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# RENOVO ENERGY CENTER, LLC

*Refined Air Dispersion Modeling Report for Plant Reconfiguration*


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*137575*

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POWER ENGINEERS

# Refined Air Dispersion Modeling Report

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# 1.0 INTRODUCTION

The proposed Renovo Energy Center (REC) is subject to New Source Review (NSR) Prevention of Significant Deterioration (PSD) review for NOx, CO, $PM_{10}$, $PM_{2.5}$, $SO_2$, $H_2SO_4$, and GHG emissions because the project has the potential to emit these pollutants at annual rates above the applicable PSD threshold. In addition, REC is subject to Non-Attainment Area New Source Review (NNSR) for NOx and VOC emissions because the project has the potential to emit these pollutants at annual rates above the applicable NNSR threshold in the Ozone Transport Region.

PSD and NNSR review require a source to demonstrate that a project's allowable emissions will not cause or contribute to air pollution in violation of the applicable National Ambient Air Quality Standards (NAAQS) or exceed any applicable maximum allowable increase over the project area's baseline concentrations (PSD Increment Standards). The source must also demonstrate that the project emissions will not adversely impact vegetation, soils, or regional visibility.

This refined air dispersion modeling summary report describes the methods and procedures that were used in REC's Air Quality Impact Analysis (AQIA) to demonstrate compliance with the applicable NAAQS and PSD Increment Standards and to demonstrate that the project emissions will not adversely impact vegetation, soils, or regional visibility.

# 2.0 PROJECT CONTACTS

Contact information for the project team is provided in the following table.

**TABLE 1 PROJECT TEAM CONTACT INFORMATION**

| NAME | TITLE | COMPANY | TELEPHONE | EMAIL |
|---|---|---|---|---|
| Rick Franzese | Project Manager | Renovo Energy Center LLC | (571) 392-6383 | rfranzes@bechtel.com |
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# 3.0 PROJECT SUMMARY

REC proposes to construct a nominally rated 1,240 MW (net) dual fuel (natural gas and ultra-low sulfur diesel (ULSD)) combined cycle electric generating plant in Renovo, Pennsylvania. The proposed REC facility will consist of two 1-on-1 power blocks consisting of a combustion turbine and a steam turbine in line to produce electricity for distribution into regional transmission grid systems. Each combined cycle system consists of a Combustion Turbine (CT), which is intended to be fired on natural gas unless there is an interruption in gas supply, and a Heat Recovery Steam Generator (HRSG) with a natural gas-fired Duct Burner (DB). The steam from the HRSGs will be routed through the condensing steam turbine generator. REC will utilize air cooled condensers for condensing the exhaust steam, which is an environmentally preferred method as compared to a traditional wet cooling tower.

The proposed REC facility will also include two auxiliary boilers, one emergency generator, an emergency firewater pump, and four natural gas heaters. The auxiliary boilers and fuel gas heaters will only combust pipeline quality natural gas. The emergency firewater pump and emergency generator will utilize ULSD fuel oil.

In addition to the combustion devices, the REC facility will also have potential air emissions from the petroleum storage tanks, ammonia slip from the selective catalytic reaction process, and $SF_6$ containing circuit breakers.

## 3.1 Project Location

REC's proposed site is a 68-acre parcel located north-northeast of the Town of Renovo between Erie Avenue and Industrial Park Road. The site is the location of the former PRR/Philadelphia & Erie railroad car renovation facility.

The approximate UTM coordinates of the proposed site are 269.442 kilometers (km) Easting and 4,578.895 km Northing. The project will be located at a base elevation of approximately 672 feet (204.8 meters) above mean sea level. The immediate project site consists of flat terrain in an east-west orientated river valley with increasing elevated terrain to the north and south of the proposed site.

## 3.2 Equipment Inventory and Description

Appendix A includes a site plan with the proposed location of the buildings and equipment indicated. REC is proposing to install and operate the following devices:

- Two GE 7HA.02 natural gas/ULSD fired combustion turbines (each with maximum heat input capacities of 3,541 million British thermal units per hour (MMBtu/hr) High Heating Value (HHV) when firing natural gas, and 3,940 MMBtu/hr HHV when firing ULSD) with inlet evaporative coolers;
- Two heat recovery steam generators (HRSG) with supplementary natural gas-fired duct burners, each with maximum heat input capacities of ~1,005 MMBtu/hr (HHV);
- Each combustion turbine will be paired with one condensing steam turbine and one driven electric generator;
- Two natural gas-fired auxiliary boilers (one for each power block), each with maximum heat input capacities of 66 MMBtu/hr;
- One diesel-fired Emergency Generator, rated at 1,500 kW (~14.3 MMBtu/hr heat input);
- Three natural gas-fired fuel gas heaters, each with maximum heat input capacities of 15 MMBtu/hr and located approximately 1.25 miles from the site at a pressure reducing station;
- One on-site natural gas-fired dew point heater with a maximum heat input capacity of 3.0 MMBtu/hr;
- One diesel-fired Emergency Fire Water Pump, rated at 250 hp (~1.8 MMBtu/hr heat input);
- Two Aqueous Ammonia aboveground storage tanks with a capacity of 26,000 gallons each;

- One ultra-low sulfur diesel oil aboveground storage tank with a capacity of 3.5 million gallons;
- Two lube oil aboveground storage tanks each with a capacity of 20,000 gallons; and
- Twelve high voltage circuit breakers containing sulfur hexafluoride ($SF_6$) within the facility's electrical switchyard.

Clinton County is classified as either attainment or unclassifiable for all criteria pollutants and the state of Pennsylvania is entirely in the Ozone Transport Region (OTR). Clinton County is currently designated as "attainment/unclassifiable" for the 1-hour $SO_2$ NAAQS. Based on the project's potential emissions estimates, under the NSR permitting program REC will be a new major stationary source of NOx, CO, VOC, $PM_{10}$, $PM_{2.5}$, $SO_2$, and Greenhouse Gas (GHG) emissions. Thus, a PSD modeling analysis was required for $NO_2$, CO, $PM_{10}$, $PM_{2.5}$, and $SO_2$.

The NAAQS, Class II Increment Standards and Significant Impact Levels (SILs) and Significant Monitoring Concentrations (SMCs) are summarized in the following table.

**TABLE 2 SUMMARY OF NAAQS, CLASS II PSD INCREMENTS, SILS, AND SMCS**

| POLLUTANT | AVERAGING PERIOD | NAAQS[A] (µg/m³) | CLASS II INCREMENT STANDARDS (µg/m³) | CLASS II SIL (µg/m³) | SMC (µg/m³) |
|---|---|---|---|---|---|
| $SO_2$ | 1-hour | 196.4 | -- | 7.8[b] | -- |
| | 3-hour | 1,300[c] | 512 | 25[e] | -- |
| | 24-hour | -- | 91 | 5[e] | 13 |
| | Annual | -- | 20 | 1[e] | -- |
| $PM_{10}$ | 24-hour | 150 | 30 | 5[e] | 10 |
| | Annual | -- | 17 | 1[e] | -- |
| $PM_{2.5}$ | 24-hour | 35 | 9 | 1.2[d] | 0 (no averaging period) |
| | Annual | 12 | 4 | 0.2[d] | |
| $NO_2$ | 1-hour | 188 | -- | 7.5[b] | -- |
| | Annual | 100 | 25 | 1[e] | 14 |
| CO | 1-hour | 40,000 | -- | 2,000[e] | -- |
| | 8-hour | 10,000 | -- | 500[e] | 575 |

[a]Primary Standard unless otherwise noted.
[b]EPA Interim SIL adopted by PaDEP 12/01/2010.
[c]Secondary standard.
[d]U.S. EPA's April 17, 2018 memorandum, "Guidance on Significant Impact Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program."
[e]40 CFR §51.165(b)(2)

The applicable forms of the monitored and modeled values for these standards and thresholds are summarized in the following table.

**TABLE 3 FORM OF MONITORED AND MODELED VALUES FOR COMPARISON TO NAAQS, CLASS II INCREMENT STANDARDS, SILS, AND SMCS AND FOR DETERMINING REPRESENTATIVE AMBIENT BACKGROUND FOR POLLUTANTS SUBJECT TO REC'S AQIA[A]**

| POLLUTANT | AVERAGING PERIOD | AMBIENT BACKGROUND MONITORING DESIGN VALUE | MODELED VALUE - NAAQS | MODELED VALUE - CLASS II INCREMENT | MODELED VALUE - CLASS II SIL | SMC |
|---|---|---|---|---|---|---|
| $SO_2$ | 1-hour | 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour values | 99th percentile of the annual distribution of daily maximum 1-hour values[e] | -- | highest 1-hour concentration across all receptors for 1 year of site-specific data[c] | -- |
| | 3-hour | maximum value over 3 years[f] | highest-2nd-highest | highest-2nd-highest | highest-1st-highest | -- |
| | 24-hour | -- | -- | highest-2nd-highest | highest-1st-highest | highest -1st-highest |
| | Annual | -- | -- | highest-1st-highest | highest-1st-highest | -- |
| $PM_{10}$ | 24-hour | maximum value over 3 years[f] | highest-2nd-highest value over one year of site-specific data | highest-2nd-highest | highest-1st-highest | highest -1st-highest |
| | Annual | -- | -- | highest-1st-highest | highest-1st-highest | -- |
| $PM_{2.5}$ | 24-hour | average over 3 years of the 98th percentile values for each year | 98th percentile value over one year of site-specific data[b] | highest-2nd-highest[b] | highest 24-hour average over 1 year of site-specific data[b] | highest -1st-highest |
| | Annual | average over 3 years of annual arithmetic average values for each year | highest-1st-highest | highest-1st-highest | highest annual average across all receptors over 1 year of site-specific data[b] | |
| $NO_2$ | 1-hour | 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour values | 98th percentile of the annual distribution of daily maximum 1-hour values[d] | -- | highest 1-hour concentration across all receptors for 1 year of site-specific data[c] | -- |
| | Annual | maximum over 3 years of annual arithmetic average values for each year | highest-1st-highest | highest-1st-highest | highest-1st-highest | highest -1st-highest |
| CO | 1-hour | maximum value over 3 years[f] | highest-2nd-highest | -- | highest-1st-highest | -- |
| | 8-hour | maximum value over 3 years[f] | highest-2nd-highest | -- | highest-1st-highest | highest -1st-highest |

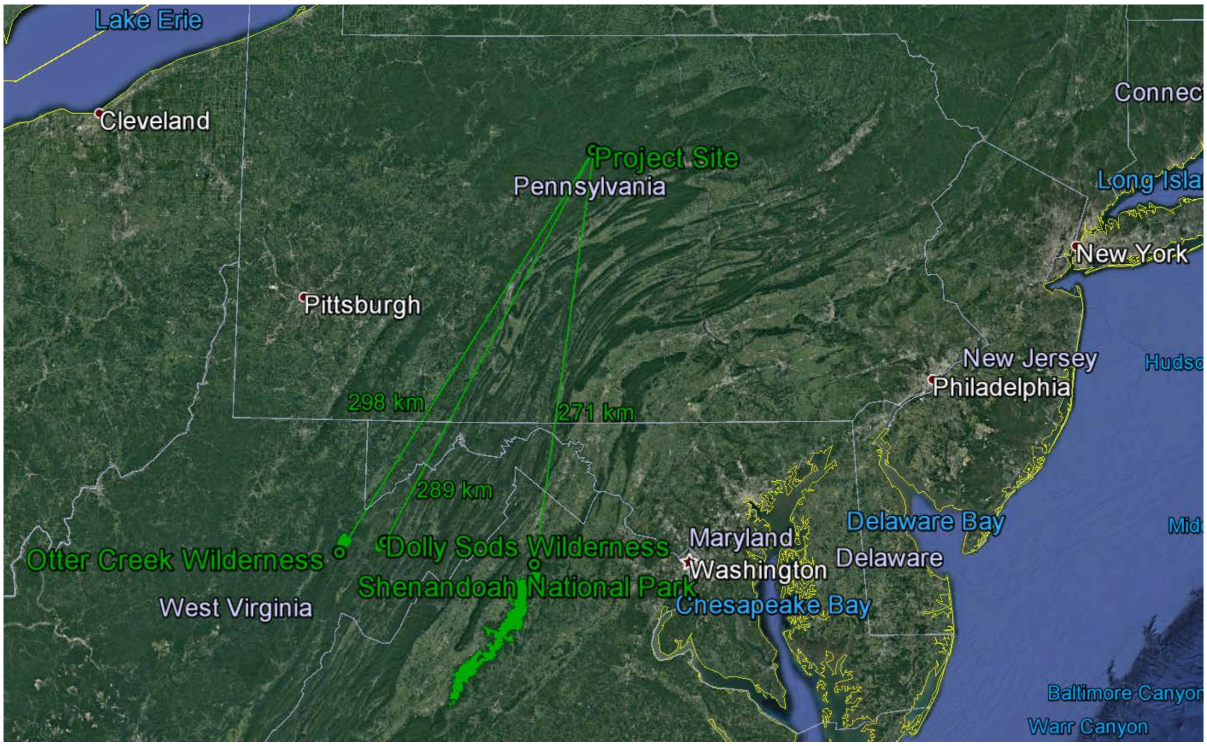
[a]$O_3$ and Pb are not subject to PSD review and therefore are not presented in this table.
[b]EPA memorandum, dated May 20, 2014, from S. Page "Guidance for $PM_{2.5}$ Permit Modeling".
[c]EPA memorandum, dated March 1, 2011, from T. Fox, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour $NO_2$ National Ambient Air Quality Standard".
[d]EPA's June 28, 2010 memorandum, "Applicability of Appendix W Modeling Guidance for the 1-hour $NO_2$ National Ambient Air Quality Standard," EPA's June 29, 2010 memorandum "Guidance Concerning the Implementation of the 1-hour NO2 NAAQS for the Prevention of Significant Deterioration Program," and PADEP's December 1, 2010 memorandum "Interim 1-hour SILs for $NO_2$ and $SO_2$.".
[e]EPA memorandum, dated August 23, 2010, from S. Page, "Guidance Concerning the Implementation of the 1-hour $SO_2$ NAAQS for the Prevention of Significant Deterioration Program," and PADEP's December 1, 2010 memorandum "Interim 1-hour SILs for $NO_2$ and $SO_2$".
[f]Recommended by PaDEP as a "first tier" approach without justification

# 4.0 CLASS I AREAS

Class I areas are designated to protect Federal lands such as national parks and wildlife refuges, considered the most pristine areas where a minimal amount of ambient air impacts is allowed. Proposed sources within 100 km of these areas are required to assess impacts of ambient air by comparing impacts to PSD Class I Increment standards. Federal Land Managers (FLMs) have discretion in determining which sources must complete a Class I analysis and may require an analysis for sources further than 100 km from a Class I area. According to the FLMs' AQRV Work Group guidance, a source located greater than 50 km from a Class I area is considered to have a negligible impact on the Class I area if its total $SO_2$, NOx, $PM_{10}$, and $H_2SO_4$ annual potential emissions (in tons per year) divided by the distance from the source to the class I area (in kilometers) is less than 10. This is known as the "Q/d" analysis, where the total annual emissions of $SO_2$, NOx, $PM_{10}$, and $H_2SO_4$ (based on 24-hour maximum allowable emissions) are designated as "Q," and the distance from the source to the Class I area is designated as "d".

The closest Class I area to the proposed location of REC is Shenandoah National Park in Virginia, whose closest border is approximately 271 km away. The next closest Class I areas are the Dolly Sods Wilderness and the Otter Creek Wilderness areas in West Virginia which are approximately 289 km and 298 km from the proposed project site, respectively. The locations of these Class I areas are shown below in Figure 1.

**FIGURE 1 CLASS I AREA LOCATIONS**




The "Q/d" analysis for each class I area is shown below in Table 4. The FLMs were notified of the proposed project and the correspondence between the REC project team and the FLMs is documented in Appendix K. Due to the results of the Q/d analysis and as confirmed by the FLMs, a further review of impacts to Class I area AQRVs was not required.

**TABLE 4 Q/D ANALYSIS**

| | |
|---|---|
| 24-hour Maximum Allowable NOx Emissions (lbs): | 3,328.3 |
| 24-hour Maximum Allowable $SO_2$ Emissions (lbs): | 336.0 |
| 24-hour Maximum Allowable $PM_{10}$ Emissions (lbs): | 2,313.6 |
| 24-hour Maximum Allowable $H_2SO_4$ Emissions (lbs): | 211.2 |
| Q (Based on 365 Days of 24-hour Maximums): | 1,129.5 tons |
| Distance to Shenandoah National Park: | 271 kilometers |
| Q/d for Shenandoah National Park: | 4.17 |
| Distance to Dolly Sods Wilderness: | 289 kilometers |
| Q/d for Dolly Sods Wilderness: | 3.91 |
| Distance to Otter Creek Wilderness: | 298 kilometers |
| Q/d for Otter Creek Wilderness: | 3.79 |

*NOx based on 1 ULSD cold start and shutdown, remaining hours on ULSD steady state emissions. $SO_2$, $PM_{10}$, and $H_2SO_4$ based on 24 hours of ULSD steady state emissions. ULSD firing represents the 24-hour maximum emissions scenario.*

# 5.0 MODEL SELECTION

REC used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD, version 19191) for the required AQIA. AERMOD also incorporates the Plume Rise Model Enhancement (PRIME) downwash algorithm. AERMOD is an EPA-approved and required dispersion model for evaluating impacts of land-based stationary sources as outlined in EPA's "Guideline on Air Quality Models" (40 CFR 51, Appendix W).

AERMOD was run using the Providence/Oris BEEST (version 12.01) software interface. Test-case files demonstrating that AERMOD within the proprietary BEEST software will predict the same results as the EPA-provided AERMOD code are included on electronic media in Appendix C.

AERMOD is capable of modeling receptors both in the near-building wake (cavity) region as well as far-building wake regions. The PRIME algorithm accounts for the distance from each structure to potentially affected sources in that structure's region of influence.

Default AERMOD control options used in the AQIA consistent with EPA recommendations included the following:

- Stack-tip downwash
- Effects of elevated terrain (simple and complex)
- Rural dispersion coefficients
- Ambient Ratio Method 2 algorithm for NO to $NO_2$ conversion

# 6.0 PROJECT SOURCES, OPERATING SCENARIOS, AND STACK PARAMETERS

REC's main air emissions sources will be the two CTs (CT1 and CT2) with duct-fired HRSGs. Ancillary sources include two auxiliary boilers (AUX1 and AUX2), one emergency generator (EG), one fire pump engine (FP), three off-site fuel gas heaters, and one on-site dew point gas heater (DPH). The three off-site fuel gas heaters are not included in this modeling analysis as they are considered insignificant sources of emissions. REC is proposing annual operational limitations on the emergency generator of 500 hours, 250 hours for the fire pump engine, and 118,800 MMBtu/year of heat input (equivalent to 1,800 hours/year at maximum load) for each of the auxiliary boilers. Based on the limited operating scenarios and relatively insignificant nature of the ancillary sources, load screening analyses were performed separately for each group of equipment (the combustion turbines and the ancillary equipment). All project sources will be included in the refined modeling analysis.

Table 5 below summarizes the locations and physical dimensions of each pollution source to be included in the modeling analysis.

**TABLE 5 LOCATIONS AND DIMENSIONS OF POLLUTION SOURCES TO BE INCLUDED IN MODELING ANALYSIS**

| SOURCE ID | UTM COORDINATES | | STACK BASE ELEVATION (m) | STACK HEIGHT (m) | STACK EXIT DIAMETER (m) |
|---|---|---|---|---|---|
| | EASTING (m) | NORTHING (m) | | | |
| CT1 | 269,428.0 | 4,578,946.0 | 204.8 | 79.9 | 6.7 |
| CT2 | 269,450.0 | 4,578,851.0 | 204.8 | 79.9 | 6.7 |
| AUX1 | 269,434.0 | 4,578,926.0 | 204.8 | 15.2 | 0.91 |
| AUX2 | 269,456.0 | 4,578,831.0 | 204.8 | 15.2 | 0.91 |
| EG | 269,470.9 | 4,578,804.6 | 204.8 | 4.9 | 0.25 |
| FP | 269,573.2 | 4,578,863.3 | 204.8 | 4.9 | 0.13 |
| DPH | 269,373.3 | 4,578,996.0 | 204.8 | 4.6 | 0.25 |

## 6.1 CT Steady State Operations

Steady state operation of the CTs is considered as continuous operation at loads of ~30% to 100%. Both CTs may be operated for a maximum of 8,760 hours per year. While market conditions will drive the electrical output demands of the REC plant, the heat input, emission rates, and exhaust parameters of the CTs will vary depending on fuel type and ambient temperature, with the maximum heat input and corresponding exhaust parameters typically occurring at the minimum design ambient temperature (-20°F for REC) and minimum heat input and corresponding exhaust parameters typically occurring at the maximum design ambient temperatures (95.8°F for REC). Emission rates are generally higher when firing ULSD fuel. A load case analysis was performed over the entire range of steady state operating scenarios provided by GE (Appendix B) to determine which scenarios were to be included in the refined modeling analysis. The results of this load case analysis are presented below in Table 6 (natural gas operating scenarios) and Table 7 (ULSD operating scenarios). Because NOx emissions are elevated during startup and shutdown scenarios (as well as during ULSD firing), the emission rates of NOx for the annual averaging period were calculated by averaging each of the natural gas steady state operating scenarios with the appropriate amount of potential NOx emissions during ULSD firing as well as startup and shutdown operations (for both fuels) based on the proposed limits on hours for all scenarios. Appendix B contains the detailed calculations for the NOx annual averaging period load case inputs.

## TABLE 6 LOAD CASE ANALYSIS FOR CT STEADY STATE OPERATIONS, NATURAL GAS

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH OPERATING SCENARIO (µg/m³) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 15 | 16 | 17 | 18 | 19 |
| $SO_2$ | 1-hour | 9.14 | 8.84 | 9.64 | 8.82 | 6.88 | 6.74 | 6.22 | 13.17 | 11.46 | 12.75 | 11.86 | 12.22 |
| | 3-hour | 5.22 | 4.83 | 5.31 | 5.02 | 4.11 | 4.20 | 3.96 | 7.05 | 6.46 | 6.89 | 6.53 | 6.83 |
| | 24-hour | 1.05 | 0.99 | 1.08 | 1.01 | 1.08 | 1.05 | 1.01 | 1.44 | 1.33 | 1.40 | 1.33 | 1.38 |
| | Annual | 0.14 | 0.13 | 0.14 | 0.13 | 0.12 | 0.11 | 0.10 | 0.192 | 0.17 | 0.187 | 0.18 | 0.18 |
| $PM_{10}$ | 24-hour | 2.52 | 2.56 | 2.59 | 2.47 | 4.50 | 5.11 | 4.89 | 5.30 | 5.00 | 5.01 | 4.84 | 5.09 |
| | Annual | 0.34 | 0.34 | 0.35 | 0.33 | 0.48 | 0.52 | 0.50 | 0.71 | 0.66 | 0.67 | 0.65 | 0.68 |
| $PM_{2.5}$ | 24-hour | 1.31 | 1.37 | 1.38 | 1.28 | 1.88 | 2.06 | 1.98 | 2.88 | 2.67 | 2.72 | 2.57 | 2.67 |
| | Annual | 0.34 | 0.34 | 0.35 | 0.33 | 0.48 | 0.52 | 0.50 | 0.71 | 0.66 | 0.67 | 0.65 | 0.68 |
| $NO_2$ | 1-hour | 17.59 | 16.62 | 18.54 | 16.88 | 16.76 | 17.32 | 15.88 | 26.21 | 24.40 | 24.94 | 22.81 | 23.37 |
| | Annual | 0.88 | 0.86 | 0.90 | 0.85 | 1.04 | 1.07 | 1.02 | 1.10 | 1.04 | 1.07 | 1.03 | 1.05 |
| CO | 1-hour | 23.97 | 22.37 | 24.81 | 22.67 | 21.15 | 18.78 | 17.33 | 47.83 | 43.00 | 46.73 | 44.67 | 46.64 |
| | 8-hour | 6.05 | 5.63 | 6.20 | 5.80 | 4.63 | 4.60 | 4.12 | 11.83 | 10.63 | 11.60 | 11.18 | 11.68 |

Note: Results reflect statistical form of NAAQS. Bold/italics indicate maximum impacts per pollutant and averaging period.

## TABLE 7 LOAD CASE ANALYSIS FOR CT STEADY STATE OPERATIONS, ULSD

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH OPERATING SCENARIO (µg/m³) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 20 | 21 |
| $SO_2$ | 1-hour | 8.15 | 8.57 | 8.00 | 7.68 | 7.79 | 8.33 | 7.96 | 8.48 | 8.10 |
| | 3-hour | 5.23 | 5.66 | 5.81 | 5.45 | 4.78 | 4.56 | 4.31 | 5.76 | 5.24 |
| | 24-hour | 1.14 | 1.18 | 1.185 | 1.10 | 1.01 | 1.02 | 0.96 | 1.190 | 1.13 |
| | Annual | 0.13 | 0.139 | 0.1413 | 0.13 | 0.13 | 0.13 | 0.12 | 0.1410 | 0.13 |
| $PM_{10}$ | 24-hour | 7.87 | 8.13 | 8.263 | 8.264 | 8.47 | 10.00 | 9.87 | 8.20 | 7.96 |
| | Annual | 0.92 | 0.96 | 0.985 | 0.991 | 1.09 | 1.26 | 1.25 | 0.97 | 0.93 |
| $PM_{2.5}$ | 24-hour | 3.82 | 3.84 | 3.99 | 4.02 | 4.40 | 5.18 | 5.12 | 3.91 | 3.81 |
| | Annual | 0.92 | 0.96 | 0.985 | 0.991 | 1.09 | 1.26 | 1.25 | 0.97 | 0.93 |
| $NO_2$ | 1-hour | 26.39 | 27.56 | 26.99 | 25.51 | 25.95 | 28.20 | 26.16 | 27.67 | 26.16 |
| | Annual | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CO | 1-hour | 24.19 | 25.79 | 26.18 | 24.64 | 24.79 | 24.72 | 22.82 | 26.23 | 24.15 |
| | 8-hour | 8.22 | 8.39 | 8.45 | 7.91 | 6.56 | 6.33 | 5.87 | 8.51 | 8.10 |

Note: Results reflect statistical form of NAAQS. Bold/italics indicate maximum impacts per pollutant and averaging period.

The load case analysis indicates that the operating scenarios in Table 8 below result in the worst-case predicted ambient impacts, and were used in the significant impact area analysis and ultimately, the cumulative ambient impact analysis (with the exception of CO, which is explained in the next section) along with the design load case for REC (Operating Scenario 17).

**TABLE 8 STEADY STATE OPERATING SCENARIOS RESULTING IN WORST-CASE AMBIENT IMPACTS**

| POLLUTANT | AVERAGE PERIOD | WORST-CASE OPERATING SCENARIO | OPERATING SCENARIO AMBIENT TEMPERATURE | OPERATING SCENARIO COMBUSTION TURBINE CAPACITY |
|---|---|---|---|---|
| $SO_2$ | 1-hour | 15 | -20°F | 50% |
| | 3-hour | 15 | -20°F | 50% |
| | 24-hour | 15 | -20°F | 50% |
| | Annual | 15 | -20°F | 50% |
| $PM_{10}$ | 24-hour | 13 | 59°F | 50% |
| | Annual | 13 | 59°F | 50% |
| $PM_{2.5}$ | 24-hour | 13 | 59°F | 50% |
| | Annual | 13 | 59°F | 50% |
| $NO_2$ | 1-hour | 13 | 59°F | 50% |
| | Annual | 15 | -20°F | 50% |
| CO | 1-hour | 15 | -20°F | 50% |
| | 8-hour | 15 | -20°F | 50% |

Note: Operating scenario details are identified in Appendix B.

## 6.2 CT Startup and Shutdown Operations

During startup and/or shutdown (SUSD) of the CTs, short-term emissions are higher than steady-state emissions, as combustion conditions must stabilize, and emission control equipment must be brought into operation. There are four main types of SUSD scenarios: hot starts, warm starts, cold starts, and shutdowns. The GE-provided SUSD emission characteristics and corresponding hourly calculations are shown in Appendix B. For the hourly calculations, the SUSD emission parameters were averaged with appropriate steady-state values to complete a one-hour period. For example: hot starts are expected to occur in a 35-minute period. Therefore, 25 minutes of steady-state operational parameters were averaged with the hot start parameters to complete the one-hour period. Parameters that were averaged in this manner were stack exhaust flow rate, stack exit temperature, and pollutant emissions. Only NOx and CO emissions are elevated during SUSD scenarios, thus, only NOx and CO emissions were included in the SUSD hourly calculations and corresponding SUSD load case analysis. The annual average period for NOx was excluded from this analysis, as explained previously.

Cold starts when firing either fuel are expected to be a rare occurrence at REC. Each CT may undergo up to five cold starts firing ULSD each year (with the expectation that there would be zero ULSD cold starts). EPA's March 1, 2011 Memorandum from Tyler Fox, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour $NO_2$ NAAQS" (March 1, 2011 Fox Memo), states EPA "will consider it acceptable to limit the emission scenarios included in the modeling compliance demonstration for the 1-hour $NO_2$ NAAQS to those emissions that are continuous enough or frequent enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations." Based on this guidance and due to the ULSD cold starts not being considered continuous (roughly one hour in duration) or frequent (zero to five episodes at unpredictable times throughout the year), REC did not include ULSD cold starts in the 1-hour $NO_2$ load case or NAAQS analyses.

Similar to cold starts when firing ULSD, cold starts when firing natural gas are expected to be rare, albeit potentially more numerous than when firing ULSD. However, cases when both CTs will be undergoing cold starts simultaneously are expected to be extremely rare. These episodes are also not expected to be continuous enough (roughly one hour in duration) or frequent enough (zero to ten episodes at unpredictable times throughout the year) to contribute significantly to the annual distribution of daily maximum 1-hour $NO_2$ concentrations. Thus, REC did not include simultaneous cold starts when firing natural gas in the 1-hour $NO_2$ load case or NAAQS analyses. REC did, however, include scenarios when one CT is undergoing a cold start on natural gas with the other unit undergoing a warm start. While these scenarios are not expected to be frequent enough to contribute to the annual distribution of daily maximum 1-hour $NO_2$ concentrations, they were included for conservatism.

The results of the SUSD load case analysis are presented in Table 9 (natural gas SUSD scenarios) and Table 10 (ULSD SUSD scenarios) below.

### TABLE 9 LOAD CASE ANALYSIS FOR CT SUSD OPERATIONS, NATURAL GAS

| | | PREDICTED AMBIENT IMPACTS FROM EACH SUSD SCENARIO (μg/m³) | | | | | |
|---|---|---|---|---|---|---|---|
| | | | COLD/WARM STARTS | | | | |
| POLLUTANT | AVERAGE PERIOD | COLD STARTS | CT1 COLD CT2 WARM | CT1 WARM CT2 COLD | WARM STARTS | HOT STARTS | SHUT DOWNS |
| $NO_2$ | 1-hour | -- | **151.60** | 146.99 | 124.79 | 100.98 | 41.54 |
| CO | 1-hour | **3,539.75** | 2,190.47 | 2,318.64 | 969.36 | 1,057.78 | 1,124.07 |
| | 8-hour | **82.06** | 63.72 | 56.52 | 30.57 | 34.62 | 37.21 |

Note: Results reflect statistical form of NAAQS. Bold/italics indicate maximum impacts per pollutant and averaging period.

### TABLE 10 LOAD CASE ANALYSIS FOR CT SUSD OPERATIONS, ULSD

| | | PREDICTED AMBIENT IMPACTS FROM EACH SUSD SCENARIO (μg/m³) | | | |
|---|---|---|---|---|---|
| POLLUTANT | AVERAGE PERIOD | COLD STARTS | WARM STARTS | HOT STARTS | SHUT DOWNS |
| $NO_2$ | 1-hour | -- | **166.26** | 138.19 | 92.90 |
| CO | 1-hour | **2,120.59** | 868.05 | 961.63 | 276.95 |
| | 8-hour | **62.58** | 30.54 | 35.45 | 15.87 |

Note: Results reflect statistical form of NAAQS. Bold/italics indicate maximum impacts per pollutant and averaging period.

The load case analysis indicates that the startup and shutdown operating scenarios in Table 11 below result in the worst-case predicted ambient impacts. EPA guidance from the March 1, 2011 Fox Memo suggests that if startup and shutdown emission scenarios are expected to be intermittent (i.e. not continuous or frequent), their inclusion in the 1-hour $NO_2$ NAAQS analysis is not required. While REC did include certain startup and shutdown scenarios in the 1-hour $NO_2$ NAAQS compliance demonstration, REC based the significant impact area for the 1-hour $NO_2$ NAAQS compliance demonstration on the continuous steady-state operating scenario that resulted in the worst-case impact. For CO the worst-case startup and shutdown scenarios are predicted to have the highest ambient impacts when compared to the steady state operating scenarios, and with no “intermittent scenario” provision for the CO NAAQS analyses, were used in the significant impact area analysis, and ultimately the cumulative ambient impact analysis.

**TABLE 11 STARTUP AND SHUTDOWN OPERATING SCENARIOS RESULTING IN WORST-CASE AMBIENT IMPACTS**

| POLLUTANT | AVERAGE PERIOD | WORST-CASE OPERATING SCENARIO |
|---|---|---|
| $NO_2$ | 1-hour | Warm Starts (ULSD) |
| CO | 1-hour | Cold Starts (Natural Gas) |
| | 8-hour | Cold Starts (Natural Gas) |

## 6.3 Stack Parameters for Auxiliary Equipment

As previously discussed, a separate load screening analysis was performed for the auxiliary equipment. Per EPA guidance from the March 1, 2011 Fox Memo, the emergency generator and fire pump engine were not included in the 1-hour $NO_2$ or $SO_2$ load screening analyses, nor were they included in the 1-hour $NO_2$ or $SO_2$ cumulative NAAQS analysis. For annual averaging periods, only the emissions associated with REC's proposed annual limitations (500 hours for the EG, 250 hours for the FP engine, and 118,800 MMBtu/year heat input for each of the auxiliary boilers) were included in the load screening analysis. Because of the nature of the emergency equipment (generator and fire pump), only the auxiliary boilers are expected to fire at operating loads other than 100% for prolonged periods. Thus, for the auxiliary boiler 75% and 50% load cases, the emergency generator and fire pump were assumed to be operating at 100% load.

