Air Quality Impact Analysis Review

Sunflower Electric Power Corporation
Holcomb Unit 1
Low NOx Burner/Overfire Air Project
Air Quality Construction Permit Application

Kansas
Department of Health and Environment
Bureau of Air

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I. Introduction

Sunflower Electric Power Corporation (Sunflower) submitted a prevention of significant deterioration (PSD) air permit application for the installation of low nitrogen oxide burners (LNB) and overfire air (OFA) System on the existing Holcomb 1 steam generator system (H1). The PSD application was received by KDHE on June 6, 2011.

An air dispersion modeling protocol and an update were received by KDHE on March 16 and May 5, 2011respectively. Comments about the protocol from EPA and KDHE were provided to Sunflower on June 1st, 2011.

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.

Dispersion modeling for this project includes a demonstration of compliance with the NAAQS for carbon monoxide (CO), since it is the only primary pollutant that increases in emission level with the installation of LNB/OFA, and which exceeds the PSD significant emission rate for CO of 100 tons per year.

II. Facility Description

The existing facility is a pulverized coal (PC) electric generating station. The H1 steam generator is designed to use low sulfur Powder River Basin (PRB) coal with a nominal net generation capacity of 360 megawatts (MW). The facility is located south of the city of Holcomb in Finney County, Kansas. Finney County is designated as an attainment area for all criteria pollutants.

III. Air Quality Impact Analysis 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).

The only emissions to be affected by the proposed project are nitrogen oxides and carbon monoxide. The emissions change for these two pollutants 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 Change From the Proposed Project and PSD Significant Emission Rates					
Pollutant	**Baseline Emissions (tpy)**	**Proposed Project Potential Emissions (tpy)**	**Net Emissions Change (tpy)**	**Significant Emission Rate (tpy)**	**PSD Review Required**
NO_x	4687.2	2671.9	-2015.3	40	No
CO	509.1	3711.0	3201.8	100	Yes

IV. Model Selection

The emissions were modeled using the latest version (11126) of AERSCREEN. AERSCREEN is based on AERMOD, EPA's preferred near-field dispersion model, and replaces SCREEN3 as the recommended screening model based on the *Guideline on Air Quality Models*. Similar to SCREEN3, AERSCREEN allows for user entry of emission inputs, source coordinates, building information (for downwash), receptor information, and meteorological information in a quick and easy fashion, either through an input file, or interactive prompts. However, AERSCREEN incorporates several enhancements relative to the SCREEN3 model. For example, AERSCREEN generates application-specific worst-case meteorology, via MAKEMET, that takes full advantage of the boundary layer scaling algorithms implemented in the AERMET meteorological processor using representative minimum and maximum ambient air temperatures, and site-specific surface characteristics (albedo, Bowen ratio, and surface roughness). AERSCREEN incorporates the PRIME downwash algorithms that are part of the AERMOD refined model and utilizes the BPIPPRIM tool to provide a detailed analysis of downwash influences on a direction-specific basis. AERSCREEN also incorporates AERMOD's complex terrain algorithms and utilizes the AERMAP terrain processor to account for the actual terrain in the vicinity of the source on a direction-specific basis[1].

AERSCREEN was produced to give the user two options for modeling: either by using the command prompt interface to give a more automated process for the user or by using the MAKEMET program which gives the user more flexibility for defining receptors. Sunflower used the command-prompt interface of the AERSCREEN model for this air quality impact analysis because the MAKEMET approach is more appropriate for an area with a more complex terrain than Holcomb. All "regulatory default" options in the AERSCREEN model were used for this air quality impact analysis.

Based on the proposed facility emissions, carbon monoxide (CO) was evaluated as part of the AQIA. AERSCREEN was used by Sunflower to evaluate the impacts of CO that will result from the LNB/OFA project at H1 for 1-hour CO and 8-hour CO. Sunflower's evaluation was reviewed by KDHE using AERSCREEN version 11126.

[1] *AERSCREEN Released as the EPA Recommended Screening Model* Memorandum by Tyler Fox issued on April 11, 2011 (http://www.epa.gov/ttn/scram/20110411_AERSCREEN_Release_Memo.pdf).

V. Model Inputs

A. Source Data

The emission rate, point location, and stack parameters for the emission source used in the model were based on the data presented in the permit application. Modeling runs were conducted at full and partial loads to confirm that operation of the steam generator would not result in impacts greater than the NAAQS or PSD increments. The H1 steam generator load (and consequently the hourly emission rates) was modeled at four different load points (100%, 75%, 50% and 25%) to account for varying loads and process conditions. The low load conditions (25% and 50%) will account for startup and shutdown conditions. This methodology will account for all worst-case conditions that can be experienced at the facility. These input data are shown in the table below.

