Analysis to Support a Designation of Attainment for Columbia County

Wisconsin Power and Light Columbia Energy Center - Portage, Wisconsin
September 2015

INTRODUCTION

The Wisconsin Department of Natural Resources (WDNR) was notified by the United States Environmental Protection Agency (EPA) on March 20, 2015 that Wisconsin Power and Light's Columbia Energy Center (also known as WPL-Columbia) met the criteria established in the agreement between EPA, Sierra Club, and Natural Resources Defense Council that was accepted as an enforceable order on March 2, 2015 by the U.S. District Court of California. Specifically, during calendar year 2012, Columbia Energy Center reported emissions to the EPA Air Markets Database of more than 16,000 tons of sulfur dioxide (SO_2) and therefore EPA is directed to complete designation of the area relative to the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) by July 2, 2016.

In response to this action, WDNR completed a five factor analysis as described in EPA's SO_2 area designations guidance and is recommending that EPA designate Columbia County, Wisconsin as attainment for the 1-hour SO_2 NAAQS. The supporting information includes a dispersion modeling analysis using the regulatory model AERMOD (AMS/EPA Regulatory Model) that demonstrates the 1-hour SO_2 NAAQS will be attained and maintained in Columbia County.

AREA CHARACTERIZATION

Columbia Energy Center (part of Alliant Energy) is located south of the City of Portage along the Wisconsin River in central Columbia County, Wisconsin (refer to Figure 1). Columbia County is located in south central Wisconsin, approximately 45 kilometers north of the Wisconsin State Capitol in Madison. The climate of Columbia County is characterized by variable weather patterns with a large seasonal temperature range and moderate amounts of precipitation. Terrain in Columbia County is generally flat, except in the western part where the Baraboo Range is the dominant feature. In addition, the Wisconsin River crosses Columbia County in a broad, shallow river valley.

Columbia Energy Center is a base load electrical generating facility with nominal capacity of 1,054 megawatts that began operation during the 1970's. The facility consists of two pulverized subbituminous coal fired boiler/generator sets, each with maximum rated heat capacity of 5,880 million British Thermal Units per hour (MMBtu/hr). As of January 1, 2015 the facility is limited by federally enforceable conditions to 3,286 tons of SO_2 per year, while continuously operating their air quality control system and not exceeding emissions of 0.075 pounds of SO_2 per million Btu (lbs/MMBtu) over a 30-day rolling average.

MODEL & METEOROLOGY

WDNR used the current regulatory version of AERMOD (15181) in the dispersion modeling analysis. AERMOD options that are subject to public comment and revision were not used. The area around Columbia Energy Center consists of small farm parcels, wetland associated with the Wisconsin River, and scattered residences. Following Section 7.2.3(c) of the current *Guideline on Air Quality Models (40 CFR Part 51,*

Appendix W, EPA, November 2005), an assessment of the land use around Columbia Energy Center shows that less than 50% of the land area within 3 kilometers is industrial, commercial, or dense residential. Therefore, rural dispersion coefficients were used in AERMOD.

Meteorological data were processed from 2012-2014 Dane County Regional Airport (KMSN) surface data with Green Bay upper air data. The raw meteorological data were processed with the regulatory options in AERMET version 15181. Options that are subject to public comment and revision were not used. The surface wind data at KMSN is 2-minute average speed and direction reported each minute. This minute-based wind information was processed with AERMINUTE version 14337. Processing assumed an anemometer height of 10.0 meters (m) above ground.

The instrumentation tower at KMSN is 40 kilometers south-southeast of Columbia Energy Center and is considered representative of meteorological conditions around the facility. Dane County Regional Airport is at the northern boundary of the City of Madison, Wisconsin, and is surrounded by small farm fields and wetlands, similar to the land cover around Columbia Energy Center. Surface characteristics around KMSN were generated using AERSURFACE version 13016 following the methods described in the *AERMOD Implementation Guide.* Specifically, snow cover for each month during the period 2012-2014 was derived from National Snow Analyses maps from the National Operational Hydrologic Remote Sensing Center. AERSURFACE was run both for snow and no-snow conditions. The albedo, Bowen ratio, and surface roughness were adjusted based on the number of days with snow cover during each month. Soil moisture conditions for each year were a weighted average of the monthly Palmer Drought Severity Index obtained from the National Centers for Environmental Information. The months of May, June, July, and August were weighted twice as high as the other months to account for the importance of soil moisture during the traditional growing season.

EMISSIONS INVENTORY

When determining attainment boundaries, EPA evaluates actual SO_2 emissions from sources located in and around the area characterized, according to the *Updated Guidance for Area Designations for the 2010 Primary Sulfur Dioxide National Ambient Air Quality Standard (EPA, Mar 20, 2015)*. The *Updated Guidance* describes how data from the latest National Emissions Inventory or other relevant data would be reviewed. In support of the recommendation that all of Columbia County be designated attainment for the 2010 SO_2 NAAQS, WDNR considered known SO_2 emissions in the county.