**TABLE 12 LOAD CASE ANALYSIS FOR AUXILIARY SOURCE OPERATIONS**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH LOAD CASE SCENARIO ($\mu g/m^3$) | | |
|---|---|---|---|---|
| | | 100% | 75% | 50% |
| $SO_2$ | 1-hour | 1.72 | 1.34 | 1.08 |
| | 3-hour | 1.19 | 0.97 | 0.83 |
| | 24-hour | 0.209 | 0.20 | 0.211 |
| | Annual | 0.010 | 0.011 | 0.013 |
| $PM_{10}$ | 24-hour | 4.08 | 4.09 | 4.14 |
| | Annual | 0.045 | 0.049 | 0.054 |
| $PM_{2.5}$ | 24-hour | 1.85 | 1.88 | 1.87 |
| | Annual | 0.045 | 0.049 | 0.054 |
| $NO_2$ | 1-hour | 23.23 | 18.51 | 14.45 |
| | Annual | 1.12 | 1.142 | 1.138 |
| CO | 1-hour | 435.06 | 444.33 | 390.62 |
| | 8-hour | 101.50 | 102.04 | 102.17 |

Note: Results reflect statistical form of NAAQS. Bold/italics indicate maximum impacts per pollutant and averaging period.

The load case analysis indicated that the operating scenarios (shown in Appendix B) in Table 13 below result in the worst-case predicted ambient impacts and were used in the significant impact area analysis and ultimately, the cumulative ambient impact analysis along with the design load case (100%).

**TABLE 13 AUXILIARY EQUIPMENT OPERATING SCENARIOS RESULTING IN WORST-CASE AMBIENT IMPACTS**

| POLLUTANT | AVERAGE PERIOD | WORST-CASE OPERATING SCENARIO |
|---|---|---|
| $SO_2$ | 1-hour | 100% |
| | 3-hour | 100% |
| | 24-hour | 50% |
| | Annual | 50% |
| $PM_{10}$ | 24-hour | 50% |
| | Annual | 50% |
| $PM_{2.5}$ | 24-hour | 75% |
| | Annual | 50% |
| $NO_2$ | 1-hour | 100% |
| | Annual | 75% |
| CO | 1-hour | 75% |
| | 8-hour | 50% |

# 7.0 GOOD ENGINEERING PRACTICE STACK HEIGHT AND BUILDING DOWNWASH EVALUATION

Dimensional data for all significant buildings and structures are based on the site plans provided by the REC project development team and are included in Appendix A. The UTM coordinates for all buildings and structures were determined by overlaying the site plan on Google Earth satellite imagery, ensuring that the surrounding landmarks are adequately aligned. The buildings and structures were processed using the EPA Building Profile Input Program (BPIP-PRIME version 04274) to determine the Good Engineering Practice (GEP) stack heights and direction-specific building heights and widths for each 10-degree direction for each emission source included in the AQIA.

# 8.0 RECEPTOR DATA

A discrete Cartesian receptor grid for the load case analysis, Significant Impact Area (SIA) Analysis, NAAQS analysis, and PSD Increment Analysis was generated in AERMOD extending out a sufficient distance to ensure the entire SIA was captured. Receptor spacing was as follows:

- 25-meter spacing at the facility fence line;
- 50-meter spacing from the fence line to a distance of 2,000 meters from the source;
- 100-meter spacing from a distance of 2,000 meters to 5,000 meters from the source;
- 500-meter spacing from a distance of 5,000 meters to 10,000 meters from the source; and
- 1,000-meter spacing from a distance of 10,000 meters to 15,000 meters from the source (this grid was extended to a distance of 25,000 meters from the source for the 1-hour $NO_2$, 24-hour $PM_{2.5}$, and Annual $PM_{2.5}$ SIL analyses to ensure the extent of the SIA was determined).

REC's fence will preclude public access to the facility property, and a gate will be installed to ensure that only authorized personnel are able to access the property. Therefore, receptors were not included inside the facility fence line. The receptors were set up using the same coordinate system as the emission sources and buildings/structures (NAD83, UTM Zone 18).

Receptor terrain elevations were determined by importing into the BEEST interface a U.S. Geologic Survey (USGS) National Elevation Dataset terrain file (in GeoTIFF format) covering the entire modeling domain. The terrain file's domain was sufficiently sized to include all terrain features that exceed a 10% slope from any given receptor in the grid indicated above. The GeoTIFF file has 1/3 arc-second (10 meter) resolution and was obtained from the USGS Seamless Data Server. Receptor elevations and hill heights were determined using the latest version of AERMAP, using the BEEST software interface.

For the 1-hour $NO_2$ cumulative impact analysis, only the receptors that REC was shown to have significant impacts based on the SIA analysis were included, per EPA's March 1, 2011 memorandum "Additional Clarification Regarding Appendix W Modeling Guidance for the 1-hour $NO_2$ NAAQS." The receptors that were shown to have significant impacts for both the worst-case and design scenarios were included in the 1-hour $NO_2$ NAAQS analysis.

The area of maximum impact for the 1-hour $NO_2$ NAAQS analysis and 24-hour and annual $PM_{2.5}$ NAAQS analyses was outside of the aforementioned initial sub-grid with 50-meter spacing. Thus, additional sub-grids were set up in AERMOD to ensure that the receptor coverage surrounding the area of maximum impact was adequate.

For both $PM_{2.5}$ averaging periods, the area of maximum impact for the worst-case and design scenarios was centered between two of the interactive sources included in the analysis–Dominion Transmission Corp.'s Finnefrock and Leidy Stations. The sub-grid was roughly centered between these two sources and was approximately 2,000 meters by 2,000 meters with 50-meter spacing. Both facilities' fence lines were identified through satellite imagery, and receptors inside of those fence lines were excluded as those areas are not considered ambient air.

For the 1-hour $NO_2$ averaging period, the area of maximum impact for only the design scenario (operating scenario 17) extended outside of the initial 50-meter sub-grid, located approximately 11 km to the NNW of REC's proposed location. The area of maximum impact for the worst-case scenario (CT1 undergoing a cold start, with CT2 undergoing a warm start) was within the initial 50-meter sub-grid, located approximately 0.9 km ENE of REC's proposed location. The additional sub-grid was centered on the area of maximum impact for the design scenario and was roughly 3,000 meters by 3,000 meters with 50-meter spacing. The entire area of this sub-grid is considered ambient air; thus, no receptors were excluded in this sub-grid. Additionally, for conservatism all sub-grid receptors were included in the NAAQS analysis rather than performing a SIA analysis for the subgrid to determine which of the subgrid receptors were significant.

# 9.0 METEOROLOGICAL DATA

PaDEP determined that there were no adequate sources of available meteorological data that would reasonably represent conditions at the project site due to the nature of the terrain in the immediate vicinity of the project site. One year of meteorological data has been collected on-site by Ambient Air Quality Services, Inc. (AAQS). The on-site meteorological data was collected using methods that were approved by PaDEP modeling staff–the meteorological monitoring plan submitted by AAQS was determined to be acceptable by PaDEP on May 15, 2015. The meteorological data period covers 365 consecutive days from October 27, 2015 and October 26, 2016.

The on-site meteorological data was collected from a meteorological tower on the REC project site, along with a co-located SODAR unit, located at 41.329 degrees north latitude, -77.755 degrees west longitude. The tower was 20 meters in height, and collected the following data:

- Solar radiation, net radiation, temperature, relative humidity, barometric pressure, and total precipitation at 2 meters
- Horizontal wind speed and direction, horizontal wind gust speed and direction, standard deviation of horizontal wind (turbulence), vertical wind speed, standard deviation of vertical wind (turbulence), and temperature at 20 meters

Provided below in Table 14 is a data completeness summary in accordance with Section 5.3.2 of EPA's "Meteorological Monitoring Guidance for Regulatory Modeling Applications."

**TABLE 14 ON-SITE METEOROLOGICAL DATA COMPLETENESS SUMMARY**

| | DATA COMPLETENESS FOR SELECTED VARIABLES | | | | |
|---|---|---|---|---|---|
| PERIOD | Horizontal Wind Speed | Horizontal Wind Direction | Temperature (20 meter) | Barometric Pressure | Solar Radiation |
| Quarter 1 | 100% | 100% | 100% | 100% | 100% |
| Quarter 2 | 99.9% | 99.9% | 99.9% | 100% | 100% |
| Quarter 3 | 100% | 100% | 100% | 100% | 100% |
| Quarter 4 | 99.8% | 99.8% | 99.8% | 100% | 100% |
| Total | 99.9% | 99.9% | 99.9% | 100% | 100% |

The SODAR unit collected measurements of horizontal wind speed, horizontal wind direction, and vertical wind speed and direction every 10 meters starting at 30 meters in height, up to 200 meters in height.

The SODAR data is necessary to correctly characterize wind flows down the Susquehanna River valley in the Renovo area. Thus, data from the SODAR from heights of 30 meters to 200 meters, spaced 10 meters apart, were included in the meteorological data processing. The final height of the plumes from REC were predicted by screening modeling to reach a height of roughly 180 meters, thus, wind data heights of 200 meters are sufficient to characterize the plume's transport in the area surrounding the project site.

The full meteorological monitoring plan is included in Appendix D.

## 9.1 Meteorological Data Processing

The on-site surface data was processed with National Weather Service (NWS) cloud cover data and upper air data through the AERMET/AERSURFACE meteorological preprocessing system. The NWS surface station used was Williamsport, PA (WBAN 14778), while the upper air station used was Pittsburgh, PA (WBAN 94832). Both of these sites were determined to be most representative for the purposes of supplemental data for this modeling analysis.

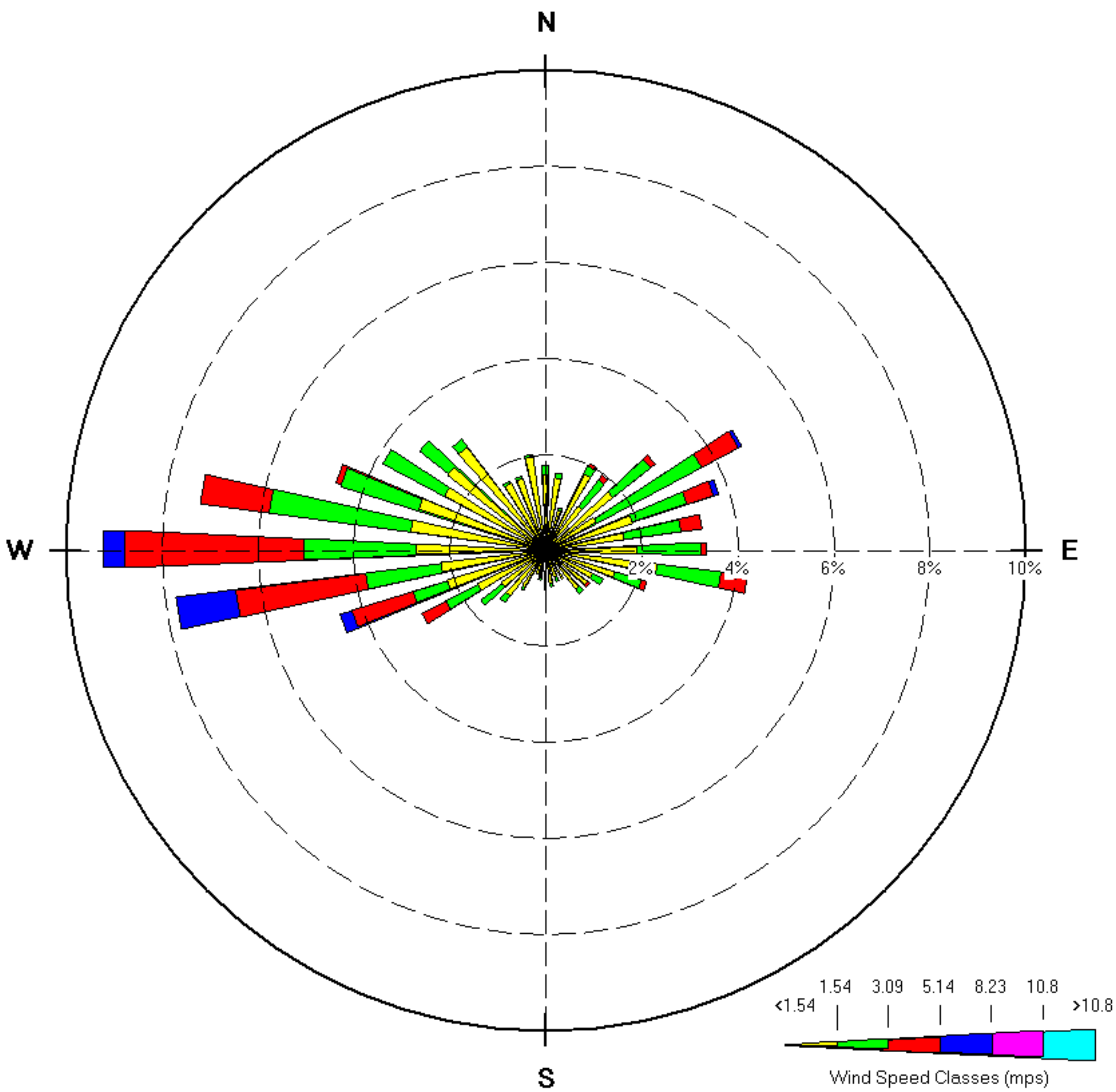
### 9.1.1 Raw On-Site Data

The meteorological tower and SODAR data were obtained from AAQS. The data is in a Microsoft Excel notebook format that was modified and reformatted into a text file that can be read by AERMET. Part of this process included checking the missing data flags and ensuring that AERMET is configured to recognize the flags as missing data. The SODAR wind data was collected as vector North/South and East/West components and was converted to scalar speed and direction prior to processing in AERMET in order to be consistent with measured data from the tower. On-site data that was included in the meteorological processing included:

- Solar radiation, temperature, relative humidity, barometric pressure, and total precipitation at 2 meters
- Horizontal wind speed and direction, and temperature at 20 meters
- Temperature difference between the 2 meter and 20 meter sensors (calculated value)
- SODAR horizontal wind speed and direction from 30 meters to 200 meters in increments of 10 meters

Turbulence data was not included in the processing because of the use of the surface friction velocity adjustment (ADJ_U*), and the 20-meter SODAR data was not processed due to the inclusion of tower data at the 20-meter level. For the on-site data, a threshold wind speed (calm definition) was set at 0.22 m/s, which is the tower anemometer manufacturer's starting threshold for wind measurements. The base elevation of the on-site meteorological tower of 204 meters was entered. Displayed in Figure 2 below is a wind rose from the on-site meteorological data collected by the tower at 20 meters.

**FIGURE 2 WIND ROSE FOR ON-SITE METEOROLOGICAL DATA COLLECTION**



### 9.1.2 National Weather Service Data

Although the on-site data met the EPA data availability requirements, NWS surface data was downloaded in order to include cloud cover data. Raw hourly surface data was obtained from the National Climatic Data Center's (NCDC) ftp site (ftp://ftp.ncdc.noaa.gov/pub/data//noaa) in Integrated Surface Hourly Data (ISHD) format (TD-3505). Williamsport is representative of the project area for cloud cover due to the proximity of the two locations in comparison to the large-scale nature of cloud formations in the Northcentral Pennsylvania region.

Raw upper air (rawinsonde) data for Pittsburgh, PA (WBAN 94832) was downloaded from the National Oceanic and Atmospheric Administration's Earth Systems Research Laboratory Radiosonde Database website in FSL format. (http://esrl.noaa.gov/raobs/) Both ISHD data and FSL data are time-stamped in Greenwich Mean Time (GMT). Because ISHD surface data and FSL upper air data are based on Greenwich Mean Time (GMT), the 1st day of the following year (January 1, 2016) must be part of the ISHD and FSL files. The ASOS data for the following month must also be used. Otherwise, AERMET writes missing (99999) data for the last 5 hours of the year (for Eastern Time). Pittsburgh is the most representative site for upper air data purposes when compared to other nearby upper air data collection sites, such as Albany, NY. The locations of Pittsburgh and Renovo relative to major geographical features (such as the Great Lakes, Appalachian Mountains, and Atlantic Ocean) are more similar than for any other nearby upper air data collection site.

### 9.1.3 Land Use/Land Cover Data

For AERMET to adequately characterize various planetary boundary layer parameters (e.g., sensible heat flux, surface friction velocity, Monin-Obukhov length, boundary layer height, etc.), the user is required to input values for albedo, Bowen ratio, and surface roughness length. These parameters may be either single value, assumed constant both spatially and temporally, or may vary spatially and temporally. In order to efficiently provide this data, EPA's AERSURFACE (v13106) program was run. AERSURFACE reads 1992 National Land Cover Database data and determines albedo, Bowen ratio, and surface roughness length. Based on historical aerial photos and satellite imagery the land cover in the immediate Renovo area has not changed since 1992, therefore no adjustments will need to be made during the AERSURFACE processing.

## 9.2 Data Processing

The actual AERMET/AERSURFACE processing was done using Providence/Oris's (formerly Oris Solutions) BEEST software. The AERMET process involves 3 Stages:

- Stage 1 de-archives the NWS surface and upper air data and conducts quality assurance routines on it, as well as the raw on-site data.
- Stage 2 writes the surface and upper air data into 24-hour blocks.
- Stage 3 creates the final meteorological data files (*.SFC and *.PFL) for input to AERMOD

Upper air values of temperature and cloud cover were substituted. Substitutions for both were based on linear interpolation, and substitutions for hours 23 and 24 were based on persistence. The search window around soundings was adjusted to 3 hours before, and 1 hour after sunrise.

As noted above, AERSURFACE was used to determine values of albedo, Bowen ratio, and surface roughness length. These data are used by AERMET in the computation of the hourly planetary boundary layers values of surface friction velocity, convective velocity scale, vertical potential temperature gradient, convective boundary layer height, mechanical boundary layer height and Monin-Obukhov length. For this AERSURFACE processing, the study area for the project site had a 1-kilometer radius, the MONTHLY temporal switch was used and 12 30-degree wind sectors were used as the spatial extent. Other information regarding the station locations were also provided to AERSURFACE:

- Is there continuous snow cover for one or more months of winter? No.

  Based on data from the NWS's Cooperative Observer Program (COOP) site for Renovo (36-7409-07, approximately 1.5 km east of the proposed REC facility), there were only four days during the 2015/2016 winter season where snow depth was greater than one inch.

- Is the station at an airport? No.
- Is the area around the station arid (less than 9" of rain/year)? No.
- Is the soil moisture wet, average, or dry?

Monthly average precipitation data for Pennsylvania Climate Division 7 from the National Centers for Environmental Information (ftp://ftp.ncdc.noaa.gov/pub/data/cirs/climdiv/) was analyzed to estimate surface moisture conditions. Relative to 1981 – 2010 monthly average precipitation data for Pennsylvania Climate Division 7, the monthly estimates of surface moisture condition are:

- October 2015: Average
- November 2015: Dry
- December 2015: Wet
- January 2016: Average
- February 2016: Wet
- March 2016: Dry
- April 2016: Dry
- May 2016: Average
- June 2016: Dry
- July 2016: Dry
- August 2016: Wet
- September 2016: Average
- October 2016: Wet

The surface characteristics output from AERSURFACE is shown in Appendix E.

Once the AERSURFACE processing was complete, the AERMET processing was run to yield one set of SFC and PFL files, and will invoke AERMET's ADJ_U* (or Adjust u*) option. ADJ_U* was incorporated as a default option beginning with AERMET version 16216, released in December 2016.

The ADJ_U* option is based upon an approach outlined in a paper by Qian and Venkatram (*Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions,* March 2011). The ADJ_U* option is designed to address the issue of AERMOD over predicting concentrations from low-level releases during stable (night-time) conditions.

All files associated with meteorological data processing are included on electronic format for PaDEP review in Appendix F of this protocol.

# 10.0 REPRESENTATIVE AMBIENT BACKGROUND CONCENTRATIONS

In order to determine the cumulative impacts of REC's emissions, the levels of ambient background must be considered. REC and any nearby interactive sources' modeled impacts will be added to the selected background concentrations to determine the cumulative ambient impact, which will be compared to the NAAQS for each applicable pollutant and averaging period. The background concentrations must be representative of the project site and were obtained from the most recent three years (2016 through 2018) of certified monitoring data available from the most representative monitoring sites nearest to the project site. Representativeness of each monitoring site to the project site was justified based on EPA guidance contained in Section 8.2 of the "Guideline on Air Quality Models" (Background Concentrations), and Section 2.4 of the "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (Use of Representative Air Quality Data). Also, attention was given to the EPA May 20, 2014 memorandum "Guidance for $PM_{2.5}$ Permit Modeling" for the justification of $PM_{2.5}$ background monitoring sites. Generally, the location of the data relative to the project site, and the quality of the data are the most important factors in selecting an ambient monitoring location.

The ambient background monitors whose data was included in this analysis were selected based on quantitative and qualitative analyses. County emissions estimates for each pollutant included in the modeling analysis were obtained from EPA's 2014 National Emission Inventory (NEI), and were compared to the Clinton County 2014 NEI emissions estimates on both a quantity of emissions per county basis, as well as an "emissions density" (county-wide emissions divided by county area in square miles) basis. Clinton County was typically one of the lowest pollutant emitters for both methods. The qualitative analysis involved a comparison of the areas immediately surrounding the monitoring sites and the project site to determine which monitoring site was most representative of the project site for each pollutant to be included in the ambient air quality impact analysis based on the commercial and industrial development density and topographical features.

The list of monitoring sites selected as representative of the project site, the monitored pollutants whose data was used from each site, and the distances from the project site are summarized in Table 15 below.

**TABLE 15 MONITORING SITES**

| MONITORING SITE | COUNTY | POLLUTANTS MONITORED | DISTANCE AND DIRECTION FROM PROJECT SITE |
|---|---|---|---|
| Altoona | Blair | $SO_2$ | ~102 km SSW |
| Arendtsville | Adams | CO | ~160 km SSE |
| Montoursville | Lycoming | $PM_{10}$ | ~71 km E |
| State College | Centre | $PM_{2.5}$ | ~58 km SSW |
| Tioga County | Tioga | $NO_2$ | ~77 km ENE |

The ambient background concentrations that were used in this analysis are presented below in Table 16. Ambient monitoring reports provided by PaDEP that were used to develop the background values are provided in Appendix G.

**TABLE 16 REPRESENTATIVE AMBIENT BACKGROUND DATA**

| POLLUTANT | AVERAGE PERIOD | AMBIENT BACKGROUND VALUE (µg/m³) |
|---|---|---|
| $SO_2$ | 1-hour | 23.6 |
| $PM_{10}$ | 24-hour | 29.0 |
| $PM_{2.5}$ | 24-hour | 20.0 |
| | Annual | 8.1 |
| $NO_2$ | 1-hour | 18.8 |
| | Annual | 3.6 |
| CO | 1-hour | 1,485.7 |

# 11.0 SECONDARY FORMATION OF $PM_{2.5}$

Secondary formation of $PM_{2.5}$ from REC's emissions of NOx and $SO_2$ will contribute to the overall ambient impacts of $PM_{2.5}$ that will occur from REC's emission sources. For this reason, an analysis of the impacts resulting from the secondary formation of $PM_{2.5}$ must be considered. According to EPA guidance, if a project's direct emissions of $PM_{2.5}$ are greater than 10 tons per year and the NOx and/or $SO_2$ emissions are greater than 40 tons per year, a qualitative or hybrid qualitative/quantitative approach is recommended. REC is proposing a hybrid qualitative/quantitative approach to estimating the ambient impacts of the secondary formation of $PM_{2.5}$.

The conversion of NOx and $SO_2$ to $PM_{2.5}$ generally takes place some period of time (several hours) after the direct emission of NOx and $SO_2$. This temporal aspect leads to spatial considerations in the dispersion of the particles that are formed, resulting in impacts from secondary formation at distances that are further downwind from the source than the impacts from direct $PM_{2.5}$ emissions. Since the highest predicted ambient impacts from REC's direct $PM_{2.5}$ emissions occur very near REC (within approximately one kilometer), it is likely that the highest impacts resulting from the secondary formation of $PM_{2.5}$ from NOx and $SO_2$ will not occur in these same areas. As the distance from REC increases, the magnitude of the modeled $PM_{2.5}$ impacts from the direct $PM_{2.5}$ emissions decreases. This effect will minimize the potential for adverse impacts–areas of higher direct impacts will likely see lower secondary formation impacts, while areas of higher secondary impacts will likely see lower direct impacts.

The quantitative approach involves using techniques outlined in EPA's memorandum "Guidance on the Development of Modeled Emission Rates for Precursors as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program" (April 30, 2019 Memo). The term Modeled Emissions Rate for Precursors (MERPs) is used to describe an emission rate of a precursor that is expected to result in an insignificant change in ambient $PM_{2.5}$ when compared to a specific air quality concentration threshold for $PM_{2.5}$.

According to Section 4.1 of the April 30, 2019 Memo, permit applicants may utilize the EPA analytical work reflected in the guidance, incorporating the detailed results of EPA's analysis into the applicant's compliance demonstration. EPA conducted this analytical work by creating hypothetical emission sources for use in photochemical grid air quality models to predict the impacts of the hypothetical sources on downwind $PM_{2.5}$. The hypothetical sources were located throughout the U.S. and reflect different release heights and emission rates. Low-level (stacks 10 meters in height) and high-level (stacks 90 meters in height) stacks were modeled, each with stack diameters of 5 meters, exit temperatures of 311 K, exit velocities of 27 meters per second, and flow rates of 537 cubic meters per second. The hypothetical sources in EPA's analysis were modeled at multiple emission rates for NOx and $SO_2$, ranging from 100 to 3,000 tons per year of each pollutant.

One of EPA's hypothetical sources is in Adams County, Pennsylvania, which was the most representative hypothetical source to the REC project site. Additionally, of the nearby hypothetical sources that were considered (including those in Tuscarawas County, Ohio and Livingston County, New York), the Adams County hypothetical source typically resulted in the highest precursor impacts, which will lead to a more conservative result. REC used the results of EPA's analysis of the low-level stack to better account for the complex terrain near REC. The model-predicted precursor impacts from the low-level release heights are also higher than those for the high-level stacks, providing another level of conservatism for REC's analysis.

Hypothetical source-specific MERPs were developed by EPA for each hypothetical source, release height, and emission rate, and are presented in the table below.

**TABLE 17 COMPARISON OF $PM_{2.5}$ MERPS TO REC POTENTIAL EMISSIONS**

| PRECURSOR | HYPOTHETICAL SOURCE EMISSIONS (TONS/YEAR) | 24-HOUR $PM_{2.5}$ MERP (TONS/YEAR) | ANNUAL $PM_{2.5}$ MERP (TONS/YEAR) | REC MAXIMUM POTENTIAL EMISSIONS (TONS/YEAR) | REC PERCENTAGES OF 24-HOUR AND ANNUAL $PM_{2.5}$ MERPs |
|---|---|---|---|---|---|
| NOx | 500 | 5,977 | 10,142 | 364.4 | 6.1% / 3.6% |
| $SO_2$ | 500 | 1,643 | 10,885 | 53.6 | 3.3% / 0.5% |

Based on these comparisons, the secondary formation impacts of REC's precursor NOx and $SO_2$ emissions may be expected to account for 9.4% of the 24-hour $PM_{2.5}$ SIL, and 4.1% of the annual $PM_{2.5}$ SIL. Even with this favorable comparison, due to REC's primary $PM_{2.5}$ impacts exceeding both the 24-hour and annual $PM_{2.5}$ SILs (see Significant Impact Area Analysis section below), further analysis is required to determine REC's project-specific ambient $PM_{2.5}$ impact.

To develop the project-specific additive $PM_{2.5}$ impacts, an analysis of the hypothetical source impacts was conducted. Table 18 below summarizes the results of EPA's photochemical grid modeling of the low-level hypothetical emission source in Adams County, Pennsylvania, as well as the calculated project-specific impacts based on REC's maximum potential emissions of each precursor.

**TABLE 18 EPA HYPOTHETICAL EMISSION SOURCE ANALYSIS RESULTS**

| PRECURSOR | NOx | $SO_2$ | TOTAL |
|---|---|---|---|
| Precursor Emissions (tons/year) | 500 | 500 | -- |
| 24-hour $PM_{2.5}$ Maximum Modeled Impact (µg/m$^3$) | 0.10 | 0.37 | 0.47 |
| Annual $PM_{2.5}$ Maximum Modeled Impact (µg/m$^3$) | 0.0099 | 0.009 | 0.019 |
| REC Maximum Potential Emissions (tons/year) | 364.4 | 53.6 | -- |
| REC Fraction of Hypothetical Source Emissions | 0.73 | 0.11 | -- |
| Prorated 24-hour $PM_{2.5}$ Impact (µg/m$^3$) | 0.073 | 0.039 | 0.11 |
| Prorated Annual $PM_{2.5}$ Impact (µg/m$^3$) | 0.0072 | 0.00098 | 0.0082 |

REC's maximum potential NOx emissions are lower in magnitude than those of the hypothetical source in Adams County (364.4 tons/year for REC vs. 500 tons/year), and REC's maximum potential $SO_2$ emissions are far less (53.6 tons/year for REC vs. 500 tons). Therefore, the hypothetical source impacts were pro-rated by ~73% for NOx emissions and ~11% for $SO_2$ emissions. As shown in Table 18, this adjustment results in a 24-hour maximum modeled impact of 0.11 µg/m$^3$ for the 24-hour averaging period, and 0.0082 μg/m$^3$ for the annual averaging period. These are the concentrations added to the maximum predicted ambient impacts in REC's $PM_{2.5}$ SIA, PSD Increment, and NAAQS analyses.

As stated above, it is also important to consider that the areas with the highest ambient impacts from REC's primary $PM_{2.5}$ emissions are very unlikely to occur at the same time and place as the highest ambient impacts resulting from the secondary formation of $PM_{2.5}$ from REC's precursor emissions.

# 12.0 SIGNIFICANT IMPACT AREA ANALYSIS

In order to assess the cumulative impacts of REC's emission sources in conjunction with other nearby sources, a Significant Impact Area (SIA) analysis was performed to determine which, if any, nearby sources should be included in the cumulative impact analysis. The load case analysis was used to identify which operating scenarios for each group of equipment resulted in the worst-case predicted ambient impacts; those operating scenarios as well as the design operating scenario (operating scenario 17) were used in the SIA analysis. The table below summarizes the operating scenarios used for each pollutant and averaging period in the SIA analysis. REC's operating scenarios are included in Appendix B.

**TABLE 19 OPERATING SCENARIOS USED IN SIA ANALYSIS**

| | | WORST-CASE SCENARIO | | DESIGN SCENARIO | |
|---|---|---|---|---|---|
| POLLUTANT | AVERAGE PERIOD | COMBUSTION TURBINE OPERATING SCENARIO | AUXILIARY EQUIPMENT OPERATING SCENARIO | COMBUSTION TURBINE OPERATING SCENARIO | AUXILIARY EQUIPMENT OPERATING SCENARIO |
| $SO_2$ | 1-hour | 15 (NG) | 100% | 17 (NG) | 100% |
| | 3-hour | 15 (NG) | 100% | 17 (NG) | 100% |
| | 24-hour | 15 (NG) | 50% | 17 (NG) | 100% |
| | Annual | 15 (NG) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $PM_{10}$ | 24-hour | 13 (ULSD) | 50% | 17 (NG) | 100% |
| | Annual | 13 (ULSD) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $PM_{2.5}$ | 24-hour | 13 (ULSD) | 75% | 17 (NG) | 100% |
| | Annual | 13 (ULSD) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $NO_2$ | 1-hour | 13 (ULSD) | 100% | 17 (NG) | 100% |
| | Annual | 15 (NG) | 75% (Annual) | 17 (NG) | 100% (Annual) |
| CO | 1-hour | Cold Starts (NG) | 75% | 17 (NG) | 100% |
| | 8-hour | Cold Starts (NG) | 50% | 17 (NG) | 100% |

The predicted ambient concentrations from the SIA analysis were compared to the Significant Impact Levels (SILs) listed previously in Table 2 to determine the geographic extent of the SIA (measured in kilometers from the mid-point of the emission sources), for each pollutant and averaging period. The results of the SIA are summarized in the following table.

**TABLE 20 SIA ANALYSIS RESULTS**

| POLLUTANT | AVERAGE PERIOD | SIL ($\mu g/m^3$) | RADIUS OF IMPACT (km) WORST-CASE SCENARIO | RADIUS OF IMPACT (km) DESIGN SCENARIO |
|---|---|---|---|---|
| $SO_2$ | 1-hour | 7.8 | 3.48 | 3.48 |
| | 3-hour | 25 | n/a[1] | n/a[1] |
| | 24-hour | 5 | n/a[1] | n/a[1] |
| | Annual | 1 | n/a[1] | n/a[1] |
| $PM_{10}$ | 24-hour | 5 | 3.20 | 2.01 |
| | Annual | 1 | 0.93 | n/a[1] |
| $PM_{2.5}$ | 24-hour | 1.2 | 17.01 | 9.01 |
| | Annual | 0.2 | 16.47 | 6.98 |
| $NO_2$ | 1-hour | 7.5 | 20.04 | 17.16 |
| | Annual | 1 | 0.95 | 0.93 |
| CO | 1-hour | 2,000 | 2.62 | n/a[1] |
| | 8-hour | 500 | n/a[1] | n/a[1] |

[1]Impacts below SIL.