Table 2. Stack Parameters for H1 Steam Generator[2]

Load	Stack height (ft)	Stack diameter (ft)	Exit temperature (°F)	Exit velocity (ft/s)
100%	475	16.33	180	113.5
75%				85.2
50%				56.8
25%				28.4

B. Urban or Rural

The area surrounding the facility is deemed "rural" for air modeling purposes.

C. Terrain

The terrain in the vicinity of the facility is relatively flat therefore no terrain was included in the modeling.

D. Meteorological Data

AERSCREEN estimates concentrations without the need for the user to input meteorological data. The "regulatory default" settings for minimum and maximum temperature, minimum wind speed, and anemometer height were used to determine the meteorology in this model. The meteorology was calculated using the AERMET seasonal tables. Being in western Kansas, the surface characteristics option had the number six selection of "Grassland." The dominant surface profile is average moisture since western Kansas is not classified as an arid region.

E. Building Downwash

[2] Emissions from this unit are based on a 0.25 lb/MMBtu emission rate and Unit 1's heat input rate of 3,390 MMBtu/hr. See also Table 5-5 in Part 5.0 of the Permit Application, the Air Disperson Modeling Analysis.

Good engineering practice 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 H1 generating unit stack height exceeds 65 meters; therefore, the model's Building Downwash option was selected and the building dimensions supplied by Sunflower were used for the model run.

F. Receptors

Receptors were placed so that the maximum offsite ground-level concentrations can be determined. The only receptor information that AERSCREEN requires in its command-prompt user interface program is the maximum receptor distance, the distance to the fence line, and the height of any flagpole receptor. The closest fence line to H1 is at a distance of approximately 1,300 meters. That value was used as the minimum distance to ambient air in the AERSCREEN program. For the maximum distance to a receptor, a value of 10 kilometers was used. Flag pole receptors were not used in the 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 modeled emission rate was set at 1.0 grams per second (1 g/s) for all load cases. Since only one source is being modeled, this was done so the results are directly scalable to this rate and multiple emission rates do not need to be considered in separate modeling runs. The resulting concentration from the AERSCREEN model can be directly multiplied by the proposed emission rate for H1 to arrive at a corresponding concentration. The AERSCREEN program also includes averaging time factors for worst-case 1-hour and 8-hour averages. The results from the significance determination are shown in Table 3 below.

Table 3. Significance Determination Table						
Load	Averaging Period	Maximum Concentration ($\mu g/m^3$)	Proposed Emission rate (g/s)	Scaled Concentration ($\mu g/m^3$)	Modeling SIL ($\mu g/m^3$)	Exceeds SIL?
100%	1-hour	1.743	92.33	160.9	2,000	No
	8-hour	1.568		144.8	500	No
75%	1-hour	1.912	69.25	132.4	2,000	No
	8-hour	1.720		119.1	500	No
50%	1-hour	2.287	46.17	105.6	2,000	No
	8-hour	2.059		95.1	500	No
25%	1-hour	3.240	23.08	74.8	2,000	No
	8-hour	2.916		67.3	500	No

For the 1-hour and 8-hour CO averaging periods the modeled impacts for the proposed facility fall below the modeling SIL so no refined modeling is required. The modeling results are also well below the pre-application monitoring threshold of 575 $\mu g/m^3$ for the 8-hour averaging period. There is no pre-application threshold established for the 1-hour averaging period. Therefore, pre-construction monitoring is not required for CO.

VII. Additional PSD Impact Analyses

A. Commercial, Residential, and Industrial Growth

The growth analysis considers predicted air quality impacts due to emissions resulting from the commercial, industrial and residential growth associated with the LNB/OFA project. Only permanent growth is considered and impacts from emissions from temporary and mobile sources are not included in the analysis.

There will be no associated growth due to the LNB/OFA project. Project construction will be limited and no commercial or residential growth is projected to occur because of this project. Given the temporary nature of the construction and the lack of other source growth in the area, the Project is not expected to cause any adverse construction or growth related air quality impacts

B. Visibility Impairment

An additional visibility impact analysis may be used to determine if the air emission increases associated with a proposed PSD project will have an impact on Class II sensitive areas such as state parks, wilderness areas, or scenic sites and overlooks. Visibility impairment is a function of the emissions of primary particulate matter, NO_x (including NO_2), elemental carbon (soot), and primary sulfate (SO_4). This project will substantially decrease the emissions of NO_x, thereby improving visibility over current conditions. As CO, not a visibility impairing pollutant, is the only pollutant with an emission increase, the project is not predicted to negatively impact visibility.

