E-02	0.04
WIMO1	7	2.26E-02	6.85E-02	0.04
WIMO1	33	0.0245823	0.0618755	0.04
WIMO1	47	0.0297575	5.55E-02	0.04
WIMO1	1	4.55E-02	3.92E-02	0.04
WIMO1	307	6.57E-02	1.85E-02	0.04
WIMO1	2	3.68E-02	4.55E-02	0.04
WIMO1	327	4.06E-02	4.14E-02	0.04
WIMO1	354	1.88E-02	6.07E-02	0.04

WIMO1	11	0.0147696	6.38E-02	0.04
WIMO1	63	0.022538	5.42E-02	0.04
WIMO1	40	0.0594941	1.67E-02	0.04
WIMO1	80	0.0622436	0.0132052	0.04
WIMO1	264	7.10E-02	4.11E-03	0.04
WIMO1	48	0.0399502	3.41E-02	0.04
WIMO1	318	6.74E-02	5.08E-03	0.04
WIMO1	34	2.54E-02	4.50E-02	0.03
WIMO1	68	0.0511927	0.019053	0.03
WIMO1	15	0.0209406	4.78E-02	0.03
WIMO1	31	0.024684	0.043762	0.03
WIMO1	271	6.65E-02	1.42E-03	0.03
WIMO1	303	5.43E-02	1.28E-02	0.03
WIMO1	56	0.0536982	1.17E-02	0.03
WIMO1	270	6.30E-02	1.06E-03	0.03
WIMO1	58	0.0206062	4.26E-02	0.03
WIMO1	337	2.79E-02	3.52E-02	0.03
WIMO1	32	0.0182816	4.41E-02	0.03
WIMO1	334	2.88E-02	3.28E-02	0.03
WIMO1	322	5.10E-02	1.05E-02	0.03
WIMO1	79	0.0533059	7.91E-03	0.03
WIMO1	82	0.0506305	1.03E-02	0.03
WIMO1	8	2.01E-02	4.07E-02	0.03
WIMO1	301	5.21E-02	8.59E-03	0.03
WIMO1	257	6.00E-02	4.14E-04	0.03
WIMO1	87	0.0591416	3.33E-04	0.03
WIMO1	315	3.11E-02	2.80E-02	0.03
WIMO1	310	3.27E-02	2.35E-02	0.03
WIMO1	21	0.0175148	3.86E-02	0.03
WIMO1	314	2.93E-02	2.56E-02	0.03
WIMO1	285	5.02E-02	3.82E-03	0.03
WIMO1	71	0.0448433	8.70E-03	0.03
WIMO1	88	0.0525789	0.000398339	0.03
WIMO1	74	0.0419255	1.08E-02	0.03
WIMO1	319	3.67E-02	1.36E-02	0.02
WIMO1	123	4.68E-02	5.50E-04	0.02
WIMO1	83	0.046307	4.39E-04	0.02
WIMO1	50	4.56E-02	6.07E-04	0.02
WIMO1	37	0.0321769	1.35E-02	0.02
WIMO1	27	3.14E-02	1.42E-02	0.02
WIMO1	84	3.44E-02	9.00E-03	0.02
WIMO1	72	3.83E-02	4.48E-03	0.02
WIMO1	59	2.28E-02	1.98E-02	0.02
WIMO1	43	0.0167564	2.47E-02	0.02
WIMO1	336	3.65E-02	4.99E-03	0.02
WIMO1	41	0.024677	1.62E-02	0.02
WIMO1	73	0.040452	5.51E-05	0.02
WIMO1	328	3.09E-02	9.24E-03	0.02
WIMO1	62	9.85E-03	2.98E-02	0.02
WIMO1	350	1.80E-02	2.15E-02	0.02

WIMO1	280	3.77E-02	1.40E-03	0.02
WIMO1	122	0.0385415	2.15E-04	0.02
WIMO1	311	3.11E-02	7.32E-03	0.02
WIMO1	124	0.0355916	1.97E-04	0.02
WIMO1	54	0.0206799	1.46E-02	0.02
WIMO1	49	0.0288634	5.57E-03	0.02
WIMO1	30	0.0164938	1.79E-02	0.02
WIMO1	42	1.11E-02	2.32E-02	0.02
WIMO1	265	3.24E-02	1.77E-03	0.02
WIMO1	323	1.50E-02	1.87E-02	0.02
WIMO1	312	3.15E-02	3.68E-04	0.02
WIMO1	24	0.0121605	0.0191778	0.02
WIMO1	86	0.0272782	4.04E-03	0.02
WIMO1	168	3.10E-02	1.79E-04	0.02
WIMO1	330	1.24E-02	1.85E-02	0.01
WIMO1	355	1.15E-02	1.86E-02	0.01
WIMO1	119	0.0285772	0.00129779	0.01
WIMO1	306	2.40E-02	5.89E-03	0.01
WIMO1	364	1.67E-02	1.26E-02	0.01
WIMO1	167	2.87E-02	2.96E-05	0.01
WIMO1	254	2.81E-02	4.32E-05	0.01
WIMO1	60	0.0220048	4.42E-03	0.01
WIMO1	272	2.60E-02	8.46E-05	0.01
WIMO1	294	2.38E-02	1.36E-03	0.01
WIMO1	295	2.41E-02	9.69E-04	0.01
WIMO1	113	0.0243216	4.66E-05	0.01
WIMO1	22	0.0164938	7.30E-03	0.01
WIMO1	81	1.74E-02	6.25E-03	0.01
WIMO1	304	1.88E-02	4.60E-03	0.01
WIMO1	66	0.0221696	9.46E-04	0.01
WIMO1	16	1.47E-02	8.10E-03	0.01
WIMO1	57	6.72E-03	1.54E-02	0.01
WIMO1	146	0.0215539	0.000192141	0.01
WIMO1	23	1.57E-02	5.86E-03	0.01
WIMO1	305	1.80E-02	3.27E-03	0.01
WIMO1	267	2.04E-02	7.18E-04	0.01
WIMO1	291	2.00E-02	1.05E-03	0.01
WIMO1	143	0.0209209	2.65E-11	0.01
WIMO1	331	8.50E-03	1.24E-02	0.01
WIMO1	142	0.0207853	1.88E-05	0.01
WIMO1	115	2.01E-02	2.24E-04	0.01
WIMO1	36	9.66E-03	1.06E-02	0.01
WIMO1	141	1.99E-02	3.29E-04	0.01
WIMO1	46	0.0124858	7.62E-03	0.01
WIMO1	100	0.0192421	4.53E-04	0.01
WIMO1	65	0.019339	2.31E-04	0.01
WIMO1	55	0.0187865	5.55E-04	0.01
WIMO1	129	0.0190447	6.13E-05	0.01
WIMO1	17	0.00802911	1.09E-02	0.01
WIMO1	145	1.88E-02	1.10E-04	0.01