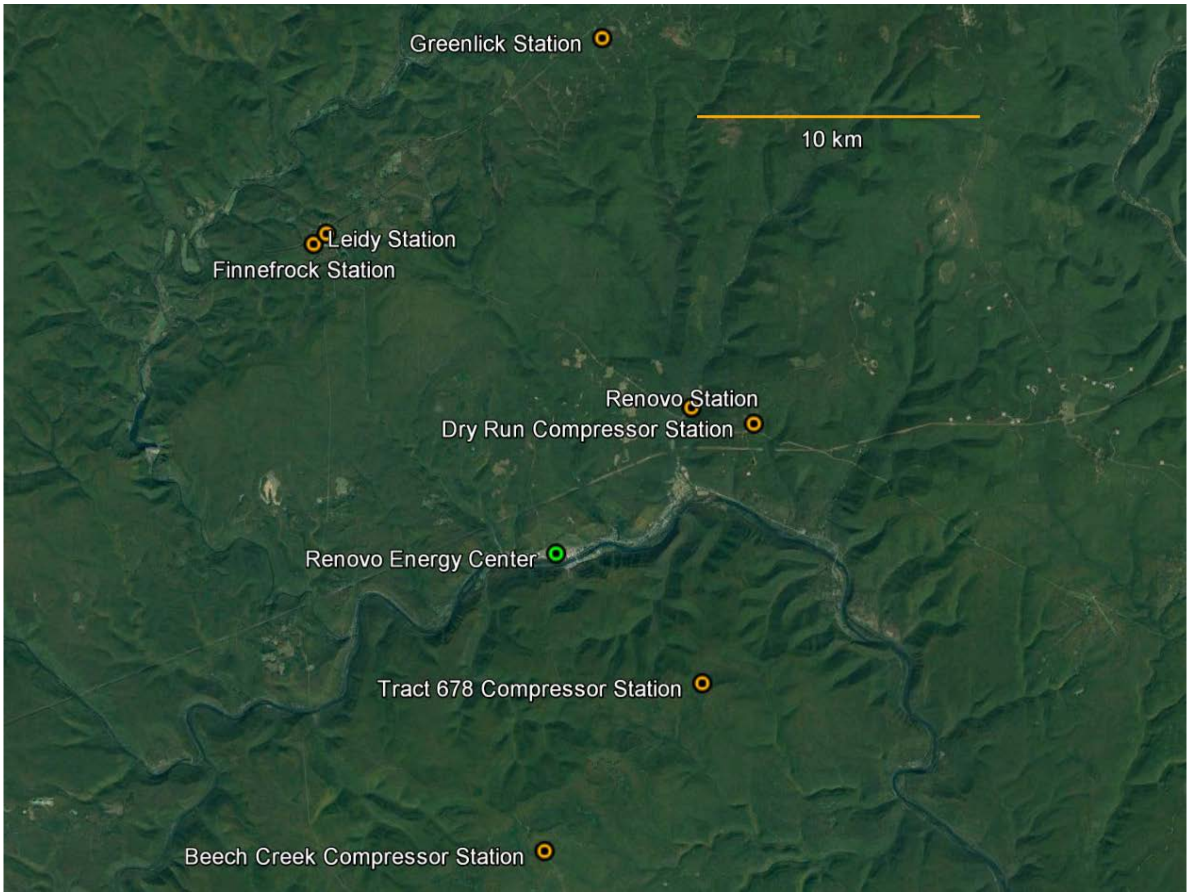
Based on the results of the SIA analysis, the 3-hour, 24-hour, and annual $SO_2$ averaging periods and the 8-hour CO averaging period were not required to be included in REC's cumulative impact analysis. The relatively small radii of impact for 1-hour $SO_2$, both $PM_{10}$ averaging periods, the annual $NO_2$ averaging period, and the 1-hour CO averaging period did not warrant the inclusion of any nearby interactive sources in REC's cumulative impact analysis. The nearest emission sources to REC that did warrant inclusion in the cumulative impact analyses are the Columbia Gas Transmission Corp.'s Renovo Station, Mountain Gathering LLC's Dry Run Compressor Station, NCL Natural Resources LLC's Tract 678 and Beech Creek Compressor Stations, as well as Dominion Transmission Inc.'s Leidy, Finnefrock, and Greenlick Stations. The relative distances of these sources to REC are presented in Table 21, which also summarizes the annual emissions from 2016 and 2017 (the most recent inventory years available). Due to their distance from REC, these sources did not warrant inclusion in the $SO_2$, $PM_{10}$, or CO cumulative impact analyses. However, they did warrant inclusion in the $PM_{2.5}$ and 1-hour $NO_2$ cumulative impact analyses.

**TABLE 21 NEARBY FACILITY EMISSIONS SUMMARY**

| FACILITY | DISTANCE FROM REC | 2016 EMISSIONS (TONS) | | 2017 EMISSIONS (TONS) | |
|---|---|---|---|---|---|
| | | NOx | $PM_{2.5}$ | NOx | $PM_{2.5}$ |
| Columbia Gas Renovo Station | 7.0 km to NE | 14.25 | 0.11 | 10.61 | 0.15 |
| Tract 678 Compressor Station | 7.1 km to SE | 0.32 | 0.02 | 0.32 | 0.02 |
| Dry Run Compressor Station | 8.5 km to NE | 8.95 | 0.16 | 6.06 | 0.11 |
| Beech Creek Compressor Station | 10.6 km to S | -- | -- | 6.54 | 0.14 |
| Dominion Leidy Station | 14.0 km to NW | 238.28 | 8.41 | 220.06 | 3.65 |
| Dominion Finnefrock Station | 14.0 km to NW | 140.87 | 6.78 | 118.44 | 5.42 |
| Dominion Greenlick Station | 18.2 km to N | 153.65 | 8.99 | 126.06 | 5.56 |

Section 8.3.3(b)(iii) of EPA's Guideline on Air Quality Models (Appendix W) states that "the number of nearby sources to be explicitly modeled in the air quality analysis is expected to be few except in unusual cases. In most cases, the few nearby sources will be located within the first 10 to 20 km from the source(s) under consideration… identification of nearby sources calls for the exercise of professional judgement by the appropriate reviewing authority." Based on EPA's guidance and available data, nearby sources to be included in the cumulative ambient impact analyses were limited to the sources listed above. The locations of the nearby sources and REC's proposed location are shown in the following figure.

**FIGURE 3 NEARBY SOURCE LOCATIONS**




Stack dimensions, exhaust flows, exhaust temperatures, and emission limits for the interactive sourced identified were provided by PaDEP, and are summarized in Appendix H. The nearby sources' maximum potential emission rates were included in the cumulative impact analyses, not the actual emissions presented in Table 21. There were numerous instances where stack dimensions and exhaust parameters were not available. In these instances, professional judgement was used to develop conservative estimates of the values for a given device. For instances where data for an emission source at a facility was unavailable, two methods were used to develop appropriate input parameters for use in AERMOD. If data was available for the same emission source type (i.e. compressor engine, emergency engine, boiler, etc.) at that facility, the emission source whose data was not available was assumed to be equal to that of the same emission source type whose data was available. If there were no appropriate emission sources at the same facility for this method to be used, conservative values compared to typical data for representative installations based on professional experience for stack height, diameter, exhaust temperature, and exit velocity were used.

## 12.1 Class I PSD Increment Standards

Based on the Class I PSD SIL analysis results, REC has demonstrated that its emissions will not cause or contribute to violations of Class I PSD Increment Standards for $NO_2$, $PM_{10}$, $SO_2$, and $PM_{2.5}$.

The impacts from REC's facility on the nearest Class I areas were compared with EPA's proposed Class I PSD Increment SILs for $NO_2$, $PM_{10}$, and $SO_2$, and the EPA's recommended Class I PSD Increment SILs for $PM_{2.5}$ as displayed below in Table 22.

**TABLE 22 CLASS I PSD SILS**

| POLLUTANT | AVERAGING PERIOD | CLASS I SIL (µg/m³) |
|---|---|---|
| $SO_2$ | 1-hour | -- |
| | 3-hour | 1.0[a] |
| | 24-hour | 0.2[a] |
| | Annual | 0.1[a] |
| $PM_{10}$ | 24-hour | 0.3[a] |
| | Annual | 0.2[a] |
| $PM_{2.5}$ | 24-hour | 0.27[b] |
| | Annual | 0.05[b] |
| $NO_2$ | 1-hour | -- |
| | Annual | 0.1[a] |

[a]Proposed Class I PSD increment SILs published in the July 23, 1996 Federal Register.
[b]Class I PSD increment SILs recommended in EPA's April 17, 2018 memorandum "Guidance on Significant Impact Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program."

AERMOD was used to complete the Class I SIL analysis. Due to variations in meteorology that is expected to occur beyond 50 kilometers and the time required for a plume to travel this distance, steady-state models such as AERMOD are expected to be overly conservative in the far field.

Class I receptor data, including the elevations and maximum terrain heights for each receptor. was provided by PaDEP.

The same operating scenarios previously identified for use in the Class II SIL analysis were used in the Class I PSD SIL analysis. The results of the Class I PSD SIL analysis are presented below in Table 23.

**TABLE 23 PSD CLASS I SIL ANALYSIS RESULTS**

| POLLUTANT | AVERAGE PERIOD | MAXIMUM PREDICTED IMPACT (µg/m³) | | CLASS I SIL (µg/m³) | FURTHER CLASS I ANALYSIS REQUIRED? |
|---|---|---|---|---|---|
| | | WORST-CASE LOAD SCENARIO | DESIGN LOAD SCENARIO | | |
| $SO_2$ | 3-hour | 0.013 | 0.012 | 1.0 | No |
| | 24-hour | 0.0029 | 0.0029 | 0.2 | No |
| | Annual | 0.0010 | 0.0010 | 0.1 | No |
| $PM_{10}$ | 24-hour | 0.019 | 0.010 | 0.3 | No |
| | Annual | 0.0067 | 0.0036 | 0.2 | No |
| $PM_{2.5}$[1] | 24-hour | 0.13 | 0.12 | 0.27 | No |
| | Annual | 0.015 | 0.012 | 0.05 | No |
| $NO_2$ | Annual | 0.0067 | 0.0066 | 0.1 | No |

[1]Secondary PM2.5 concentrations found in Table 18 were added to the primary PM2.5 modeled impacts for comparison to the Class I SIL values.

Based on the results of Table 23, further analyses of PSD Class I increment standards were not warranted.

# 13.0 RESULTS

## 13.1 NAAQS

REC's pollutants whose emissions resulted in predicted ambient impacts above their respective SILs were required to be included in the cumulative ambient impact analysis, with interactive sources as appropriate, and ambient background air quality concentrations included for comparison to NAAQS. The same load case scenarios used for the SIA analysis were used for the cumulative impact analysis. As previously explained, interactive source data was obtained from PaDEP. Table 24 displays the results of the NAAQS analysis. $PM_{2.5}$ impacts have been adjusted to account for secondary formation, by adding 0.11 µg/m$^3$ for the 24-hour averaging period and adding 0.0082 µg/m$^3$ for the annual averaging period (see Section 11.0 "Secondary Formation of $PM_{2.5}$"). As indicated by the results, REC demonstrates compliance with all applicable NAAQS. All modeling input and output files are included in Appendix I.

**TABLE 24 NAAQS ANALYSIS RESULTS**

| POLLUTANT | AVERAGE PERIOD | MAXIMUM PREDICTED IMPACT (µg/m³) | | AMBIENT BACKGROUND CONCENTRATION (µg/m³) | MAXIMUM CUMULATIVE AMBIENT IMPACT (µg/m³) | NAAQS (µg/m³) |
|---|---|---|---|---|---|---|
| | | WORST-CASE SCENARIO | DESIGN SCENARIO | | | |
| $SO_2$ | 1-hour | 13.17 | 12.75 | 23.6 | 36.77 | 196.4 |
| $PM_{10}$ | 24-hour | 10.01 | 5.03 | 29.0 | 39.01 | 150 |
| $PM_{2.5}$ | 24-hour | 10.59 | 10.59 | 20.0 | 30.59 | 35 |
| | Annual | 3.02 | 2.99 | 8.1 | 11.12 | 12 |
| $NO_2$ | 1-hour | 167.99 | 167.79 | 18.8 | 186.79 | 188 |
| | Annual | 1.27 | 1.25 | 3.6 | 4.87 | 100 |
| CO | 1-hour | 3,540.05 | 435.06 | 1,485.7 | 5,025.75 | 40,000 |

## 13.2 Class II Increment Standards

Pollutants whose emissions resulted in predicted ambient impacts above their respective SILs were required to be compared to the Class II Increment Standards to demonstrate that emissions increases since each PSD Increment standards' baseline dates will not cause or contribute to significant deterioration of air quality. Table 25 below displays the Class II Increment Standards that are applicable to REC

**TABLE 25 CLASS II INCREMENT STANDARDS**

| POLLUTANT | AVERAGING PERIOD | CLASS II INCREMENT STANDARD (µg/m³) | BASELINE DATE |
|---|---|---|---|
| $PM_{10}$ | 24-hour | 30 | January 6, 1975 |
| | Annual | 17 | |
| $PM_{2.5}$ | 24-hour | 9 | October 20, 2010 |
| | Annual | 4 | |
| $NO_2$ | Annual | 25 | February 8, 1988 |

The small radius of impact for $PM_{10}$ and annual $NO_2$ impacts did not warrant the inclusion of any nearby sources in the $PM_{10}$ cumulative impact analyses. The Dry Run and 285 Compressor Stations are not increment consuming sources and do not require inclusion in the PSD Increment analysis. Additionally, REC is not aware of any changes in actual emissions of the other nearby sources after the $PM_{2.5}$ major source baseline date. Thus, only REC's emission sources were included in the PSD Increment analyses.

The PSD Increment analysis is intended to be representative of actual impacts, i.e. design scenarios, and is also only applicable to 24-hour and greater averaging periods. For this reason, the worst-case and design load scenarios (operating scenarios 11 and 17, respectively) for base-load combustion turbine operations only were used to determine the predicted ambient impacts for each pollutant and averaging period. The worst-case and design load for the ancillary equipment was used in conjunction with the combustion turbines regardless of load case scenario.

The results of the PSD Increment analysis are presented in Table 26. $PM_{2.5}$ impacts have been adjusted to account for secondary formation, by adding 0.11 $\mu g/m^3$ for the 24-hour averaging period and adding 0.0082 $\mu g/m^3$ for the annual averaging period (see Section 11.0 "Secondary Formation of $PM_{2.5}$").

**TABLE 26 CLASS II INCREMENT ANALYSIS RESULTS**

| POLLUTANT | AVERAGING PERIOD | CT LOAD CASES USED IN ANALYSIS | MAXIMUM PREDICTED IMPACT ($\mu g/m^3$) | CLASS II INCREMENT STANDARD ($\mu g/m^3$) |
|---|---|---|---|---|
| $PM_{10}$ | 24-hour | 17 (design), 11 (worst-case) | 8.28 | 30 |
| | Annual | 17 (design), 11 (worst-case) | 0.99 | 17 |
| $PM_{2.5}$ | 24-hour | 17 (design), 11 (worst-case) | 8.39 | 9 |
| | Annual | 17 (design), 11 (worst-case) | 1.00 | 4 |
| $NO_2$ | Annual | 17 (design), 15 (worst-case) | 1.27 | 25 |

# 14.0 ADDITIONAL IMPACT ANALYSES

## 14.1 Visibility

REC is required to conduct a visibility impairment analysis to determine the visibility impacts to certain sensitive areas within 50 km of the proposed project location. Although there are no Class I areas within this range, a visibility analysis of other sensitive areas was warranted. A search for sensitive areas within 50 km of REC's location was conducted, and the following sensitive areas were identified:

- Hyner View State Park 11 km; 90° from REC
- Kettle Creek State Park 15 km; 290° from REC
- Ole Bull State Park 24 km; 8° from REC
- Sinnemahoning State Park 28 km; 299° from REC
- Little Pine State Park 34 km; 83° from REC
- Bald Eagle State Park 34 km; 164° from REC
- Cherry Springs State Park 37 km; 352° from REC
- Sizerville State Park 47 km; 309° from REC
- Lyman Run State Park 44 km; 0°/360° from REC
- Colton Point State Park 48 km; 30° from REC
- Leonard Harrison State Park 48 km; 31° from REC

A stack plume visibility screening analysis was performed based upon the procedures described in EPA's "Workbook for Plume Visual Impact Screening and Analysis." The screening analysis involved plume perceptibility and contrast calculations and was performed using EPA's VISCREEN software model. VISCREEN required inputs of distance from the emission source to the sensitive areas, $NO_2$, $PM/PM_{10}$, and sulfate ($SO_4$) emissions, and used worst-case meteorological conditions and other default parameters to calculate plume perceptibility and contrast.

A Level-1 VISCREEN analysis was performed for the closest sensitive area identified above–Hyner View State Park (HVSP), as it is expected that visibility impacts will be greatest closest to REC. VISCREEN can assess visibility impacts for two different backgrounds: a sky background and a terrain background. The terrain background visibility assessment is only applicable in situations when major terrain features (i.e. mountains of significant height) would serve as a background behind to the plume. There are no major terrain features that would serve as a background to REC's plume; thus, the terrain background visibility assessment was not conducted.

Table 27 summarizes the pertinent inputs into REC's Level-1 VISCREEN analysis.

**TABLE 27 INPUTS FOR LEVEL-1 VISCREEN ANALYSIS**

| | INPUT VALUES FOR BOTH TURBINES COMBINED | |
|---|---|---|
| PARAMETER | NATURAL GAS | ULSD |
| Particulate Emissions | 45.0 lb/hr | 96.4 lb/hr |
| NOx Emissions | 66.6 lb/hr | 119.2 lb/hr |
| Background Visual Range | 40 km | 40 km |
| Source-Observer Distance | 11 km | 11 km |

The overly conservative nature of the Level-1 VISCREEN analysis indicated that visibility at HVSP may be adversely impacted in the most stable atmospheric conditions (F-class stability). In order to further assess the visibility impacts using a Level-2 VISCREEN analysis, REC's one-year meteorological data set was further processed to determine the atmospheric stability class for each hour of the one-year dataset using the procedures described by the NOAA's Air Resources Laboratory (https://www.ready.noaa.gov/READYpgclass.php), as well as to categorize the wind direction of each hour into sixteen wind sectors, each with a 22.5° directional width. The following table presents a frequency distribution of the wind direction for the sixteen sectors and each of the six stability categories for the entire one-year dataset.

**TABLE 28 FREQUENCY DISTRIBUTION OF WIND DIRECTION AND ATMOSPHERIC STABILITY FOR FULL YEAR**

| Cardinal Direction | Limits of Wind Direction | | | Percentage of Year in Wind Sector and Stability Class | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D | E | F | |
| N | 348.75° | to | 11.25° | 0.0 | 0.1 | 0.0 | 1.7 | 0.2 | 3.8 | 5.8 |
| NNE | 11.25° | to | 33.75° | 0.0 | 0.1 | 0.0 | 1.8 | 0.2 | 1.2 | 3.4 |
| NE | 33.75° | to | 56.25° | 0.0 | 0.3 | 0.0 | 2.5 | 0.3 | 1.0 | 4.1 |
| ENE | 56.25° | to | 78.75° | 0.0 | 0.6 | 0.3 | 4.5 | 0.4 | 1.4 | 7.2 |
| E | 78.75° | to | 101.25° | 0.0 | 0.9 | 0.6 | 4.8 | 0.4 | 1.2 | 7.9 |
| ESE | 101.25° | to | 123.75° | 0.1 | 1.9 | 0.6 | 1.9 | 0.2 | 0.6 | 5.1 |
| SE | 123.75° | to | 146.25° | 0.0 | 1.6 | 0.2 | 0.8 | 0.0 | 0.4 | 3.0 |
| SSE | 146.25° | to | 168.75° | 0.1 | 0.9 | 0.1 | 0.5 | 0.0 | 0.1 | 1.7 |
| S | 168.75° | to | 191.25° | 0.1 | 0.8 | 0.0 | 0.3 | 0.0 | 0.2 | 1.4 |
| SSW | 191.25° | to | 213.75° | 0.1 | 0.9 | 0.0 | 0.4 | 0.0 | 0.1 | 1.5 |
| SW | 213.75° | to | 236.25° | 0.2 | 2.1 | 0.3 | 0.9 | 0.1 | 0.2 | 3.8 |
| WSW | 236.25° | to | 258.75° | 0.2 | 2.8 | 2.7 | 5.6 | 0.4 | 1.4 | 13.0 |
| W | 258.75° | to | 281.25° | 0.1 | 1.6 | 2.0 | 9.6 | 1.8 | 3.0 | 18.1 |
| WNW | 281.25° | to | 303.75° | 0.0 | 0.4 | 0.1 | 4.2 | 0.9 | 4.0 | 9.6 |
| NW | 303.75° | to | 326.25° | 0.0 | 0.2 | 0.0 | 2.8 | 0.7 | 3.8 | 7.6 |
| NNW | 326.25° | to | 348.75° | 0.0 | 0.1 | 0.0 | 1.8 | 0.4 | 4.2 | 6.5 |
| Total | 0° | to | 360° | 1.0 | 15.2 | 7.0 | 44.2 | 6.1 | 26.6 | 100 |

Typically, F-class stability is only experienced during night-time conditions (defined as the period from one hour before sunset to one hour after sunrise), while HVSP (as well as all other state parks that do not have camping) is closed from sunset to sunrise. The following table presents a frequency distribution of the wind direction for the sixteen sectors and each of the six stability categories for only daylight hours (i.e. the period from sunrise to sunset).

**TABLE 29 FREQUENCY DISTRIBUTION OF WIND DIRECTION AND ATMOSPHERIC STABILITY DURING DAYLIGHT HOURS**

| Cardinal Direction | Limits of Wind Direction | | | Percentage of Year in Wind Sector and Stability Class | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D | E | F | |
| N | 348.75° | to | 11.25° | 0.0 | 0.1 | 0.0 | 1.7 | 0.0 | 0.2 | 2.0 |
| NNE | 11.25° | to | 33.75° | 0.0 | 0.2 | 0.0 | 1.7 | 0.0 | 0.0 | 2.0 |
| NE | 33.75° | to | 56.25° | 0.0 | 0.5 | 0.0 | 2.3 | 0.0 | 0.3 | 3.2 |
| ENE | 56.25° | to | 78.75° | 0.0 | 1.1 | 0.6 | 3.9 | 0.3 | 0.2 | 6.1 |
| E | 78.75° | to | 101.25° | 0.1 | 1.9 | 1.1 | 5.7 | 0.1 | 0.4 | 9.3 |
| ESE | 101.25° | to | 123.75° | 0.1 | 3.7 | 1.2 | 2.6 | 0.0 | 0.4 | 8.0 |
| SE | 123.75° | to | 146.25° | 0.1 | 3.1 | 0.4 | 1.1 | 0.0 | 0.3 | 5.0 |
| SSE | 146.25° | to | 168.75° | 0.2 | 1.8 | 0.2 | 0.7 | 0.0 | 0.1 | 3.0 |
| S | 168.75° | to | 191.25° | 0.1 | 1.6 | 0.1 | 0.5 | 0.0 | 0.1 | 2.4 |
| SSW | 191.25° | to | 213.75° | 0.2 | 1.8 | 0.1 | 0.6 | 0.0 | 0.1 | 2.8 |
| SW | 213.75° | to | 236.25° | 0.4 | 4.2 | 0.6 | 1.4 | 0.0 | 0.0 | 6.7 |
| WSW | 236.25° | to | 258.75° | 0.3 | 5.5 | 5.4 | 8.3 | 0.3 | 0.5 | 20.3 |
| W | 258.75° | to | 281.25° | 0.2 | 3.1 | 3.9 | 9.6 | 0.7 | 1.0 | 18.5 |
| WNW | 281.25° | to | 303.75° | 0.1 | 0.7 | 0.2 | 3.6 | 0.1 | 0.7 | 5.4 |
| NW | 303.75° | to | 326.25° | 0.0 | 0.3 | 0.0 | 2.4 | 0.1 | 0.5 | 3.4 |
| NNW | 326.25° | to | 348.75° | 0.0 | 0.1 | 0.0 | 1.5 | 0.0 | 0.5 | 2.1 |
| Total | 0° | to | 360° | 1.9 | 29.9 | 13.8 | 47.4 | 1.6 | 5.4 | 100 |

As indicated by Table 29, F-class stability only occurs for a total of 5.4% of the hours that HVSP is open to the public. Based on NOAA's procedures for determining atmospheric stability classes, these periods of time are limited to the hour immediately after sunrise and the hour immediately before sunset. Furthermore, with HVSP being located due east of REC, only wind directions directly from the west would transport the exhaust plume to HVSP. Extending that wind transport sector to encompass all winds from WSW through WNW (236.25° to 303.75°), only 2.2% of the hours that HVSP are open experience F-class atmospheric stability with winds that may transport the exhaust plume from REC towards HVSP.

Regarding the other state parks near REC, similar conditions apply. Therefore, REC's Level-2 VISCREEN analysis did not include F-class stability as an input, with all other inputs remaining as default. The Level-2 VISCREEN analysis did not indicate any potential adverse visibility impacts at HVSP, and therefore any of the other state parks near REC. The VISCREEN summary reports are provided in Appendix J, while the meteorological data processing files are included with the electronic modeling files in Appendix I.

## 14.2 Vegetation and Soils

REC is required to conduct an analysis of impacts to sensitive vegetation types with significant commercial or recreational value, as well as sensitive types of soil. The analysis of vegetation types was performed by comparing the maximum modeled impacts from the project to the AQRV screening concentrations provided in EPA's "A Screening Procedure for the impacts of Air Pollution Sources on Plants, Soils, and Animals" (December 12, 1980) as well as secondary NAAQS. The following table includes the screening levels and ambient air quality standards applicable to the analysis of sensitive vegetation types.

**TABLE 30 AMBIENT AIR CONCENTRATIONS FOR VEGETATION ANALYSIS**

| POLLUTANT | AVERAGING PERIOD | AQRV SCREENING LEVELS ($\mu g/m^3$) | SECONDARY NAAQS ($\mu g/m^3$) |
|---|---|---|---|
| $SO_2$ | 1-hour | 917 | -- |
| | 3-hour | 783 | 1,300 |
| | 24-hour | -- | 260 |
| | Annual | 18 | 60 |
| $PM_{10}$ | 24-hour | -- | 150 |
| | Annual | -- | -- |
| $PM_{2.5}$ | 24-hour | -- | 35 |
| | Annual | -- | 15 |
| $NO_2$ | 1-hour | -- | -- |
| | 4-hour | 3,760 | -- |
| | 8-hour | 3,760 | -- |
| | 1-month | 564 | -- |
| | Annual | 94 | 100 |
| CO | 1-hour | -- | -- |
| | 8-hour | -- | -- |
| | Weekly | 1,800,000 | -- |
| Pb | Quarterly | 1.5 | 0.15 |

The Web Soil Survey (WSS) tool available from the U.S. Department of Agriculture's Natural Resources Conservation Service (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) was used to determine that the predominant soil types in the general project area are a variety of silts and stony loams. The WSS review area was centered on the project site and included a square area of approximately 10,000 acres. The moderate to high buffering capacity of these soil types will mitigate the effect of acidic deposition, which is expected to be the most significant impact from the air emissions associated with REC. Because REC will have very low $SO_2$ emissions due to the use of natural gas and ULSD as well as low NOx emissions due to the high level of controls used, it is not expected that REC's emissions will have an adverse impact on soils.

In addition to the qualitative analysis outlined above, Tables 5.7 and 5.8 included in Section 5.2.2 of EPA's "A Screening Procedure for the impacts of Air Pollution Sources on Plants, Soils, and Animals" indicate that emissions of all trace elements from REC with the exception of manganese are below the "Significant Emission Rates" in tons per year that would potentially cause adverse impacts on sensitive soil types. Manganese has a Significant Emission Rate value of 0.33 tons per year, which, using the "Emission Rate Increase Factor" in Table 5.8 for a 30-meter stack with an exit temperature of 350 K and an exhaust flow rate of 4 $m^3/s$, is increased to 1.13 tons per year. REC's maximum potential emissions of manganese are 2.37 tons per year and are solely the result of ULSD firing. ULSD firing is expected to be a rare occurrence; however, for maximum operational flexibility REC is proposing to fire ULSD for no more than 760 hours per year (including SUSD). Furthermore, REC is proposing a stack nearly 80 meters in height with exit temperatures nearer 360 K, and exhaust flow rates at least two orders of magnitude greater than 4 $m^3/s$. There is no "Emission Rate Increase Factor" in Table 5.8 that would account for such an exhaust stack, but it can be assumed that there would be a considerable adjustment to the Significant Emission Rate for manganese that would be greater than REC's maximum potential manganese emissions. Therefore, a further analysis of impacts on sensitive soil types is not warranted.

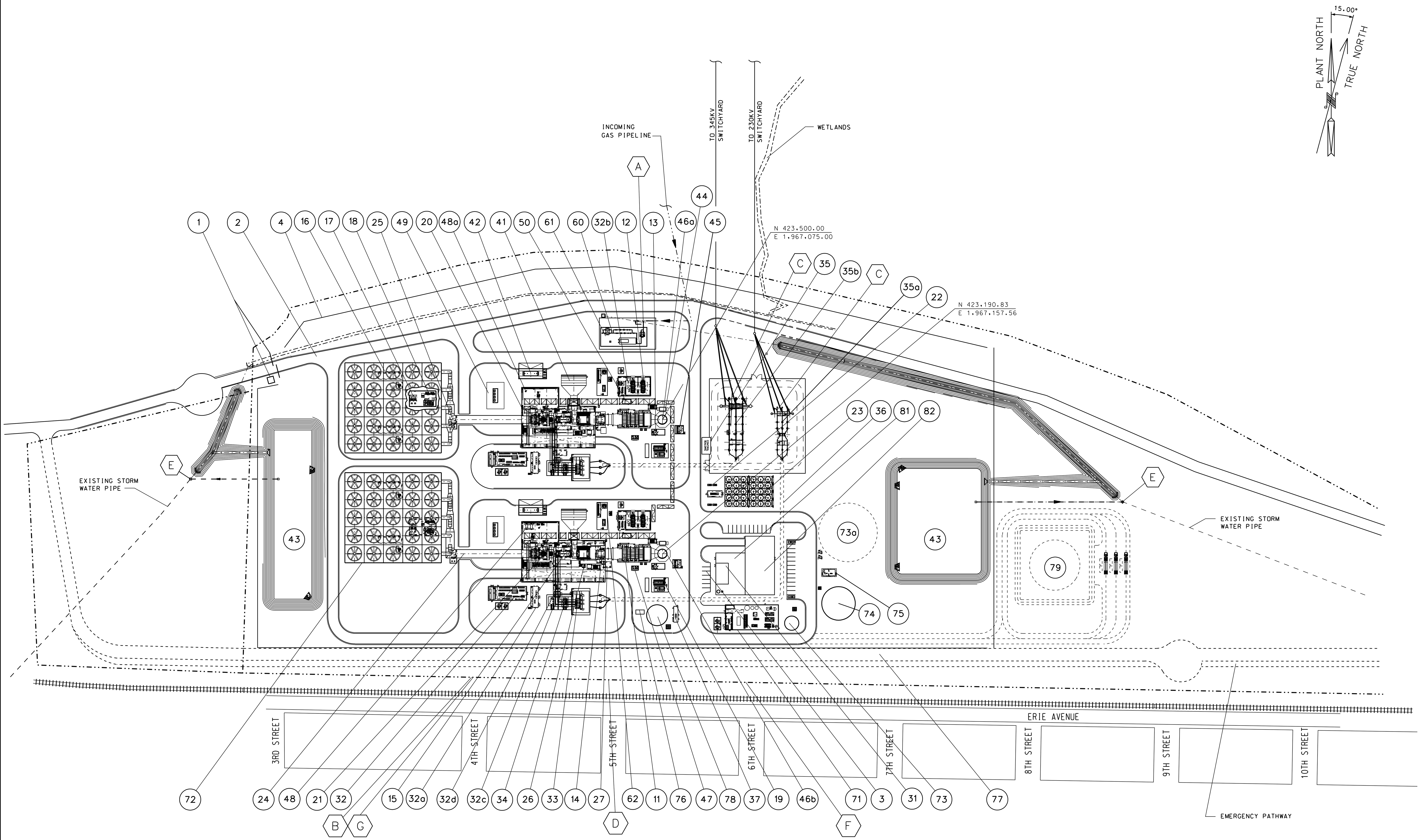
## 14.3 Associated Growth Analysis

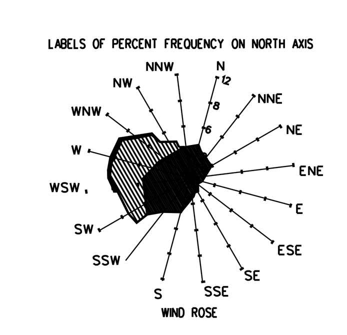
Pursuant to federal PSD regulations, REC is required to provide an analysis of general commercial, residential, industrial, and other growth in the area associated with the source. The REC project is not anticipated to have significant impacts on secondary source growth in the Renovo Township area. The construction portion of the project will generate up to several hundred jobs; however, these positions will be temporary. Many of the temporary positions will be filled by local residents, as according to the Clinton County Profile provided by the Pennsylvania Department of Labor and Industry, approximately 697 Clinton County residents worked in the construction industry as of 2018. A portion of the construction workforce may be filled by workers commuting to the site from other nearby communities. There is sufficient short-term housing in the vicinity of Renovo as well as other services available to accommodate the temporary workforce.

REC will employ 25 to 35 full time staff once the plant is fully operational. This represents a relatively small portion of the local population, assuming that all full-time employees would be considered new residents of the area (conservative assumption). Realtor.com currently (as of February 20, 2020) lists 22 homes for sale in the immediate vicinity of Renovo, with an additional 100 homes for sale in the Lock Haven area, which is roughly a 30-mile commute to/from Renovo. In addition, there are adequate commercial services to support this permanent potential increase in the workforce in Renovo.

The new industrial jobs at REC may lead to a small number of local support jobs; however, the relatively small number of permanent positions is not expected to cause significant commercial or industrial growth in Renovo or its surrounding communities. Because the electricity produced at REC will be fed to the PJM and NY-ISO grids, there is little to no risk of industrial growth in Clinton County associated with industries seeking lower electricity costs.

