Attachment 6

Modeling Protocol for Duke Energy Carolinas, LLC – Allen Steam Station

Duke Energy
Allen Steam Station
Modeling Protocol
For 1-hour SO$_2$ National Ambient Air Quality Standard (NAAQS)

Contents

1. Purpose

On June 2, 2010 USEPA issued a final rule that revised the SO_2 National Ambient Air Quality Standard.[1] The revised SO_2 standard is 75 ppb based on a three-year average of the 99th percentile of the daily maximum hourly concentration. On August 21, 2015 EPA issued the Data Requirements Rule [2] (DRR) to implement the new standard. The DRR requires all sources of SO_2 greater than 2,000 tons/year to characterize the SO_2 concentrations where the sources are located using either a modeling or monitoring approach. The North Carolina Division of Air Quality (NCDAQ) will demonstrate attainment for the 1 hour SO_2 NAAQS for the Duke Energy Allen Steam Station (Allen) based on a modeling approach. This modeling protocol describes the proposed procedures for conducting a dispersion modeling analysis for the 2012-2014 period. In general, the proposed modeling procedures are consistent with applicable guidance, including the February 2016 SO_2 NAAQS Designations Modeling Technical Assistance Document[3] (TAD) issued by the EPA.

2. Plant Information

Duke Energy's Allen Steam Station is a 1,140 MW coal-fired electric power plant located in Gaston County North Carolina. The Allen Steam Station is permitted for five coal/No. 2 fuel oil-fired electric utility boilers (ID Nos. ES-1 (U1 Boiler), ES-2 (U2 Boiler), ES-3 (U3 Boiler), ES-4 (U4 Boiler), and ES-5 (U5 Boiler)) and one No. 2 fuel oil-fired auxiliary boiler (ID No. ES-6 (AuxB)). Units 1 & 2 are Coal/No. 2 fuel oil-fired electric utility boilers (1,980 million Btu per hour heat input capacity) equipped with modified fuel burner systems (low NOx concentric firing system), separated overfire air (SOFA), lowered fired (LOFIR) low NOx technologies, and alkaline-based fuel additives. Units 3 & 4 are Coal/No. 2 fuel oil-fired electric utility boilers (3,390 million Btu per hour heat input capacity), also equipped with modified fuel burner systems (low NOx concentric firing system), separated overfire air (SOFA), lowered-fire (LOFIR) low-NOx equipment, and alkaline-based fuel additives. Unit 5 is a Coal/No. 2 fuel oil-fired electric utility boiler (3,390 million Btu per hour heat input capacity) equipped with a modified fuel burner system (low NOx concentric firing system), separated overfire air (SOFA), lowered fired (LOFIR) low-NOx equipment, and alkaline-based fuel additive.

The Allen Station is located on located on the Lake Wylie Reservoir near the town of Belmont, Gaston County, North Carolina. A map and aerial photograph of the facility and surrounding area are provided in Figures 1 and 2, respectively.

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[1] Primary National Ambient Air Quality Standard for Sulfur Dioxide75 FR 35520–35603, Jun 22, 2010
[2] *Data Requirements Rule for the 1-Hour Sulfur Dioxide (SO2) Primary National Ambient Air Quality Standards (NAAQS): Proposed Rule, Federal Register Vol. 79 No. 92, pages 27445-27472, May 13, 2014.*
[3] https://www.epa.gov/airquality/sulfurdioxide/pdfs/SO2ModelingTAD.pdf

Figure 1. Location of the Duke Energy Allen Steam Station

Figure 2. Aerial View of the Allen Steam Station

3. Modeling Approach

Following the procedures in the modeling TAD, the dispersion modeling analysis will be used to evaluate the attainment status of the area in the vicinity of Allen Steam Station for the 1 hour SO_2 NAAQS. The DRR allows the use of modeling rather than monitoring to make attainment designations.   Air quality modeling provides a conservative estimate of the actual air quality within the vicinity of the plant.   As recommended, the modeling analysis will use the preferred model AERMOD. In addition, to allow for a more accurate representation of actual ambient SO_2 concentrations, the modeling analysis will be conducted as follows:

- Using actual emissions as an input for assessing current actual air quality;
- Using three years of modeling results to calculate a design value consistent with the 3-year monitoring period required to develop a design value for comparison to the NAAQS;
- Placing receptors for the modeling only in locations where a monitor could be placed; and
- Using actual stack heights rather than following the Good Engineering Practice (GEP) stack height policy when using actual emissions.

The following sections provides an overview of the modeling procedures to be used for Allen.