Columbia Energy Center has the largest emissions of SO_2 within Columbia County. In addition to the two coal power boilers, Columbia Energy Center also operates a limited use, fuel-oil fired, 182 MMBtu/hr auxiliary boiler. This unit is used in boiler operator training and to provide small amounts of heat for the facility. The SO_2 emissions from the unit are, at maximum, 0.3 lbs/hr and these emissions vent from a 78 m (256 feet) tall, unobstructed stack. A screening level dispersion modeling analysis was performed to assess the impact of the auxiliary boiler SO_2 emissions to ambient air, and it was determined that modeled concentrations at all locations are below the 1-hour SO_2 significant impact level (SIL).

The following table lists all other point sources of SO_2 in Columbia County based on the 2014 emission inventory data. The location of these sources is shown in the attached Figure 1.

COLUMBIA ENERGY CENTER - PORTAGE **Emissions Inventory**	
FACILITY NAME	2014 TONS SO_2
Cardinal FG	61.6
United Wisconsin Grain Producers	8.5
Fall River Foundry	2.3

The data shows no other major (greater than 100 tons per year) sources of SO_2 emissions within Columbia County or within 50 kilometers (km) of Columbia Energy Center. Fall River Foundry is located 31 km southeast of Columbia Energy Center and the SO_2 emissions result from brass and bronze induction melting. United Wisconsin Grain Producers is 30 kilometers northeast of Columbia Energy Center and the SO_2 emissions result from drying of distiller grain solubles. Due to their distance, the impacts of both Fall River and UWGP do not result in a significant concentration gradient around Columbia Energy Center and are assumed to be included in the background concentration used in the analysis (refer to the Background Concentration section).

SO_2 emissions are also reported from Cardinal FG in Portage, approximately 10 km north-northwest of Columbia Energy Center. In 2014, Cardinal FG reported 61.6 tons of SO_2 emitted from the glass furnace stack. The glass furnace stack is 61 m (200 feet) tall with an unobstructed, warm gas flow. A screening level dispersion modeling analysis was performed to assess the impact of the *potential* SO_2 emissions from Cardinal FG to ambient air. The maximum modeled impact of Cardinal FG is well below the 1-hour SO_2 standard and southwest of the facility in an area of elevated terrain. Further review of the Cardinal FG screening level modeling results reveals that the impact is above the 1-hour SO_2 SIL only in the areas of elevated terrain. For all other receptors, including the area around Columbia Energy Center, the modeled impact of Cardinal FG in Portage is below the 1-hour SO_2 SIL.

Due to the screening analyses described, it was assumed that the selected background concentration provides adequate representation of additional distant SO_2 emissions, so only the two main Columbia Energy Center boilers were explicitly included in the modeling analysis.

INPUT PARAMETERS

Modeled stack parameters and building downwash data for Columbia Energy Center were taken from the most recent WDNR analysis for the facility, with additional information provided by WPL/Alliant. Modeled emission rates reflected both the highest potential short-term hourly rate corresponding to the maximum heat input and the normal or typical scenario corresponding to the most common heat input. Columbia Energy Center is a base load plant, so there are minimal variations in the heat input throughout the year. For each modeled scenario (maximum or normal), the representative exhaust gas flow rate and temperature were provided by WPL/Alliant as derived from actual performance during calendar year 2015. BPIP-PRIME was also be used to produce the building downwash information from facility provided plot plans.

The federally enforceable emission limit for Columbia Energy Center is based on the 30-day average of 0.075 lbs/MMBtu. To conservatively estimate a comparable hourly emission rate, the method outlined in Appendix B of the *Guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions (EPA, Apr 23, 2014)* was followed. From the 2015 emission data captured on the continuous emission monitors at Columbia Energy Center, the 99th percentile of the hourly mass (lbs) value was divided by the 99th percentile of the 30-day average hour mass (lbs) value. The ratios for each unit were calculated separately and the higher ratio was determined to be 5.67. After rounding this value up to 6.0, the Columbia Energy Center 30-day emissions limit of 0.075 lbs/MMBtu was multiplied by 6.0 resulting in a maximum hourly emission rate estimate of 0.45 lbs/MMBtu (0.075 * 6.0 =

0.45). This value was then used in both the maximum and normal model scenarios to calculate a representative, conservative estimate of potential hourly emissions from both stacks based on boiler heat input.

Note that in comparison to Appendix D of the *Guidance for 1-Hour SO_2 Nonattainment Area SIP Submissions*, the scaling factor of 6.0 is much higher than what would be expected. Based on the information provided in Appendix D, the scaling factor of 6.0 is more than two standard deviations from the average scaling factor of 1.6. Considering that Columbia Energy Center has just recently begun using the control devices on the boilers, it is expected that the actual scaling factor will be lower than 6.0, thus confirming the conservative nature of this dispersion modeling analysis.