WIMO1	290	1.47E-02	4.12E-03	0.01
WIMO1	262	1.85E-02	2.13E-04	0.01
WIMO1	28	1.67E-02	1.92E-03	0.01
WIMO1	99	1.78E-02	6.73E-04	0.01
WIMO1	125	1.71E-02	2.61E-05	0.01
WIMO1	313	1.69E-02	1.78E-06	0.01
WIMO1	29	0.0123987	4.46E-03	0.01
WIMO1	151	1.68E-02	1.12E-05	0.01
WIMO1	118	0.016809	1.82E-05	0.01
WIMO1	281	1.61E-02	6.65E-04	0.01
WIMO1	53	6.79E-03	9.65E-03	0.01
WIMO1	91	1.31E-02	3.25E-03	0.01
WIMO1	10	9.78E-03	6.52E-03	0.01
WIMO1	273	1.62E-02	3.54E-05	0.01
WIMO1	339	1.03E-02	5.41E-03	0.01
WIMO1	85	0.0126213	2.97E-03	0.01
WIMO1	133	0.0153149	1.28E-04	0.01
WIMO1	130	0.0154166	1.47E-06	0.01
WIMO1	269	1.47E-02	4.81E-04	0.01
WIMO1	92	1.42E-02	0.000951285	0.01
WIMO1	266	1.44E-02	6.69E-04	0.01
WIMO1	296	1.39E-02	8.57E-04	0.01
WIMO1	75	0.0119524	2.33E-03	0.01
WIMO1	69	8.23E-03	6.01E-03	0.01
WIMO1	64	0.0113998	1.77E-03	0.01
WIMO1	238	1.28E-02	9.02E-05	0.01
WIMO1	268	1.26E-02	1.36E-04	0.01
WIMO1	102	1.21E-02	5.32E-04	0.01
WIMO1	18	6.38E-03	5.99E-03	0.01
WIMO1	169	1.21E-02	4.71E-11	0.01
WIMO1	89	0.0108085	1.02E-03	0.01
WIMO1	134	1.17E-02	1.45E-04	0.01
WIMO1	76	0.0104789	1.21E-03	0.01
WIMO1	293	9.81E-03	1.74E-03	0.01
WIMO1	144	1.15E-02	5.14E-06	0.01
WIMO1	259	1.14E-02	4.35E-05	0.01
WIMO1	357	0.00366501	7.67E-03	0.01
WIMO1	226	1.09E-02	2.06E-04	0.01
WIMO1	237	1.10E-02	2.61E-05	0.01
WIMO1	358	0.00369368	0.00724161	0.01
WIMO1	150	0.0107905	5.78E-05	0.01
WIMO1	260	1.03E-02	9.56E-05	0.01
WIMO1	288	7.43E-03	2.96E-03	0.01
WIMO1	120	0.0101881	1.17E-04	0.00
WIMO1	90	8.27E-03	1.77E-03	0.00
WIMO1	96	0.00979069	1.98E-04	0.00
WIMO1	136	0.00996768	2.86E-07	0.00
WIMO1	77	0.00939034	0.000493468	0.00
WIMO1	158	9.62E-03	1.62E-04	0.00
WIMO1	70	0.00943396	1.98E-05	0.00

WIMO1	363	8.88E-03	0.000545031	0.00
WIMO1	97	9.01E-03	2.95E-04	0.00
WIMO1	274	9.10E-03	1.09E-06	0.00
WIMO1	95	8.42E-03	6.55E-04	0.00
WIMO1	135	9.04E-03	1.33E-11	0.00
WIMO1	140	0.00829716	3.09E-04	0.00
WIMO1	255	8.34E-03	2.37E-04	0.00
WIMO1	61	4.98E-03	3.26E-03	0.00
WIMO1	253	8.07E-03	1.06E-04	0.00
WIMO1	352	0.00203777	5.95E-03	0.00
WIMO1	110	7.51E-03	3.98E-04	0.00
WIMO1	298	6.16E-03	1.42E-03	0.00
WIMO1	256	7.26E-03	3.06E-05	0.00
WIMO1	283	7.05E-03	2.00E-04	0.00
WIMO1	338	2.67E-03	4.35E-03	0.00
WIMO1	292	6.69E-03	2.73E-04	0.00
WIMO1	204	6.88E-03	2.92E-05	0.00
WIMO1	170	0.0068107	1.50E-06	0.00
WIMO1	67	6.54E-03	5.78E-05	0.00
WIMO1	138	0.00641982	1.81E-05	0.00
WIMO1	194	0.00632437	4.46E-05	0.00
WIMO1	284	5.86E-03	2.26E-04	0.00
WIMO1	286	5.04E-03	1.04E-03	0.00
WIMO1	101	0.00588023	5.34E-05	0.00
WIMO1	289	4.39E-03	1.41E-03	0.00
WIMO1	103	5.55E-03	2.20E-04	0.00
WIMO1	137	0.00562978	9.86E-07	0.00
WIMO1	329	4.04E-03	1.38E-03	0.00
WIMO1	227	5.39E-03	1.32E-05	0.00
WIMO1	45	3.58E-03	1.60E-03	0.00
WIMO1	239	5.08E-03	1.95E-06	0.00
WIMO1	159	0.00488904	1.04E-05	0.00
WIMO1	282	4.68E-03	2.18E-04	0.00
WIMO1	362	2.79E-03	0.00207318	0.00
WIMO1	132	0.00424183	9.09E-05	0.00
WIMO1	349	2.31E-03	1.90E-03	0.00
WIMO1	157	0.00410733	4.06E-05	0.00
WIMO1	93	0.00343256	5.35E-04	0.00
WIMO1	147	3.84E-03	4.79E-06	0.00
WIMO1	261	3.77E-03	2.37E-06	0.00
WIMO1	78	3.08E-03	4.53E-04	0.00
WIMO1	139	3.35E-03	3.42E-06	0.00
WIMO1	104	0.00301669	5.69E-05	0.00
WIMO1	94	2.75E-03	2.93E-04	0.00
WIMO1	98	0.00299343	5.17E-05	0.00
WIMO1	205	0.0030129	1.09E-05	0.00
WIMO1	240	2.93E-03	1.10E-05	0.00
WIMO1	171	0.0029239	7.93E-07	0.00
WIMO1	44	0.00105503	1.75E-03	0.00
WIMO1	152	0.00259465	1.23E-06	0.00