4. Model Selection

The modeling analysis for the 1 hour SO_2 NAAQS will be performed using AERMOD version 15181 (or an update if available), and pre-processing program, AERMAP (version 11130). The modeling analysis will account for building downwash. The BPIPPRIME (version 04274) will be used to input building parameters for AERMOD. This modeling analysis will be run using the regulatory default options. The pollutant identification will be set to "SO_2"in AERMOD, to allow AERMOD to properly calculate an SO_2 design value based on the 3-year average of the 99th percentile of the annual distribution of the daily maximum 1-hour concentrations for comparison with the 1- hour SO_2 NAAQS of 75 ppb (196 µg/m3).

5. Rural or Urban Dispersion

Modeling for this area would most appropriately use the rural dispersion mode. The procedure in section 7.2.3 of Guidelines on Air Quality Models Appendix W, is used to determine if the area is rural or urban. This procedure classifies land use within an area circumscribed by a circle, centered on the source, with a radius of 3 kilometers. If Auer land use types I-1, I-2, C-1, R-2, and R-3 account for 50 percent or more of the land use within 3 kilometers of the source,

then the modeling regime is considered urban. Following EPA's guidance the 2011 land use will be obtained from USGS[4] for a 3 km radius around the plant.

6. Building Downwash

EPA's Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) (version 04274), will be used to account for building downwash influences on the plume. Building downwash analysis is used to determine if the plume will be affected by the turbulent wake from onsite buildings or other structures. The effects of downwash on the plume can result in elevated ground-level concentrations in the near wake of a building and is required for consideration in the modeling. Building downwash will not be considered for other nearby sources that may be included in the modeling analysis.

7. Allen Source Parameters

Allen operates five coal fired boilers. The boilers are vented through two separate stacks as follows: Stack 1 – Units 1, 2 & 5 and Stack 2 – Units 3 & 4. Figure 3 shows the facility's stack locations, buildings and fenceline. Table 1 summarizes the source parameters that will be used in the modeling.

As recommended in the SO_2 modeling TAD, the actual hourly emissions data will be used in the modeling. The hourly emissions data will coincide with the meteorological data for the period 1/1/2012 thru 12/31/2014. The hourly SO_2 emissions measured by the continuous emissions monitoring system located on each of the boiler stacks will be used in the modeling analysis. The hourly SO_2 pounds per hour emission rate will be converted to units of grams per second. All the SO_2 emissions data will be quality assured and missing data substituted using the Part 75 data procedures. The hourly data will be input into AERMOD using the HOUREMIS keyword in the source pathway of the AERMOD control file (AERMOD.INP).

We propose to hold the stack exit velocity and temperature constant over the modeling period. The stack exit velocity of 5.1 m/s, reflects the exit velocity at maximum load and maximum SO_2 emissions rate. The stack temperature of 322 K reflects the normal stack temperature. The actual stack temperature remains relatively constant over the load range.

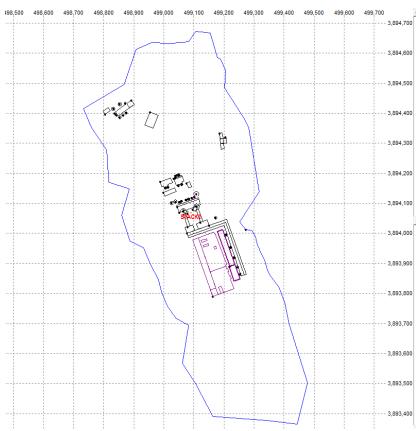---

[4] http://www.mrlc.gov/viewerjs/

Figure 3. Allen Steam Station Layout

Table 1. Allen Stack Parameters

Source Description	Easting (X)	Northing (Y)	Base Elevation	Stack Height	Exit Temp	Exit Velocity	Stack Diameter
	(m)	(m)	(m)	(m)	(K)	(m/s)	(m)
Units 1, 2, and 5	499,091	3,894,069	179.4	111.3	322.0	5.1	9.0
Units 3 and 4	499,091	3,894,070	179.4	111.3	322.0	5.1	9.0

8. Intermittent Sources

Most other emitting sources at Allen are associated with coal and ash handling, conveying, and transport and do not emit SO_2. Allen also operates four emergency generators and one auxiliary boiler which operate infrequently and emit small quantities of SO_2. According to Section 5.4 of the modeling TAD, EPA states that it is most appropriate to include sources of emissions which operate continuous or frequent enough to contributed to the annual distribution of the daily maximum concentrations. We propose that the emergency engines and auxiliary boiler be considered intermittent sources and not specifically included in the modeling.

9. Nearby Emissions Sources

An evaluation was conducted to determine if other sources of SO_2 emissions in the area surrounding Allen will be included in the modeling as required to fully characterize the air quality in the area. According to the EPA March 1, 2011 Memorandum[5] and the analysis presented at the 2011 EPA modeling workshop,[6] selection of regional background sources should be focused on sources located within 10 kilometers from Allen. According to the NCDAQ's Emissions Inventory for 2012-2014, there no other sources of SO_2 located within 10 km of the Allen plant; therefore, no additional sources will be included in the modeling.

