AIR DISPERSION MODELING RESULTS

Data Requirements Rule for the 1-Hour Sulfur Dioxide (SO_2)
Primary National Ambient Air Quality Standard

FPL ENERGY - WYMAN STATION

YARMOUTH, MAINE

JANUARY 2017

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1.0 INTRODUCTION

This Air Dispersion Modeling Results document was prepared by the Maine Department of Environmental Protection (MEDEP) for the FPL Wyman Station (Wyman Station) facility, located on Cousins Island in Yarmouth, Maine. Specifically, this report was generated to demonstrate that SO2 emissions from Wyman Station will not violate the 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard, as requested by USEPA in accordance with the Data Requirements Rule (DRR).

Subsequent to the finalization of the DRR, USEPA published the SO_2 Technical Assistance Document (TAD) in February 2016. The TAD provided guidance for conducting air dispersion modeling, focusing on the use of actual emissions data with actual site design parameters in quantifying nearby ambient air impacts from Wyman Station.

USEPA notes in Section 6.1 of the TAD that, "*...as previously stated, the purpose of the modeling is to act as a surrogate for monitoring.*" For those sources relying on actual emissions, the TAD notes that USEPA provides further guidance for periodic review of source-level emissions. Furthermore, modeling analyses have the ability to differ from 40 CFR part 51 Appendix W in the following major ways:

- Receptors are to be placed only in areas where feasible to place a monitor;
- Use of three years of meteorological data rather than five years off-site data (or one year of site-specific on-site data); and
- Use of actual stack height(s) instead of GEP stack height(s)

To be consistent with the intent of the TAD, the modeling analysis for Wyman Station incorporated actual emissions during the three most-recent years of meteorological data (calendar years 2013, 2014 and 2015). Hourly emissions data, extracted from USEPA's Clean Air Markets Division (CAMD) Air Markets Program Data, was utilized as appropriate. In addition, actual stack heights (including full stack height above formula GEP height) were used.

While the June 2016 modeling protocol provided in-depth discussions of the various modeling options and assumptions, a brief summary of each option had been provided in Section 2.0.

2.0 MODEL AND OPTION SELECTION

The AERMOD-PRIME refined dispersion model with its associated pre-processors was used to predict SO_2 concentrations in the modeling domain surrounding Wyman Station.

The following versions were used:

- AERMOD (version 15181)
- AERMET (version 15181)
- AERMINUTE (version 15272)
- AERMAP (version 11103)
- AERSURFACE (version 13016)

Only USEPA regulatory-default modeling options were utilized in this analysis. The use of non-regulatory defaults or other beta options were not used.

The modeling analysis accounted for the potential of building wake and cavity effects on emissions from all modeled stacks, as appropriate.

Due to the terrain variations over the modeling domain, the 'elevated terrain' setting was chosen.

Since Wyman Station is not located near a population center and is somewhat isolated on Cousins Island, the 'rural' option was chosen.

The current 1-hour SO_2 NAAQS is set at 75 parts-per-billion (196 micrograms per cubic meter), based on the 99th percentile of daily one-hour maximum concentrations averaged over a three-year period. The '1-hour SO_2 NAAQS' switch was selected so that AERMOD-PRIME would internally calculate and normalize the predicted SO_2 concentrations to the form of the NAAQS so that a direct comparison could be made.

2.1 UNITS AND PHYSICAL STACK ATTRIBUTES

For this modeling analysis, the equipment inventory at Wyman Station was comprised of five oil-fired units. Tables 1 and 2 of the modeling protocol contained detailed unit and stack data that was extracted from Wyman Station's Part 70 Air License as well as data from previous modeling efforts on file at MEDEP. Due to the availability of more accurate geo-spatial data, physical stack parameters (height, diameter, base elevation, etc.), modeling analysis inputs may differ slightly from those proposed in the modeling protocol.

The modeling analysis did not include emissions from emergency generators, which are considered intermittent sources, to be consistent with the March 2011 Tyler Fox (USEPA-

OAQPS) clarification memo "*Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard*".