Federally designated Class I areas are afforded special protection in the air permitting process. Generally, Class I area visibility analyses are only conducted for projects located within 100 km of a Class I area. 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. A visibility analysis was not required since the proposed project results in a substantial decrease in NO_x emissions and there is no increase in any other visibility-impairing pollutants.

C. Vegetation

In accordance with 40 CFR 52.21(o)(1), the owner shall provide an analysis of the impairment to visibility, soils and vegetation that would occur as a result of the modification to the source. Sunflower determined that the proposed project and the associated increase in CO are not expected to have significant effects on vegetation.

Air pollutants can affect vegetation through direct absorption through the foliage, or uptake from the soil of trace elements deposited in the soil. The effects of air pollution on vegetation can include visible damage to foliage and fruit, changes in metabolic function, adverse changes in plant activity, and crop yield reduction. The effects of air pollutants on vegetation fall into three categories: acute (short exposure to high concentration), chronic (lower concentration over months or years), and long term (abnormal changes to ecosystems and physiological alterations in organisms that occur gradually over very long time periods).

The United States Department of Interior (USDOI) has published a document called Impacts of Coal Fired Power Plants on Fish, Wildlife, and their Habitats. This document was used to consider the effects of CO on vegetation. Sunflower Electric Power Corporation conducted a survey of the vegetation located in the vicinity of the modification, which indicated the predominant types of vegetation are pasture and crop land. Switchgrass, little bluestem, big bluestem, Indian grass, and Canada wild rye are found in pastures and meadows. Wheat, corn, soybeans, and alfalfa are the predominant row crops. Trees occur in hedgerows, creek beds, and along the Arkansas River. While adequate information is available to make generalizations regarding air pollution impacts on various types of vegetation, concrete conclusions as to site-specific vegetation exposure impacts cannot be presently concluded from available research study data. At the Sunflower facility vegetation is composed of disturbance-tolerant weedy species including lamb's-quarters (*Chenopodium album*), pigweed (*Amaranthus sp.*), and Russian thistle (*Salsola kali*). Turf grasses, such as western wheatgrass (*Agropyron smithii*) and tall fescue (*Festuca arundinacea*) are planted in lawn areas.

Concentrations of CO, even in polluted atmospheres, are not typically detrimental to vegetation. CO has not been found to produce detrimental effects on plant growth at concentrations below 1,800,000 $\mu g/m^3$ for a one week exposure.[3] NAAQS are set for 1-hour and 8-hour averaging periods, at rates more stringent than the literature exposure threshold. Therefore, the NAAQS were utilized for comparison with modeled

[3] Smith, A.E. and J.B. Levenson. *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals*. Argonne National Laboratory, USEPA Publication EPA-450/2-81-078. December 12, 1980.

concentrations to predict any CO effects on vegetation. Additionally, the USEPA has stated that "*for most types of soils and vegetation, ambient concentrations of criteria pollutants below the secondary national ambient air quality standards (NAAQS) will not result in harmful effects*."[4] Since the maximum model-predicted 1-hour and 8-hour CO impacts are significantly lower than the NAAQS, no adverse impacts to vegetation due to the proposed project are expected from CO emissions.

D. Soils

Two soil types are mapped at or near the project site (Harner *et al.* 1965). They include:
• Tivoli fine sand
• Tivoli-Vona loamy fine sands

Both soil types are deep, noncalcareous, very sandy soils in steep, duny (numerous sand-dunes) terrain. The soils are low in fertility and drain very easily. Water is absorbed quickly, and consequently, runoff is very low. Blowout of the soil is prevalent where vegetation is lacking. Erosion often is a problem.

Sulfates and nitrates caused by SO_2 and NO_x deposition on soil can be beneficial and detrimental to soils depending on its composition. However, the modification on H1 will not affect SO_2 emissions from the unit, and NO_x emissions will be decreasing as a result of the project, so no adverse effects are anticipated.

IX. Conclusions

- Evaluation of the facility potential emissions indicated that emissions of CO above current levels are expected.
- The AERSCREEN model (version 11126) was used to determine predicted maximum ground level concentrations.
- The analysis indicated that concentration levels of CO resulting from the proposed project would not significantly cause or contribute to an exceedance of the NAAQS.
- The modeled impacts for the proposed facility fall below the pre-application monitoring threshold and the modeling SIL for the 8-hour and 1-hour averaging periods.
- The analysis indicated that concentration levels of all pollutants resulting from the proposed project would comply with PSD Class II increments.
- The analysis indicated that no evaluation of visibility impacts is required.

[4] *New Source Review Workshop Manual.* Environmental Protection Agency, Office of Air Quality Planning and Standards, October 1990, Draft. (NSR Manual).