RECEPTOR GRID

The receptor grid used in the analysis will consist of a series of nested rectangular grids with terrain derived from AERMAP using National Elevation Dataset information (refer to Figure 1).

- 50 meter spacing to 1000 meters from the stacks
- 100 meter spacing to 10 kilometers
- Additional 100-meter spaced points on the Baraboo Range (west of the facility), extending to 30 km

Individual receptors will be removed where it is not feasible to place a monitor following the recommendations in the *SO_2 NAAQS Designations Technical Assistance Documents (EPA, December 2013).* Receptors located immediately adjacent to Columbia Energy Center that are inside the fence line or are not considered ambient air will be removed from the modeling analysis. In addition, using WDNR geographic information service (GIS) data, receptors located over the permanent wetlands between Columbia Energy Center and the Wisconsin River, or over any open water body in the modeling domain, will also be removed from the modeling analysis.

BACKGROUND CONCENTRATION

The closest representative SO_2 monitoring location to Columbia Energy Center is the Horicon (Dodge County) monitor located 65 kilometers east of the facility. Columbia Energy Center is the only major (100 tons per year) SO_2 source within 65 kilometers of the Horicon site, which uses high sensitivity equipment to detect low SO_2 concentrations. The 2012-2014 Horicon design value of 7 ppb (18.3 $\mu g/m^3$) is used as background concentration for this analysis. The modeling analysis includes all known point sources of SO_2 within Columbia County and within 50 kilometers of Columbia Energy Center, and the monitor location is similarly affected by distant SO_2 sources (in central, southern, and eastern Wisconsin). Nationally, the impact from locomotives and trucks has been minimized as the sulfur content in diesel fuel has been reduced to 0.015%, and the local impact of these vehicles is even smaller as Columbia Energy Center is located outside of any incorporated city or village.

MODELING RESULTS

The stack parameters and emission rates for the dispersion modeling analysis are provided in the table.

WPL COLUMBIA - PORTAGE **Point Source Stack Parameters & Emission Rates**							
ID	LOCATION (UTM83)	HEIGHT (M)	HEIGHT (ft)	DIAM (M)	VELOCITY (M/S)	TEMP (K)	SO_2 Rate (#/HR)
S11Max	304248, 4817601	152.4	500.0	6.401	29.49	350.0	2700
S11Norm	304248, 4817601	152.4	500.0	6.401	23.04	343.0	2025
S12Max	304248, 4817675	198.1	650.0	6.401	30.55	359.0	2648
S12Norm	304248, 4817675	198.1	650.0	6.401	21.88	350.0	1800

The impact of Columbia Energy Center in relation to the 1-hour SO_2 NAAQS is calculated for each scenario (maximum and normal) with both stacks operating. The regulatory default option in AERMOD was selected and results compiled consistent with the form of the 1-hr NAAQS, i.e. the three-year average of the fourth-highest daily max-hour was computed for each receptor and added to the background concentration.

The result from the analysis shows concentrations below the NAAQS assuming either maximum or normal load conditions Columbia Energy Center. Results are presented both in micrograms per cubic meter ($\mu g/m^3$) and in parts per billion (ppb), assuming a conversion factor (1 atm, 20° C) of 1 ppb = 2.616 ($\mu g/m^3$).

WPL COLUMBIA - PORTAGE **Modeling Results** (Concentrations in $\mu g/m^3$)		
	1-Hour SO_2 Maximum Heat Input	1-Hour SO_2 Normal Heat Input
Modeled Impact	140.7	124.2
Background Concentration	18.3	18.3
Total Impact	159.0	142.5
NAAQS	196	196

WPL COLUMBIA - PORTAGE **Modeling Results** (Concentrations in ppb)		
	1-Hour SO_2 Maximum Heat Input	1-Hour SO_2 Normal Heat Input
Modeled Impact	53.8	47.5
Background Concentration	7	7
Total Impact	60.8	54.5
NAAQS	75	75

CONCLUSION

The impact of the SO_2 sources in Columbia County is not predicted to result in a violation of the 1-hour SO_2 NAAQS in any part of the county. Columbia Energy Center, the main source of SO_2 in the county, was explicitly modeled following the procedures in the *Guideline on Air Quality Models (40 CFR Part 51, Appendix W, EPA, November 2005)* and the *SO_2 NAAQS Designations Technical Assistance Documents (EPA, December 2013)*. The other smaller sources of SO_2 emissions in the county were appropriately considered in the selected background concentration or otherwise demonstrated to have a small impact relative to Columbia Energy Center. This analysis supports WDNR's recommendation that EPA designate all of Columbia County, Wisconsin as attainment for the 1-hour SO_2 NAAQS.

Enclosure to WDNR letter of September 18, 2015

Figure 1 – Columbia County Emissions and Columbia Energy Center Modeling Domain