WIMO1	220	2.56E-03	8.90E-06	0.00
WIMO1	116	0.00233135	0.000152969	0.00
WIMO1	252	2.40E-03	6.37E-06	0.00
WIMO1	109	0.00220533	1.10E-04	0.00
WIMO1	9	1.97E-03	3.01E-04	0.00
WIMO1	275	2.14E-03	1.81E-06	0.00
WIMO1	166	2.07E-03	1.18E-11	0.00
WIMO1	250	2.07E-03	9.29E-06	0.00
WIMO1	241	2.03E-03	1.43E-05	0.00
WIMO1	335	8.07E-04	1.16E-03	0.00
WIMO1	297	1.60E-03	2.94E-04	0.00
WIMO1	193	1.82E-03	6.11E-06	0.00
WIMO1	165	1.77E-03	1.49E-05	0.00
WIMO1	247	1.70E-03	1.17E-05	0.00
WIMO1	221	1.65E-03	5.18E-05	0.00
WIMO1	105	0.00167217	6.02E-06	0.00
WIMO1	149	0.0015993	4.60E-06	0.00
WIMO1	222	0.00136085	1.35E-05	0.00
WIMO1	225	1.36E-03	4.25E-12	0.00
WIMO1	148	0.001319	7.41E-06	0.00
WIMO1	218	1.26E-03	2.35E-07	0.00
WIMO1	242	1.17E-03	7.42E-06	0.00
WIMO1	117	1.18E-03	1.64E-06	0.00
WIMO1	219	0.0011536	1.47E-06	0.00
WIMO1	131	0.00102966	6.23E-06	0.00
WIMO1	243	9.34E-04	9.12E-06	0.00
WIMO1	217	0.000853467	1.18E-05	0.00
WIMO1	249	8.56E-04	7.77E-06	0.00
WIMO1	276	8.43E-04	8.72E-06	0.00
WIMO1	248	8.40E-04	4.85E-06	0.00
WIMO1	156	0.000839482	8.57E-07	0.00
WIMO1	172	0.000790509	6.36E-07	0.00
WIMO1	228	7.86E-04	7.93E-08	0.00
WIMO1	154	0.000749197	1.51E-07	0.00
WIMO1	106	6.83E-04	9.44E-07	0.00
WIMO1	287	5.68E-04	4.60E-05	0.00
WIMO1	244	5.61E-04	4.59E-06	0.00
WIMO1	246	5.47E-04	4.05E-12	0.00
WIMO1	155	0.000493253	2.96E-07	0.00
WIMO1	153	4.50E-04	8.50E-08	0.00
WIMO1	224	0.000450294	2.17E-12	0.00
WIMO1	160	0.000435479	7.54E-07	0.00
WIMO1	207	4.32E-04	1.46E-08	0.00
WIMO1	126	4.29E-04	1.37E-06	0.00
WIMO1	197	0.000385688	8.34E-06	0.00
WIMO1	192	3.69E-04	5.18E-07	0.00
WIMO1	121	0.000356368	9.53E-08	0.00
WIMO1	216	3.56E-04	1.97E-07	0.00
WIMO1	179	0.000342295	4.56E-07	0.00
WIMO1	245	3.17E-04	1.05E-06	0.00

WIMO1	196	0.000282868	8.68E-06	0.00
WIMO1	206	0.000274247	1.56E-06	0.00
WIMO1	195	0.000254826	2.07E-06	0.00
WIMO1	229	2.56E-04	8.10E-08	0.00
WIMO1	174	0.000233891	8.64E-06	0.00
WIMO1	175	2.14E-04	7.55E-06	0.00
WIMO1	191	0.000198289	7.81E-07	0.00
WIMO1	211	0.000184313	7.54E-06	0.00
WIMO1	223	0.000187117	1.47E-06	0.00
WIMO1	164	0.000181398	4.45E-07	0.00
WIMO1	173	1.77E-04	6.43E-07	0.00
WIMO1	178	0.00016711	3.13E-07	0.00
WIMO1	251	1.55E-04	1.74E-07	0.00
WIMO1	208	1.53E-04	4.28E-09	0.00
WIMO1	190	0.000149375	5.07E-07	0.00
WIMO1	163	0.000133667	5.03E-08	0.00
WIMO1	214	1.17E-04	4.68E-08	0.00
WIMO1	176	1.11E-04	1.52E-07	0.00
WIMO1	107	9.31E-05	2.28E-07	0.00
WIMO1	177	9.37E-05	3.84E-07	0.00
WIMO1	108	8.59E-05	6.97E-07	0.00
WIMO1	189	8.19E-05	2.96E-06	0.00
WIMO1	203	8.49E-05	1.12E-09	0.00
WIMO1	230	8.28E-05	6.27E-07	0.00
WIMO1	215	7.68E-05	1.11E-07	0.00
WIMO1	127	7.22E-05	2.04E-07	0.00
WIMO1	180	6.48E-05	2.88E-07	0.00
WIMO1	188	5.98E-05	1.47E-06	0.00
WIMO1	236	4.82E-05	2.17E-13	0.00
WIMO1	231	4.68E-05	1.53E-07	0.00
WIMO1	234	3.93E-05	1.37E-13	0.00
WIMO1	235	3.88E-05	2.14E-09	0.00
WIMO1	162	3.65E-05	7.11E-09	0.00
WIMO1	209	3.73E-05	8.54E-10	0.00
WIMO1	232	3.51E-05	3.90E-09	0.00
WIMO1	210	3.08E-05	5.57E-08	0.00
WIMO1	233	3.22E-05	6.59E-11	0.00
WIMO1	200	2.42E-05	9.72E-09	0.00
WIMO1	202	2.37E-05	1.56E-09	0.00
WIMO1	213	2.50E-05	3.05E-10	0.00
WIMO1	199	1.89E-05	3.45E-09	0.00
WIMO1	161	1.38E-05	3.86E-10	0.00
WIMO1	201	1.33E-05	1.27E-08	0.00
WIMO1	187	7.74E-06	1.04E-07	0.00
WIMO1	198	7.95E-06	4.86E-09	0.00
WIMO1	212	7.42E-06	2.66E-08	0.00
WIMO1	128	4.27E-06	3.55E-07	0.00
WIMO1	183	5.40E-06	4.62E-08	0.00
WIMO1	185	5.07E-06	1.29E-07	0.00
WIMO1	186	6.05E-06	7.24E-08	0.00

WIMO1	182	2.56E-06	4.84E-09	0.00
WIMO1	184	2.23E-06	9.13E-08	0.00
WIMO1	181	1.12E-06	6.10E-09	0.00
WIMO1	365	0	0	0.00

These results indicate that sulfate impacts are about twice that of nitrate for the majority of the days that have higher del-dv impacts. These higher modeled days generally occurred in the winter months when the weather patterns take the plume toward the Wichita Mountains. On the day with maximum modeled del-dv (0.47), Julian day 342 (December 8, 2002), the sulfate impact was 2.24 times that of the nitrate. This is to be expected as the emissions rate for sulfate is higher than nitrate for Sunflowers proposed expansion, and during this time of year sulfate is the dominant pollutant impacting visibility in the Wichita Mountains Class I area, as Figure 1 shows.

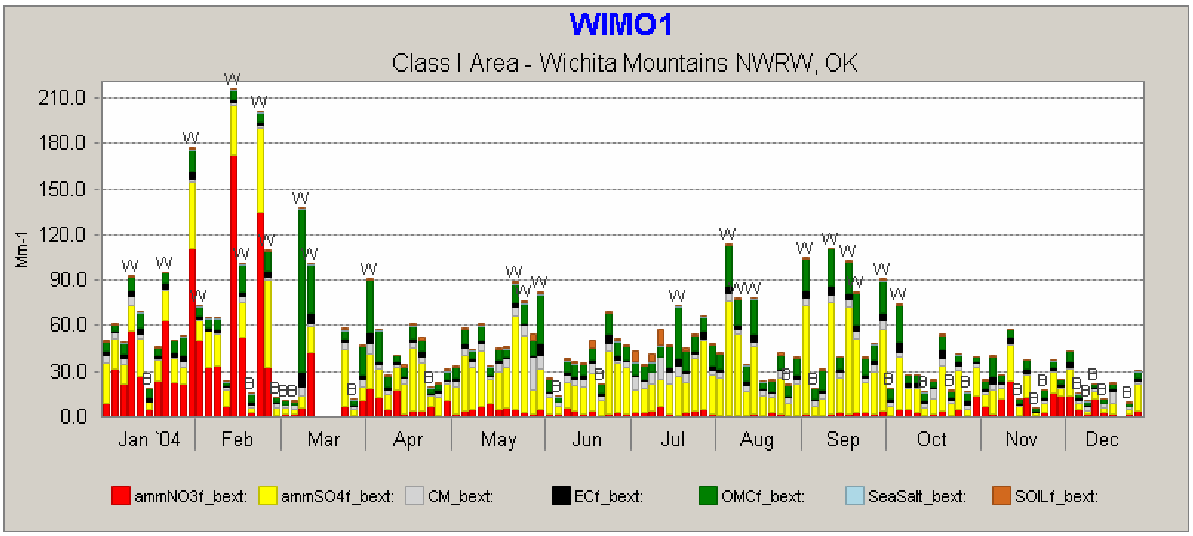


Figure 1. Monthly monitored visibility species impacts in 2004 for Wichita Mountains.