# APPENDIX A SITE PLAN AND ELEVATION DRAWING







## LEGEND

| ITEM NO. | DESCRIPTION |
|---|---|
| 1 | MAIN GATE \ GUARDHOUSE |
| 2 | PLANT ACCESS ROAD |
| 3 | PARKING |
| 4 | SECURITY FENCE |
| 11 | HEAT RECOVERY STEAM GENERATOR (HRSG) |
| 12 | BOILER FEEDWATER PUMPS |
| 13 | HRSG BLOWDOWN TANK & SUMP |
| 14 | COMBUSTION TURBINE |
| 15 | GENERATOR |
| 16 | ACC ELECTRICAL BUILDING |
| 17 | CONDENSATE PUMPS |
| 18 | STEAM JET AIR EJECTOR |
| 19 | AUXILIARY BOILER |
| 20 | TURBINE BUILDING |
| 21 | STEAM TURBINE |
| 22 | CLOSED COOLING WATER PUMPS |
| 23 | FIN FAN COOLERS |
| 24 | STEAM DUCT |
| 25 | STEAM DUCT DRIP POT AND PUMPS |
| 26 | CTG WATER WASH SKID |
| 27 | FALSE START AND WATER WASH DRAINS TANK |
| 31 | CONTROL ROOM |
| 32 | MAIN SWITCHGEAR AND BATTERY ROOM |
| 32a | LEC COMBINED LCI MODULE |
| 32b | HRSG LOAD CENTER BUILDING |
| 32c | ISOLATION TRANSFORMER |
| 32d | GENERATOR BREAKER |
| 33 | GENERATOR STEP-UP TRANSFORMER |
| 34 | UNIT AUXILIARY TRANSFORMER |
| 35 | SWITCHYARD CONTROL BUILDING |
| 35a | 230KV SWITCHYARD |
| 35b | 345KV SWITCHYARD |
| 36 | HV \ EHV UNDERGROUND CABLE CORRIDOR |
| 37 | DIESEL GENERATOR WITH DAY TANK |
| 41 | COMBUSTION TURBINE AIR INLET FILTER |
| 42 | AMMONIA STORAGE TANK & FORWARDING PUMPS |
| 43 | STORM WATER MANAGEMENT POND |
| 44 | CONTINUOUS EMISSIONS MONITORING |
| 45 | HRSG \ AUX BOILER CHEMICAL STORAGE AREA |
| 46a | UNIT 1 STACK |
| 46b | UNIT 2 STACK |
| 47 | SCR SKID |
| 48 | AIR COMPRESSORS \ DRYERS \ RECEIVER |
| 48a | AIR RECEIVER |
| 49 | HYDROGEN TUBE TRAILER |
| 50 | STEAM WATER ANALYSIS SAMPLE (SWAS) |
| 60 | FUEL GAS PRESSURE REDUCTION |
| 61 | FUEL GAS DEW POINT HEATER |
| 62 | FUEL GAS PERFORMANCE HEATER \ FILTER \ SCRUBBER |
| 71 | WATER TREATMENT(W/ELECTRICAL ROOM & LAB) |
| 72 | AIR COOLED CONDENSER (ACC) |
| 73 | DEMINERALIZED WATER STORAGE TANK |
| 73a | DEMINERALIZED. WTR STORAGE TANK FOR FUTURE ULSD ( REPLACES ITEM 73 ) |
| 74 | SERVICE WATER \ FIRE WATER STORAGE TANK |
| 75 | DIESEL/ELECTRIC FIRE PUMP HOUSE |
| 76 | OIL/WATER SEPARATOR |
| 77 | CONSTRUCTION ROAD |
| 78 | WASTEWATER STORAGE TANK |
| 79 | DIESEL FUEL OIL STORAGE TANK \ UNLOADING (FUTURE ULSD) |
| 81 | ADMINISTRATION BUILDING |
| 82 | MAINTENANCE SHOP/WAREHOUSE BUILDING |

| TIE-IN POINTS | |
|---|---|
| A | FUEL GAS |
| B | RAW WATER |
| C | ELECTRIC TRANSMISSION |
| D | DISCHARGE WATER (SANITARY) |
| E | STORM WATER |
| F | POTABLE WATER |
| G | PROCESS WATER DISCHARGE |

LEGEND

- PROPERTY BOUNDARY
- FENCELINE
- RAILROAD TRACKS

NOTES:

1. COORDINATES SHOWN ARE IN FEET (FT) PENNSYLVANIA STATE PLANE NORTH ZONE 3701.

| NO. | DATE | REVISIONS | BY | CHK | DESIGN SUPV | ENGR | PROJ ENGR | |
|---|---|---|---|---|---|---|---|---|
| | / / | | | | | | | |
| | / / | | | | | | | |
| C | 12/20/19 | ISSUED FOR REVIEW | DB | JRB | DB | - | RAP | |
| B | 08/05/16 | ISSUED FOR REVIEW | SW | JVG | JVG | - | VS | |
| A | 08/02/16 | ISSUED FOR REVIEW | SW | JVG | JVG | - | VS | |

SCALE AS NOTED | DESIGNED SW | DRAWN SW | CHIEF ENGR

**BECHTEL**
*DEDICATED TO SAFETY EXCELLENCE - ZERO ACCIDENTS*
RESTON, VIRGINIA

# RENOVO ENERGY CENTER
# CLINTON COUNTY, PA

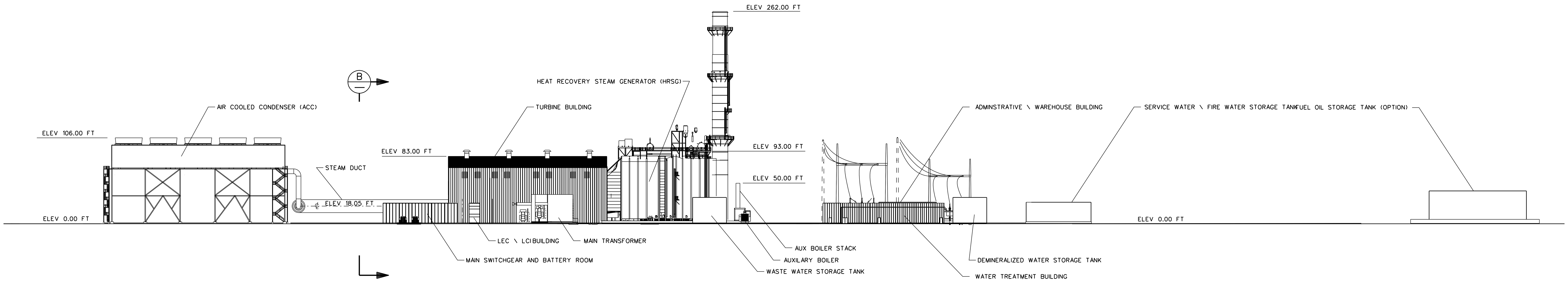
## PLOT PLAN

| JOB NO. | DRAWING NO. | REV |
|---|---|---|
| 26081-000 | P1-0010-00001 | C |

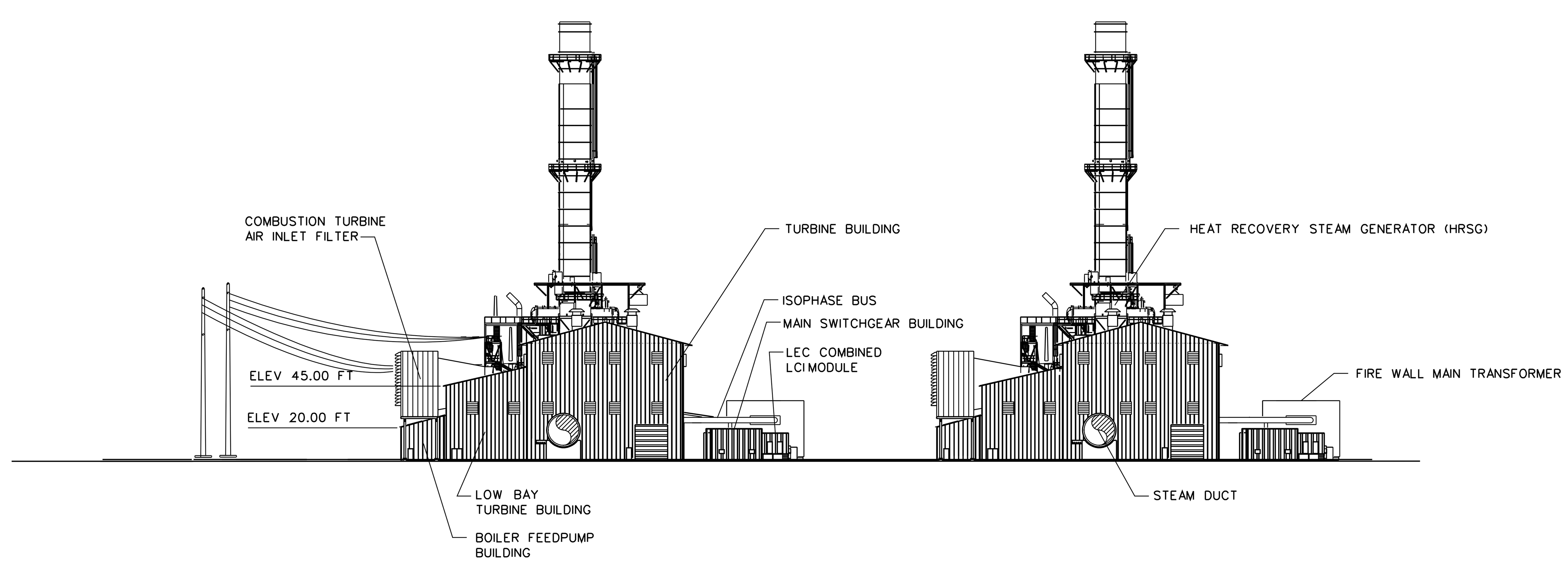
REF DFN=[ ] . DFN=[ ] .
22 x 34 "D" SIZE
LEVELS 1 11 11111222222222233333333334444444444555555555566666 1234567890 23 5678901234567890123456789012345678901234567890123
PSC= :1 :



D C B A
6 5 4 3 2




ELEVATION A
LKG NORTH




ELEVATION B
LKG EAST

REFERENCE DRAWING:
26081-000-P1-0010-00001 - PLOT PLAN

0 100 200 300FT

| NO. | DATE | REVISIONS | BY | CHK | DESIGN SUPV | ENGR | PROJ ENGR | |
|---|---|---|---|---|---|---|---|---|
| △ | / / | | | | | | | |
| △ | / / | | | | | | | |
| △ | / / | | | | | | | |
| B | 12/20/19 | ISSUED FOR REVIEW | DB | JRB | DB | - | RAP | |
| A | 9/22/16 | ISSUED FOR REVIEW | JVG | VS | JVG | -- | VS | |

| SCALE | DESIGNED | DRAWN | CHIEF ENGR |
|---|---|---|---|

BECHTEL
FREDERICK, MARYLAND

RENOVO ENERGY CENTER
CLINTON COUNTY, PA

ELEVATION VIEWS

| JOB NO. | DRAWING NO. | REV |
|---|---|---|
| 26081-000 | P1-0090-00001 | B |

REF DFN=[ ] . DFN=[ ] .
22 x 34 "D" SIZE
LEVELS 1111111111222222222233333333334444444444555555555566666
123456789012345678901234567890123456789012345678901234567890123
PSC= :1 :

6 5 4 3 2
D C B A

# APPENDIX B EMISSION CALCULATIONS, OPERATING SCENARIO PARAMETERS, VENDOR-PROVIDED EMISSIONS DATA

Renovo Energy Center
Facility-Wide Maximum Potential Emissions
Tons Per Year

| Pollutant | Power-blocks | Auxiliary Boilers | Diesel Generator | Diesel Fire Pump | Heater | ULSD storage tank | Circuit Breakers | Facility-Wide Total |
|---|---|---|---|---|---|---|---|---|
| NOx | 355.17 | 0.87 | 5.45 | 0.18 | 2.72 | --- | --- | 364.4 |
| CO | 356.78 | 5.23 | 1.50 | 0.059 | 5.93 | --- | --- | 369.5 |
| $PM_{10}$ | 211.92 | 0.28 | 0.16 | 0.0065 | 0.27 | --- | --- | 212.6 |
| VOC | 110.73 | 0.29 | 0.97 | 0.0065 | 0.73 | 0.042 | --- | 112.8 |
| $SO_2$ | 53.48 | 0.084 | 0.0055 | 0.00032 | 0.084 | --- | --- | 53.6 |
| $NH_3$ | 277.36 | --- | --- | --- | --- | --- | --- | 277.4 |
| Lead | 0.042 | --- | --- | --- | --- | --- | --- | 0.042 |
| $CO_2$ | 5,413,496 | 16,949 | 582.92 | 33.44 | 16,852 | --- | --- | 5,447,914 |
| $CH_4$ | 82.26 | 0.32 | 0.024 | 0.0014 | 0.32 | --- | --- | 82.9 |
| $N_2O$ | 10.21 | 0.032 | 0.0047 | 0.00027 | 0.032 | --- | --- | 10.3 |
| $SF_6$ | --- | --- | --- | --- | --- | --- | 0.0080 | 0.0080 |
| $CO_{2e}$ | 5,418,594 | 16,967 | 584.92 | 33.55 | 16,869 | --- | 182.97 | 5,453,232 |
| $H_2SO_4$ | 35.40 | 0.013 | --- | --- | --- | --- | --- | 35.4 |
| HAPs | 19.87 | 0.27 | 0.014 | 0.00078 | 0.27 | --- | --- | 20.4 |
| Hexane[1] | 7.36 | 0.26 | --- | --- | 0.25 | --- | --- | 7.9 |

[1] *Hexane is the single HAP with the highest potential emissions.*

Renovo Energy Center
Raw Data for General Electric Equipment

| OPERATING POINT | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ambient Temperature | °F | -20 | 95.8 | 59 | 95.8 | -0.7 | 59 | 95.8 | -20 | 35 | 59 | 95.8 | -0.7 | 59 | 95.8 | -20 | 95.8 | 59 | 95.8 | -20 | 59 | 95.8 |
| Ambient Pressure | psia | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 |
| Ambient Relative Humidity | % | 60 | 35 | 60 | 35 | 60 | 60 | 35 | 60 | 60 | 60 | 35 | 60 | 60 | 35 | 60 | 35 | 60 | 35 | 60 | 60 | 35 |
| PLANT STATUS | | | | | | | | | | | | | | | | | | | | | | |
| SCR/CO Catalyst | | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| Evaporative Cooler State[1] | on/off | Off | Off | On | On | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | On | On | Off | On | On |
| Gas Turbine Load | % | 100% | 100% | 100% | 100% | 38% | 30% | 32% | 100% | 100% | 100% | 100% | 60% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Duct Burner Status | on/off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | On | On | On | On | On | Off | Off |
| Turbine Diluent Injection Type | | None | None | None | None | None | None | None | Water | Water | Water | Water | Water | Water | Water | None | None | None | None | None | Water | Water |
| Diluent Injection Flow | klb/hr | -- | -- | -- | -- | -- | -- | -- | 260.8 | 266.4 | 266.4 | 249.8 | 151.8 | 120.1 | 109.8 | -- | -- | -- | -- | -- | 266.4 | 254.2 |
| FUEL DATA | | | | | | | | | | | | | | | | | | | | | | |
| Fuel Type | | NG | NG | NG | NG | NG | NG | NG | DO | DO | DO | DO | DO | DO | DO | NG | NG | NG | NG | NG | DO | DO |
| HHV | Btu/lb | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 20,130 | 20,130 |
| LHV | Btu/lb | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 18,300 | 18,300 |
| Fuel Molecular Weight | lb/lbmole | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | n/a | n/a |
| Fuel Bound Nitrogen | Wt % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | 0 | 0 | 0 | 0 | 0 | ≤ 0.015% | ≤ 0.015% |
| Fuel Sulfur Content | ppmw | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 15 | 15 |
| GT Heat Consumption[2] | MMBtu/hr HHV | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 1,837.7 | 1,516.3 | 1,470.6 | 3,940.4 | 3,892.8 | 3,848.4 | 3,588.7 | 2,646.6 | 2,258.0 | 2,109.7 | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 3,523.8 | 3,914.6 | 3,824.7 |
| DB Heat Consumption[2] | MMBtu/hr HHV | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,001.9 | 821.6 | 906.8 | 878.2 | 1,005.3 | 0.0 | 0.0 |
| Total Heat Consumption | MMBtu/hr HHV | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 1,837.7 | 1,516.3 | 1,470.6 | 3,940.4 | 3,892.8 | 3,848.4 | 3,588.7 | 2,646.6 | 2,258.0 | 2,109.7 | 4,525.7 | 4,051.7 | 4,447.9 | 4,337.4 | 4,529.1 | 3,914.6 | 3,824.7 |
| HRSG EXIT EXHAUST GAS | | | | | | | | | | | | | | | | | | | | | | |
| Stack N2 mole fraction | - | 0.7474 | 0.7326 | 0.7374 | 0.7266 | 0.75 | 0.7445 | 0.7377 | 0.7058 | 0.7001 | 0.6947 | 0.6889 | 0.7147 | 0.7113 | 0.7071 | 0.738 | 0.7244 | 0.7289 | 0.7184 | 0.738 | 0.6938 | 0.6862 |
| Stack O2 mole fraction | - | 0.1149 | 0.1115 | 0.1108 | 0.1086 | 0.1233 | 0.126 | 0.1262 | 0.09819 | 0.09532 | 0.09332 | 0.09369 | 0.1035 | 0.103 | 0.1052 | 0.08825 | 0.08783 | 0.08635 | 0.0846 | 0.08816 | 0.09297 | 0.09254 |
| Stack AR mole fraction | - | 0.0089 | 0.008724 | 0.008781 | 0.008653 | 0.008932 | 0.008865 | 0.008785 | 0.008406 | 0.008338 | 0.008274 | 0.008205 | 0.008511 | 0.008471 | 0.008422 | 0.008788 | 0.008626 | 0.008679 | 0.008554 | 0.008788 | 0.008263 | 0.008172 |
| Stack H2O mole fraction | - | 0.0852 | 0.1039 | 0.09875 | 0.1122 | 0.07808 | 0.0831 | 0.09079 | 0.1243 | 0.132 | 0.1391 | 0.1459 | 0.1121 | 0.1163 | 0.1205 | 0.1092 | 0.125 | 0.1206 | 0.1335 | 0.1093 | 0.1402 | 0.1496 |
| Stack CO2 mole fraction | - | 0.04344 | 0.04314 | 0.04418 | 0.04381 | 0.03958 | 0.03744 | 0.03641 | 0.06314 | 0.06407 | 0.06444 | 0.06312 | 0.06111 | 0.06083 | 0.05857 | 0.05561 | 0.05397 | 0.05533 | 0.05478 | 0.05565 | 0.06453 | 0.0634 |
| Molecular Weight | lb/lbmole | 28.42 | 28.21 | 28.28 | 28.13 | 28.46 | 28.39 | 28.29 | 28.27 | 28.19 | 28.12 | 28.03 | 28.38 | 28.33 | 28.26 | 28.26 | 28.08 | 28.14 | 27.99 | 28.26 | 28.11 | 28.00 |
| Temperature | °F | 185.2 | 190.5 | 181.4 | 194 | 163.1 | 160.3 | 166.9 | 291.5 | 284.5 | 280 | 288.3 | 259.6 | 243.4 | 251.2 | 172.8 | 178.6 | 176.3 | 182.2 | 180.5 | 281.3 | 293.8 |
| Mass Flow | lb/hr | 6,111,200 | 5,598,900 | 6,007,200 | 5,885,500 | 3,505,200 | 3,050,800 | 3,032,500 | 6,366,300 | 6,181,400 | 6,059,300 | 5,751,100 | 4,436,300 | 3,795,900 | 3,674,700 | 6,155,800 | 5,635,400 | 6,047,500 | 5,924,500 | 6,155,900 | 6,152,600 | 6,093,500 |
| Volume Flow | scf/hr (60°F) | 81,604,584 | 75,312,363 | 80,617,373 | 79,407,353 | 46,734,281 | 40,781,955 | 40,670,960 | 85,461,030 | 83,198,246 | 81,767,914 | 77,853,532 | 59,317,047 | 50,841,652 | 49,342,117 | 82,648,282 | 76,168,273 | 81,562,002 | 80,322,176 | 82,651,792 | 83,061,790 | 82,598,636 |
| | acf/hr | 103,700,000 | 96,501,000 | 101,850,000 | 102,280,000 | 57,353,000 | 49,823,000 | 50,219,000 | 126,510,000 | 122,010,000 | 119,190,000 | 114,760,000 | 84,074,000 | 70,446,000 | 69,122,000 | 103,010,000 | 95,811,000 | 102,230,000 | 101,600,000 | 104,270,000 | 121,290,000 | 122,650,000 |
| | acf/min | 1,728,333 | 1,608,350 | 1,697,500 | 1,704,667 | 955,883 | 830,383 | 836,983 | 2,108,500 | 2,033,500 | 1,986,500 | 1,912,667 | 1,401,233 | 1,174,100 | 1,152,033 | 1,716,833 | 1,596,850 | 1,703,833 | 1,693,333 | 1,737,833 | 2,021,500 | 2,044,167 |
| | fps | 75.778 | 70.517 | 74.426 | 74.740 | 41.910 | 36.408 | 36.697 | 92.446 | 89.157 | 87.097 | 83.860 | 61.436 | 51.478 | 50.510 | 75.273 | 70.013 | 74.703 | 74.243 | 76.194 | 88.631 | 89.625 |
| HRSG EXIT EXHAUST GAS EMISSIONS | | | | | | | | | | | | | | | | | | | | | | |
| NOx (pre-control)[3] | ppmvd @ 15% $O_2$ | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 25 | 25 | 25 | 25 | 25 | 42 | 42 |
| | lb/hr as $NO_2$ | 320.00 | 292.50 | 321.25 | 313.75 | 166.25 | 137.50 | 133.75 | 745.00 | 736.25 | 727.50 | 678.75 | 500.00 | 426.25 | 398.75 | 416.25 | 371.25 | 408.75 | 397.50 | 416.25 | 740.00 | 722.50 |
| NOx (post-control) | ppmvd @ 15% $O_2$ | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 4 |
| | lb/MMBtu | 0.0073 | 0.0072 | 0.0073 | 0.0073 | 0.0072 | 0.0073 | 0.0073 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.0074 | 0.0073 | 0.0074 | 0.0073 | 0.0074 | 0.015 | 0.015 |
| | lb/hr as $NO_2$ | 25.6 | 23.4 | 25.7 | 25.1 | 13.3 | 11 | 10.7 | 59.6 | 58.9 | 58.2 | 54.3 | 40 | 34.1 | 31.9 | 33.3 | 29.7 | 32.7 | 31.8 | 33.3 | 59.2 | 57.8 |
| CO (pre-control)[3] | ppmvd @ 15% $O_2$ | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 9 | 9 | 9 | 9 | 9 | 25 | 25 |
| | lb/hr | 45.45 | 41.85 | 45.90 | 44.55 | 23.85 | 19.80 | 18.90 | 81.45 | 80.55 | 79.65 | 74.25 | 54.90 | 46.80 | 43.65 | 86.40 | 77.40 | 85.05 | 82.80 | 86.85 | 81.00 | 79.20 |
| CO (post-control) | ppmvd @ 15% $O_2$ | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 2 | 2 |
| | lb/MMBtu | 0.0029 | 0.0029 | 0.0029 | 0.0029 | 0.0029 | 0.0029 | 0.0029 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0042 | 0.0042 | 0.0042 | 0.0042 | 0.0043 | 0.0046 | 0.0046 |
| | lb/hr | 10.10 | 9.30 | 10.20 | 9.90 | 5.30 | 4.40 | 4.20 | 18.10 | 17.90 | 17.70 | 16.50 | 12.20 | 10.40 | 9.70 | 19.20 | 17.20 | 18.90 | 18.40 | 19.30 | 18.00 | 17.60 |
| VOC (pre-control)[3] | ppmvd @ 15% $O_2$ | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.5 | 3.5 |
| | lb/hr as methane | 6.20 | 5.80 | 6.20 | 6.20 | 3.20 | 2.60 | 2.60 | 18.20 | 18.03 | 17.68 | 16.63 | 12.25 | 10.50 | 9.80 | 19.07 | 17.05 | 18.88 | 18.33 | 19.07 | 18.03 | 17.68 |
| VOC (post-control) | ppmvd @ 15% $O_2$ | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 2 | 2 |
| | lb/MMBtu | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0026 | 0.0026 | 0.0026 | 0.0026 | 0.0026 | 0.0027 | 0.0027 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0026 | 0.0026 |
| | lb/hr as methane | 3.10 | 2.90 | 3.10 | 3.10 | 1.60 | 1.30 | 1.30 | 10.40 | 10.30 | 10.10 | 9.50 | 7.00 | 6.00 | 5.60 | 10.40 | 9.30 | 10.30 | 10.00 | 10.40 | 10.30 | 10.10 |
| $CO_2$ | lb/hr | 432,000 | 396,000 | 434,000 | 424,000 | 225,000 | 186,000 | 180,000 | 657,000 | 649,000 | 642,000 | 598,000 | 441,000 | 377,000 | 352,000 | 560,000 | 501,000 | 550,000 | 536,000 | 560,000 | 653,000 | 638,000 |
| | lb/MMBtu w/margin | 134.9 | 134.9 | 134.8 | 134.8 | 134.7 | 134.9 | 134.6 | 183.4 | 183.4 | 183.5 | 183.3 | 183.3 | 183.7 | 183.5 | 136.1 | 136.0 | 136.0 | 135.9 | 136.0 | 183.5 | 183.5 |
| | lb/hr w/10% margin[4] | 475,200 | 435,600 | 477,400 | 466,400 | 247,500 | 204,600 | 198,000 | 722,700 | 713,900 | 706,200 | 657,800 | 485,100 | 414,700 | 387,200 | 616,000 | 551,100 | 605,000 | 589,600 | 616,000 | 718,300 | 701,800 |
| | lb/MW-hr | 836 | 819 | 813 | 821 | 931 | 953 | 979 | 1,259 | 1,228 | 1,223 | 1,235 | 1,282 | 1,283 | 1,315 | 894 | 874 | 872 | 876 | 892 | 1,210 | 1,220 |
| $NH_3$ | ppmvd @ 15% $O_2$ | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | lb/MMBtu | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0068 | 0.0068 | 0.0068 | 0.0068 | 0.0068 | 0.0070 | 0.0070 |
| | lb/hr | 23.7 | 21.7 | 23.8 | 23.2 | 12.3 | 10.2 | 9.9 | 27.6 | 27.2 | 26.9 | 25.1 | 18.5 | 15.8 | 14.8 | 30.8 | 27.5 | 30.2 | 29.5 | 30.8 | 27.4 | 26.8 |
| | lb/hr w/5% margin[4] | 24.89 | 22.79 | 24.99 | 24.36 | 12.92 | 10.71 | 10.40 | 28.98 | 28.56 | 28.25 | 26.36 | 19.43 | 16.59 | 15.54 | 32.34 | 28.88 | 31.71 | 30.98 | 32.34 | 28.77 | 28.14 |
| SOx[5] | lb/hr as $SO_2$ (+20%) | 4.70 | 4.30 | 4.70 | 4.60 | 2.40 | 2.00 | 2.00 | 7.00 | 7.00 | 6.90 | 6.40 | 4.70 | 4.00 | 3.80 | 6.10 | 5.40 | 6.00 | 5.80 | 6.10 | 7.00 | 6.80 |
| PM | lb/hr | 11.3 | 11.1 | 11.3 | 11.3 | 10.0 | 9.7 | 9.7 | 48.2 | 48.2 | 48.1 | 47.9 | 39.6 | 39.2 | 39.0 | 22.5 | 20.3 | 21.5 | 21.1 | 22.5 | 48.2 | 48.1 |
| | lb/MMBtu | 0.0032 | 0.0034 | 0.0032 | 0.0033 | 0.0054 | 0.0064 | 0.0066 | 0.0122 | 0.0124 | 0.0125 | 0.0133 | 0.0150 | 0.0174 | 0.0185 | 0.0050 | 0.0050 | 0.0048 | 0.0049 | 0.0050 | 0.0123 | 0.0126 |
| $H_2SO_4$ | lb/hr | 2.60 | 2.40 | 2.70 | 2.60 | 1.40 | 1.10 | 1.10 | 4.00 | 3.90 | 3.90 | 3.60 | 2.70 | 2.30 | 2.10 | 3.70 | 3.30 | 3.70 | 3.60 | 3.70 | 3.90 | 3.90 |
| | lb/hr w/10% margin[4] | 2.86 | 2.64 | 2.97 | 2.86 | 1.54 | 1.21 | 1.21 | 4.40 | 4.29 | 4.29 | 3.96 | 2.97 | 2.53 | 2.31 | 4.07 | 3.63 | 4.07 | 3.96 | 4.07 | 4.29 | 4.29 |
| $CH_2O$[6] | ppbvd @ 15% $O_2$ | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 |
| | lb/MMBtu | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 |
| | lb/hr | 0.42 | 0.38 | 0.42 | 0.41 | 0.22 | 0.18 | 0.17 | 0.47 | 0.46 | 0.46 | 0.43 | 0.31 | 0.27 | 0.25 | 0.54 | 0.48 | 0.53 | 0.52 | 0.54 | 0.46 | 0.45 |
| | lb/hr w/10% margin[4] | 0.46 | 0.42 | 0.46 | 0.45 | 0.24 | 0.20 | 0.19 | 0.51 | 0.51 | 0.50 | 0.47 | 0.35 | 0.30 | 0.28 | 0.59 | 0.53 | 0.58 | 0.57 | 0.59 | 0.51 | 0.50 |

[1] Operating points included list evaporative coolers as "off," however evaporative coolers may be operated when firing ULSD.

[2] The heat consumption provided by G.E. included a ~5% margin to account for equipment degradation and site variability.

[3] Pre-control emissions rates when firing natural gas were provided by G.E. on a ppm basis. The same control efficiency for ppm values was used for the lb/hr pre-control emission rates. For emission rates when firing ULSD, the same control efficiency as determined for natural gas emissions was used to determine pre-control emissions when firing ULSD.

[4] A 10% margin was added to lb/hr emission values of $CO_2$, $H_2SO_4$, $NH_3$, and $CH_2O$ to account for equipment degradation and site variability.

[5] SOx emission rates provided by G.E. included a margin of 20% to account for fuel and site variability.

[6] $CH_2O$ emission rate of 91 ppb @ 15% $O_2$ is the turbine outlet concentration provided by G.E. (91 ppb) with a 50% control efficiency applied for the oxidation catalyst.

Renovo Energy Center
Determination of Maximum Potential Emissions
Powerblocks- Turbines, HRSGs firing Natural Gas

| | | | |
|---|---|---|---|
| Maximum Fuel Flow Rate: | 150,002 | lb/hr each | |
| Fuel Gross Heating Value: | 23,607 | Btu/lb | |
| Maximum GT heat input capacity: | 3,541 | MMBtu/hr each | |
| Maximum GT+DB heat input capacity: | 4,529 | MMBtu/hr each | |
| Annual capacity factor: | 100 | % | |
| Maximum emissions scenario operating hours: | 7,540 | hours each | *(not including SUSD or ULSD operations)* [1] |
| Maximum emissions scenario annual heat input: | 34,149,414 | MMBtu/yr each | *(not including SUSD or ULSD operations)* |

Maximum annual emissions calculated based on maximum potential operating hours.
Values below represent emissions from each individual unit.

| Pollutant[2] | Emission Factor (ppmvd @ 15% $O_2$) | Maximum Short-term Emission Rate (GT only) (lb/hr) | Maximum Short-term Emission Rate (GT+DB) (lb/hr) | Maximum Potential Annual Emissions[5] (ton/yr) |
|---|---|---|---|---|
| NOx | 2 | 25.70 | 33.30 | 125.54 |
| CO | 2 | 10.20 | 19.30 | 72.76 |
| $PM_{10}$ | -- | 11.30 | 22.50 | 84.83 |
| VOC | 1 (GT); 2 (GT+DB) | 3.10 | 10.40 | 39.21 |
| $SO_2$ | -- | 4.70 | 6.10 | 23.00 |
| $NH_3$ | 5 | 24.99 | 32.34 | 121.92 |
| $H_2SO_4$ | -- | 2.97 | 4.07 | 15.34 |
| *GHGs* [3] | (kg/MMBtu) | (lb/hr) | (lb/hr) | (ton/yr) |
| $CO_2$ | -- | 477,400 | 616,000 | 2,322,320 |
| $CH_4$ | 1.0E-03 | 7.81 | 7.81 | 29.43 |
| $N_2O$ | 1.0E-04 | 0.78 | 0.78 | 2.94 |
| $CO_{2equivalent}$ | | 477,827.8 | 616,427.8 | 2,323,933 |
| *HAPs* [4] | GT (lb/MMBtu) | DB (lb/MMscf) | GT+DB (lb/hr) | (ton/yr) |
| 1,3-butadiene | 2.2E-07 | 0 | 7.6E-04 | 0.0029 |
| acetaldehyde | 2.0E-05 | 0 | 7.0E-02 | 0.27 |
| acrolein | 3.2E-06 | 0 | 1.1E-02 | 0.043 |
| benzene | 6.0E-06 | 1.2E-03 | 2.2E-02 | 0.08 |
| dichlorobenzene | 0 | 6.6E-04 | 6.5E-04 | 0.0025 |
| ethyl benzene | 1.6E-05 | 0 | 5.6E-02 | 0.21 |
| formaldehyde[2] | -- | -- | 5.9E-01 | 2.23 |
| hexane | 0 | 9.9E-01 | 9.8E-01 | 3.68 |
| naphthalene | 6.5E-07 | 3.4E-04 | 2.6E-03 | 0.010 |
| PAH | 1.1E-06 | 0 | 3.9E-03 | 0.015 |
| POM | 0 | 4.9E-05 | 4.8E-05 | 0.00018 |
| propylene oxide | 1.5E-05 | 0 | 5.1E-02 | 0.19 |
| toluene | 6.5E-05 | 1.9E-03 | 2.3E-01 | 0.87 |
| xylenes | 3.3E-05 | 0 | 1.1E-01 | 0.43 |

| *HAPs* [4] | GT (lb/MMBtu) | DB (lb/MMscf) | GT+DB (lb/hr) | (ton/yr) |
|---|---|---|---|---|
| arsenic | 0 | 2.0E-04 | 2.0E-04 | 0.00074 |
| beryllium | 0 | 1.2E-05 | 1.2E-05 | 0.000045 |
| cadmium | 0 | 1.1E-03 | 1.1E-03 | 0.0041 |
| chromium | 0 | 1.4E-03 | 1.4E-03 | 0.0052 |
| cobalt | 0 | 8.4E-05 | 8.3E-05 | 0.00031 |
| lead | 0 | 0 | 0 | 0 |
| manganese | 0 | 3.8E-04 | 3.7E-04 | 0.0014 |
| mercury | 0 | 2.6E-04 | 2.6E-04 | 0.00097 |
| nickel | 0 | 2.1E-03 | 2.1E-03 | 0.0078 |
| selenium | 0 | 0 | 2.4E-05 | 0.000089 |
| TOTAL HAPs | | 1.00 | 2.14 | 8.06 |

[1]Maximum potential operating hours not including SUSD or ULSD operations was used to estimate emissions.

[2]Emission factors provided by vendor. The maximum emissions rate from all available operating scenarios was used to calculate maximum potential emissions.

[3]Emission factor for $CO_2$ provided by vendor. Emission factors for $CH_4$ and $N_2O$ obtained from 40 CFR 98.

[4]HAP emission factors for GT obtained from EPA's AP-42, Table 3.1-3 and reflect control level of 50% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from the vendor. HAP emission factors for DB obtained from EPA's AP-42, Tables 1.4-3 and 1.4-4 and reflect control level of 45% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from vendor.

[5]Potential annual emissions based on the GT + DB scenario, as this is considered worst-case.