All stack and building coordinates were in North American Datum 1983 (NAD83).

2.2 SOURCE OF EMISSIONS DATA

Actual hourly data, extracted from USEPA's Clean Air Markets Division (CAMD) Air Markets Program Data, was utilized for Wyman Station Units 1 - 4.

Units 1 – 4 are covered under the federal Acid Rain program that requires quarterly submission of QA/QC'd hourly SO_2 emissions data to USEPA. Unit 5 is an auxiliary boiler which does not generate electricity and is operated only to supply building heat and process steam to the Wyman Station facility. Since Unit 5 is not covered under the Acid Rain program, hourly operational data was not available.

It is important to note that the Acid Rain program does not currently require reporting of stack exit temperature or stack exit velocity data. Stack temperature data for Units 1 and 2 are provided by Wyman Station's in-house monitoring instrumentation and were utilized for these units. For all other parameters, simple linear regression analyses were used to generate hourly estimated stack exit temperature and velocity values based on unit load level. The equations were based on data from recent stack emissions tests and/or permits.

For the purposes of this modeling analysis, since Units 1 and 2 share a common stack, Continuous Emission Monitoring Systems (CEMS) hourly emission rates and exit velocities for Units 1 and 2 were combined. Stack exit temperatures used a weighted average based on the actual heat input load for each unit.

Since hourly emissions data for Unit 5 were not available, Unit 5 was conservatively modeled at its maximum design heat input rate based on 8,760 hours per year of operation. Since Units 1, 2 and 5 vent to a common stack, Unit 5 was modeled as an entirely separate stack in AERMOD-PRIME as to take advantage of actual emissions data for Units 1 and 2.

2.3 MODELING DOMAIN AND RECEPTOR GRID

A four-tiered nested Cartesian receptor grid was utilized in the modeling analysis; extending outwards from Wyman Station to approximately 20 kilometers.

The receptor grid contained a total of approximately 3,000 receptors and was centered near the middle of the Wyman Station property, composed of the following spacing:

- 25 meter fence-line spacing around the property boundary
- 100 meter spacing out to 1,500 meters
- 250 meter spacing out to 2,000 meters
- 500 meter spacing out to 5,000 meters
- 1,000 meter spacing out to 20,000 meters

Due to the variation of land and sea coverage in the modeling domain, receptors were included even in those areas that are not feasible to place a monitor.

2.4 TERRAIN DATA

Receptor elevations and corresponding receptor height scales (h_c) were generated by the AERMAP terrain pre-processor using terrain data from the US Geological Survey's National Elevation Dataset (NED).

2.5 METEOROLOGICAL DATA

Three complete years (January 1, 2013 – December 31, 2015) of representative meteorological data were used in the analysis comprised of surface data collected at the Portland Jetport ASOS site and upper-air data collected at the Gray National Weather Service site.

Both the surface and upper-air meteorological data were concurrently processed using the AERMET meteorological pre-processor.

To reduce the number of total calms in the Portland Jetport surface dataset, the AERMINUTE utility was applied with 1-minute average ASOS wind data, which decreased the percentage of calm hours to 0.51% over the three-year period.

AERMET also requires that site-specific surface characteristics around the meteorological and application sites be evaluated. Accordingly, the site surface characteristics values for albedo (r), surface roughness (z_o) and Bowen Ratio (B_o) were calculated using USEPA's AERSURFACE program for each of the twelve 30-degree sectors.

While the Department recognizes that the AERSURFACE is a non-regulatory tool, it does provide a straightforward and consistent approach for calculating the necessary surface characteristics needed for AERMET to process an AERMOD-ready meteorological database usable for dispersion modeling.

Per USEPA guidance, the surface roughness values were calculated within in a one-kilometer radius of the monitoring site, while values of albedo and Bowen ratio were developed over a 10 x 10 kilometer region, centered over the monitoring site.

The seasonal categories for AERSURFACE were assigned in accordance with MEDEP modeling guidance as shown in Table 4 of the modeling protocol.