Appendix A contains graphics of the sulfate plume location for the five highest del-dv days.

Conclusion

The proposed Sunflower Holcomb expansion has been evaluated for visibility impacts using the alternative CAMx model utilizing PSAT and PiG. The results indicate that for the year modeled the maximum visibility attributed to the proposed expansion would be 0.47 del-dv. This maximum modeled del-dv occurred on December 8, 2002. Based on this level of maximum visibility impacts under worst case normal operating conditions, the modeling indicates the proposed Sunflower expansion does not adversely impact visibility in the Wichita Mountains Class I area in Oklahoma. KDHE believes this analysis is more representative than the CALPUFF analysis because of the large source receptor distance from Sunflower to surrounding Class I areas (~400 km).

References

EPA. 2003. Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule. EPA-454/B-03-005. U.S. Environmental Protection Agency, Research Triangle Park, NC.

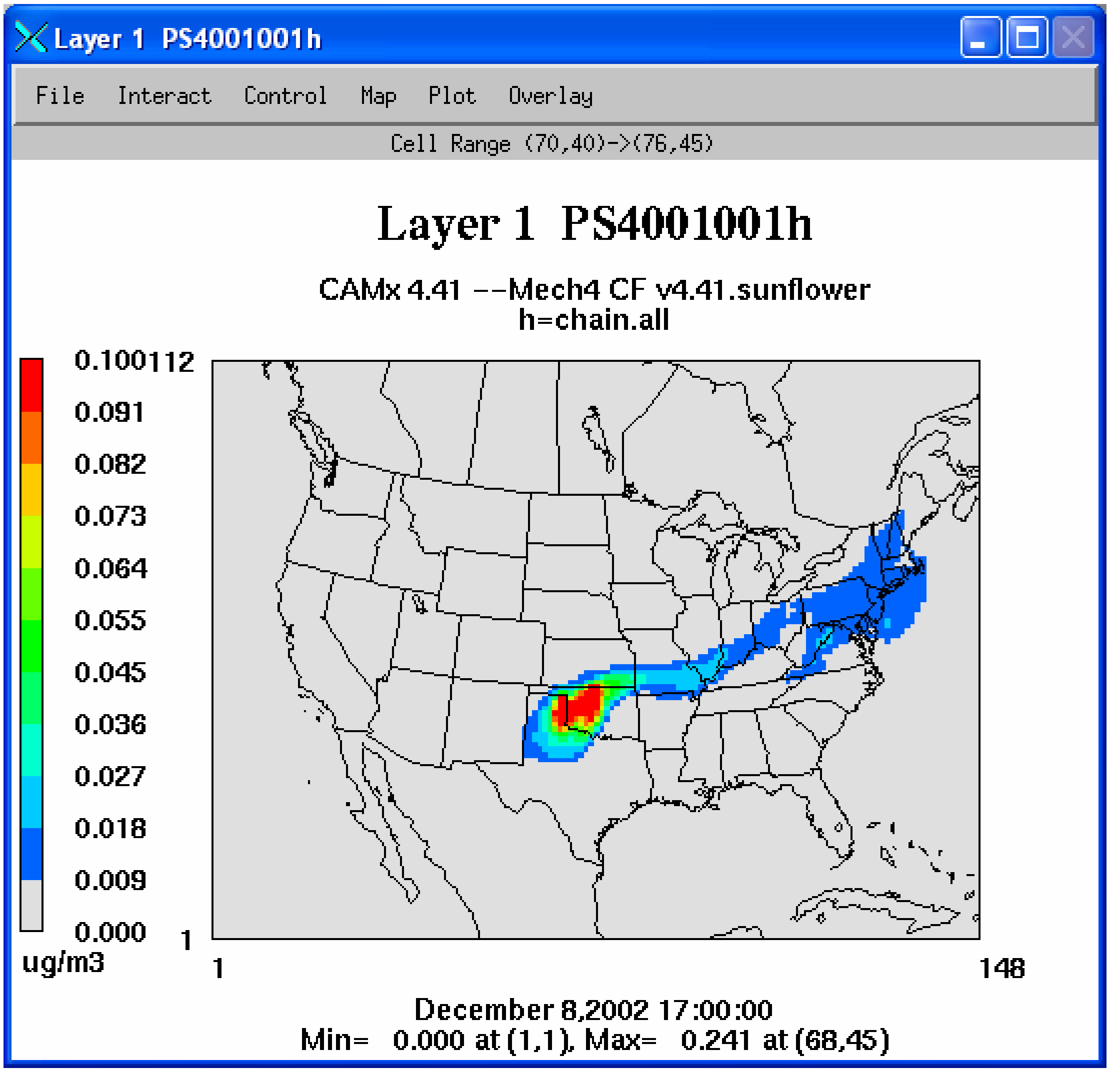
ENVIRON. 2006a. "User's Guide – Comprehensive Air-quality Model with extensions, Version 4.40." ENVIRON International Corporation, Novato, California. (Available at http://www.camx.com). September 2006