Renovo Energy Center
Determination of Maximum Potential Emissions
Powerblocks- Turbines firing ULSD

| | | | |
|---|---|---|---|
| Maximum Fuel Flow Rate: | 195,748 | lb/hr each | |
| Fuel Gross Heating Value: | 20,130 | Btu/lb | |
| Maximum heat input capacity: | 3,940 | MMBtu/hr each | |
| Annual capacity factor: | 100 | % | |
| Maximum potential operating hours: | 720 | hours each | *(not including SUSD)* [1] |
| Maximum annual heat input: | 2,837,088 | MMBtu/yr | *(not including SUSD)* |

Maximum annual emissions calculated based on maximum potential operating hours.
Values below represent emissions from each individual unit.

| Pollutant[2] | Emission Factor (ppmvd @ 15% $O_2$) | Maximum Short-Term Emission Rate (lb/hr) | Maximum Potential Annual Emissions (ton/yr) |
|---|---|---|---|
| NOx | 4 | 59.60 | 21.46 |
| CO | 2 | 18.10 | 6.52 |
| $PM_{10}$ | -- | 48.20 | 17.35 |
| VOC | 2 | 10.40 | 3.74 |
| $SO_2$ | -- | 7.00 | 2.52 |
| $NH_3$ | 5 | 28.98 | 10.43 |
| $H_2SO_4$ | -- | 4.40 | 1.58 |
| *GHGs* [3] | (kg/MMBtu) | (lb/hr) | (ton/yr) |
| $CO_2$ | -- | 722,700 | 260,172 |
| $CH_4$ | 3.0E-03 | 26.06 | 9.38 |
| $N_2O$ | 6.0E-04 | 5.21 | 1.88 |
| $CO_{2equivalent}$ | -- | 724,904.8 | 260,966 |
| *HAPs* [4] | (lb/MMBtu) | (lb/hr) | (ton/yr) |
| 1,3-butadiene | 1.1E-05 | 4.4E-02 | 0.016 |
| acetaldehyde | 0 | 0 | 0 |
| acrolein | 0 | 0 | 0 |
| benzene | 3.9E-05 | 1.5E-01 | 0.055 |
| dichlorobenzene | 0 | 0 | 0 |
| ethyl benzene | 0 | 0 | 0 |
| formaldehyde[2] | -- | 5.1E-01 | 0.19 |
| hexane | 0 | 0 | 0 |
| naphthalene | 2.5E-05 | 9.7E-02 | 0.035 |
| PAH | 2.8E-05 | 1.1E-01 | 0.040 |
| POM | 0 | 0 | 0 |
| propylene oxide | 0 | 0 | 0 |
| toluene | 0 | 0 | 0 |
| xylenes | 0 | 0 | 0 |
| arsenic | 1.1E-05 | 4.3E-02 | 0.016 |
| beryllium | 3.1E-07 | 1.2E-03 | 0.00044 |
| cadmium | 4.8E-06 | 1.9E-02 | 0.0068 |
| chromium | 1.1E-05 | 4.3E-02 | 0.016 |
| cobalt | 0 | 0 | 0 |
| lead | 1.4E-05 | 5.5E-02 | 0.020 |

| *HAPs* [4] | (lb/MMBtu) | (lb/hr) | (ton/yr) |
|---|---|---|---|
| manganese | 7.9E-04 | 3.11 | 1.12 |
| mercury | 1.2E-06 | 4.7E-03 | 0.0017 |
| nickel | 4.6E-06 | 1.8E-02 | 0.0065 |
| selenium | 2.5E-05 | 9.9E-02 | 0.035 |
| TOTAL HAPs | | 4.31 | 1.55 |

[1]Maximum potential operating hours not including SUSD was used to estimate emissions.

[2]Emission factors provided by vendor. The maximum emissions rate from all available operating scenarios was used to calculate maximum potential emissions.

[3]Emission factor for $CO_2$ provided by vendor. Emission factors for $CH_4$ and $N_2O$ obtained from 40 CFR 98.

[4]HAP emission factors obtained from EPA's AP-42, Tables 3.1-4 and 3.1-5 and reflect control level of 30% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from the vendor.

Renovo Energy Center
Startup and Shutdown Operations Emissions Data
Natural Gas Firing

| SUSD Parameter | Amount per Event - GE Provided | Pro-Rated Amount per Hour | Amount per Event with Time Increase[1] |
|---|---|---|---|
| **Cold Start** | | | |
| Time from Ignition until Compliance (minutes) | 45 | -- | 60 |
| Fuel Consumed (lb) | 39,451 | 52,602 | 52,602 |
| Fuel Consumed (MMBtu LHV) | 840 | 1,120 | 1,120 |
| Fuel Consumed (MMBtu HHV) | 931 | 1,242 | 1,242 |
| Maximum Potential NOx Emissions (lb) | 123.0 | 164.0 | 164.0 |
| Maximum Potential CO Emissions (lb) | 699.0 | 932.0 | 932.0 |
| Maximum Potential VOC Emissions (lb) | 53.0 | 70.7 | 70.7 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 8.3 | 11.1 | 11.1 |
| **Warm Start** | | | |
| Time from Ignition until Compliance (minutes) | 40 | -- | 55 |
| Fuel Consumed (lb) | 38,277 | 57,416 | 52,631 |
| Fuel Consumed (MMBtu LHV) | 815 | 1,223 | 1,121 |
| Fuel Consumed (MMBtu HHV) | 904 | 1,355 | 1,242 |
| Maximum Potential NOx Emissions (lb) | 81.0 | 121.5 | 111.4 |
| Maximum Potential CO Emissions (lb) | 190.0 | 285.0 | 261.3 |
| Maximum Potential VOC Emissions (lb) | 24.0 | 36.0 | 33.0 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 7.3 | 11.0 | 10.0 |
| **Hot Start** | | | |
| Time from Ignition until Compliance (minutes) | 20 | -- | 35 |
| Fuel Consumed (lb) | 15,264 | 45,792 | 26,712 |
| Fuel Consumed (MMBtu LHV) | 325 | 975 | 569 |
| Fuel Consumed (MMBtu HHV) | 360 | 1,081 | 631 |
| Maximum Potential NOx Emissions (lb) | 53.0 | 159.0 | 92.8 |
| Maximum Potential CO Emissions (lb) | 177.0 | 531.0 | 309.8 |
| Maximum Potential VOC Emissions (lb) | 22.0 | 66.0 | 38.5 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 4.0 | 12.0 | 7.0 |
| **Shutdown from 50% load** | | | |
| Time to Shutdown (minutes) | 12 | -- | 27 |
| Fuel Consumed (lb) | 9,393 | 46,966 | 21,135 |
| Fuel Consumed (MMBtu LHV) | 200 | 1,000 | 450 |
| Fuel Consumed (MMBtu HHV) | 222 | 1,109 | 499 |
| Maximum Potential NOx Emissions (lb) | 14.0 | 70.0 | 31.5 |
| Maximum Potential CO Emissions (lb) | 152.0 | 760.0 | 342.0 |
| Maximum Potential VOC Emissions (lb) | 19.0 | 95.0 | 42.8 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 3.0 | 15.0 | 6.8 |

| Annual Totals[2] | | |
|---|---|---|
| Total SUSD Operating Hour Limitation Per Unit: | 460 | hrs |
| Total Annual SUSD Fuel Consumption Per Unit: | 25,302,027 | lbs |
| Total Annual SUSD Heat Input Per Unit: | 538,731 | MMBtu LHV |
| Total Annual SUSD Heat Input Per Unit: | 597,305 | MMBtu HHV |
| Total Maximum Potential NOx Emissions Per Unit: | 25.2 | tons |
| Total Maximum Potential CO Emissions Per Unit: | 90.8 | tons |
| Total Maximum Potential VOC Emissions Per Unit: | 11.4 | tons |
| Total Maximum Potential $PM_{10/2.5}$ Emissions Per Unit: | 2.7 | tons |

Renovo Energy Center
Startup and Shutdown Operations Emissions Data
ULSD Firing

| SUSD Parameter | Amount per Event - GE Provided | Pro-Rated Amount per Hour | Amount per Event with Time Increase[1] |
|---|---|---|---|
| **Cold Start** | | | |
| Time from Ignition until Compliance (minutes) | 45 | -- | 60 |
| Fuel Consumed (lb) | 54,208 | 72,277 | 72,277 |
| Fuel Consumed (MMBtu LHV) | 992 | 1,323 | 1,323 |
| Fuel Consumed (MMBtu HHV) | 1,100 | 1,466 | 1,466 |
| Maximum Potential NOx Emissions (lb) | 221.0 | 294.7 | 294.7 |
| Maximum Potential CO Emissions (lb) | 704.0 | 938.7 | 938.7 |
| Maximum Potential VOC Emissions (lb) | 141.0 | 188.0 | 188.0 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 36.0 | 48.0 | 48.0 |
| **Warm Start** | | | |
| Time from Ignition until Compliance (minutes) | 40 | -- | 55 |
| Fuel Consumed (lb) | 54,645 | 81,967 | 75,137 |
| Fuel Consumed (MMBtu LHV) | 1,000 | 1,500 | 1,375 |
| Fuel Consumed (MMBtu HHV) | 1,109 | 1,663 | 1,525 |
| Maximum Potential NOx Emissions (lb) | 172.0 | 258.0 | 236.5 |
| Maximum Potential CO Emissions (lb) | 286.0 | 429.0 | 393.3 |
| Maximum Potential VOC Emissions (lb) | 33.0 | 49.5 | 45.4 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 32.0 | 48.0 | 44.0 |
| **Hot Start** | | | |
| Time from Ignition until Compliance (minutes) | 20 | -- | 35 |
| Fuel Consumed (lb) | 18,579 | 55,738 | 32,514 |
| Fuel Consumed (MMBtu LHV) | 340 | 1,020 | 595 |
| Fuel Consumed (MMBtu HHV) | 377.0 | 1,131 | 660 |
| Maximum Potential NOx Emissions (lb) | 112.0 | 336.0 | 196.0 |
| Maximum Potential CO Emissions (lb) | 273.0 | 819.0 | 477.8 |
| Maximum Potential VOC Emissions (lb) | 30.0 | 90.0 | 52.5 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 16.0 | 48.0 | 28.0 |
| **Shutdown from 50% load** | | | |
| Time to Shutdown (minutes) | 8 | -- | 23 |
| Fuel Consumed (lb) | 7,213 | 54,098 | 20,738 |
| Fuel Consumed (MMBtu LHV) | 132 | 990 | 380 |
| Fuel Consumed (MMBtu HHV) | 146 | 1,098 | 421 |
| Maximum Potential NOx Emissions (lb) | 43.0 | 322.5 | 123.6 |
| Maximum Potential CO Emissions (lb) | 48.0 | 360.0 | 138.0 |
| Maximum Potential VOC Emissions (lb) | 7.0 | 52.5 | 20.1 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 10.0 | 75.0 | 28.8 |

| Annual Totals[2] | | |
|---|---|---|
| Total SUSD Operating Hour Limitation Per Unit: | 40 | hrs |
| Total Annual SUSD Fuel Consumption Per Unit: | 3,092,896 | lbs |
| Total Annual SUSD Heat Input Per Unit: | 56,600 | MMBtu LHV |
| Total Annual SUSD Heat Input Per Unit: | 62,755 | MMBtu HHV |
| Total Maximum Potential NOx Emissions Per Unit: | 5.4 | tons |
| Total Maximum Potential CO Emissions Per Unit: | 8.4 | tons |
| Total Maximum Potential VOC Emissions Per Unit: | 1.0 | tons |
| Total Maximum Potential $PM_{10/2.5}$ Emissions Per Unit: | 1.1 | tons |

February 2020

Notes

[1] REC is proposing to add 15 minutes of margin to each SUSD scenario in order to allow operational flexibility in order to ensure that the SUSD can be completed in the permitted length of time. All heat input and emission parameters have been pro-rated for the increased time.

[2] Annual totals are based on warm starts and the corresponding amount of shutdowns. For the natural gas scenarios, 460 hours of SUSD corresponds to 308.5 hours of warm starts and 151.5 hours of shutdowns. For the ULSD scenarios, 40 hours of SUSD corresponds to 28.2 hours of warm starts and 11.8 hours of shutdowns.

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

NOx: 1-hour Averaging Period

| SUSD Scenario | Natural Gas[1] | | | | ULSD[2] | | | |
|---|---|---|---|---|---|---|---|---|
| | Cold Start | Warm Start | Hot Start | Shut Down | Cold Start | Warm Start | Hot Start | Shut Down |
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| NOx per event (lb) | 164.00 | 111.38 | 92.75 | 31.50 | 294.67 | 236.50 | 196.00 | 123.63 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Low Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 10.70 | | *Operating Point #7* | | 31.90 | | *Operating Point #14* | |
| Stack Temperature (°F) | 166.9 | | | | 251.2 | | | |
| Exhaust Flow Rate (acfm) | 836,983 | | | | 1,152,033 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 33.30 | | *Operating Point #19* | | 59.60 | | *Operating Point #8* | |
| Stack Temperature (°F) | 180.5 | | | | 291.5 | | | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Steady State Average Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 22 | | | | 45.75 | | | |
| Stack Temperature (°F) | 173.7 | | | | 271.35 | | | |
| Exhaust Flow Rate (acfm) | 1,287,408 | | | | 1,630,267 | | | |
| Remaining Duration of Hour (minutes) | 0 | 5 | 25 | 33 | 0 | 5 | 25 | 37 |
| SS Contribution (lb) | 0.00 | 1.83 | 9.17 | 12.10 | 0.00 | 3.81 | 19.06 | 28.21 |
| Hourly Emission Rate for Modeling (lb/hr) | 164.00 | 113.21 | 101.92 | 43.60 | 294.67 | 240.31 | 215.06 | 151.84 |
| Average Stack Temperature for Modeling (°F) | 174.00 | 173.98 | 173.88 | 173.84 | 270.00 | 270.11 | 270.56 | 270.83 |
| Average Flow Rate for Modeling (acfm) | 942,329 | 971,086 | 1,086,112 | 1,132,123 | 1,190,426 | 1,227,079 | 1,373,693 | 1,461,661 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

NOx: Annual Averaging Period

| Operating Point[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS NG Emission Rate (lb/hr) | 25.6 | 23.4 | 25.7 | 25.1 | 13.3 | 11 | 10.7 | 33.3 | 29.7 | 32.7 | 31.8 | 33.3 |
| SS NG Duration (hrs) | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 |
| Maximum SS ULSD Emission Rate (lb/hr) | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 |
| Maximum SS ULSD Duration (hrs) | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 |
| Maximum NG SUSD Emission Rate (lb/hr) | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 |
| Maximum NG SUSD Duration (hrs) | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 |
| Maximum ULSD SUSD Emission Rate (lb/hr) | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 |
| Maximum ULSD SUSD Duration (hrs) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Hourly Emission Rate for Modeling (lb/hr) | 36.89 | 35.00 | 36.98 | 36.46 | 26.30 | 24.32 | 24.07 | 43.52 | 40.42 | 43.00 | 42.23 | 43.52 |

[1]The stack temperature and flow rate from each operating point as numbered in the raw data will be used for these scenarios, as the majority of the duration (~86%) is spent at that operating point.

Renovo Energy Center

Startup and Shutdown Emission Parameters for Modeling Purposes

Natural Gas and ULSD Firing

CO: 1-hour Averaging Period

| | Natural Gas[1] | | | | ULSD[2] | | | |
|---|---|---|---|---|---|---|---|---|
| SUSD Scenario | Cold Start | Warm Start | Hot Start | Shut Down | Cold Start | Warm Start | Hot Start | Shut Down |
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| CO per event (lb) | 932.00 | 261.25 | 309.75 | 342.00 | 938.67 | 393.25 | 477.75 | 138.00 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Low Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 4.20 | | | | 9.70 | | | |
| Stack Temperature (°F) | 166.9 | | *Operating Point #7* | | 251.2 | | *Operating Point #14* | |
| Exhaust Flow Rate (acfm) | 836,983 | | | | 1,152,033 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 19.30 | | | | 18.10 | | | |
| Stack Temperature (°F) | 180.5 | | *Operating Point #19* | | 291.5 | | *Operating Point #8* | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Steady State Average Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 11.75 | | | | 13.9 | | | |
| Stack Temperature (°F) | 173.7 | | | | 271.35 | | | |
| Exhaust Flow Rate (acfm) | 1,287,408 | | | | 1,630,267 | | | |
| Remaining Duration of Hour (minutes) | 0 | 5 | 25 | 33 | 0 | 5 | 25 | 37 |
| SS Contribution (lb) | 0.00 | 0.98 | 4.90 | 6.46 | 0.00 | 1.16 | 5.79 | 8.57 |
| Hourly Emission Rate for Modeling (lb/hr) | 932.00 | 262.23 | 314.65 | 348.46 | 938.67 | 394.41 | 483.54 | 146.57 |
| Average Stack Temperature for Modeling (°F) | 174.00 | 173.98 | 173.88 | 173.84 | 270.00 | 270.11 | 270.56 | 270.83 |
| Average Flow Rate for Modeling (acfm) | 942,329 | 971,086 | 1,086,112 | 1,132,123 | 1,190,426 | 1,227,079 | 1,373,693 | 1,461,661 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

CO: 8-hour Averaging Period

| SUSD Scenario | Natural Gas[1] Cold Start | Natural Gas[1] Warm Start | Natural Gas[1] Hot Start | Natural Gas[1] Shut Down | ULSD[2] Cold Start | ULSD[2] Warm Start | ULSD[2] Hot Start | ULSD[2] Shut Down |
|---|---|---|---|---|---|---|---|---|
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| CO per event (lb) | 932.00 | 261.25 | 309.75 | 342.00 | 938.67 | 393.25 | 477.75 | 138.00 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 19.3 | | *Operating Point #19* | | 18.1 | | *Operating Point #8* | |
| Stack Temperature (°F) | 180.5 | | | | 291.5 | | | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Remaining Duration of Hour (minutes) | 420 | 425 | 445 | 453 | 420 | 425 | 445 | 457 |
| SS Contribution (lb) | 135.10 | 136.71 | 143.14 | 145.72 | 126.70 | 128.21 | 134.24 | 137.86 |
| Hourly Emission Rate for Modeling (lb/hr) | 133.39 | 49.74 | 56.61 | 60.96 | 133.17 | 65.18 | 76.50 | 34.48 |
| Average Stack Temperature for Modeling (°F) | 179.69 | 179.76 | 180.03 | 180.13 | 288.81 | 289.04 | 289.93 | 290.47 |
| Average Flow Rate for Modeling (acfm) | 1,638,395 | 1,646,682 | 1,679,828 | 1,693,086 | 1,993,741 | 2,003,304 | 2,041,557 | 2,064,509 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Summary of Worst-Case Maximum Potential Annual Emissions Scenario
Powerblocks- Turbines, HRSGs

| | | |
|---|---|---|
| ULSD Normal Operating Hours: | 720 | each powerblock |
| ULSD SUSD Operating Hours: | 40 | each powerblock |
| Natural Gas Normal Operating Hours: | 7,540 | each powerblock |
| Natural Gas SUSD Operating Hours: | 460 | each powerblock |
| Total Operating Hours: | 8,760 | each powerblock |

| Pollutant | Annual Emissions from ULSD Firing[1] (tons) | Annual Emissions from ULSD SUSD[2] (tons) | Annual Emissions from NG Firing[3] (tons) | Annual Emissions from Natural Gas SUSD[4] (tons) | Total Maximum Potential Annual Emissions from Both Powerblocks (tons) | Total Maximum Potential Annual Emissions from Each Powerblock (tons) |
|---|---|---|---|---|---|---|
| NOx | 42.91 | 10.75 | 251.08 | 50.42 | 355.17 | 177.58 |
| CO | 13.03 | 16.70 | 145.52 | 181.52 | 356.78 | 178.39 |
| $PM_{10}$ | 34.70 | 2.10 | 169.65 | 5.47 | 211.92 | 105.96 |
| VOC | 7.49 | 2.00 | 78.42 | 22.82 | 110.73 | 55.36 |
| $SO_2$ | 5.04 | 0.28 | 45.99 | 2.16 | 53.48 | 26.74 |
| $NH_3$ | 20.87 | 1.16 | 243.84 | 11.50 | 277.36 | 138.68 |
| $H_2SO_4$ | 3.17 | 0.18 | 30.69 | 1.37 | 35.40 | 17.70 |
| *GHGs* | | | | | | |
| $CO_2$ | 520,344 | 28,908 | 4,644,640 | 219,604 | 5,413,496 | 2,706,748 |
| $CH_4$ | 18.76 | 1.04 | 58.86 | 3.59 | 82.26 | 41.13 |
| $N_2O$ | 3.75 | 0.21 | 5.89 | 0.36 | 10.21 | 5.10 |
| $CO_{2equivalent}$ | 521,931 | 28,996 | 4,647,866 | 219,801 | 5,418,594 | 2,709,297 |
| *HAPs* | | | | | | |
| 1,3-butadiene | 0.032 | 0.0018 | 0.0057 | 0.00035 | 0.040 | 0.020 |
| acetaldehyde | 0 | 0 | 0.53 | 0.033 | 0.56 | 0.28 |
| acrolein | 0 | 0 | 0.085 | 0.0052 | 0.09 | 0.045 |
| benzene | 0.11 | 0.0061 | 0.17 | 0.010 | 0.29 | 0.15 |
| dichlorobenzene | 0 | 0 | 0.0049 | 0 | 0.0049 | 0.0025 |

Renovo Energy Center
Summary of Worst-Case Maximum Potential Annual Emissions Scenario
Powerblocks- Turbines, HRSGs

| Pollutant | Annual Emissions from ULSD Firing[1] (tons) | Annual Emissions from ULSD SUSD[2] (tons) | Annual Emissions from NG Firing[3] (tons) | Annual Emissions from Natural Gas SUSD[4] (tons) | Total Maximum Potential Annual Emissions from Both Powerblocks (tons) | Total Maximum Potential Annual Emissions from Each Powerblock (tons) |
|---|---|---|---|---|---|---|
| ethyl benzene | 0 | 0 | 0.43 | 0.026 | 0.45 | 0.23 |
| formaldehyde | 0.37 | 0.021 | 4.46 | 0.21 | 5.06 | 2.53 |
| hexane | 0 | 0 | 7.36 | 0 | 7.36 | 3.68 |
| naphthalene | 0.070 | 0.0039 | 0.020 | 0.0011 | 0.09 | 0.047 |
| PAH | 0.079 | 0.0044 | 0.029 | 0.0018 | 0.11 | 0.057 |
| POM | 0 | 0 | 0.00036 | 0 | 0.00036 | 0.00018 |
| propylene oxide | 0 | 0 | 0.39 | 0.024 | 0.41 | 0.20 |
| toluene | 0 | 0 | 1.74 | 0.11 | 1.85 | 0.92 |
| xylenes | 0 | 0 | 0.86 | 0.053 | 0.92 | 0.46 |
| arsenic | 0.031 | 0.0017 | 0.0015 | 0 | 0.034 | 0.017 |
| beryllium | 0.00088 | 0.000049 | 0.000089 | 0 | 0.0010 | 0.00051 |
| cadmium | 0.014 | 0.00076 | 0.0082 | 0 | 0.023 | 0.011 |
| chromium | 0.031 | 0.0017 | 0.010 | 0 | 0.043 | 0.022 |
| cobalt | 0 | 0 | 0.00062 | 0 | 0.00062 | 0.00031 |
| lead | 0.040 | 0.0022 | 0 | 0 | 0.042 | 0.021 |
| manganese | 2.24 | 0.12 | 0.0028 | 0 | 2.37 | 1.18 |
| mercury | 0.0034 | 0.00019 | 0.0019 | 0 | 0.0055 | 0.0028 |
| nickel | 0.013 | 0.00073 | 0.016 | 0 | 0.029 | 0.015 |
| selenium | 0.071 | 0.0039 | 0.00018 | 0 | 0.075 | 0.038 |
| TOTAL HAPs | 3.11 | | 16.12 | | 19.87 | 9.93 |

[1]Annual Emissions from ULSD Firing based on 720 nornal operating hours on ULSD for each powerblock.

[2]Annual Emissions from ULSD SUSD based on 40 SUSD hours per powerblock when firing ULSD, using emission rates for Warm Starts and Shutdowns for emissions of NOx, CO, PM, and VOC. All other pollutant emissions based on the maximum emission rate for all operating loads when firing ULSD.

[3]Annual Emissions from Natural Gas Firing based on 7,540 normal operating hours firing natural gas in the CT and DB for each powerblock.

[4]Annual Emissions from Natural Gas SUSD based on 460 SUSD hours per powerblock when firing natural gas, using emission rates for Warm Starts and Shutdowns for emissions of NOx, CO, PM, and VOC. All other pollutant emissions based on the maximum emission rate for all operating loads when firing natural gas.

Renovo Energy Center
Determination of Maximum Potential Emissions
Auxiliary Boilers

Two natural gas fired auxiliary boilers

| | | | |
|---|---|---|---|
| Maximum heat input capacity: | 66 | MMBtu/hr | per boiler |
| Equivalent to: | 64,706 | scf/hr | per boiler |
| Maximum proposed annual heat input per boiler: | 145,200 | MMBtu/yr | |
| Equivalent to: | 2,200 | hours at 100% load | |
| Maximum annual heat input total: | 290,400 | MMBtu/yr | total |
| Maximum fuel input per boiler: | 142 | MMcf/yr | |

| Pollutant | Emission Factor (lb/MMBtu) | Maximum Potential Emission Rate per Boiler (lb/hr) | Maximum Potential Emissions for One Boiler (tpy) | Total Maximum Potential Emissions (tpy) |
|---|---|---|---|---|
| NOx | 0.0060 | 0.40 | 0.44 | 0.87 |
| CO | 0.036 | 2.38 | 2.61 | 5.23 |
| $PM_{10}$ | 0.0019 | 0.13 | 0.14 | 0.28 |
| VOC | 0.0020 | 0.13 | 0.15 | 0.29 |
| $SO_2$ | 0.00058 | 0.038 | 0.042 | 0.084 |
| $H_2SO_4$ | 9.0E-05 | 0.0059 | 0.0065 | 0.013 |
| $NH_3$ | negligible | | --- | --- |
| GHGs | (kg/MMBtu) | | (tpy) | (tpy) |
| $CO_2$ | 53.06 | | 8,474.74 | 16,949.49 |
| $CH_4$ | 1.00E-03 | | 0.16 | 0.32 |
| $N_2O$ | 1.00E-04 | | 0.016 | 0.032 |
| $CO_{2e}$ | -- | | 8,483.50 | 16,966.99 |

| HAPs | Emission Factor (lb/MMcf) | Maximum Potential Emission Rate per Boiler (lb/hr) | Maximum Potential Emissions for One Boiler (tpy) | Total Maximum Potential Emissions (tpy) |
|---|---|---|---|---|
| benzene | 2.10E-03 | 1.36E-04 | 1.5E-04 | 0.00030 |
| formaldehyde | 7.50E-02 | 4.85E-03 | 5.3E-03 | 0.011 |
| hexane | 1.8 | 1.16E-01 | 1.3E-01 | 0.26 |
| naphthalene | 6.10E-04 | 3.95E-05 | 4.3E-05 | 0.000087 |
| toluene | 3.40E-03 | 2.20E-04 | 2.4E-04 | 0.00048 |
| POM | 8.82E-05 | 5.71E-06 | 6.3E-06 | 0.000013 |
| Total HAP emissions: | | 0.12 | 0.13 | 0.27 |

Emission factors for NOx, CO, and VOC are vendor estimates and/or LAER/BACT limits.

Emission factors for PM and HAPs are based on AP-42, Section 1.4. PM factor is for filterable portion only (1.9 lb/MMcf/1,020 Btu/cf = 0.0019 lb/MMBtu)

Emission factor for $SO_2$ and $H_2SO_4$ are based on RBLC database entries for BACT/BAT

Emission factors for $CO_2$, $CH_4$ and $N_2O$ are provided by Tables C-1 and C-2 of 40 CFR Part 98 - Mandatory Reporting of Greenhouse Gases

Renovo Energy Center
Determination of Emission Rates for Modeling Purposes
Auxiliary Boilers

Two natural gas fired auxiliary boilers

| | | |
|---|---|---|
| Maximum potential heat input per boiler: | 145,200 | MMBtu/year per boiler |
| Maximum potential operating hours: | 2,200 | hours per boiler |

| | | 100% Load | 75% Load | 50% Load |
|---|---|---|---|---|
| Heat Input Rate (MMBtu/hr) | | 66 | 49 | 33 |
| Exhaust Flow Rate (lb/hr) | | 60,293 | 45,058 | 30,003 |
| Exhaust Flow Rate (acfm) | | 20,313 | 14,801 | 9,617 |
| Stack Temperature (°F) | | 301 | 282 | 264 |
| Pollutant | Emission Factor (lb/MMBtu) | Emissions per Boiler (lb/hr) | Emissions per Boiler (lb/hr) | Emissions per Boiler (lb/hr) |
| NOx | 0.0060 | 0.396 | 0.294 | 0.196 |
| CO | 0.036 | 2.376 | 1.764 | 1.174 |
| $PM_{10/2.5}$ | 0.0019 | 0.125 | 0.0931 | 0.0619 |
| $SO_2$ | 0.00058 | 0.0383 | 0.0284 | 0.0189 |

Emission Rates for Annual Averaging Period

| Pollutant | Emission Rate (lb/hr) |
|---|---|
| NOx | 0.0995 |
| CO | 0.597 |
| $PM_{10/2.5}$ | 0.0315 |
| $SO_2$ | 0.00961 |

Renovo Energy Center
Determination of Maximum Potential Emissions
Diesel Engines

Emergency Generator

| | | |
|---|---|---|
| Maximum rating: | 1500 | kW |
| | 2206 | hp |
| Maximum operating hours: | 500 | hr |
| Maximum fuel firing rate: | 104.6 | gal/hr |
| Maximum heat input rate: | 14.33 | MMBtu/hr |

| Pollutant | Tier 2 Emission Factor (g/hp-hr) | Emission Rate (lb/hr) | Maximum Potential Emissions (tpy) |
|---|---|---|---|
| NOx | 4.48 | 21.79 | 5.45 |
| CO | 1.23 | 5.98 | 1.50 |
| $PM_{10}$ | 0.13 | 0.63 | 0.16 |
| VOC | 0.80 | 3.89 | 0.97 |
| $SO_2$[1] | --- | 0.022 | 0.0055 |

Emission rates for NOx, CO, and $PM_{10}$ are based on EPA Weighted Emissions Calculator for Constant Speed Engines - 40 CFR 89, Table 2 of Appendix B to Section E.

VOC emission rate is based on maximum calculated emission rate provide by CAT for a 3512C engine.

$SO_2$ emissions are based on ultra low diesel fuel not to exceed 15 ppm sulfur.

[1](15 lb S/ $10^6$ lb fuel) ( 64 lb $SO_2$/32 lb S) (7 lb/gal) ( gal/137,000 Btu) (14.33 MMBtu/hr) = 0.022 lb $SO_2$/hr

Fire Pump Engine

| | | |
|---|---|---|
| Maximum rating: | 237 | hp |
| Maximum operating hours: | 250 | hr |
| Maximum fuel firing rate: | 12 | gal/hr |
| Maximum firing rate: | 1.64 | MMBtu/hr |

| Pollutant | Emission Factor (g/hp-hr) | Emission Rate (lb/hr) | Maximum Potential Emissions (tpy) |
|---|---|---|---|
| NOx | 2.7 | 1.41 | 0.18 |
| CO | 0.9 | 0.47 | 0.059 |
| $PM_{10}$ | 0.10 | 0.052 | 0.0065 |
| VOC | 0.10 | 0.052 | 0.0065 |
| $SO_2$[1] | --- | 0.0025 | 0.00032 |

Emissions for NOx, CO, VOC, and $PM_{10}$ are based on vendor data

$SO_2$ emissions are based on ultra low diesel fuel not to exceed 15 ppm sulfur.

[1](15 lb S/ $10^6$ lb fuel) ( 64 lb $SO_2$/32 lb S) (7 lb/gal) ( gal/137,000 Btu) (1.75 MMBtu/hr) = 0.003 lb $SO_2$/hr

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| HAP Emissions[1] | Emission Factor (lb/MMBtu) | Maximum Potantial Generator Emissions (tpy) | Maximum Potential Fire Pump Emissions (tpy) | Combined Maximum Potential Emissions (tpy) |
|---|---|---|---|---|
| benzene | 9.33E-04 | 3.34E-03 | 1.92E-04 | 3.53E-03 |
| toluene | 4.09E-04 | 1.47E-03 | 8.40E-05 | 1.55E-03 |
| xylene | 2.85E-04 | 1.02E-03 | 5.86E-05 | 1.08E-03 |
| 1,3 butadiene | 3.91E-05 | 1.40E-04 | 8.04E-06 | 1.48E-04 |
| formaldehyde | 1.18E-03 | 4.23E-03 | 2.42E-04 | 4.47E-03 |
| acetaldehyde | 7.67E-04 | 2.75E-03 | 1.58E-04 | 2.91E-03 |
| acrolein | 9.25E-05 | 3.31E-04 | 1.90E-05 | 3.50E-04 |
| naphthalene | 8.48E-05 | 3.04E-04 | 1.74E-05 | 3.21E-04 |
| Total | | 1.36E-02 | 7.79E-04 | 1.44E-02 |

[1]HAP emission factors are based on AP-42, Section 3.

Renovo Energy Center
Determination of Emission Rates for Modeling Purposes
Diesel Engines

Emergency Generator

| Parameter | 100% Load |
|---|---|
| Genset Power (kW) | 1,500 |
| Engine Power (bhp) | 2,206 |
| Fuel Consumption (gal/hr) | 104.6 |
| Heat Input Rate (MMBtu/hr) | 14.33 |
| Exhaust Flow Rate (acfm) | 11,734.1 |
| Exhaust Temperature (°F) | 756.6 |
| **Pollutant Emissions** | **(lb/hr)** |
| NOx | 21.788 |
| CO | 5.982 |
| $PM_{10/2.5}$ | 0.632 |
| $SO_2$ | 0.0220 |
| **Pollutant Emissions for Annual Averaging Period** | **(lb/hr)** |
| NOx | 1.244 |
| CO | 0.341 |
| $PM_{10/2.5}$ | 0.0361 |
| $SO_2$ | 0.00125 |

Fire Pump Engine

| Parameter | 100% Load |
|---|---|
| Engine Power (hp) | 237 |
| Fuel Consumption (gal/hr) | 12.0 |
| Heat Input Rate (MMBtu/hr) | 1.64 |
| Exhaust Flow Rate (acfm) | 1,189 |
| Exhaust Temperature (°F) | 986 |
| **Pollutant Emissions** | **(lb/hr)** |
| NOx + VOC | 1.411 |
| CO | 0.470 |
| $PM_{10}$ | 0.0522 |
| $SO_2$ | 0.00252 |
| **Pollutant Emissions for Annual Averaging Period** | **(lb/hr)** |
| NOx | 0.0403 |
| CO | 0.0134 |
| $PM_{10}$ | 0.00149 |
| $SO_2$ | 0.0000719 |

Renovo Energy Center
Determination of Maximum Potential Emissions
Heaters

Two natural gas water bath heaters (located 1.25 miles from site at pressure reducing station)

Maximum heat input capacity (each): 15 MMBtu/hr

Maximum potential operating hours: 8,760 hours

*Note: Site will be equipped with three heaters. Third heater is for standby/redundancy only. Only two heaters will be operated at the same time.*

| Pollutant | Emission Factor (lb/MMBtu) | Maximum Potential Emission Rate per Unit (lb/hr) | Combined Maximum Potential Emissions (tpy) |
|---|---|---|---|
| NOx | 0.011 | 0.17 | 1.45 |
| CO | 0.037 | 0.56 | 4.86 |
| $PM_{10}$ | 0.0019 | 0.029 | 0.25 |
| VOC | 0.0050 | 0.075 | 0.66 |
| $SO_2$ | 0.00058 | 0.0087 | 0.076 |
| $NH_3$ | negligible | | --- |
| GHGs | (kg/MMBtu) | | (tpy) |
| $CO_2$ | 53.06 | | 15,338.58 |
| $CH_4$ | 1.00E-03 | | 0.29 |
| $N_2O$ | 1.00E-04 | | 0.029 |
| $CO_{2e}$ | -- | | 15,354.43 |

| HAPs | Emission Factor (lb/MMcf) | Maximum Potential Emissions (tpy) |
|---|---|---|
| benzene | 2.10E-03 | 2.7E-04 |
| formaldehyde | 7.50E-02 | 0.0097 |
| hexane | 1.8 | 0.23 |
| naphthalene | 6.10E-04 | 7.9E-05 |
| toluene | 3.40E-03 | 0.00044 |
| POM | 8.82E-05 | 1.1E-05 |

Total HAP emissions: 0.24

Emission factors for NOx, CO, VOC, $PM_{10}$ and $SO_2$ are based on RBLC database entries for BACT/BAT

Emission factors for HAPs are based on AP-42, Section 1.4.