For this analysis, 'average moisture condition' was selected for use. Using the method outlined in the AERMET's User's Guide, thirty years of annual precipitation data, collected at the Portland Jetport meteorological collection site, were downloaded from the National Climactic Data Center. The precipitation data spanned the period 1986 – 2015. Annual rainfall totals from the modeled period (2013 – 2015) were arithmetically averaged and ranked versus rainfall over the 1986 – 2015 thirty-year period. The three-year annual average rainfall was calculated to be 47.89" which ranked 13th overall. Given that the 2013-2015 annual three-year average fell within the middle 40th percentile, the proposal to use 'average moisture' was warranted.

2.6 BUILDINGS AND STRUCTURES

Major buildings and tanks at Wyman Station were input into USEPA's Building Profile Input Program with Plume Rise Model Enhancement (BPIP-PRIME) to determine any downwash effects from these structures. The building and tank data developed and input into BPIP-PRIME for this modeling analysis is reasonably consistent with data used in previous MEDEP approved permit-related modeling analyses.

2.7 AMBIENT BACKGROUND CONCENTRATIONS

An analysis of SO_2 monitors currently-operating in Maine was conducted to select a monitor that would best represent existing 1-hour SO_2 background concentrations near Wyman Station. The Deering Oaks monitor, located near downtown Portland, was chosen for the following reasons:

- close proximity to Wyman Station (~13.5 kilometers)
- located upwind of Wyman Station, which limits Wyman Station's direct contribution
- monitoring data was concurrent with 2013-2015 meteorological data used in AERMOD
- comprises a complete data set which meets all minimum data recovery requirements
- conservative background concentration, due to its proximity to downtown Portland

For this modeling analysis, Certified 2013-15 Deering Oaks hourly SO_2 data were downloaded from USEPA's Air Quality System (AQS) database and 40 CFR Part 50, Appendix T to Part 50 data handling conventions were used to calculate the design value (average of the annual 99th percentile concentrations).

Using this methodology, the SO_2 data provides a single average background concentration of 12 parts per billion (31.4 $\mu g/m^3$), which was applied for all modeled hours over the three year period. No additional refinement methods for background data were used (i.e., background values by season and hour of day, etc).

The single annual SO_2 background value of 31.4 $\mu g/m^3$ was conservatively added to the maximum predicted impact to achieve a total impact that was compared to the 1-hour SO_2 NAAQS. For reference, the current 1-hour SO_2 NAAQS is set at 75 parts-per-billion (196 micrograms per cubic meter). This standard is based on the 99th percentile of daily one-hour maximum concentrations averaged over a three-year period.

3.0 MAXIMUM 1-HOUR SO_2 RESULTS

The maximum predicted fourth-high one-hour SO_2 impact was 108.36 $\mu g/m^3$. When the background value is added, the maximum total impact is calculated to be 139.76 $\mu g/m^3$, which is well below the NAAQS value of 196.00 $\mu g/m^3$.

Max Impact ($\mu g/m^3$)	Rank	Receptor UTM E (m)	Receptor UTM N (m)	Receptor Elevation (m)	Background ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
108.3573	4TH	407,871	4,844,759	0.08	31.4	139.76	196.00

Because the maximum total 1-hour SO_2 impact is below its respective NAAQS, MEDEP believes that this modeling analysis satisfies the intent and requirements of the DRR.

Figures 1 and 2 show graphical depictions of predicted concentrations, in both isopleth and receptor impact form.

Finally, MEDEP feels it is important to understand future changes to Wyman Station that will dramatically decrease overall SO_2 emission rates. Per Maine State Statute Title 38 §603-A *Low Sulfur Fuel*, beginning July 1, 2018, Wyman Station may no longer purchase residual fuel oil with a sulfur level of up to 2.0% on Units 1, 2 & 5 and up to 0.7% on Units 3 & 4 and may only purchase residual fuel with a maximum sulfur content of 0.5% for use facility-wide. Therefore, the results of this modeling analysis are likely to be significantly more conservative than future actual operational conditions will be after these requirements take effect in 2018.