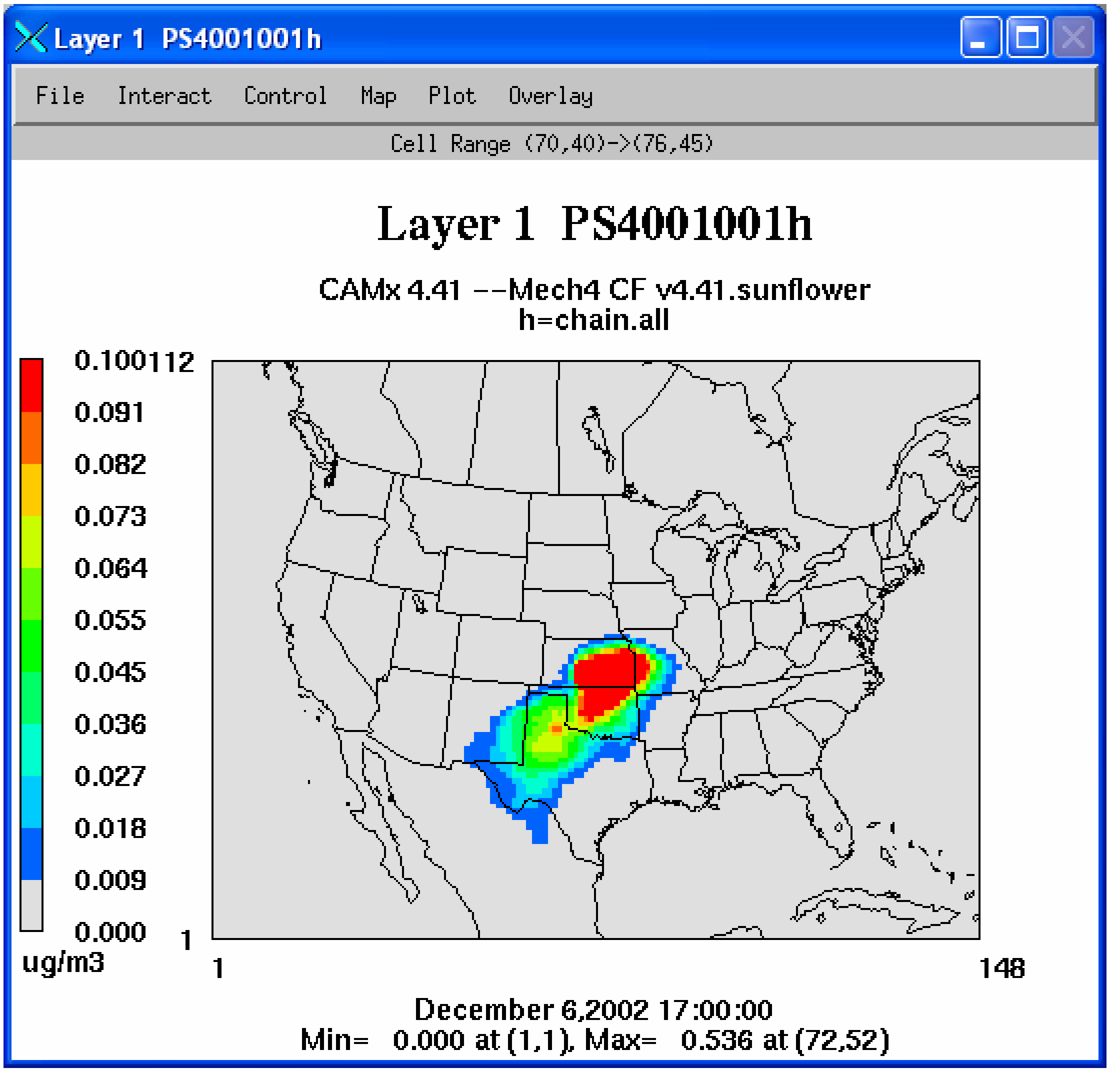
ENVIRON. 2006b. Guidance for the Application of the CAMx Hybrid Photochemical Grid Model to Assess Visibility Impacts of Texas BART Sources at Class I Areas. Prepared for Texas Commission of Environmental Quality, Austin Texas. Prepared by ENVIRON International Corporation, Novato, CA. September 27.

FLAG. 2000. "Federal Land Managers' Air Quality Related Values Workgroup (FLAG)": Phase I Report. USDI – National Park Service, Air Resources Division, Denver, CO.

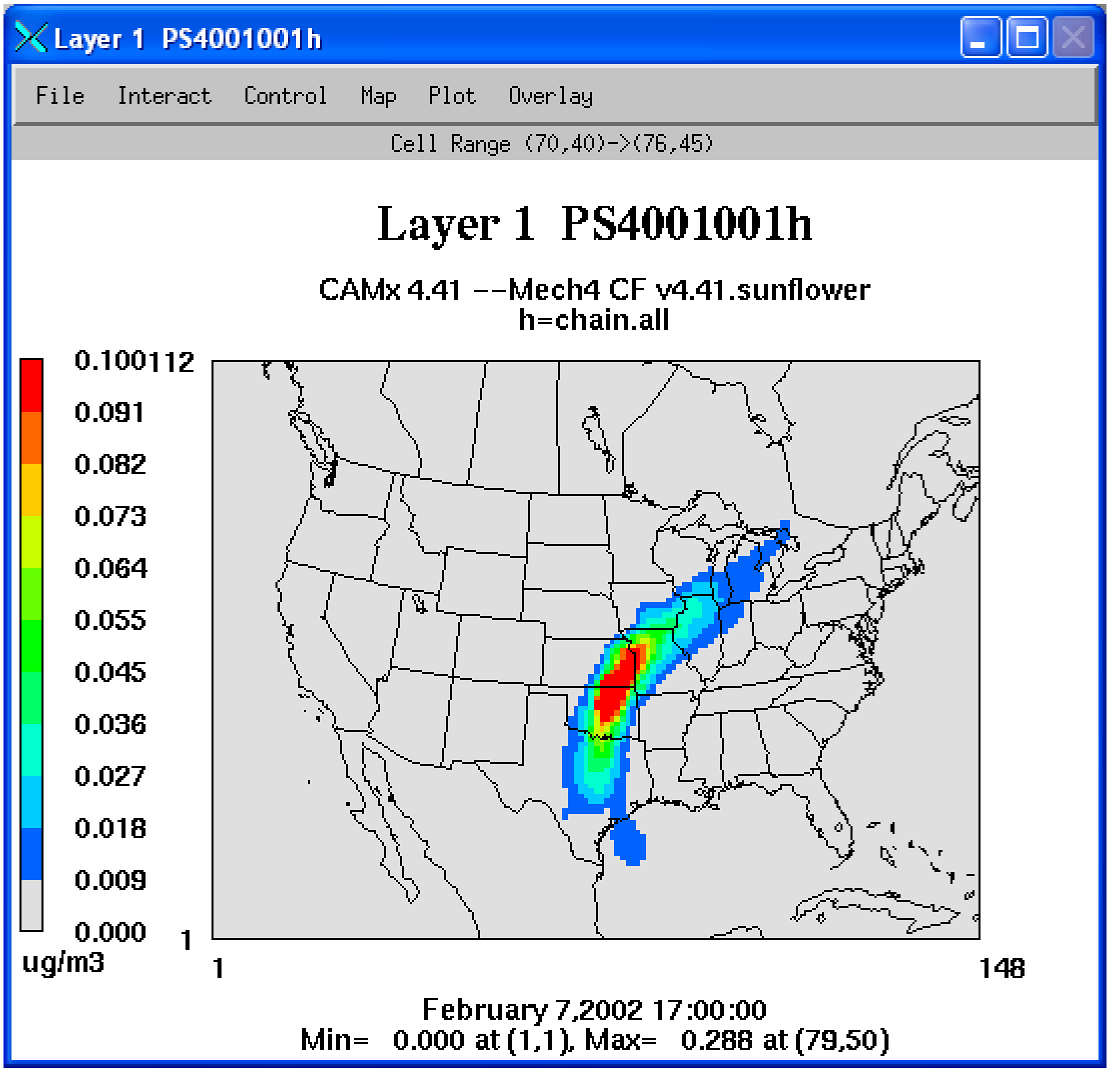
Sunflower Electric Power Corporation. 2006. Holcomb Expansion Project Visibility Impact on Class I areas and PM2.5 Impact in Northeast Kansas. Prepared by HDR Engineering, Inc. November 2006.