Emission factors for $CO_2$, $CH_4$ and $N_2O$ are provided by Tables C-1 and C-2 of 40 CFR Part 98 - Mandatory Reporting of Greenhouse Gases

Renovo Energy Center
Determination of Maximum Potential Emissions
Heaters

One natural gas dew point heater

| | | |
|---|---|---|
| Maximum heat input capacity: | 2.96 | MMBtu/hr |
| Maximum potential operating hours: | 8,760 | hours |

*Since heater is exempt from permitting (natural gas, less than 10 MMBtu/hr), BAT/BACT/LAER emission rates are not required. Emissions are provided for inclusion in facility-wide potential emissions.*

| Pollutant | Emission Factor (lb/MMcf) | Potential Emissions (tpy) |
|---|---|---|
| NOx | 100 | 1.27 |
| CO | 84 | 1.07 |
| $PM_{10}$ | 1.9 | 0.024 |
| VOC | 5.5 | 0.070 |
| $SO_2$ | 0.6 | 0.0076 |
| $NH_3$ | negligible | --- |
| GHGs | (kg/MMBtu) | (tpy) |
| $CO_2$ | 53.06 | 1,513.41 |
| $CH_4$ | 1.00E-03 | 0.029 |
| $N_2O$ | 1.00E-04 | 0.0029 |
| $CO_{2e}$ | -- | 1,514.97 |

| HAPs | Emission Factor (lb/MMcf) | Maximum Potential Emissions (tpy) |
|---|---|---|
| benzene | 2.10E-03 | 2.7E-05 |
| formaldehyde | 7.50E-02 | 9.5E-04 |
| hexane | 1.8 | 2.3E-02 |
| naphthalene | 6.10E-04 | 7.8E-06 |
| toluene | 3.40E-03 | 4.3E-05 |
| POM | 8.82E-05 | 1.1E-06 |

Total HAP emissions: 0.024

Emission factors for criteria pollutants and HAPs are based on AP-42, Section 1.4.
Emission factors for $CO_2$, $CH_4$ and $N_2O$ are provided by Tables C-1 and C-2 of 40 CFR Part 98 - Mandatory Reporting of Greenhouse Gases

Renovo Energy Center
Determination of Emission Rates for Modeling Purposes
Dew Point Heater

| | | |
|---|---|---|
| Maximum heat input capacity: | 2.96 | MMBtu/hr |
| Maximum NG flow rate: | 2,902 | scf/hr |

| Operating Load: | 100% | 75% | 50% |
|---|---|---|---|
| Exhaust Flow Rate (acfm): | 1,371.0 | 1,028.3 | 685.5 |
| Exhaust Temperature (°F): | 842 | 842 | 842 |
| NOx Emissions (lb/hr): | 0.290 | 0.218 | 0.145 |
| CO Emissions (lb/hr): | 0.244 | 0.183 | 0.122 |
| $PM_{10/2.5}$ Emissions (lb/hr): | 0.00551 | 0.00414 | 0.00276 |
| $SO_2$ Emissions (lb/hr): | 0.00174 | 0.00131 | 0.000871 |

| SIZE | DWG NO | SH | REV |
|---|---|---|---|
| **A** | | **1** | **C** |

THIS DOCUMENT SHALL BE REVISED IN ITS ENTIRETY ALL SHEETS OF THIS DOCUMENT ARE THE SAME REVISION LEVEL AS INDICATED IN THE REVISION BLOCK

REVISIONS

| REV | DESCRIPTION | DATE (dd-mmm-yyyy) | APPROVED |
|---|---|---|---|
| - | Preliminary Issue | 01-Oct-2019 | A. Dicke |
| A | Preliminary Issue | 08-Oct-2019 | A. Dicke |
| B | Preliminary Issue | 22-Nov-2019 | A. Dicke |
| C | Preliminary Issue | 11-Dec-2019 | A. Dicke |

# Combined Cycle Systems

# Combined Cycle Systems Emissions Estimates

**7HA.02**



| SIGNATURES | | DATE (dd-mmm-yyyy) |
|---|---|---|
| PREPARED BY | Mike Boisclair | 01-Oct-2019 |
| SYSTEM ENGINEER | n/a | 01-Oct-2019 |
| PROJECT ENGINEER | n/a | 01-Oct-2019 |
| ISSUED | Andrew Dicke | 01-Oct-2019 |

**GE Power**

GENERAL ELECTRIC COMPANY
GENERAL ELECTRIC INTERNATIONAL, INC.
POWER PLANT SYSTEMS

**Renovo**

MADE FOR: IPS # 1270381 — MDL - T218

FIRST MADE FOR: Renovo

| | | | |
|---|---|---|---|
| SIZE **A** | CAGE CODE **NONE** | DWG NO | |
| SCALE **NONE** | | SHEET | 1 |

DT-7N

Non-Public
GE Proprietary Information

## Drawing Revision Status

| Revision | Date | Description |
|---|---|---|
| - | 01-Oct-2019 | Initial issue |
| A | 08-Oct-2019 | Additional cases |
| B | 22-Nov-2019 | Reduce VOC |
| C | 11-Dec-2019 | Reduce CO/VOC increased ULSD Stack Temp |

## Combined Cycle Systems Emissions Estimates: Renovo

| | | | | |
|---|---|---|---|---|
| **Operating Point** | | **1** | **2** | **3** |
| Case Description | | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% |
| **Ambient Conditions** | | | | |
| Ambient Temperature | °F | -20.0 | 95.8 | 59.0 |
| Ambient Pressure | psia | 14.350 | 14.350 | 14.350 |
| Ambient Relative Humidity | % | 60 | 35 | 60 |
| **Gas Turbine** | | | | |
| GT Fuel Type | | Gas | Gas | Gas |
| GT load fraction | - | 1 | 1 | 1 |
| Evap Cooler status | | off | off | On |
| Gas turbine water injection flow rate | klb/h | 0.0 | 0.0 | 0.0 |
| **Plant Performance (not guaranteed)** | | | | |
| CC Net Plant output | kW | 516571 | 482965 | 533150 |
| **Abatement Status** | | | | |
| CO Catalyst Operating status | | Operating | Operating | Operating |
| SCR Operating status | | Operating | Operating | Operating |
| **GT Fuel** | | | | |
| Gas Turbine fuel LHV | Btu/lb | 21292 | 21292 | 21292 |
| Gas Turbine fuel HHV | Btu/lb | 23607 | 23607 | 23607 |
| Gas Turbine gas fuel molecular weight | lb/lbmole | 16.52 | 16.52 | 16.52 |
| Gas Turbine sulfur ppm (by mass) | ppm | 13.1 | 13.1 | 13.1 |
| **Duct Burner** | | | | |
| Duct Burner fuel LHV | Btu/lb | 21292 | 21292 | 21292 |
| Duct Burner fuel HHV | Btu/lb | 23607 | 23607 | 23607 |
| Duct Burner fuel molecular weight | lb/lbmole | 16.52 | 16.52 | 16.52 |
| Duct Burner fuel sulfur content (by mass) | ppm | 13.1 | 13.1 | 13.1 |
| Duct Burner status | | Off | Off | Off |
| Duct Burner gas fuel flow | lb/h | 0.0 | 0.0 | 0.0 |
| Duct Burner load fraction | % | 0.0 | 0.0 | 0.0 |
| **Heat Consumption for permitting (per unit)** | | | | |
| GT Heat Cons (HHV), with permitting margin | MMBtu/h | 3523.8 | 3230.1 | 3541.1 |
| DB Heat Cons (HHV) | MMBtu/h | 0.0 | 0.0 | 0.0 |
| **HRSG Exit Exhaust gas (per unit)** | | | | |
| Stack N2 mole fraction | - | 0.7474 | 0.7326 | 0.7374 |
| Stack O2 mole fraction | - | 0.1149 | 0.1115 | 0.1108 |
| Stack AR mole fraction | - | 0.0089 | 0.008724 | 0.008781 |
| Stack H2O mole fraction | - | 0.0852 | 0.1039 | 0.09875 |
| Stack CO2 mole fraction | - | 0.04344 | 0.04314 | 0.04418 |
| Stack Molecular Weight | lb/lbmole | 28.42 | 28.21 | 28.28 |
| Stack Temperature | °F | 185.2 | 190.5 | 181.4 |
| Stack Mass flow, including Permitting Margin, per stack | lb/h | 6111200 | 5598900 | 6007200 |
| Margined exhaust vol flow (incl. permitting margin) | Mft3/h | 103.7 | 96.501 | 101.85 |
| Normalized vol flow, SCF @ 60F (incl. permitting margin) | SCF/h | 81604464 | 75312253 | 80617252 |
| **HRSG Exit Emissions (per unit)** | | | | |
| NOx Volume fraction, dry, at 15 % O2 | ppm | 2 | 2 | 2 |
| NOx mass flow rate (as NO2) | lb/h | 25.6 | 23.4 | 25.7 |
| CO Volume fraction, dry, at 15 % O2 | ppm | 1.3 | 1.3 | 1.3 |
| CO mass flow rate | lb/h | 10.1 | 9.3 | 10.2 |
| VOC Volume fraction, dry, at 15 % O2 | ppm | 0.7 | 0.7 | 0.7 |
| VOC mass flow rate (as methane) | lb/h | 3.1 | 2.9 | 3.1 |
| NH3 Volume fraction, dry, at 15 % O2 | ppm | 5 | 5 | 5 |
| NH3 mass flow rate | lb/h | 23.7 | 21.7 | 23.8 |
| SOx mass flow rate (as SO2) | lb/h | 4.7 | 4.3 | 4.7 |
| Total Particulates | lb/h | 11.3 | 11.1 | 11.3 |
| Sulfur Mist as H2SO4 | lb/h | 2.6 | 2.4 | 2.7 |
| Stack CO2 mass flow rate, including Permitting margin | lb/h | 432000 | 396000 | 434000 |
| Stack CO2 rate (per Net Plant CC Power per stack) | lb/MWh | 836 | 819 | 813 |

**The notes page is an integral part of this document and must be reviewed prior to use of this data.**

| 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|
| 1 GT @ 100% | 1 GT @ 38% load, | 1 GT @ 30% load, | 1 GT @ 32% load, | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 60% load, |
| 95.8 | -0.7 | 59.0 | 95.8 | -20.0 | 35.0 | 59.0 | 95.8 | -0.7 |
| 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 |
| 35 | 60 | 60 | 35 | 60 | 60 | 60 | 35 | 60 |
| Gas | Gas | Gas | Gas | Liquid | Liquid | Liquid | Liquid | Liquid |
| 1 | 0.38 | 0.3 | 0.32 | 1 | 1 | 1 | 1 | 0.6 |
| On | off | off | off | off | off | off | off | off |
| 0.0 | 0.0 | 0.0 | 0.0 | 260.8 | 266.4 | 266.4 | 249.8 | 151.8 |
| 516252 | 241852 | 194994 | 184161 | 521793 | 528537 | 524694 | 484380 | 344384 |
| Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| 21292 | 21292 | 21292 | 21292 | 18300 | 18300 | 18300 | 18300 | 18300 |
| 23607 | 23607 | 23607 | 23607 | 20130 | 20130 | 20130 | 20130 | 20130 |
| 16.52 | 16.52 | 16.52 | 16.52 | n.a. | n.a. | n.a. | n.a. | n.a. |
| 13.1 | 13.1 | 13.1 | 13.1 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 |
| 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 |
| 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 |
| 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 |
| Off | Off | Off | Off | Off | Off | Off | Off | Off |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3459.2 | 1837.7 | 1516.3 | 1470.6 | 3940.4 | 3892.8 | 3848.4 | 3588.7 | 2646.6 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7266 | 0.75 | 0.7445 | 0.7377 | 0.7058 | 0.7001 | 0.6947 | 0.6889 | 0.7147 |
| 0.1086 | 0.1233 | 0.126 | 0.1262 | 0.09819 | 0.09532 | 0.09332 | 0.09369 | 0.1035 |
| 0.008653 | 0.008932 | 0.008865 | 0.008785 | 0.008406 | 0.008338 | 0.008274 | 0.008205 | 0.008511 |
| 0.1122 | 0.07808 | 0.0831 | 0.09079 | 0.1243 | 0.132 | 0.1391 | 0.1459 | 0.1121 |
| 0.04381 | 0.03958 | 0.03744 | 0.03641 | 0.06314 | 0.06407 | 0.06444 | 0.06312 | 0.06111 |
| 28.13 | 28.46 | 28.39 | 28.29 | 28.27 | 28.19 | 28.12 | 28.03 | 28.38 |
| 194.0 | 163.1 | 160.3 | 166.9 | 291.5 | 284.5 | 280.0 | 288.3 | 259.6 |
| 5885500 | 3505200 | 3050800 | 3032500 | 6366300 | 6181400 | 6059300 | 5751100 | 4436300 |
| 102.28 | 57.353 | 49.823 | 50.219 | 126.51 | 122.01 | 119.19 | 114.76 | 84.074 |
| 79407236 | 46734218 | 40781904 | 40670910 | 85461030 | 83198246 | 81767914 | 77853532 | 59317047 |
| 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 |
| 25.1 | 13.3 | 11.0 | 10.7 | 59.6 | 58.9 | 58.2 | 54.3 | 40.0 |
| 1.3 | 1.3 | 1.3 | 1.3 | 2 | 2 | 2 | 2 | 2 |
| 9.9 | 5.3 | 4.4 | 4.2 | 18.1 | 17.9 | 17.7 | 16.5 | 12.2 |
| 0.7 | 0.7 | 0.7 | 0.7 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| 3.1 | 1.6 | 1.3 | 1.3 | 10.4 | 10.3 | 10.1 | 9.5 | 7.0 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 23.2 | 12.3 | 10.2 | 9.9 | 27.6 | 27.2 | 26.9 | 25.1 | 18.5 |
| 4.6 | 2.4 | 2.0 | 2.0 | 7.0 | 7.0 | 6.9 | 6.4 | 4.7 |
| 11.3 | 9.97 | 9.72 | 9.68 | 48.2 | 48.2 | 48.1 | 47.9 | 46.8 |
| 2.6 | 1.4 | 1.1 | 1.1 | 4.0 | 3.9 | 3.9 | 3.6 | 2.7 |
| 424000 | 225000 | 186000 | 180000 | 657000 | 649000 | 642000 | 598000 | 441000 |
| 821 | 931 | 953 | 979 | 1259 | 1228 | 1223 | 1235 | 1282 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|
| 1 GT @ 50% load, | 1 GT @ 50% load, | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% | 1 GT @ 100% |
| 59.0 | 95.8 | -20.0 | 95.8 | 59.0 | 95.8 | -20.0 | 59.0 | 95.8 |
| 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 | 14.350 |
| 60 | 35 | 60 | 35 | 60 | 35 | 60 | 60 | 35 |
| Liquid | Liquid | Gas | Gas | Gas | Gas | Gas | Liquid | Liquid |
| 0.5 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| off | off | off | off | On | On | off | On | On |
| 120.1 | 109.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 266.4 | 254.2 |
| 293649 | 267593 | 626058 | 572742 | 630208 | 612004 | 627850 | 533260 | 515753 |
| Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| 18300 | 18300 | 21292 | 21292 | 21292 | 21292 | 21292 | 18300 | 18300 |
| 20130 | 20130 | 23607 | 23607 | 23607 | 23607 | 23607 | 20130 | 20130 |
| n.a. | n.a. | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | n.a. | n.a. |
| 15.0 | 15.0 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 15.0 | 15.0 |
| 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 | 21292 |
| 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 | 23607 |
| 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 |
| 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 |
| Off | Off | Operating | Operating | Operating | Operating | Operating | Off | Off |
| 0.0 | 0.0 | 42441.2 | 34804.6 | 38413.1 | 37201.3 | 42584.9 | 0.0 | 0.0 |
| 0.0 | 0.0 | 99.7 | 81.7 | 90.2 | 87.4 | 100.0 | 0.0 | 0.0 |
| 2258.0 | 2109.7 | 3523.8 | 3230.1 | 3541.1 | 3459.2 | 3523.8 | 3914.6 | 3824.7 |
| 0.0 | 0.0 | 1001.9 | 821.6 | 906.8 | 878.2 | 1005.3 | 0.0 | 0.0 |
| 0.7113 | 0.7071 | 0.738 | 0.7244 | 0.7289 | 0.7184 | 0.738 | 0.6938 | 0.6862 |
| 0.103 | 0.1052 | 0.08825 | 0.08783 | 0.08635 | 0.0846 | 0.08816 | 0.09297 | 0.09254 |
| 0.008471 | 0.008422 | 0.008788 | 0.008626 | 0.008679 | 0.008554 | 0.008788 | 0.008263 | 0.008172 |
| 0.1163 | 0.1205 | 0.1092 | 0.125 | 0.1206 | 0.1335 | 0.1093 | 0.1402 | 0.1496 |
| 0.06083 | 0.05857 | 0.05561 | 0.05397 | 0.05533 | 0.05478 | 0.05565 | 0.06453 | 0.0634 |
| 28.33 | 28.26 | 28.26 | 28.08 | 28.14 | 27.99 | 28.26 | 28.11 | 28.00 |
| 243.4 | 251.2 | 172.8 | 178.6 | 176.3 | 182.2 | 180.5 | 281.3 | 293.8 |
| 3795900 | 3674700 | 6155800 | 5635400 | 6047500 | 5924500 | 6155900 | 6152600 | 6093500 |
| 70.446 | 69.122 | 103.01 | 95.811 | 102.23 | 101.6 | 104.27 | 121.29 | 122.65 |
| 50841652 | 49342122 | 82648206 | 76168205 | 81561950 | 80322126 | 82651739 | 83061790 | 82598636 |
| 4 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 4 |
| 34.1 | 31.9 | 33.3 | 29.7 | 32.7 | 31.8 | 33.3 | 59.2 | 57.8 |
| 2 | 2 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 2 | 2 |
| 10.4 | 9.7 | 19.2 | 17.2 | 18.9 | 18.4 | 19.3 | 18.0 | 17.6 |
| 2.0 | 2.0 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 2.0 | 2.0 |
| 6.0 | 5.6 | 10.4 | 9.3 | 10.3 | 10.0 | 10.4 | 10.3 | 10.1 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 15.8 | 14.8 | 30.8 | 27.5 | 30.2 | 29.5 | 30.8 | 27.4 | 26.8 |
| 4.0 | 3.8 | 6.1 | 5.4 | 6.0 | 5.8 | 6.1 | 7.0 | 6.8 |
| 46.4 | 46.3 | 22.5 | 20.3 | 21.5 | 21.1 | 22.5 | 48.2 | 48.1 |
| 2.3 | 2.1 | 3.7 | 3.3 | 3.7 | 3.6 | 3.7 | 3.9 | 3.9 |
| 377000 | 352000 | 560000 | 501000 | 550000 | 536000 | 560000 | 653000 | 638000 |
| 1283 | 1315 | 894 | 874 | 872 | 876 | 892 | 1224 | 1236 |

## Estimated Steady State Emission Notes

### HRSG Emission Notes:

1. Gas turbine(s) and steam plant are in steady-state operation.
2. Steady State Emissions data above are estimated values based on GE recommended measurements and analysis procedures, per GEK 28172.
3. Reference conditions for exhaust gas SCF are: 68°F, and 14.6959 psia.
4. Reference conditions for gas fuel SCF are: 60°F, and 14.6959 psia.
5. $SO_2$ emission values have been estimated by assuming that all the sulfur in the fuel is converted to $SO_2$.
6. Consistent with previous emission calculations, the $SO_2$ and sulfur mist emission values are based on maximum sulfur content of 13.1 ppm (0.4 grains/100 scf) for gas and 15 ppm for liquid fuel.
7. $SO_2$ and sulfur mist values are margined by 20 % to account for variation in fuel sulfur content and measurement error.
8. The $CO_2$ estimate derived from the heat rate does not include any margin for measurement errors assuming that the compliance will be demonstrated using the heat rate from the performance test results. If $CO_2$ compliance is to be demonstrated using actual $CO_2$ measurements from the HRSG stack, GE recommends adding 10% margin to the estimated values.
9. Sulfur mist emission calculations conservatively assume that all $SO_3$ combines with water to form sulfur mist. In actuality, some $SO_3$ may form other chemical species. This would include ammonium sulfates in the presence of $NH_3$. The maximum sulfur mist is reported to be conservative.
10. The estimated values for heat consumption and exhaust flows are margined in this document to account for equipment variations, site operating conditions, and life-cycle operating parameters.The Plant Performance section does not include permitting margin, for more information on performance please refer to the Heat Balance.
11. Distillate oil fuel-bound nitrogen is less than or equal to 0.015 % by weight.

### Additional Notes for Particulate Emissions

1. Particulate Matter estimates over the entire emissions compliance region of GT operation are based on field data obtained at base load for the GT. In reality, particulate matter emissions measured in lb/h are expected to decrease at part load operation and the lb/MMBTU values at part load operation are expected not to exceed the lb/MMBTU value for PM at baseload.
2. $PM_{10}$ and $PM_{2.5}$ are estimated at the same rate as Total Particulates.
3. Consistent with previous emission calculations, the PM estimates are based on maximum S content in the fuel of 13.1 ppm (0.4 grains/100 scf) for gas fuel and 15 ppm for liquid fuel.

# Combined Cycle Startup/Shutdown Emissions for 207HA.02, Rapid Response Lite October 2019

| Per GT/HRSG Stack | NOx | CO | VOC as Methane | Total PM NOTE 5 | Heat Consumption | Duration |
|---|---|---|---|---|---|---|
| Cold Start (Table Note 1) | 123 | 699 | 53 | 8.3 | 840 | 45 |
| Warm Start (48 hrs median) **See Below Table Note 2** | 81 | 190 | 24 | 7.3 | 815 | 40 |
| Hot Start (Table Note 1) | 53 | 177 | 22 | 4.0 | 325 | 20 |
| Shutdown | 14 | 152 | 19 | 3 | 200 | 12 |
| | Pounds [lb] per Event | | | | MMBtu | Minutes |

**Table 1: 7HA.02, Natural Gas Fuel**

| Per GT/HRSG Stack | NOx | CO | VOC as Methane | Total PM NOTE 5 | Heat Consumption | Duration |
|---|---|---|---|---|---|---|
| Cold Start (Table Note 1) | 221 | 704 | 141 | 36 | 992 | 45 |
| Warm Start (48 hrs median) **See Below Table Note 2** | 172 | 286 | 33 | 32 | 1000 | 40 |
| Hot Start (Table Note 1) | 112 | 273 | 30 | 16 | 340 | 20 |
| Shutdown | 43 | 48 | 7 | 10 | 132 | 8 |
| | Pounds [lb] per Event | | | | MMBtu | Minutes |

**Table 2: 7HA.02, Distillate Oil Fuel**

Table Notes:

(1) Hot starts are defined as taking place within 8 hours of the previous shutdown. Cold starts are preceded by over 72 hours of shutdown. Cold Start and Hot Start values can be used for both typical estimates and not-to-exceed permit limits.

(2) **WARM START PERMITTING NOTE** – Warm Start cool down duration ranges from >8 to <72 hours after shutdown. The Warm Start emissions will vary depending on duration of the cool down period ranging between the Hot Start and Cold Start values. Warm Start values in Table 1 are based on a 48 hours cool down period as a median point. Warm Starts with less than a 48 hours cool down period will have lower emissions and Warm Starts with a greater than 48 hours cool down period will have higher emissions. For Warm Start emission estimates, the 48 hours median value

should be used. For Warm Start not-to-exceed permit limits, the Cold Start values should be used.

**End Table 1 & 2**

**Basis**

1. The table above represents the emissions during startup and shutdown events.
2. Emissions assume no contribution from pollutants present in the GT inlet air.

**Notes specific for Natural Gas**

3. An average HRSG stack temperature of 174 deg F may be assumed during starts and shutdown when the LP economizer is in service. An average HRSG stack temperature of 214 deg F may be assumed during starts and shutdown when the LP economizer is bypassed.
4. Emissions assume methane as the natural gas fuel in compliance with General Electric Gas Fuel Specification GEI-41040.
5. Particulates emissions account for sulfates resulting from 0.4gr/100SCF total fuel sulfur content. Higher fuel sulfur content will increase particulate emissions.
6. During the start-up event, an average HRSG stack flow rate of 960 lb/second may be assumed.

**Notes specific for Liquid Fuel**

7. An average HRSG stack temperature of 270 deg F may be assumed during starts and shutdown when the LP economizer is bypassed.
8. Liquid Fuel is assumed to be in compliance with General Electric Liquid Fuel Specification GEI 41047 and is assumed to have 0.015% fuel bound nitrogen or less.
9. Particulate emissions account for sulfates resulting from 15 ppmw total fuel sulfur content. Higher fuel sulfur content will increase particulate emissions.
10. During the start-up event, an average HRSG stack flow rate of 1050 lb/second may be assumed.

**General Notes**

11. The information is based on a GE designed and supplied extended scope power plant. Design, manufacture, construction, and commissioning of equipment outside of this scope of supply such as auxiliary boiler must meet GE functional requirements.
12. Event duration: Startup is from the time a non-zero value is measured at the HRSG stack (of a pollutant which is guaranteed) to the time of compliance. Emission compliance is verified by 10 subsequent consecutive compliant CEMS readings however this is only a verification measurement and not counted as part of startup emission mass or duration.

Shutdown is from the time that the HRSG stack is out of emissions compliance until the time that the GT fuel valve has closed.

13. There is OpFlex SCR Ammonia control, which optimizes ammonia injection and the resulting transient emissions during the startup transient. For this, ammonia vaporizer is assumed to be electrically pre-heated and ready to inject ammonia at GT fire.
14. NOx and CO Emissions are per HRSG stack and measured at the HRSG stack using CEMS, following the CEMs calibration and commissioning. Emissions concentration (ppm) signal from the HRSG stack CEMS at 15-second or smaller sampling intervals will be converted to emissions mass flow (lb/hr) using a mutually agreed upon method per the emissions test protocol.
15. The plant is started using GE's Rapid Response Lite auto-start sequence. Prior to start, the plant is in a ready-to-start condition, i.e. all plant equipment which is needed to be operating during startup is in a no-fault condition, operational and/or in automatic mode. Water levels and pressures in drums, hotwell and other vessels are within range and/or not in an alarmed condition. GT and HRSG Purge credit are available.
16. The plant is previously shut down from steady state operation at base load using normal shutdown sequence in accordance with General Electric's recommendations. The duration of the shutdown/non-operational/standby period for the purpose of defining the start begins at termination of fuel flow to the GT during the plant shutdown. During the standby period, the plant is maintained as per GE-recommended procedures.
17. The GT is kept at MECL load level until stack compliance is achieved.
18. HRSG drum steam is not bled off for auxiliary services, steam seals, etc. during shutdown.
19. HRSG stack damper remains closed during the shutdown period.
20. No steam purity holds are included. No sequence holds or rate reductions caused by operator intervention are allowed.
21. Turbine insulation and enclosures are installed per GE acceptance of drawings and instructions.
22. A GT start-up fuel heater is applied and the GT is kept at MECL load level until HRSG stack compliance is achieved.

**End of Startup and Shutdown Estimates**

Andrew Dicke

| Revision | Date | Purpose |
|---|---|---|
| - | 10/21/2019 | Initial Issue |
| A | 11/22/2019 | Reduced VOC emissions |

# APPENDIX C BEEST TEST CASE DOCUMENTATION

# AERMOD 19191 Test Cases

## Overview

Providence Engineering and Environmental Group LLC (Providence) sells the BEEST Suite software, which is used to run the AERMET and AERMOD models. The AERMOD model executable included in BEEST Suite 12.01 (aermod.exe) is not the executable that the United States Environmental Protection Agency (EPA) provides to modelers. The AERMOD model executable is a 64-bit executable that Providence compiled with the Intel Fortran compiler version 18.0.5. The AERMET model executable included in BEEST Suite 12.01 (aermet19191.exe) is a 64-bit executable that Providence compiled with the Intel Fortran compiler version 18.0.5.

Providence downloaded the test cases for AERMOD 19191 and the 64-bit executable for AERMOD 19191 from the EPA website.

## Running the test cases

The test cases were run on a Dell Latitude E6430 laptop which has the 64-bit Windows 7 Professional Service Pack 1 operating system installed. The CPU on the laptop is an Intel(R) Core(TM) i7-3740QM CPU with four cores. The amount of memory on the laptop is 8 GB.

There are five folders with input and output files for AERMOD 19191:

- aermet_def_18081_aermod_19191
- aermet_def_19191_aermod_19191
- aermet_ustar_18081_aermod_19191
- aermet_ustar_19191_aermod_19191
- MAXDCONT_Tests

Providence ran the AERMOD 19191 executable three times for all five folders. The EPA AERMOD model executable was used for the first run. The Providence AERMOD model executable was used for the second run and the third run.

AERMET files provided by EPA were used for the first run and the second run. These files are located in the meteorology subfolder of the first four folders and the Inputs subfolder of the MAXDCONT_Tests folder. AERMET files created by running the Providence AERMET model executable were used for the third run.

The steps for running AERMOD 19191 in the aermet_def_19191_aermod_19191 folder were:

1. Copied the aermet_def_19191_aermod_19191 folder to the C:\EPA test cases\AERMOD\19191 folder.
2. Opened the file runtests_AERMOD.bat in Notepad, changed line 6 (the basedir variable is set on line 6) and saved the file runtests_AERMOD.bat.
3. Made a copy of the meteorology subfolder and renamed the new subfolder meteorology_EPA.
4. Made a copy of the meteorology subfolder and renamed the new subfolder meteorology_Providence.
5. Copied AERMET files created by running the Providence AERMET model executable to the meteorology_Providence subfolder.
6. Copied the EPA AERMOD model executable to the inputs subfolder.
7. Double-clicked the file runtests_AERMOD.bat.
8. Made a copy of the Outputs subfolder and renamed the new subfolder Outputs_run1.
9. Copied the Providence AERMOD model executable to the inputs subfolder.
10. Double-clicked the file runtests_AERMOD.bat.
11. Made a copy of the Outputs subfolder and renamed the new subfolder Outputs_run2.
12. Copied AERMET files from the meteorology_Providence subfolder to the meteorology subfolder.
13. Double-clicked the file runtests_AERMOD.bat.
14. Made a copy of the Outputs subfolder and renamed the new subfolder Outputs_run3.

The steps for running AERMOD 19191 in the other four folders were similar to the steps for the aermet_def_19191_aermod_19191 folder.

## Test results

After running the test cases, Providence looked at the .SUM output files in the Outputs_run1, Outputs_run2 and Outputs_run3 subfolders for all five folders.

Providence copied the concentrations and receptor locations for each source group and averaging period from the .SUM output files to a spreadsheet. Formulas were then added to the spreadsheet to compare the concentrations and receptor locations in the Outputs_run2 and Output_run3 subfolders with the concentrations and receptor locations in the Output_run1 subfolder.

- There are four rows in the spreadsheet where the receptor locations in the Output_run2 and Output_run3 subfolders are different from the receptor locations in the Output_run1 folder. The concentrations in these four rows are the same in all three subfolders.
- The receptor locations are identical in the Output_run1, Output_run2 and Output_run3 subfolders for all other source groups and averaging periods.
- The maximum difference between the concentrations in the Output_run2 folder and the concentrations in the Output_run1 folder is 0.0004 percent.
- The maximum difference between the concentrations in the Output_run3 folder and the concentrations in the Output_run1 folder is 0.0004 percent.

# APPENDIX D METEOROLOGICAL MONITORING PLAN

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF AIR QUALITY

May 14, 2015

Mr. Louis M. Militana, QEP
Principal Consultant/Partner
Ambient Air Quality Services, Inc.
107 Hidden Fox Drive
Suite 101A
Lincoln University, PA 19352-1205

Re: DEP Acceptance of Meteorological Monitoring Plan
Renovo Energy Center, LLC
Proposed Renovo Energy Center, Renovo Borough, Clinton County

Dear Mr. Militana:

The Pennsylvania Department of Environmental Protection (DEP) has determined that the Renovo Energy Center, LLC (REC) meteorological monitoring plan[1] is acceptable. This determination is based on the DEP's review of the meteorological monitoring plan and a visit to the proposed meteorological monitoring site. The proposed location of the 20-meter meteorological tower and sodar, within the property of the proposed location of the Renovo Energy Center as described in the meteorological monitoring plan, is optimal. REC's meteorological monitoring plan provides adequate detail on the characteristics, siting, and exposure of the meteorological instruments and on the recording, processing, completeness requirements, reporting, and archiving of the data, consistent with the U.S. Environmental Protection Agency's (EPA) "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005, February 2000).

The DEP received a meteorological monitoring plan from Ambient Air Quality Services, Inc. (AAQS), on behalf of REC, on April 27, 2015, after meeting with representatives of REC at the proposed meteorological monitoring site on April 20, 2015. REC has proposed to conduct one year of meteorological monitoring to obtain data for use in air dispersion modeling to support a Plan Approval Application, subject to the Prevention of Significant Deterioration (PSD) rules, for the construction of the Renovo Energy Center, a natural gas-fired, combined cycle electric power generation facility. On May 7, 2015, the DEP provided written comments on the meteorological monitoring plan. On May 8, 2015, REC provided a written response to the DEP's comments, as well as a revised meteorological monitoring plan.

With adequate implementation of REC's meteorological monitoring plan, the measured and derived meteorological variables would yield a meteorological dataset that is consistent with the

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[1] Meteorological Monitoring Plan for the Renovo Energy Center Renovo, PA Plant Site. Prepared by Ambient Air Quality Services, Inc., Lincoln University, PA. Revised May 2015.

site specific data recommendations in subsection 8.3.3 of the EPA's "Guideline on Air Quality Models" (Guideline), codified in 40 CFR Part 51, Appendix W. Additionally, the resulting dataset would satisfy the meteorological data input requirements for the American Meteorological Society / Environmental Protection Agency Regulatory Model (AERMOD) listed in Appendix A, subsection A.1(b)(2) of the Guideline. Ultimately, the resulting meteorological dataset would allow AERMOD to appropriately characterize the transport and dispersion of projected emissions from the proposed Renovo Energy Center.