10. Receptor Grid

The size, spacing, and location of the receptor grid is unique to the modeling analysis. The receptor grid will take into account the location of the sources to be modeled, terrain features, and areas where the public generally has access. In accordance with the modeling TAD, a receptor will not be located in an area where it is not technically feasible to locate a monitor.

Receptor density will be setup to detect the significant concentration gradient. Typically, the receptor spacing is closer near the source and further apart farther from the source. Receptor elevations will be included in the modeling analysis. The receptor heights will be determined using 7.5 minute NEDs processed with AERMAP. Flagpole receptor height for this analysis will be set at 0 meters.

The grid receptor spacing for the area of analysis is as follows:

- Receptors along the fence line every 50 meters
- Receptors every 100 meters from fence line to 3 km
- Receptors every 250 meters from 3 km to 5 km
- Receptors every 500 meters from 5 km to 10 km
- Receptors every 1000 meter from 10 km to 20 km
- Receptors every 2000 meter from 20 km to 50 km

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[5] http://www.epa.gov/scram001/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf
[6] http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2011/Presentations/6-Thursday_AM/6-3_AB-3_Presentation_at_EPA_Modeling_Workshop.pdf,

11. Meteorological Data

For the purpose of modeling for attainment designation demonstration, three years of National Weather Service (NWS) data will be used. The years used in the analysis will be 2012-2014. The NWS sites to be used in the analysis are spatially and climatologically representative of the Allen Station. We have evaluated the meteorological data and recommended use of Charlotte, 4 kilometers northeast, as the surface station and Greensboro as the upper Air Station.[7]

Hourly surface meteorological data will be obtained from the U.S. National Climatic Data Center (NCDC) for Charlotte for 2012-2014 in the standard ISHD (integrated surface hourly data) format.[8] The hourly data will be supplemented, as recommended by the U.S. EPA with TD-6405 format (so-called "1-minute") wind data also from the archives[9] and processed using the latest version of the AERMINUTE pre-processing tool (version 14337).

In addition to surface meteorological data, AERMET requires the use of data from an upper air sounding to estimate mixing heights and other boundary layer turbulence parameters. Upper air data from the nearest U.S.NWS radiosonde equipped station will be utilized in the modeling analysis. In this case, upper air data from the Greensboro will be obtained from the National Oceanic and Atmospheric Administration (NOAA) in FSL (Forecast Systems Laboratory) format.[10]

12. Land Use Analysis

AERMET also uses data derived for land use to calculate the surface roughness, Bowen ratio, and Albedo. The methodology outlined in Section 3.1.2 and 3.1.3 of the AERMOD Implementation Guide (AIG)[11] will be used with AERSURFACE (version 13016)[12] to determine Surface Roughness Length, Bowen Ratio and Albedo. AERSURFACE read land cover data obtained from the USGS and converts this data to the surface parameters listed above.

AERSURFACE setting will be set using the location coordinates for the NWS surface site, month delineation, seasonal defaults, 12 sectors of 30 degrees each, and airport location is checked yes. The monthly surface moisture at the NWS site will be classified as wet, dry or average based on a comparison of the month's precipitation total to the 30-year precipitation

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[7] http://deq.nc.gov/about/divisions/air-quality/air-quality-permits/modeling-meteorology/meteorological-data

[8] ftp://ftp.ncdc.noaa.gov/pub/data/noaa/

[9] ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin

[10] http://www.esrl.noaa.gov/raobs/

[11] US Environmental Protection Agency. 2015 "AERMOD Implementation Guide" revised August 3,2015. Available online https://www3.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_3August2015.pdf

[12] U.S. Environmental Protection Agency. 2013. "AERSURFACE User's Guide." EPA-454/B-08-001, Revised 01/16/2013. Available Online: http://www.epa.gov/scram001/7thconf/aermod/aersurface_userguide.pdf

data. This determination is used to adjust the Bowen ratio estimated by AERSURFACE. Bowen Ratio is used in calculating convective mixing heights used in AERMOD.

13. Background Concentrations

Background concentrations in the model results are important in determining the impacts from sources of SO_2 which are not explicitly included in the model. Background concentrations will be evaluated using the EPA's March 1, 2011 memo, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 Ambient Air Quality Standard."

14. Comparison to Standard

The model will be set to output the annual 4th high daily maximum concentrations at each receptor using the MXDYBYR output option. The design value at each receptor will be calculated by averaging the annual 4th high daily maximum concentrations over the period from 2012-2014. The design values will be compared to the SO_2 standard of 196 µg/m^3. As needed the model will be set to output the individual source contributions to the design value using the MAXDCONT output option.

We will provide EPA with a report which discusses the results of the modeling analysis and input/out files necessary to validate the results of the modeling analysis.