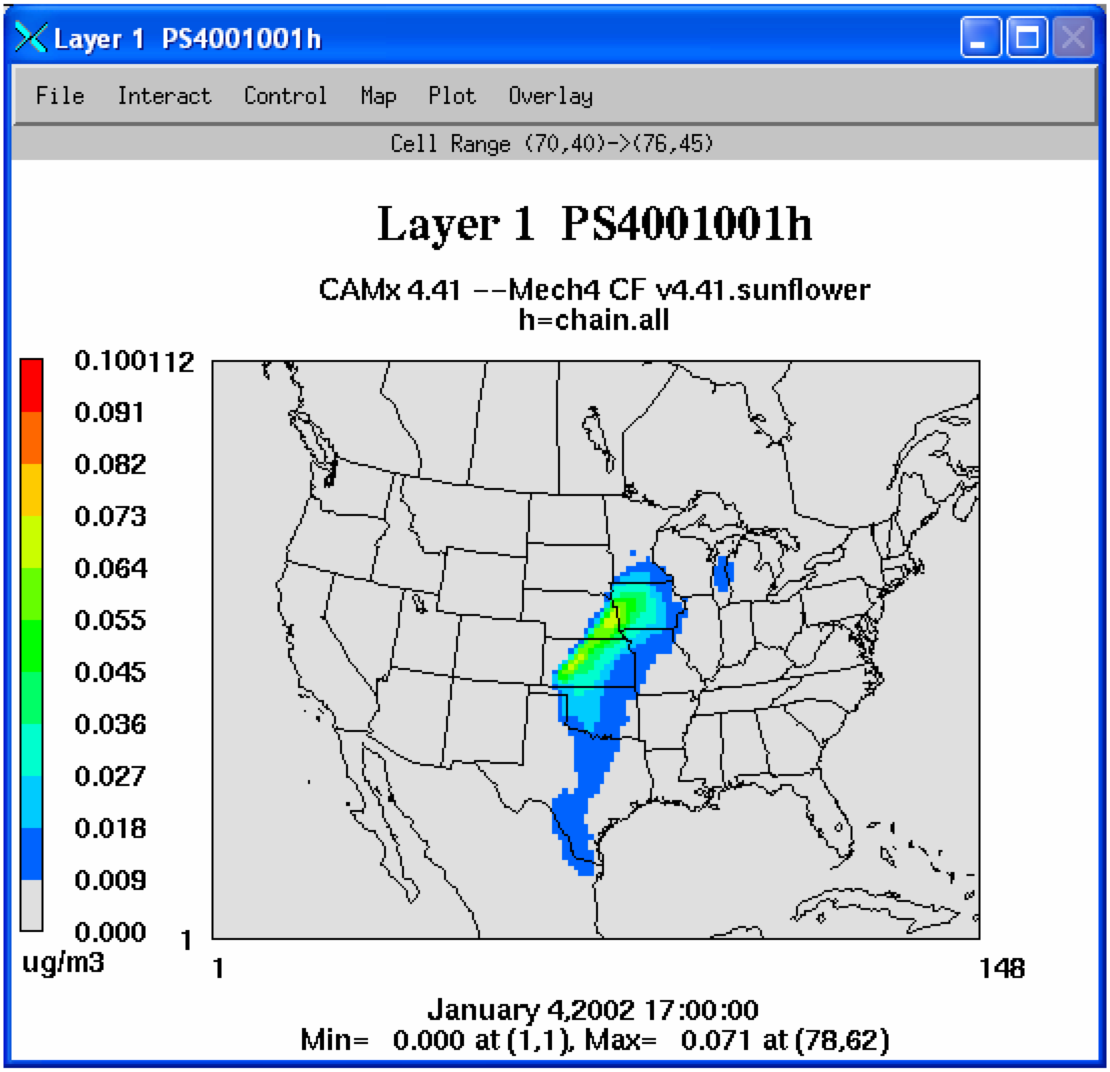
Appendix A Sulfate Plume (ug/m3) Location During high del-dv impacts.



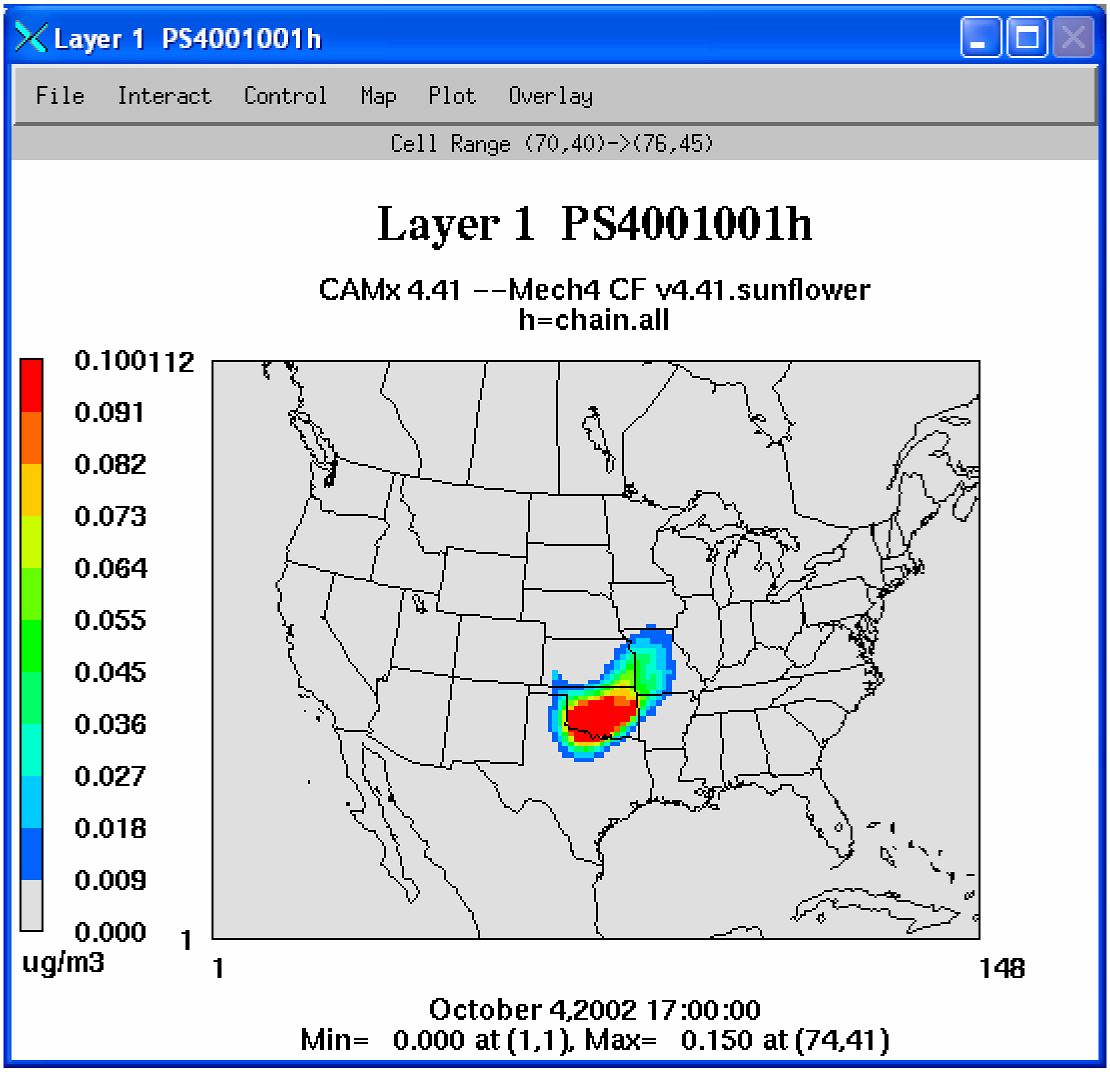


Layer 1 PS4001001h
File Interact Control Map Plot Overlay
Cell Range (70,40)->(76,45)
Layer 1 PS4001001h
CAMx 4.41 --Mech4 CF v4.41.sunflower
h=chain.all
0.100112
0.091
0.082
0.073
0.064
0.055
0.045
0.036
0.027
0.018
0.009
0.000
ug/m3
1
1
148
December 6,2002 17:00:00
Min= 0.000 at (1,1), Max= 0.536 at (72,52)