If you have any questions, you may contact me by e-mail at droble@pa.gov or by telephone at 717.705.7689. You may also contact Andrew Fleck, Chief of the Air Quality Modeling Section, by e-mail at afleck@pa.gov or by telephone at 717.783.9243.

Sincerely,

Daniel J. Roble

Daniel J. Roble
Air Quality Program Specialist
Air Quality Modeling Section
Division of Air Resource Management

cc: Tom Rolfson, Power Engineers
Tim Donnelly, Power Engineers
Richard Franzese, Bechtel
William Bousquet, Innovative Power Solutions
Joyce Epps, BAQ Director
Krishnan Ramamurthy, BAQ Division of Permits
Virendra Trivedi, BAQ New Source Review Section
Muhammad Zaman, NCRO Air Quality Program
Paul Waldman, NCRO Air Quality Program
Kirit Dalal, BAQ Division of Air Resource Management
Andrew Fleck, BAQ Air Quality Modeling Section
AQ Modeling Correspondence File

Ambient Air Quality Services, Inc.

May 8, 2015

Daniel Roble
Pennsylvania Department
of Environmental Protection
Bureau of Air Quality
P.O. Box 8468
Harrisburg, PA 17105-8468

**RE: Revised Onsite Meteorological Monitoring Plan**
**Renovo Energy Center, Renovo, PA Site**

Dear Mr. Roble:

Attached is the revised onsite meteorological monitoring plan for the proposed Renovo Energy Center (REC) in Renovo, PA.

The monitoring plan has been revised to incorporate the comments received from the PA DEP via email on May 7, 2015 on the initial monitoring plan submitted April 25, 2015. Also attached to this letter for reference are the PA DEP comments and our responses.

If the revised monitoring plan is acceptable to PA DEP please forward an approval letter to my attention.

Very truly yours,
**AAQS Inc.**

Louis M. Militana, QEP
Principal Consultant/Partner

107 Hidden Fox Drive, Suite 101A, Lincoln University, PA 19352-1205
Telephone (484) 224-6218/Voice/Fax
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R. Franzese w/copy
W. Bousquet w/o copy
T. Rolfson w/o copy
T. Donnelly w/o copy

**May 8, 2015**
**Response to DEP Comments on**
**Meteorological Monitoring Plan**
**Renovo Energy Center, LLC**

Comment 1 – Introduction

1. The meteorological monitoring plan references (in this section and again in subsection 6.1) an older 1995 version of the U.S. Environmental Protection Agency's (EPA) "Quality Assurance Handbook for Air Pollution Measurement Systems." The EPA updated this guidance document in March 2008. What revisions should be made to the meteorological monitoring plan, if any, so that it is consistent with the EPA's most recent 2008 guidance document?

**Response 1 – Introduction**

**The correct reference for Sections 1 and 6.1 is the Quality Assurance Handbook for Air Pollution Measurement Systems, March 2008. There are no required revisions to the meteorological monitoring plan for the corrected reference.**

Comment 2.2 – Site Location

2. In Table 2-1, the datum should be North American Datum of 1983 (NAD83), not 1988.

**Response 2.2 - Site Location**

**The correct datum referenced in Table 2-1 is North American Datum of 1983 (NAD83).**

3.2 – Monitoring Equipment

3. The meteorological monitoring plan does not include a brief description of the meteorological equipment and instrumentation for measuring relative humidity. Relative humidity is mentioned in subsection 2.1 and subsection 6.1.6.

**Response 3.2 – Monitoring Equipment**

**The relative humidity sensor is a capacitive thin-film polymer sensor consisting of a substrate on which a thin film of polymer is deposited between two conductive electrodes. The thin-film polymer either absorbs or releases water vapor as the relative humidity of the ambient air rises or falls. The dielectric properties of the polymer film depend on the amount of absorbed water. As the relative humidity around the sensor changes, the dielectric properties of the polymer film change, and so does the capacitance of the sensor. The instrument's electronics measure the capacitance of the sensor and convert it into a humidity reading.**

3.2.1 – Wind Speed Sensor

4. The meteorological monitoring plan should specify how many cups the cup anemometer will have for measuring the horizontal wind speed. Subsection 2.1.1 of the EPA's "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (MMG)

recommends a three cup anemometer.

**<u>Response 3.2.1 – Wind Speed Sensor</u>**

**The horizontal wind speed sensor will use a three cup anemometer.**

5. Table 3-1 should include specifications for the vertical wind speed sensor, as well as provide a comparison to the specifications listed in subsection 5.1 and subsection 5.2 of the MMG.

**<u>Response Table 3-1</u>**

**The EPA specifications for the vertical wind speed sensor and the selected sensor specifications are provided below.**

| Vertical Wind Speed Sensor Specification | Accuracy Measurement | Resolution | Starting Speed | Distance Constant |
|---|---|---|---|---|
| EPA | ± (0.2 m/s + 5% of observed) | 0.1 m/s | ≤ 0.25 m/s | ≤ 5 m |
| Selected Sensor | ± (0.2 m/s + 5% of observed) | 0.1 m/s | ≤ 0.25 m/s | 1 m |

<u>4.1 – Data Collection</u>

6. The meteorological monitoring plan should state that the DEP will be provided a copy of hourly data reports (which include the hourly data) on a quarterly basis within a specified time frame.

**<u>Response 4.1 Data Collection</u>**

**PA DEP will be provided a copy of the hourly data (in Excel spreadsheet format) within 30 days after the end of each calendar quarter**.

<u>6 – Quality Assurance/Control</u>

7. The meteorological monitoring plan should include a brief description of the audit procedures for the Doppler SODAR. Subsection 9.6 of the MMG provides guidance on quality assurance/quality control procedures for upper air measurement systems.

**<u>Response 7 – Quality Assurance/Control</u>**

**The planned audit procedure of the Doppler SODAR will follow the recommendation described in MMG Section 9.6.2.2 which is briefly provided below.**

**Comparison of the SODAR wind measurement will be made with data from the 20 meter level of the adjacent tall tower. The tower and SODAR data will be reviewed continuously throughout the monitoring program by AAQS's meteorologists. The tower data will be time averaged to correspond to the SODAR averaging interval.**

8. The meteorological monitoring plan should state that the DEP will be provided written notice (e.g., e-mail) prior to each audit within a specified time frame.

**<u>Response 8 – Quality Assurance/Control</u>**

**PA DEP will be given written notification of the planned performance audits within 1 month prior to each audit.**

9. The meteorological monitoring plan should state that the DEP will be provided a copy of all performance and technical systems audit reports within a specified time frame.

**<u>Response 9 – Quality Assurance/Control</u>**

**The performance audit reports will be submitted to PA DEP within 1 month of the completion of each audit.**

# METEOROLOGICAL MONITORING PLAN FOR THE RENOVO ENERGY CENTER RENOVO, PA PLANT SITE

**Prepared by:**
**Ambient Air Quality Services, Inc.**
**10 7 Hidden Fox Drive**
**Suite 101A**
**Lincoln University, PA 19352**

Ambient Air Quality Services, Inc.

**REVISED MAY 2015**

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# 1. INTRODUCTION

Renovo Energy Center, LLC (REC) proposes to construct a nominally rated 926 MW (net) natural gas combined cycle electric generating plant in Renovo, PA. The proposed REC facility will consist of two 1-on-1 power blocks consisting of a combustion turbine (CT) and a steam turbine to produce electricity for distribution into the transmission grid system. Each combined cycle system consists of a natural gas fired combustion turbine and a heat recovery steam generator (HRSG). The steam from the HRSGs is routed through the condensing steam turbine generator. With the exception of one OEM option, each HRSG has a gas fired duct burner (DB) for supplemental firing. The primary fuel for the plant is natural gas with oil as back up.

The proposed REC facility will also include for each power block an auxiliary boiler, an emergency generator, a turbine air inlet conditioner, a natural gas heater and an air cooled condenser. The REC will also have one fire water pump. The HRSG DBs, auxiliary boiler and fuel gas heater will primarily combust pipeline quality natural gas. The emergency firewater pump and emergency generator will combust ultra-low sulfur diesel fuel oil.

The construction of the power plant will require REC to prepare and submit an air quality Plan Approval Application including an air quality modeling analysis. In anticipation of the requirement for an air quality modeling analysis REC has undertaken a one year onsite meteorological monitoring program to collect the required meteorological data for regulatory air quality modeling purposes.

This document is a meteorological monitoring plan which describes the site, purpose, equipment, data collection methods and Quality Assurance/Quality Control procedures of the REC meteorological monitoring program. The monitoring plan has been developed to support the use of the meteorological data in a regulatory air quality modeling analysis by REC for the Renovo, PA site. REC plans to use the meteorological data in an air quality modeling analysis to support a Prevention of Significant Deterioration (PSD)/New Source Review (NSR) air permit application.

The meteorological monitoring program has been designed to meet or exceed all United States Environmental Protection Agency (USEPA) and Pennsylvania Department of Environmental Protection (PADEP) monitoring guidelines and requirements. All equipment selected for the monitoring program meets or exceeds the criteria for PSD monitoring programs. This monitoring plan was developed using the guidance in the “Ambient Monitoring Guidelines for Prevention of Significant Deterioration” (USEPA, 1987), the “Quality Assurance Handbook for Air Pollution Measurement Systems”, (USEPA 2008) and “Meteorological Monitoring Guidance for Regulatory Modeling Applications”, (USEPA February, 2000).

The remainder of the monitoring plan includes the following sections:

- Section 2 - Overview of the Monitoring Program
- Section 3 - Monitoring Parameters and Equipment
- Section 4 - Data Collection and Management Procedure
- Section 5 - Site Operations and Maintenance
- Section 6 - Quality Assurance/Quality Control Procedures
- Section 7 - Project Personnel

# 2. OVERVIEW OF MONITORING PROGRAM

## 2.1 PURPOSE AND OBJECTIVES

The purpose and objective of the meteorological monitoring program is to collect 12 months of onsite meteorological monitoring data to support the use of USEPA approved air quality models such as AERMOD in an air quality modeling analysis. The meteorological monitoring program has been designed to collect hourly meteorological parameters at or above stack release heights for the emission sources at the REC. The height for the combustion turbines' stacks are currently designed for approximately 250 ft. but may ultimately be slightly lower based upon final design of the plant.

The meteorological monitoring site was selected to satisfy the following USEPA siting and instrument exposure criteria and to collect meteorological measurements representative of the REC site including:

**Wind Speed and Direction:** Sensors for wind speed and wind direction should be located over level, open terrain at a height of 10 m above ground level and at a distance at least ten times the height of nearby obstructions. For elevated releases, additional measurements should be made at stack top or 100 m, whichever is lower.

**Ambient Temperature and Relative Humidity:** Temperature and relative humidity sensors should be mounted over a plot of open level ground at least 9 m in diameter. The ground surface should be covered with non-irrigated short grass. The standard height for the sensor is 1.5 to 2 m, but different heights may be used depending on the air quality study. Probe placement for temperature difference measurements depend on the application. For this application the temperatures will be measured at 2 and 20 meters. Temperature and relative humidity sensors should be shielded to protect them from thermal radiation and any significant heat sources or sinks and adequately ventilated using aspirated shields.

**Solar Radiation:** Pyranometers used for measuring incoming (solar) radiation should be located with an unrestricted 360 degree view of the sky without significant obstacles. The sensor should be placed so that shadows will not be cast onto the sensor. Sensor height is not critical for pyranometers; a tall platform or rooftop is an acceptable location.

**Net Radiation:** The ground cover under a net radiometer should be representative of the general site area. The given application will govern the collection of solar or net radiation data.

**Barometric Pressure**: The sensor should be placed where there is solid vertical mounting and will be protected against rough handling. The sensor should be shielded from direct sunshine.

## 2.2 SITE LOCATION

The Renovo Energy Center is located in Renovo Borough, Clinton County, PA approximately 28 miles (45 km) northwest of Lock Haven, PA along the West Branch Susquehanna River. The location of the REC site is shown in Figure 2-1. The location of the meteorological monitoring site and the site coordinates are presented in Figures 2-1 and Table 2-1, respectively. The topography of the area surrounding the Renovo Energy Center is considered

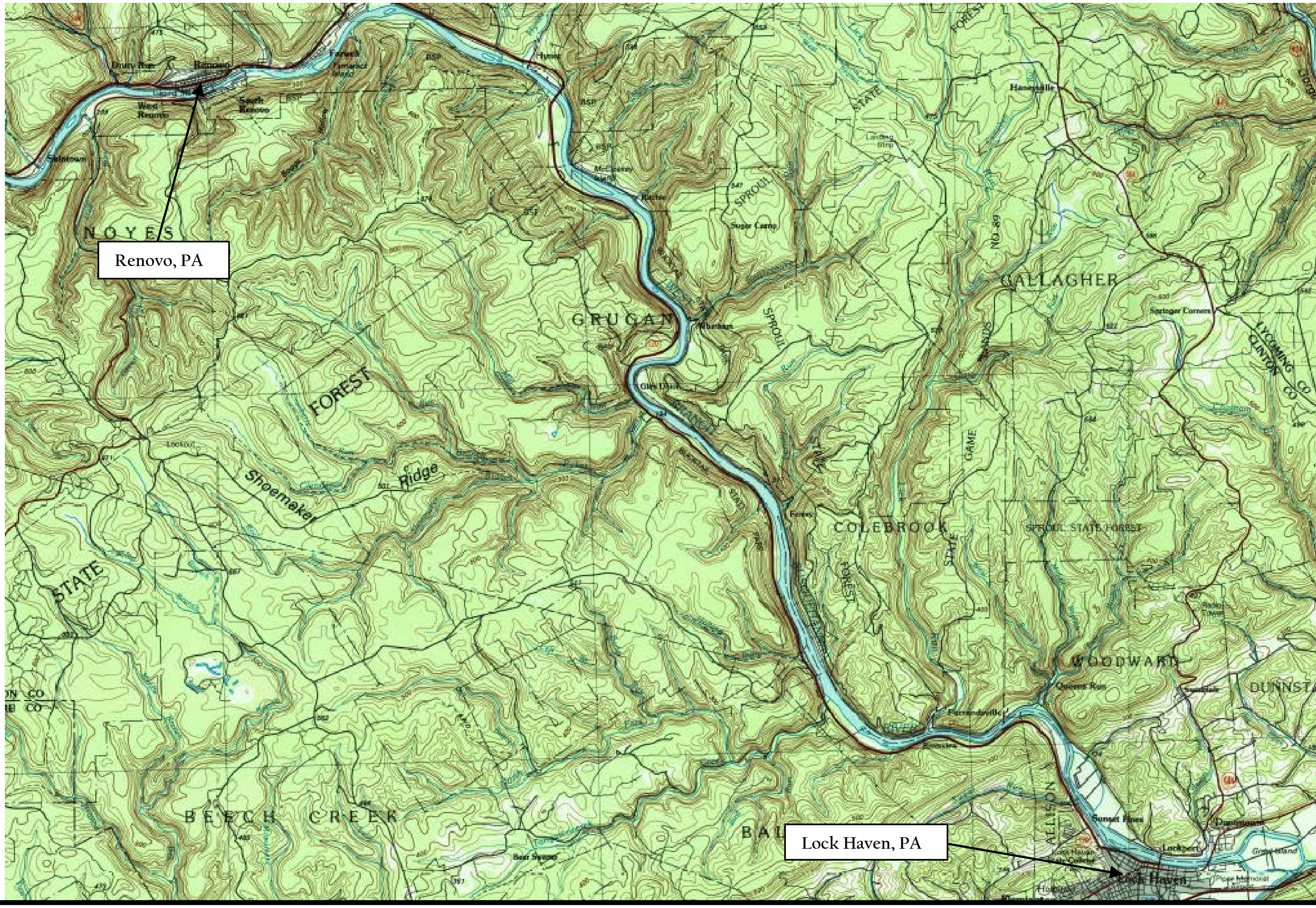


**Figure 2-1**
**Location of the Proposed Renovo Energy Center**
**Renovo, PA**


**Figure 2-2**
**Location of Meteorological Monitoring Site**

**Table 2-1**
**Coordinates for Renovo Energy Center**
**Renovo, PA**
**Meteorological Monitoring Site**

| | |
|---|---|
| Latitude | 41°19'42.42"N |
| Longitude | 77°45'18.44"W |
| UTM North meters | 4,578,881.488 |
| UTM East meters | 269,432.549 |
| Zone | 18 |
| Datum | 1983 |

complex terrain for air quality modeling purposes since the surrounding terrain exceeds the proposed combustion turbine stack height.

The elevations in the area range from approximately 700 feet above mean sea level (amsl) at the REC site to 2,000 ft. above mean sea level (amsl) on terrain within 2 miles south of the site. The highest terrain within 2 miles north of the site is approximately 1,700 ft. amsl. This information is based upon the United States Geological Survey (USGS) 1:24,000 scale topographic map of the area (Renovo West and Renovo East, 2013).

## 2.3 MONITORING STARTUP AND DURATION

Meteorological data collection is anticipated to begin in June 2015 and continue for at least 12 months.

# 3. MONITORING PARAMETERS AND EQUIPMENT

This section discusses the monitoring parameters and equipment of the Renovo Energy Center meteorological monitoring program.

## *3.1 MONITORING PARAMETERS*

The meteorological monitoring program will site consist of a 20 meter tower and a Doppler SODAR system. The meteorological tower will be instrumented to measure the following parameters:

- Horizontal and vertical wind speed and horizontal wind direction and temperature at 20-meters
- Temperature and barometric pressure at 2-meters
- Solar and net radiation at 1 meter

All equipment selected will meet or exceed the specifications for meteorological monitoring equipment in the "Meteorological Monitoring Guidance for Regulatory Modeling Applications, (USEPA, 2000). Table 3-1 provides a comparison of the monitoring sensor specifications with the USEPA criteria.

Photographs of the meteorological monitoring site from the north, east, south and west are shown in Figures 3-1 and 3-2. There were no trees, or other structures that will affect the monitoring location or exposure of the monitoring sensors. All wind sensors will be heated to avoid ice buildup during freezing precipitation events. The temperature sensors will be located in motor aspirated temperature shields.

In addition to the meteorological tower a REMTECH PA0 Doppler SODAR will be installed and operated. The SODAR will collect measurements of wind speed (horizontal and vertical) wind and direction every 30 meters starting at 20 meters and extending to at least 450 meters.

## *3.2 MONITORING EQUIPMENT*

A brief described of the principal of operation of the meteorological equipment and instrumentation is provided in this section.

### 3.2.1 Wind Speed Sensor

The horizontal and vertical wind speed sensors are cup and propeller anemometers, respectively, to produce a signal proportional to the wind speed. The horizontal wind speed sensor will use a three cup anemometer. The anemometer assemblies are shaft mounted on a frictionless transducer. The wind speed sensors will be heated to prevent freezing of the sensors. The horizontal and vertical wind speed sensors will meet or exceed the specification shown in Table 3-1.

### 3.2.2 Wind Direction Sensor

The wind direction sensor will use a wind vane to produce a signal proportional to the direction azimuth. The wind direction sensor will be heated to prevent freezing of the sensors. The wind direction sensor will meet or exceed the specification shown in Table 3-1.

### 3.2.3 Barometric Pressure

The barometric pressure sensor will be an electronic type using a silicon piezoresistive sensor and will be temperature compensating. The sensor will be installed inside a NEMA enclosure. The sensor will meet or exceed the specifications in Table 3-1.

### 3.2.4 Solar Sensors

The solar sensor will use photodiode detector to create a voltage output that is proportional to the incoming radiation (solar). The sensor will be mounted and leveled on the meteorological tower. The sensor will meet or exceed the specifications in Table 3-1.

### 3.2.5 Net Radiation Sensor

The net radiation sensor uses two black conical and is based on a thermopile sensor. The voltage is proportional to the net radiation. The sensor will be mounted and leveled on the meteorological tower. The sensor will meet or exceed the specifications in Table 3-1.

### 3.2.6 Temperature and Delta Temperature

The temperature sensors will be a thermistor bead in stainless steel. The sensor transfers heat rapidly yielding typical time constant of 3.6 seconds. The sensors will be housed inside motor aspirated temperature shields.

The temperature difference between 20 and 2 meters will be calculated by the data logger.

### 3.2.7 Meteorological Tower

The meteorological tower will be a 20 meter, multi-section, crank down and tiltable tower. A Rohn 55FK or equivalent tower will be installed.

### 3.2.8 Doppler SODAR

Doppler SODAR systems use Doppler shift technologies (frequency shift as a function of speed) to measure air movement as a function of the temperature discontinuity in the atmosphere. A Doppler SODAR system consists of antennas (speakers) that transmit and receive acoustic signals. A mono-static system uses the same antenna for transmitting and receiving and determines atmospheric scattering by temperature fluctuations. A mono-static phase array SODAR system will be used to measure wind speed at and above the stack height every 30 meter starting at 20 meters above the ground and extending to at least 450 meters.

### 3.2.9 Data Logger

All sensors will be wired to a Campbell Scientific CR1000 data logger which will scan each sensor once per second. The data logger will record 5 minute, 15 minute and hourly average values of the meteorological parameters. The data logger will be stored in a NEMA enclosure.

### 3.2.10 Equipment Enclosure

The Doppler SODAR electronic box and laptop will be stored in a climate controlled (heated/air conditioned) equipment enclosure.

### 3.2.11 Relative Humidity

The relative humidity sensor is a capacitive thin-film polymer sensor consisting of a substrate on which a thin film of polymer is deposited between two conductive electrodes. The thin-film polymer either absorbs or releases water vapor as the relative humidity of the ambient air rises or falls. The dielectric properties of the polymer film depend on the amount of absorbed water. As the relative humidity around the sensor changes, the dielectric properties of the polymer film change, and so does the capacitance of the sensor. The instrument's electronics measure the capacitance of the sensor and convert it into a humidity reading.

**Figure 3-1**
**Photograph of Meteorological Monitoring Site**
**North and East Views**

Looking North from Site

Looking East from Site

**Figure 3-2**
**Photograph of Meteorological Monitoring Site**
**South and West Views**

Looking South from Site

Looking West from Site

**Table 3-1**
**Comparison of Meteorological Sensor Specification to USEPA Criteria**

| Sensor (Meteorological Variable) | Sensor Variable | Recommended EPA System Response Characteristics[a] | Site System Specification |
|---|---|---|---|
| Horizontal Wind Speed | Starting Threshold<br>Distant Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 0.5 mps<br>≤ 5 m<br>± 0.2 mps + 5% of observed<br>0.1 mps | 0.22 mps<br>< 1.5 m<br>± 0.07 m/s or 1% of observed<br>0.07 mps |
| Vertical Wind Speed | Starting Threshold<br>Distant Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 0.25 mps<br>≤ 5 m<br>± 0.2 mps + 5% of observed<br>0.1 mps | 0.25 mps<br>< 1 m<br>± 0.07 m/s or 1% of observed<br>0.1 mps |
| Wind Direction | Starting Threshold<br>Distant Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 0.5 mps at 10° deflection<br>≤ 5 m<br>± 5 degrees<br>1 degree | 0.22 mps<br><1.0 m<br>± 2 degrees<br>1 degree |
| Ambient Temperature | Time Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 1 minute<br>± 0.5°C<br>0.1°C | ≤ 3.6 seconds<br>± 0.05°C<br>0.1°C |
| Delta Temperature | Time Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 1 minute<br>± 0.1°C<br>0.02°C | 3.6 seconds<br>± 0.1°C<br>0.01°C |
| Solar Radiation | Time Constant<br>Accuracy[b]<br>Measurement Resolution | ≤ 5 seconds<br>± 5% of observed<br>10 Watts/square meter | ≤ 10 seconds<br>± 5%<br>0.1 Watts/square meter |
| Barometric Pressure | Accuracy[b]<br>Measurement Resolution | ± 3.0 Millibars<br>0.5 Millibars | ± 0.1%<br>0.1 Millibars |

(a) "Meteorological Monitoring Guidance for Regulatory Modeling Applications", USEPA-450/R-99-005, February 2000
(b) The data logger accuracy is 0.1% of the full-scale voltage. It has been included as part of the system accuracy specifications

# 4. DATA COLLECTION AND MANAGEMENT

This section discusses the data collection and data management which will be used during the REC meteorological monitoring program.

## *4.1 DATA COLLECTION*

The data collection system for the meteorological monitoring program included a data logger for the meteorological tower sensors and a laptop computer for the Doppler SODAR system. The meteorological tower data from the 20-meter, 2-meter and surface measurements will be stored as 5-, 15- and 60-minute averages and the Doppler SODAR data will be stored as 15-minute data for every level of valid measurements, typically every 30 meters to 450 meters.

The meteorological data from the meteorological tower data logger and the Doppler SODAR laptop computer will be downloaded via cellular phone modems on a daily basis and reviewed by AAQS staff meteorologists (Monday through Friday). Data will be stored at AAQS offices on dedicated hard drives and to an internet cloud backup server.

PA DEP will be provided a copy of the hourly data (in Excel spreadsheet format) within 30 days after the end of each calendar quarter.

# 5. ROUTINE SITE OPERATION AND MAINTENANCE

The meteorological monitoring site will be routinely visited by AAQS staff personnel to check the security of the site, check the conditions of the tower, sensors and cabling, and maintain the site area. A list of the site checks to be made by the project personnel is presented in Table 5-1. In addition to a startup audit a complete audit will be performed on the meteorological tower instrumentation every six months. The specific quality assurance and control procedures to be used during the monitoring program including the performance audits are discussed in the Section 6.

**Table 5-1**
**Meteorological Monitoring Site**
**Routine Site Checks**

| External | External | Internal |
|---|---|---|
| Tower | Sensors | Equipment Enclosure |
| Tower Sections<br>Winch motor and cabling<br>Junction Boxes<br>Boom arms<br>Lighting rod and cable<br>Grounding rod<br>NEMA Enclosure | Wind speed cups<br>Wind direction vane<br>Aspirator motors<br>Radiation sensor dome<br>Sensor cables and connections | Uninterruptible power supply<br>Heating and air conditioning |

# 6. QUALITY ASSURANCE/CONTROL

This section of the monitoring plan describes the specific procedures that will be followed to implement the Quality Assurance/Quality Control (QA/QC) of the meteorological monitoring. The QA/QC procedures include system and performance audits of the monitoring site and the use of Standard Operating Procedures (SOP) by site personnel.

The purpose of the QA/QC procedures is to maximize data capture to ensure that 12 months of meteorological monitoring data can be deemed acceptable by PADEP and USEPA for future regulatory air quality modeling purposes. Specifically, the monitoring program QA/QC procedures have been designed to achieve

- 4 consecutive quarters with 90 percent recovery.
- 90 percent recovery of each of the variables wind direction, wind speed, relative humidity, barometric pressure, solar radiation, and temperature.
- 90 percent joint recovery of wind direction, wind speed, and solar radiation and temperature difference.

## *6.1 AUDIT PROCEDURES*

The specific audit procedures are based on the quality assurance recommendations contained in the USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV – Meteorological Measurements (USEPA, 2008). These are described in the following sections. Performance audits will be performed at startup, after 6 months and after 12 months of monitoring.

PA DEP will be given written notification of the planned performance audits within 1 month prior to each audit. The performance audit reports will be submitted to PA DEP within 1 month of the completion of each audit.

### 6.1.1 Wind Speed Audit Procedures (Horizontal and Vertical)

The wind speed audit will include procedures to test the accuracy of the wind speed sensor measurements at a range of wind speed conditions. A direct current (dc) voltage motor will be used to generate a known rate of rotation that corresponded to a known wind speed. The motor will be attached to the shaft of the sensor and the sensor's response will be monitored. For the vertical wind speed sensors the sensor will be audited in both clockwise and counter clockwise directions. A torque wheel will be used to measure qualitatively the starting threshold of the wind speed sensor (i.e. the lowest wind speed at which the sensor will physically operate). The torque wheel will be attached to the shaft of the sensor and 0.1 gram (g) weights will be applied at 1 centimeter (cm) intervals from the center of the torque wheel. The resulting torque (g-cm) gives a qualitative indication of the starting wind speed threshold. The difference between the known wind speed and the response wind speed will be compared to the USEPA accuracy criteria of 0.45 mile per hour (mph) ±5.0% of the known. The starting torque will be compared to the manufacturer's sensor specification to give a qualitative assessment of the starting wind speed. It should be noted that the starting threshold of a sensor can only be determined by a wind tunnel test.

### 6.1.2 Wind Direction Audit Procedures

The wind direction audit will include procedures to determine the accuracy of the alignment of the wind direction sensor and the linearity of the sensor. In addition, the starting threshold of the sensor will be qualitatively determined in a fashion similar to the wind speed sensor. A field compass will be used to determine the True North alignment of the crossarm on which the wind direction sensor is mounted. The wind direction vane will be then aligned along the crossarm and the response will be recorded. A linearity test fixture will be used to determine the accuracy of the sensor over a range of wind directions. The linearity test fixture will be attached to the shaft of the sensor and used to orient the wind sensor to a minimum of four directions. The differences from the alignment audit and the linearity audit will be added together and a combined error will be determined. The combined error will be compared to the USEPA accuracy criteria of ±5.0. In addition to the sensor's alignment and linearity, the starting torque of the wind speed sensor will be also qualified. The torque wheel will be attached to the shaft of the sensor and 0.1 g weights will be applied at 1 cm intervals from the center of the torque wheel. The resulting torque (g-cm) gives a qualitative indication of the starting wind direction threshold. The starting torque will be compared to the manufacturer's sensor specification to give a qualitative assessment of the wind speed at which the wind direction sensor will begin to respond. It should be noted that the starting threshold of a sensor can only be determined by a wind tunnel test.

### 6.1.3 Temperature and Delta Temperature Audit Procedures

The temperature audit will consist of comparing the sensors' responses to known temperatures. A warm water bath and an ice bath are used with NIST calibrated temperature probes to test the temperature sensors' accuracy. The temperature sensors are placed first in an ice bath and allowed to equilibrate before a response was recorded. The same approach will also be used for a warm water bath. Distilled water will be used for the ice and warm water baths. The U.S. EPA accuracy limit for temperature measurement is ±0.9° F. In addition to auditing the ambient temperature sensors, the temperature difference, or delta temperature, between the levels will also be audited. The delta temperature audit is performed by immersing the sensors in the water baths and observing the temperature difference between the sensors. For delta temperature, the 2-meter temperature response is subtracted from the 10-meter temperature response and should equal 0.00° F. The U.S. EPA accuracy criterion for delta temperature is ±0.18° F.

### 6.1.4 Solar and Net Radiation Audit Procedures

The solar and net radiation audit will consist of a side-by-side comparison between the site solar and net radiation sensors and independent sensors with a NIST or a WRR (World Radiometric Reference) calibration, which will be connected to a Campbell Scientific data logger. The radiation audit will be conducted over several hours so that a meaningful number of 5-minute measurement periods are available. A comparison will be made between the 5-minute data collected by the audit sensors and the site sensors. A percent difference will be calculated for each 5-minute period and all of the percent differences will be averaged and compared to the USEPA acceptance criterion of ±5%.

### 6.1.5 Barometric Pressure Audit Procedures

The barometric pressure audit will consist of a side-by-side comparison between the site barometric pressure sensor and an independent sensor with an NIST calibration, which will be connected to a Campbell Scientific data logger. The barometric pressure audit will be conducted over several hours so that a meaningful number of 5-minute measurement periods will be available. A comparison will be made between the 5-minute data collected by the audit sensor and the site sensor. A percent difference will be calculated for each 5-minute period and all of the percent differences will be averaged and compared to the USEPA acceptance criterion of ±3 millibars (mb) or ±0.09 inches of mercury (in Hg).

### 6.1.6 Relative Humidity Audit Procedures

The relative humidity audit will consist of comparing the sensor's response at ambient conditions to calibrated wet bulb and dry bulb temperature probes at the same ambient conditions or comparison with a co-located relative humidity sensor. A comparison between the calibrated temperature probes relative humidity values and audit devices are used to determine the accuracy of the site relative humidity sensor. AAQS will utilize equipment that will either directly calculate relative humidity or collect dry and wet bulb temperatures and calculate or direct relative humidity values.

### 6.1.7 Doppler SODAR Audit Procedures

The planned audit procedure of the Doppler SODAR will follow the recommendation described in MMG Section 9.6.2.2 which is briefly provided below.

Comparison of the SODAR wind measurement will be made with data from the 20 meter level of the adjacent tall tower. The tower and SODAR data will be reviewed continuously throughout the monitoring program by AAQS's meteorologists. The tower data will be time averaged to correspond to the SODAR averaging interval.

## *6.2 STANDARD OPERATION PROCEDURES*

AAQS Standard Operating Procedures (SOP) for meteorological monitoring systems will be followed by project personnel including designing, installing, operating and maintaining the meteorological monitoring site.