FIGURE 1: 1-HOUR SO_2 MAXIMUM PREDICTED IMPACT CONTOURS

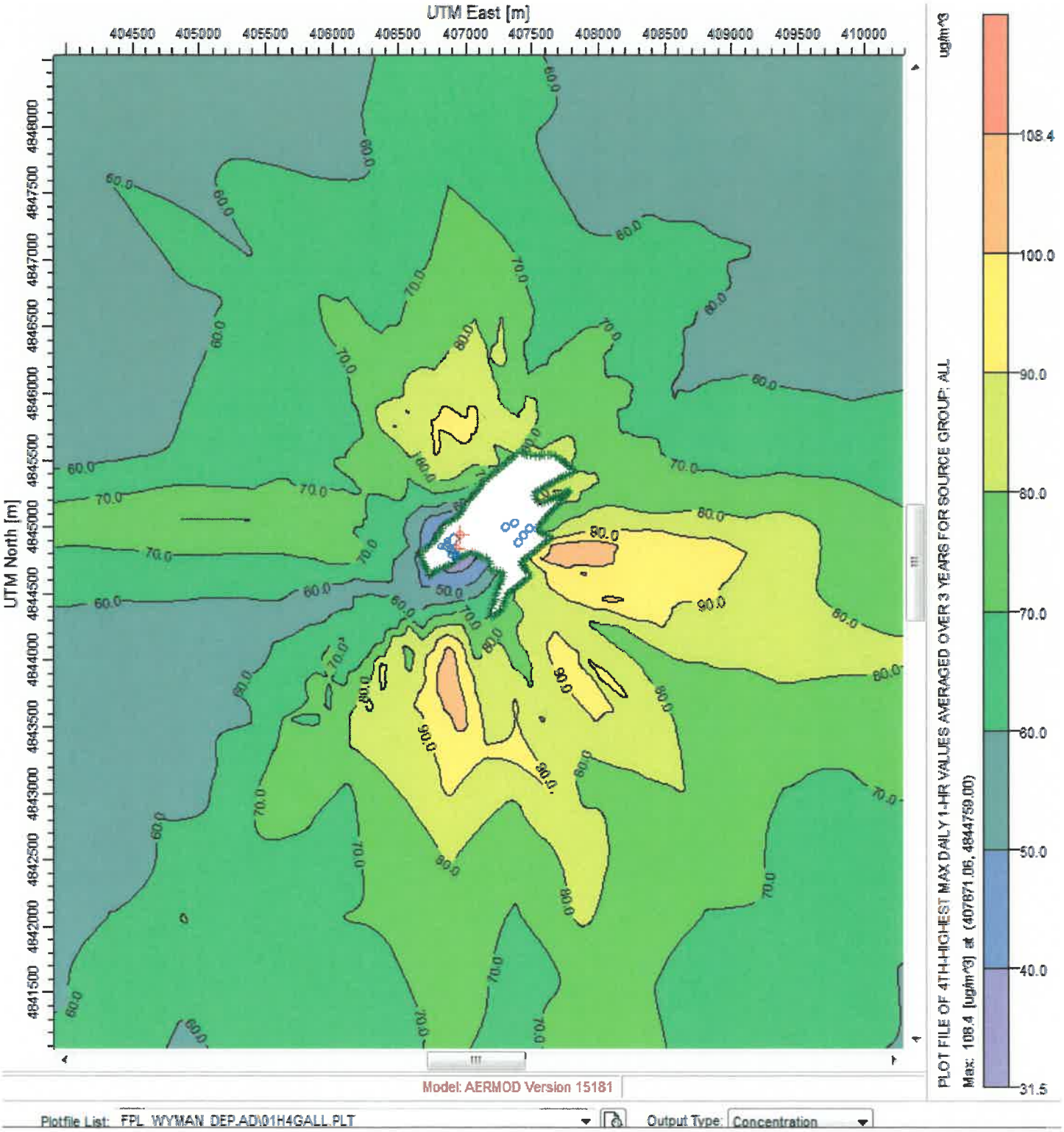

FIGURE 2: 1-HOUR SO_2 MAXIMUM PREDICTED IMPACTS