Layer 1 PS4001001h
File
Interact
Control
Map
Plot
Overlay
Cell Range (70,40)->(76,45)
Layer 1 PS4001001h
CAMx 4.41 --Mech4 CF v4.41.sunflower
h=chain.all
0.100112
0.091
0.082
0.073
0.064
0.055
0.045
0.036
0.027
0.018
0.009
0.000
ug/m3
1
1
148
February 7,2002 17:00:00
Min= 0.000 at (1,1), Max= 0.288 at (79,50)



Layer 1 PS4001001h
File Interact Control Map Plot Overlay
Cell Range (70,40)->(76,45)
Layer 1 PS4001001h
CAMx 4.41 --Mech4 CF v4.41.sunflower
h=chain.all
0.100112
0.091
0.082
0.073
0.064
0.055
0.045
0.036
0.027
0.018
0.009
0.000
ug/m3
1
1
148
January 4,2002 17:00:00
Min= 0.000 at (1,1), Max= 0.071 at (78,62)



Layer 1 PS4001001h
File
Interact
Control
Map
Plot
Overlay
Cell Range (70,40)->(76,45)
Layer 1 PS4001001h
CAMx 4.41 --Mech4 CF v4.41.sunflower
h=chain.all
0.100112
0.091
0.082
0.073
0.064
0.055
0.045
0.036
0.027
0.018
0.009
0.000
ug/m3
1
1
148
October 4,2002 17:00:00
Min= 0.000 at (1,1), Max= 0.150 at (74,41)

Appendix B - CAMx Script Used for Sunflower PSAT Analysis using the SO4 and NO3 PSAT Tracers

```
#!/bin/csh
#
# CAMx 4.31
#
setenv NCPUS 4
setenv MPSTKZ 128M
limit stacksize unlimited
set EXEC      = "/modeling/cenrap_psat/src.fixed/CAMx.sunflower.pg_linuxomp"
#

set run = revised_psat.Q1
set STARTDATE = 2001356
set ENDDATE   = 2002365
set JDATE = 2001356
#
set RUN     = "v4.42.sunflower"
set CHEM    = "/mnt/usb2/modeling/inputs/inputs"
set LUSE    = "/mnt/usb2/modeling/inputs/landuse"
set AHOMAP  = "/mnt/usb2/modeling/inputs/ahomap"
set PHOT    = "/mnt/usb2/modeling/inputs/tuv"
set ICBC    = "/mnt/usb2/modeling/inputs/icbctc"
set MET     = "/mnt/usb2/modeling/inputs/met_new/36"
set EMIS    = "/modeling/cenrap_psat/merged"
set EMIS2   = "/mnt/usb2/modeling/cenrap02f/area_uam"
set OUTPUT  = "/modeling/cenrap_psat/outputs/$run"
#
mkdir -p $OUTPUT $run
#
#  --- set the dates and times ----
#
while ( $JDATE <= $ENDDATE )

set RESTART = "true"
if ( $JDATE == $STARTDATE ) set RESTART = "false"

@ YESTERDAY = $JDATE - 1
if ( $YESTERDAY == 2002000 ) set YESTERDAY = 2001365
set YYYY = `./j2g $JDATE | awk '{print $1}'`
set Y2 = `echo $YYYY | awk '{printf("%2.2d",$1-2000)}'`
set MM = `./j2g $JDATE | awk '{print $2}'`
set DD = `./j2g $JDATE | awk '{print $3}'`
```

```
echo '---- Copying Files -----'

cp -v $EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin
$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt
.revised.bin.copy >> & $OUTPUT/CAMx.$RUN.$JDATE.stdout
cp -v $EMIS2/camx.ar.bart.36km.$JDATE.bin
$EMIS2/camx.ar.bart.36km.$JDATE.bin.copy >> &
$OUTPUT/CAMx.$RUN.$JDATE.stdo
ut


#
#  --- Create the input file (always called CAMx.in)
#
cat << ieof > CAMx.in

 &CAMx_Control

 Run_Message      = 'CAMx 4.41 --Mech4 CF $RUN',

!--- Model clock control ---

 Time_Zone        = 0,                 ! (0=UTC,5=EST,6=CST,7=MST,8=PST)
 Restart          = .${RESTART}.,
 Start_Date_Hour  = ${YYYY},${MM},${DD},0000,   ! (YYYY,MM,DD,HHHH)
 End_Date_Hour    = ${YYYY},${MM},${DD},2400,   ! (YYYY,MM,DD,HHHH)

 Maximum_Timestep    = 15.,            ! minutes
 Met_Input_Frequency = 60.,            ! minutes
 Ems_Input_Frequency = 60.,            ! minutes
 Output_Frequency    = 60.,            ! minutes

!--- Map projection parameters ---

 Map_Projection           = 'LAMBERT',  ! (LAMBERT,POLAR,UTM,LATLON)
 UTM_Zone                 = 0,
 POLAR_Longitude_Pole     = 0.,        ! deg (west<0,south<0)
 POLAR_Latitude_Pole      = 0.,        ! deg (west<0,south<0)
 LAMBERT_Central_Meridian = -97.,      ! deg (west<0,south<0)
 LAMBERT_Center_Longitude = -97.,      ! deg (west<0,south<0)
 LAMBERT_Center_Latitude  =  40.,      ! deg (west<0,south<0)
 LAMBERT_True_Latitude1   =  45.,      ! deg (west<0,south<0)
 LAMBERT_True_Latitude2   =  33.,      ! deg (west<0,south<0)

!--- Parameters for the master (first) grid ---
```

```
 Number_of_Grids      = 1,
 Master_Origin_XCoord = -2736.,        ! km or deg, SW corner of cell(1,1)
 Master_Origin_YCoord = -2088.,        ! km or deg, SW corner of cell (1,1)
 Master_Cell_XSize    = 36.,           ! km or deg
 Master_Cell_YSize    = 36.,           ! km or deg
 Master_Grid_Columns  = 148,
 Master_Grid_Rows     = 112,
 Number_of_Layers(1)  = 19,

!--- Parameters for the second grid ---

 Nest_Meshing_Factor(2) = 3,           ! Relative to master grid
 Nest_Beg_I_Index(2)    = 31,          ! Relative to master grid
 Nest_End_I_Index(2)    = 69,          ! Relative to master grid
 Nest_Beg_J_Index(2)    = 29,          ! Relative to master grid
 Nest_End_J_Index(2)    = 72,          ! Relative to master grid
 Number_of_Layers(2)    = 14,

!--- Model options ---

 Diagnostic_Error_Check = .false.,      ! True = will stop after 1st timestep
 Advection_Solver       = 'PPM',        ! (PPM,BOTT)
 Chemistry_Solver       = 'CMC',        ! (CMC,IEH)
 PiG_Submodel           = 'GREASD',     ! (None,GREASD,IRON)
 Probing_Tool           = 'PSAT',       ! (None,OSAT,GOAT,APCA,DDM,PA,RTRAC)
 Chemistry              = .true.,
 Dry_Deposition         = .true.,
 Wet_Deposition         = .true.,
 Staggered_Winds        = .true.,
 Gridded_Emissions      = .true.,
 Point_Emissions        = .true.,
 Ignore_Emission_Dates  = .true.,

!--- Output specifications ---

 Root_Output_Name         = '$OUTPUT/camx.$RUN.$JDATE',
 Average_Output_3D        = .false.,
 HDF_Format_Output        = .false.,
 Number_of_Output_Species = 35,
 Output_Species_Names(1)  = 'NO',
 Output_Species_Names(2)  = 'NO2',
 Output_Species_Names(3)  = 'O3',
 Output_Species_Names(4)  = 'PAN',
 Output_Species_Names(5)  = 'NXOY',
 Output_Species_Names(6)  = 'CO',
 Output_Species_Names(7)  = 'HONO',
```

```
 Output_Species_Names(8)  = 'HNO3',
 Output_Species_Names(9)  = 'NTR',
 Output_Species_Names(10)  = 'SO2',
 Output_Species_Names(11)  = 'SULF',
 Output_Species_Names(12)  = 'NH3',
 Output_Species_Names(13)  = 'HCL',
 Output_Species_Names(14)  = 'CG1',
 Output_Species_Names(15)  = 'CG2',
 Output_Species_Names(16)  = 'CG3',
 Output_Species_Names(17)  = 'CG4',
 Output_Species_Names(18)  = 'CG5',
 Output_Species_Names(19)  = 'PNO3',
 Output_Species_Names(20)  = 'PSO4',
 Output_Species_Names(21)  = 'PNH4',
 Output_Species_Names(22)  = 'POA',
 Output_Species_Names(23)  = 'SOA1',
 Output_Species_Names(24)  = 'SOA2',
 Output_Species_Names(25)  = 'SOA3',
 Output_Species_Names(26)  = 'SOA4',
 Output_Species_Names(27)  = 'SOA5',
 Output_Species_Names(28)  = 'PEC',
 Output_Species_Names(29)  = 'FPRM',
 Output_Species_Names(30)  = 'FCRS',
 Output_Species_Names(31)  = 'CPRM',
 Output_Species_Names(32)  = 'CCRS',
 Output_Species_Names(33)  = 'NA',
 Output_Species_Names(34)  = 'PCL',
 Output_Species_Names(35)  = 'PH2O',

!--- Input files ---

 Chemistry_Parameters = '$CHEM/CAMx4.4.chemparam.4_CF',
 Photolyis_Rates      = '$PHOT/tuv.wrap36km.${YYYY}${MM}.20051013.txt',
 Initial_Conditions   = '$ICBC/ic.wrap36km.CAMx',
 Boundary_Conditions  = '$ICBC/bc.wrap36km.CAMx.$JDATE',
 Top_Concentrations   = '$ICBC/topc.wrap36km.CAMx',
 Albedo_Haze_Ozone    = '$AHOMAP/ahomap.${YYYY}${MM}.20051013.txt',
 Point_Sources        =
'$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin',
 Master_Grid_Restart  = '$OUTPUT/camx.$RUN.$YESTERDAY.inst',
 Nested_Grid_Restart  = ' ',
 PiG_Restart          = '$OUTPUT/camx.$RUN.$YESTERDAY.pig ',

 Emiss_Grid(1)   = '$EMIS2/camx.ar.bart.36km.$JDATE.bin',
 Landuse_Grid(1) = '$LUSE/CAMx.wrap36km.luse.bin',
 ZP_Grid(1)      = '$MET/camx.zp.${Y2}${MM}${DD}.36k.bin',
```

```
 Wind_Grid(1)    = '$MET/camx.uv.${Y2}${MM}${DD}.36k.bin',
 Temp_Grid(1)    = '$MET/camx.tp.${Y2}${MM}${DD}.36k.bin',
 Vapor_Grid(1)   = '$MET/camx.qa.${Y2}${MM}${DD}.36k.bin',
 Cloud_Grid(1)   = '$MET/camx.cr.${Y2}${MM}${DD}.36k.bin',
 Kv_Grid(1)      = '$MET/camx.kv.OB70.${Y2}${MM}${DD}.36k.bin',
 Emiss_Grid(2)   = ' ',
 Landuse_Grid(2) = ' ',
 ZP_Grid(2)      = ' ',
 Wind_Grid(2)    = ' ',
 Temp_Grid(2)    = ' ',
 Vapor_Grid(2)   = ' ',
 Cloud_Grid(2)   = ' ',
 Kv_Grid(2)      = ' ',

 &
!-------------------------------------------------------------------------------

 &SA_Control

 SA_File_Root               = '$OUTPUT/camx.$RUN.$run.$JDATE',
 SA_Summary_Output          = .true.,
 SA_Master_Sfc_Output       = .true.,
 SA_Stratify_Boundary       = .false.,
 SA_Number_of_Source_Regions =  2,
 SA_Number_of_Source_Groups  =  1,
 Use_Leftover_Group         = .false.,
 Number_of_Timing_Releases   =  0,
 SA_Receptor_Definitions     =
'/mnt/usb2/modeling/camx/sa/receptor.nebraska.classI.txt',
 SA_Source_Area_Map(1)       =
'/mnt/usb2/modeling/cenrap_psat/camx/srcmap/srcmap.dat',
 SA_Master_Restart          = '$OUTPUT/camx.$RUN.$run.$YESTERDAY.sa.inst',
 SA_Nested_Restart          = ' ',
 SA_Points_Group(1)         =
'$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin.copy',
 SA_Emiss_Group_Grid(1,1)    = '$EMIS2/camx.ar.bart.36km.$JDATE.bin.copy',
 PSAT_Treat_SULFATE_Class    = .true.,
 PSAT_Treat_NITRATE_Class    = .true.,
 PSAT_Treat_SOA_Class        = .false.,
 PSAT_Treat_PRIMARY_Class    = .true.,
 PSAT_Treat_MERCURY_Class    = .false.,
 PSAT_Treat_OZONE_Class      = .false.,

  &

ieof
```

```
#
#  --- Execute the model ---
#

echo '---- Running for Date ',$JDATE

cp CAMx.in $run/camx.$RUN.$run.$JDATE.in
/usr/bin/time $EXEC >& $run/camx.$RUN.$run.$JDATE.stdout

rm -fv $EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin.copy
>> & $OUTPUT/camx.$RUN.$JDATE.stdout
rm -fv $EMIS2/camx.ar.bart.36km.$JDATE.bin.copy >> &
$OUTPUT/camx.$RUN.$JDATE.stdout

@ JDATE++
if ( $JDATE == 2001366 ) set JDATE = 2002001

end
```