# 7. PROJECT ORGANIZATION

The following is a list of the key project members of the Renovo Energy Center meteorological monitoring program and their role/responsibility during the project.

| Personnel | Position | Responsibility |
|---|---|---|
| Mr. Louis Militana | Project Director | Overall project management, and installation |
| Mr. Philip Samulewicz | Technical Director | Design, operation, data collection and data management of meteorological tower |
| Ms. Sharon Gill | Project Meteorologist | Data review and processing |

# APPENDIX E AERSURFACE OUTPUT DATA

| Month and Year | Wind Sector | Surface Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|---|
| October 2015 | 1 of 12 | 0.16 | 0.94 | 1.123 |
| October 2015 | 2 of 12 | 0.16 | 0.94 | 0.966 |
| October 2015 | 3 of 12 | 0.16 | 0.94 | 0.753 |
| October 2015 | 4 of 12 | 0.16 | 0.94 | 0.310 |
| October 2015 | 5 of 12 | 0.16 | 0.94 | 0.207 |
| October 2015 | 6 of 12 | 0.16 | 0.94 | 0.335 |
| October 2015 | 7 of 12 | 0.16 | 0.94 | 0.399 |
| October 2015 | 8 of 12 | 0.16 | 0.94 | 0.241 |
| October 2015 | 9 of 12 | 0.16 | 0.94 | 0.611 |
| October 2015 | 10 of 12 | 0.16 | 0.94 | 0.923 |
| October 2015 | 11 of 12 | 0.16 | 0.94 | 0.959 |
| October 2015 | 12 of 12 | 0.16 | 0.94 | 1.111 |
| November 2015 | 1 of 12 | 0.16 | 1.87 | 1.123 |
| November 2015 | 2 of 12 | 0.16 | 1.87 | 0.966 |
| November 2015 | 3 of 12 | 0.16 | 1.87 | 0.753 |
| November 2015 | 4 of 12 | 0.16 | 1.87 | 0.310 |
| November 2015 | 5 of 12 | 0.16 | 1.87 | 0.207 |
| November 2015 | 6 of 12 | 0.16 | 1.87 | 0.335 |
| November 2015 | 7 of 12 | 0.16 | 1.87 | 0.399 |
| November 2015 | 8 of 12 | 0.16 | 1.87 | 0.241 |
| November 2015 | 9 of 12 | 0.16 | 1.87 | 0.611 |
| November 2015 | 10 of 12 | 0.16 | 1.87 | 0.923 |
| November 2015 | 11 of 12 | 0.16 | 1.87 | 0.959 |
| November 2015 | 12 of 12 | 0.16 | 1.87 | 1.111 |
| December 2015 | 1 of 12 | 0.16 | 0.39 | 0.495 |
| December 2015 | 2 of 12 | 0.16 | 0.39 | 0.425 |
| December 2015 | 3 of 12 | 0.16 | 0.39 | 0.463 |
| December 2015 | 4 of 12 | 0.16 | 0.39 | 0.245 |
| December 2015 | 5 of 12 | 0.16 | 0.39 | 0.160 |
| December 2015 | 6 of 12 | 0.16 | 0.39 | 0.238 |
| December 2015 | 7 of 12 | 0.16 | 0.39 | 0.273 |
| December 2015 | 8 of 12 | 0.16 | 0.39 | 0.192 |
| December 2015 | 9 of 12 | 0.16 | 0.39 | 0.325 |
| December 2015 | 10 of 12 | 0.16 | 0.39 | 0.447 |
| December 2015 | 11 of 12 | 0.16 | 0.39 | 0.466 |
| December 2015 | 12 of 12 | 0.16 | 0.39 | 0.497 |

Appendix E
AERSURFACE Output for On-site Meteorological Data Collection Location

| Month and Year | Wind Sector | Surface Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|---|
| January 2016 | 1 of 12 | 0.16 | 0.94 | 0.495 |
| January 2016 | 2 of 12 | 0.16 | 0.94 | 0.425 |
| January 2016 | 3 of 12 | 0.16 | 0.94 | 0.463 |
| January 2016 | 4 of 12 | 0.16 | 0.94 | 0.245 |
| January 2016 | 5 of 12 | 0.16 | 0.94 | 0.160 |
| January 2016 | 6 of 12 | 0.16 | 0.94 | 0.238 |
| January 2016 | 7 of 12 | 0.16 | 0.94 | 0.273 |
| January 2016 | 8 of 12 | 0.16 | 0.94 | 0.192 |
| January 2016 | 9 of 12 | 0.16 | 0.94 | 0.325 |
| January 2016 | 10 of 12 | 0.16 | 0.94 | 0.447 |
| January 2016 | 11 of 12 | 0.16 | 0.94 | 0.466 |
| January 2016 | 12 of 12 | 0.16 | 0.94 | 0.497 |
| February 2016 | 1 of 12 | 0.16 | 0.39 | 0.495 |
| February 2016 | 2 of 12 | 0.16 | 0.39 | 0.425 |
| February 2016 | 3 of 12 | 0.16 | 0.39 | 0.463 |
| February 2016 | 4 of 12 | 0.16 | 0.39 | 0.245 |
| February 2016 | 5 of 12 | 0.16 | 0.39 | 0.160 |
| February 2016 | 6 of 12 | 0.16 | 0.39 | 0.238 |
| February 2016 | 7 of 12 | 0.16 | 0.39 | 0.273 |
| February 2016 | 8 of 12 | 0.16 | 0.39 | 0.192 |
| February 2016 | 9 of 12 | 0.16 | 0.39 | 0.325 |
| February 2016 | 10 of 12 | 0.16 | 0.39 | 0.447 |
| February 2016 | 11 of 12 | 0.16 | 0.39 | 0.466 |
| February 2016 | 12 of 12 | 0.16 | 0.39 | 0.497 |
| March 2016 | 1 of 12 | 0.16 | 1.44 | 0.815 |
| March 2016 | 2 of 12 | 0.16 | 1.44 | 0.687 |
| March 2016 | 3 of 12 | 0.16 | 1.44 | 0.663 |
| March 2016 | 4 of 12 | 0.16 | 1.44 | 0.296 |
| March 2016 | 5 of 12 | 0.16 | 1.44 | 0.198 |
| March 2016 | 6 of 12 | 0.16 | 1.44 | 0.309 |
| March 2016 | 7 of 12 | 0.16 | 1.44 | 0.356 |
| March 2016 | 8 of 12 | 0.16 | 1.44 | 0.226 |
| March 2016 | 9 of 12 | 0.16 | 1.44 | 0.424 |
| March 2016 | 10 of 12 | 0.16 | 1.44 | 0.685 |
| March 2016 | 11 of 12 | 0.16 | 1.44 | 0.738 |
| March 2016 | 12 of 12 | 0.16 | 1.44 | 0.814 |
| April 2016 | 1 of 12 | 0.16 | 1.44 | 0.815 |
| April 2016 | 2 of 12 | 0.16 | 1.44 | 0.687 |
| April 2016 | 3 of 12 | 0.16 | 1.44 | 0.663 |
| April 2016 | 4 of 12 | 0.16 | 1.44 | 0.296 |
| April 2016 | 5 of 12 | 0.16 | 1.44 | 0.198 |
| April 2016 | 6 of 12 | 0.16 | 1.44 | 0.309 |

Appendix E
AERSURFACE Output for On-site Meteorological Data Collection Location

| Month and Year | Wind Sector | Surface Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|---|
| April 2016 | 7 of 12 | 0.16 | 1.44 | 0.356 |
| April 2016 | 8 of 12 | 0.16 | 1.44 | 0.226 |
| April 2016 | 9 of 12 | 0.16 | 1.44 | 0.424 |
| April 2016 | 10 of 12 | 0.16 | 1.44 | 0.685 |
| April 2016 | 11 of 12 | 0.16 | 1.44 | 0.738 |
| April 2016 | 12 of 12 | 0.16 | 1.44 | 0.814 |

Appendix E
AERSURFACE Output for On-site Meteorological Data Collection Location

| Month and Year | Wind Sector | Surface Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|---|
| May 2016 | 1 of 12 | 0.16 | 0.67 | 0.815 |
| May 2016 | 2 of 12 | 0.16 | 0.67 | 0.687 |
| May 2016 | 3 of 12 | 0.16 | 0.67 | 0.663 |
| May 2016 | 4 of 12 | 0.16 | 0.67 | 0.296 |
| May 2016 | 5 of 12 | 0.16 | 0.67 | 0.198 |
| May 2016 | 6 of 12 | 0.16 | 0.67 | 0.309 |
| May 2016 | 7 of 12 | 0.16 | 0.67 | 0.356 |
| May 2016 | 8 of 12 | 0.16 | 0.67 | 0.226 |
| May 2016 | 9 of 12 | 0.16 | 0.67 | 0.424 |
| May 2016 | 10 of 12 | 0.16 | 0.67 | 0.685 |
| May 2016 | 11 of 12 | 0.16 | 0.67 | 0.738 |
| May 2016 | 12 of 12 | 0.16 | 0.67 | 0.814 |
| June 2016 | 1 of 12 | 0.16 | 0.64 | 1.123 |
| June 2016 | 2 of 12 | 0.16 | 0.64 | 0.966 |
| June 2016 | 3 of 12 | 0.16 | 0.64 | 0.753 |
| June 2016 | 4 of 12 | 0.16 | 0.64 | 0.310 |
| June 2016 | 5 of 12 | 0.16 | 0.64 | 0.207 |
| June 2016 | 6 of 12 | 0.16 | 0.64 | 0.335 |
| June 2016 | 7 of 12 | 0.16 | 0.64 | 0.399 |
| June 2016 | 8 of 12 | 0.16 | 0.64 | 0.241 |
| June 2016 | 9 of 12 | 0.16 | 0.64 | 0.611 |
| June 2016 | 10 of 12 | 0.16 | 0.64 | 0.923 |
| June 2016 | 11 of 12 | 0.16 | 0.64 | 0.959 |
| June 2016 | 12 of 12 | 0.16 | 0.64 | 1.111 |
| July 2016 | 1 of 12 | 0.16 | 0.64 | 1.123 |
| July 2016 | 2 of 12 | 0.16 | 0.64 | 0.966 |
| July 2016 | 3 of 12 | 0.16 | 0.64 | 0.753 |
| July 2016 | 4 of 12 | 0.16 | 0.64 | 0.310 |
| July 2016 | 5 of 12 | 0.16 | 0.64 | 0.207 |
| July 2016 | 6 of 12 | 0.16 | 0.64 | 0.335 |
| July 2016 | 7 of 12 | 0.16 | 0.64 | 0.399 |
| July 2016 | 8 of 12 | 0.16 | 0.64 | 0.241 |
| July 2016 | 9 of 12 | 0.16 | 0.64 | 0.611 |
| July 2016 | 10 of 12 | 0.16 | 0.64 | 0.923 |
| July 2016 | 11 of 12 | 0.16 | 0.64 | 0.959 |
| July 2016 | 12 of 12 | 0.16 | 0.64 | 1.111 |
| August 2016 | 1 of 12 | 0.16 | 0.21 | 1.123 |
| August 2016 | 2 of 12 | 0.16 | 0.21 | 0.966 |
| August 2016 | 3 of 12 | 0.16 | 0.21 | 0.753 |
| August 2016 | 4 of 12 | 0.16 | 0.21 | 0.310 |
| August 2016 | 5 of 12 | 0.16 | 0.21 | 0.207 |
| August 2016 | 6 of 12 | 0.16 | 0.21 | 0.335 |

Appendix E
AERSURFACE Output for On-site Meteorological Data Collection Location

| Month and Year | Wind Sector | Surface Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|---|
| August 2016 | 7 of 12 | 0.16 | 0.21 | 0.399 |
| August 2016 | 8 of 12 | 0.16 | 0.21 | 0.241 |
| August 2016 | 9 of 12 | 0.16 | 0.21 | 0.611 |
| August 2016 | 10 of 12 | 0.16 | 0.21 | 0.923 |
| August 2016 | 11 of 12 | 0.16 | 0.21 | 0.959 |
| August 2016 | 12 of 12 | 0.16 | 0.21 | 1.111 |
| September 2016 | 1 of 12 | 0.16 | 0.94 | 1.123 |
| September 2016 | 2 of 12 | 0.16 | 0.94 | 0.966 |
| September 2016 | 3 of 12 | 0.16 | 0.94 | 0.753 |
| September 2016 | 4 of 12 | 0.16 | 0.94 | 0.310 |
| September 2016 | 5 of 12 | 0.16 | 0.94 | 0.207 |
| September 2016 | 6 of 12 | 0.16 | 0.94 | 0.335 |
| September 2016 | 7 of 12 | 0.16 | 0.94 | 0.399 |
| September 2016 | 8 of 12 | 0.16 | 0.94 | 0.241 |
| September 2016 | 9 of 12 | 0.16 | 0.94 | 0.611 |
| September 2016 | 10 of 12 | 0.16 | 0.94 | 0.923 |
| September 2016 | 11 of 12 | 0.16 | 0.94 | 0.959 |
| September 2016 | 12 of 12 | 0.16 | 0.94 | 1.111 |
| October 2016 | 1 of 12 | 0.16 | 0.39 | 1.123 |
| October 2016 | 2 of 12 | 0.16 | 0.39 | 0.966 |
| October 2016 | 3 of 12 | 0.16 | 0.39 | 0.753 |
| October 2016 | 4 of 12 | 0.16 | 0.39 | 0.310 |
| October 2016 | 5 of 12 | 0.16 | 0.39 | 0.207 |
| October 2016 | 6 of 12 | 0.16 | 0.39 | 0.335 |
| October 2016 | 7 of 12 | 0.16 | 0.39 | 0.399 |
| October 2016 | 8 of 12 | 0.16 | 0.39 | 0.241 |
| October 2016 | 9 of 12 | 0.16 | 0.39 | 0.611 |
| October 2016 | 10 of 12 | 0.16 | 0.39 | 0.923 |
| October 2016 | 11 of 12 | 0.16 | 0.39 | 0.959 |
| October 2016 | 12 of 12 | 0.16 | 0.39 | 1.111 |

# APPENDIX F METEOROLOGICAL DATA PROCESSING FILES

Renovo Energy Center
Air Dispersion Modeling Protocol
Appendix F Filename Descriptions
February 2020

| Main Folder\Sub Folder(s) | Description |
|---|---|
| Appendix F | Main folder, location of AERMET output files for use in AERMOD |
| Appendix F\2015\aersurface | Aersurface processing files for CY2015 |
| Appendix F\2015\surface data | Raw NWS surface data obtained from NCDC for CY2015 |
| Appendix F\2015\upper air data | Raw NWS upper air data obtained from NOAA for CY2015 |
| Appendix F\2015\raw data | Raw on-site data file used in AERMET processing for CY2015 |
| Appendix F\2015 | AERMET processing files for CY2015 |
| Appendix F\2016\aersurface | Aersurface processing files for CY2016 |
| Appendix F\2016\surface data | Raw NWS surface data obtained from NCDC for CY2016 |
| Appendix F\2016\upper air data | Raw NWS upper air data obtained from NOAA for CY2016 |
| Appendix F\2016\raw data | Raw on-site data file used in AERMET processing for CY2016 |
| Appendix F\2016 | AERMET processing files for CY2016 |
| Appendix F\raw data | Raw data from on-site collection for entire data collection period, with conversion calculations |

# APPENDIX G AMBIENT BACKGROUND MONITORING DATA PROVIDED BY PADEP

User ID: AES

# DESIGN VALUE REPORT

Report Request ID: 1782941 | Report Code: AMP480 | Oct. 16, 2019

## GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 013 | | | | | | | | | |

## PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| DESIGN VALUE | 42401 | | |

## SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| SINGLE EVENT PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| USER SITE METADATA | STREET ADDRESS |
| QUARTERLY DATA IN WORKFILE | NO |
| WORKFILE DELIMITER | , |
| USE LINKED SITES | YES |

## DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

## APPLICABLE STANDARDS

| Standard Description |
|---|
| SO2 1-hour 2010 |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Sulfur dioxide(42401)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** SO2 1-hour 2010
**Statistic:** Annual 99th Percentile **Level:** 75

**Design Value Year:** 2016

**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**

**State Name:** Pennsylvania

| | | 2016 | | | 2015 | | | 2014 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | STREET ADDRESS | Comp. Qrtrs | 99th Percentile | Cert& Eval | Comp. Qrtrs | 99th Percentile | Cert& Eval | Comp. Qrtrs | 99th Percentile | Cert& Eval | Design Value | Valid Ind. |
| 42-013-0801 | 2ND AVE & 7TH ST | 4 | 13 | Y | 4 | 31 | Y | 3 | 44 * | Y | 29 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Sulfur dioxide(42401)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** SO2 1-hour 2010
**Statistic:** Annual 99th Percentile **Level:** 75

**Design Value Year:** 2017

**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**

**State Name:** Pennsylvania

| | | 2017 | | | 2016 | | | 2015 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site ID** | **STREET ADDRESS** | **Comp. Qrtrs** | **99th Percentile** | **Cert& Eval** | **Comp. Qrtrs** | **99th Percentile** | **Cert& Eval** | **Comp. Qrtrs** | **99th Percentile** | **Cert& Eval** | **Design Value** | **Valid Ind.** |
| 42-013-0801 | 2ND AVE & 7TH ST | 4 | 7 | Y | 4 | 13 | Y | 4 | 31 | Y | 17 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
PRELIMINARY DESIGN VALUE REPORT

Report Date: Oct. 16, 2019

**Pollutant:** Sulfur dioxide(42401)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** SO2 1-hour 2010
**Statistic:** Annual 99th Percentile **Level:** 75

**Design Value Year:** 2018
**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**
**State Name:** Pennsylvania

| | | 2018 | | | 2017 | | | 2016 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | STREET ADDRESS | Comp. Qrtrs | 99th Percentile | Cert& Eval | Comp. Qrtrs | 99th Percentile | Cert& Eval | Comp. Qrtrs | 99th Percentile | Cert& Eval | Design Value | Valid Ind. |
| 42-013-0801 | 2ND AVE & 7TH ST | 4 | 8 | | 4 | 7 | Y | 4 | 13 | Y | 9 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

User ID: AES

# QUICKLOOK CRITERIA PARAMETERS

Report Request ID: 1782946 | Report Code: AMP450 | Oct. 16, 2019

## GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 001 | | | | | | | | | |

## PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| QUICK LOOK | 42101 | | |

## SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| EVENTS PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| WORKFILE DELIMITER | , |

## SORT ORDER

| Order | Column |
|---|---|
| 1 | PARAMETER_CODE |
| 2 | STATE_CODE |
| 3 | COUNTY_CODE |
| 4 | SITE_ID |
| 5 | POC |
| 6 | DATES |
| 7 | EDT_ID |

## DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

## APPLICABLE STANDARDS

| Standard Description |
|---|
| CO 1-hour 1971 |
| CO 8-hour 1971 |

Oct. 16, 2019

EXCEPTIONAL DATA TYPES

| EDT | DESCRIPTION |
|---|---|
| 0 | NO EVENTS |
| 1 | EVENTS EXCLUDED |
| 2 | EVENTS INCLUDED |
| 5 | EVENTS WITH CONCURRENCE EXCLUDED |

Note: The * indicates that the mean does not satisfy summary criteria.

Oct. 16, 2019

Carbon monoxide (42101) Pennsylvania Parts per million (007)

| SITE ID | POC | PQAO | CITY | COUNTY | ADDRESS | YEAR | METH | # OBS | 1ST MAX 1-HR | 2ND MAX 1-HR | OBS >1HR STD | 1ST MAX 8-HR | 2ND MAX 8-HR | OBS >8HR STD | CERT and EVAL | EDT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42-001-0001 | 1 | 0851 | Not in a city | Adams | NARSTO SITE - ARENDTSVILLE | 2016 | 093 | 8487 | .9 | .5 | 0 | .5 | .4 | 0 | Y | 0 |
| 42-001-0001 | 1 | 0851 | Not in a city | Adams | NARSTO SITE - ARENDTSVILLE | 2017 | 093 | 8160 | .7 | .7 | 0 | .6 | .6 | 0 | Y | 0 |
| 42-001-0001 | 1 | 0851 | Not in a city | Adams | NARSTO SITE - ARENDTSVILLE | 2018 | 093 | 8332 | 1.3 | .5 | 0 | .4 | .4 | 0 |  | 0 |

Note: The * indicates that the mean does not satisfy summary criteria.

Note: These reported values do not reflect the combination of 14129 and 85129 and validation substitution tests utilized for Design Value Calculations

Oct. 16, 2019

METHODS USED IN THIS REPORT

| PARAMETER | METHOD CODE | COLLECTION METHOD | ANALYSIS METHOD |
|---|---|---|---|
| 42101 | 093 | INSTRUMENTAL | GAS FILTER CORRELATION CO ANALYZER |

Note: The * indicates that the mean does
not satisfy summary criteria.

Oct. 16, 2019

PQAOS USED IN THIS REPORT

| PQAO | AGENCY DESCRIPTION |
| --- | --- |
| 0851 | Pennsylvania Department Of Environmental Protection |

Note: The * indicates that the mean does
not satisfy summary criteria.

Oct. 16, 2019

CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

Note: The * indicates that the mean does
not satisfy summary criteria.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

User ID: AES

QUICKLOOK CRITERIA PARAMETERS

Report Request ID: 1782944 | Report Code: AMP450 | Oct. 16, 2019

GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 081 | | | | | | | | | |

PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| QUICK LOOK | 81102 | | |

SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| EVENTS PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| WORKFILE DELIMITER | , |

SORT ORDER

| Order | Column |
|---|---|
| 1 | PARAMETER_CODE |
| 2 | STATE_CODE |
| 3 | COUNTY_CODE |
| 4 | SITE_ID |
| 5 | POC |
| 6 | DATES |
| 7 | EDT_ID |

DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

APPLICABLE STANDARDS

| Standard Description |
|---|
| PM10 24-hour 2006 |

Oct. 16, 2019

EXCEPTIONAL DATA TYPES

| EDT | DESCRIPTION |
|---|---|
| 0 | NO EVENTS |
| 1 | EVENTS EXCLUDED |
| 2 | EVENTS INCLUDED |
| 5 | EVENTS WITH CONCURRENCE EXCLUDED |

Note: The * indicates that the mean does not satisfy summary criteria.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
QUICK LOOK REPORT (AMP450)

Oct. 16, 2019

PM10 Total 0-10um STP (81102) Pennsylvania Micrograms/cubic meter (25 C) (001)

24-HOUR

| SITE ID | POC | PQAO | CITY | COUNTY | ADDRESS | YEAR | METH | #OBS | NUM REQ | VALID DAYS | %OBS | 1ST MAX | 2ND MAX | 3RD MAX | 4TH MAX | DAY MAX >STD | EST DAYS >STD | WTD ARITH MEAN | CERT and EVAL | EDT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42-081-0100 | 5 | 0851 | Montoursville | Lycoming | 899 CHERRY STREET | 2016 | 079 | 8612 | 366 | 360 | 98 | 29 | 27 | 27 | 26 | 0 | 0 | 11.2 | Y | 0 |
| 42-081-0100 | 5 | 0851 | Montoursville | Lycoming | 899 CHERRY STREET | 2017 | 079 | 8319 | 365 | 348 | 95 | 29 | 27 | 24 | 24 | 0 | 0 | 10.9 | Y | 0 |
| 42-081-0100 | 5 | 0851 | Montoursville | Lycoming | 899 CHERRY STREET | 2018 | 079 | 776 | 365 | 32 | 9 | 20 | 19 | 19 | 18 | 0 | 0 | 11.7* | | 0 |

Note: The * indicates that the mean does not satisfy summary criteria.

Note: These reported values do not reflect the combination of 14129 and 85129 and validation substitution tests utilized for Design Value Calculations

Oct. 16, 2019

METHODS USED IN THIS REPORT

| PARAMETER | METHOD CODE | COLLECTION METHOD | ANALYSIS METHOD |
|---|---|---|---|
| 81102 | 079 | INSTRUMENTAL-R&P SA246B-INLET | TEOM-GRAVIMETRIC |

Note: The * indicates that the mean does
not satisfy summary criteria.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
QUICK LOOK REPORT (AMP450 END)

Oct. 16, 2019

PQAOS USED IN THIS REPORT

| PQAO | AGENCY DESCRIPTION |
| --- | --- |
| 0851 | Pennsylvania Department Of Environmental Protection |

Note: The * indicates that the mean does not satisfy summary criteria.

Oct. 16, 2019

## CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

Note: The * indicates that the mean does not satisfy summary criteria.

User ID: AES

DESIGN VALUE REPORT

Report Request ID: 1782943 | Report Code: AMP480 | Oct. 16, 2019

GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 027 | | | | | | | | | |

PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| DESIGN VALUE | 88101 | | |

SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| SINGLE EVENT PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| USER SITE METADATA | STREET ADDRESS |
| QUARTERLY DATA IN WORKFILE | NO |
| WORKFILE DELIMITER | , |
| USE LINKED SITES | YES |

DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

APPLICABLE STANDARDS

| Standard Description |
|---|
| PM25 24-hour 2012 |
| PM25 Annual 2012 |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Site-LevelPM2.5 - Local Conditions(88101)
**Standard Units:** Micrograms/cubic meter (LC)(105)
**NAAQS Standard:** PM25 24-hour 2012 / PM25 Annual 2012
**Statistic:** Annual Weighted Mean **Level:** 12
**Statistic:** Annual 98th Percentile **Level:** 35

**Design Value Year:** 2016

**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**

**State Name:** Pennsylvania

| Site_ID / STREET ADDRESS | 2016 Cred. Days | 2016 Comp. Qrtrs | 2016 98th Perctil | 2016 Wtd. Mean | 2016 Cert& Eval | 2015 Cred. Days | 2015 Comp. Qrtrs | 2015 98th Perctil | 2015 Wtd. Mean | 2015 Cert& Eval | 2014 Cred. Days | 2014 Comp. Qrtrs | 2014 98th Perctil | 2014 Wtd. Mean | 2014 Cert& Eval | 24-Hour Design Value | 24-Hour Valid Ind. | Annual Design Value | Annual Valid Ind. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42-027-0100<br>PENN STATE UNIVERSITY - ARBORETUM SITE | 310 | 2 | 16.8 | 7.2* | N | 356 | 4 | 20.9 | 8.4 | Y | 352 | 4 | 20.4 | 8.7 | N | 19 | Y | 8.1 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
PRELIMINARY DESIGN VALUE REPORT

Report Date: Oct. 16, 2019

**Pollutant:** Site-LevelPM2.5 - Local Conditions(88101)
**Standard Units:** Micrograms/cubic meter (LC)(105)
**NAAQS Standard:** PM25 24-hour 2012 / PM25 Annual 2012
**Statistic:** Annual Weighted Mean **Level:** 12
**Statistic:** Annual 98th Percentile **Level:** 35

**Design Value Year:** 2017

**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**

**State Name:** Pennsylvania

| | 2017 | | | | | 2016 | | | | | 2015 | | | | | 24-Hour | | Annual | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site_ID / STREET ADDRESS | Cred. Days | Comp. Qrtrs | 98th Perctil | Wtd. Mean | Cert& Eval | Cred. Days | Comp. Qrtrs | 98th Perctil | Wtd. Mean | Cert& Eval | Cred. Days | Comp. Qrtrs | 98th Perctil | Wtd. Mean | Cert& Eval | Design Value | Valid Ind. | Design Value | Valid Ind. |
| 42-027-0100 PENN STATE UNIVERSITY - ARBORETUM SITE | 340 | 4 | 21.8 | 8.5 | Y | 310 | 2 | 16.8 | 7.2 * | N | 356 | 4 | 20.9 | 8.4 | Y | 20 | Y | 8.0 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Site-LevelPM2.5 - Local Conditions(88101)
**Standard Units:** Micrograms/cubic meter (LC)(105)
**NAAQS Standard:** PM25 24-hour 2012 / PM25 Annual 2012
**Statistic:** Annual Weighted Mean **Level:** 12
**Statistic:** Annual 98th Percentile **Level:** 35

**Design Value Year:** 2018
**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**

**State Name:** Pennsylvania

| Site_ID / STREET ADDRESS | 2018 Cred. Days | 2018 Comp. Qrtrs | 2018 98th Perctil | 2018 Wtd. Mean | 2018 Cert& Eval | 2017 Cred. Days | 2017 Comp. Qrtrs | 2017 98th Perctil | 2017 Wtd. Mean | 2017 Cert& Eval | 2016 Cred. Days | 2016 Comp. Qrtrs | 2016 98th Perctil | 2016 Wtd. Mean | 2016 Cert& Eval | 24-Hour Design Value | 24-Hour Valid Ind. | Annual Design Value | Annual Valid Ind. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42-027-0100<br>PENN STATE UNIVERSITY - ARBORETUM SITE | 330 | 4 | 22.6 | 8.7 | | 340 | 4 | 21.8 | 8.5 | Y | 310 | 2 | 16.8* | 7.2* | N | 20 | Y | 8.1 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

User ID: AES

# DESIGN VALUE REPORT

Report Request ID: 1782942 | Report Code: AMP480 | Oct. 16, 2019

## GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 117 | | | | | | | | | |

## PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| DESIGN VALUE | 42602 | | |

## SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| SINGLE EVENT PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| USER SITE METADATA | STREET ADDRESS |
| QUARTERLY DATA IN WORKFILE | NO |
| WORKFILE DELIMITER | , |
| USE LINKED SITES | YES |

## DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

## APPLICABLE STANDARDS

| Standard Description |
|---|
| NO2 1-hour |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
PRELIMINARY DESIGN VALUE REPORT

Report Date: Oct. 16, 2019

**Pollutant:** Nitrogen dioxide (NO2)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** NO2 1-hour
**Statistic:** Annual 98th Percentile **Level:** 100

**Design Value Year:** 2016
**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**
**State Name:** Pennsylvania

| | | 2016 | | | 2015 | | | 2014 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | STREET ADDRESS | Comp. Qtrs | 98th Percentile | Cert& Eval | Comp. Qtrs | 98th Percentile | Cert& Eval | Comp. Qtrs | 98th Percentile | Cert& Eval | Design Value | DV Validity Indicator |
| 42-117-4000 | TIOGA | 4 | 10.0 | Y | 4 | 14.0 | Y | 4 | 14.0 | Y | 13 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Nitrogen dioxide (NO2)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** NO2 1-hour
**Statistic:** Annual 98th Percentile **Level:** 100

**Design Value Year:** 2017
**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**
**State Name:** Pennsylvania

| | | 2017 | | | 2016 | | | 2015 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | STREET ADDRESS | Comp. Qtrs | 98th Percentile | Cert& Eval | Comp. Qtrs | 98th Percentile | Cert& Eval | Comp. Qtrs | 98th Percentile | Cert& Eval | Design Value | DV Validity Indicator |
| 42-117-4000 | TIOGA | 4 | 10.0 | Y | 4 | 10.0 | Y | 4 | 14.0 | Y | 11 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

**Pollutant:** Nitrogen dioxide (NO2)
**Standard Units:** Parts per billion(008)
**NAAQS Standard:** NO2 1-hour
**Statistic:** Annual 98th Percentile **Level:** 100

**Design Value Year:** 2018
**REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.**
**State Name:** Pennsylvania

| | | 2018 | | | 2017 | | | 2016 | | | 3-Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site ID** | **STREET ADDRESS** | **Comp. Qtrs** | **98th Percentile** | **Cert& Eval** | **Comp. Qtrs** | **98th Percentile** | **Cert& Eval** | **Comp. Qtrs** | **98th Percentile** | **Cert& Eval** | **Design Value** | **DV Validity Indicator** |
| 42-117-4000 | TIOGA | 4 | 10.0 | | 4 | 10.0 | Y | 4 | 10.0 | Y | 10 | Y |

**Notes:** 1. Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Some PM2.5 24-hour DVs for incomplete data that are marked invalid here may be marked valid in the Official report due to additional analysis.
3. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

User ID: AES

QUICKLOOK CRITERIA PARAMETERS

Report Request ID: 1782951 | Report Code: AMP450 | Oct. 16, 2019

GEOGRAPHIC SELECTIONS

| Tribal Code | State | County | Site | Parameter | POC | City | AQCR | UAR | CBSA | CSA | EPA Region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42 | 117 | | | | | | | | | |

PROTOCOL SELECTIONS

| Parameter Classification | Parameter | Method | Duration |
|---|---|---|---|
| QUICK LOOK | 42602 | | |

SELECTED OPTIONS

| Option Type | Option Value |
|---|---|
| EVENTS PROCESSING | EXCLUDE REGIONALLY CONCURRED EVENTS |
| MERGE PDF FILES | YES |
| AGENCY ROLE | PQAO |
| WORKFILE DELIMITER | , |

SORT ORDER

| Order | Column |
|---|---|
| 1 | PARAMETER_CODE |
| 2 | STATE_CODE |
| 3 | COUNTY_CODE |
| 4 | SITE_ID |
| 5 | POC |
| 6 | DATES |
| 7 | EDT_ID |

DATE CRITERIA

| Start Date | End Date |
|---|---|
| 2016 | 2018 |

APPLICABLE STANDARDS

| Standard Description |
|---|
| NO2 1-hour |
| NO2 Annual 1971 |

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
QUICK LOOK REPORT (AMP450)

Oct. 16, 2019

EXCEPTIONAL DATA TYPES

| EDT | DESCRIPTION |
|---|---|
| 0 | NO EVENTS |
| 1 | EVENTS EXCLUDED |
| 2 | EVENTS INCLUDED |
| 5 | EVENTS WITH CONCURRENCE EXCLUDED |

Note: The * indicates that the mean does
not satisfy summary criteria.

Oct. 16, 2019

Nitrogen dioxide (NO2) (42602) Pennsylvania Parts per billion (008)

| SITE ID | POC | PQAO | CITY | COUNTY | ADDRESS | YEAR | METH | COMP QTRS | 1ST MAX 1-HR | 2ND MAX 1-HR | 98TH PCTL | OBS | PCT COMP | ARITH MEAN | CERT and EVAL | EDT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42-117-4000 | 1 | 0851 | Not in a city | Tioga | TIOGA | 2016 | 099 | 4 | 18.0 | 14.0 | 10.0 | 8633 | 98 | 1.88 | Y | 0 |
| 42-117-4000 | 1 | 0851 | Not in a city | Tioga | TIOGA | 2017 | 099 | 4 | 15.0 | 12.0 | 10.0 | 8230 | 94 | 1.91 | Y | 0 |
| 42-117-4000 | 1 | 0851 | Not in a city | Tioga | TIOGA | 2018 | 099 | 4 | 14.0 | 13.0 | 10.0 | 7948 | 91 | .62 | | 0 |

Note: The * indicates that the mean does
not satisfy summary criteria.

Note: These reported values do not reflect the combination of 14129 and 85129 and validation substitution tests utilized for Design Value Calculations

Oct. 16, 2019

METHODS USED IN THIS REPORT

| PARAMETER | METHOD CODE | COLLECTION METHOD | ANALYSIS METHOD |
|---|---|---|---|
| 42602 | 099 | INSTRUMENTAL | GAS PHASE CHEMILUMINESCENCE |

Note: The * indicates that the mean does not satisfy summary criteria.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AIR QUALITY SYSTEM

QUICK LOOK REPORT (AMP450 END)

Oct. 16, 2019

PQAOS USED IN THIS REPORT

| PQAO | AGENCY DESCRIPTION |
|---|---|
| 0851 | Pennsylvania Department Of Environmental Protection |

Note: The * indicates that the mean does not satisfy summary criteria.

Oct. 16, 2019

CERTIFICATION EVALUATION AND CONCURRENCE FLAG MEANINGS

| FLAG | MEANING |
|---|---|
| M | The monitoring organization has revised data from this monitor since the most recent certification letter received from the state. |
| N | The certifying agency has submitted the certification letter and required summary reports, but the certifying agency and/or EPA has determined that issues regarding the quality of the ambient concentration data cannot be resolved due to data completeness, the lack of performed quality assurance checks or the results of uncertainty statistics shown in the AMP255 report or the certification and quality assurance report. |
| S | The certifying agency has submitted the certification letter and required summary reports. A value of "S" conveys no Regional assessment regarding data quality per se. This flag will remain until the Region provides an "N" or "Y" concurrence flag. |
| U | Uncertified. The certifying agency did not submit a required certification letter and summary reports for this monitor even though the due date has passed, or the state's certification letter specifically did not apply the certification to this monitor. |
| X | Certification is not required by 40 CFR 58.15 and no conditions apply to be the basis for assigning another flag value |
| Y | The certifying agency has submitted a certification letter, and EPA has no unresolved reservations about data quality (after reviewing the letter, the attached summary reports, the amount of quality assurance data submitted to AQS, the quality statistics, and the highest reported concentrations). |

Note: The * indicates that the mean does
not satisfy summary criteria.

# APPENDIX H NEARBY SOURCE MODEL INPUT DATA

Appendix H
Renovo Energy Center
Input Data for Interactive Sources

| Facility | Source | Source Model ID | Emission Limits PM2.5 (lb/hr) | Emission Limits PM2.5 (tpy) | Emission Limits NOx (lb/hr) | Emission Limits NOx (tpy) | Stack Height (ft) | Stack Diameter (ft) | Exit Temp (°F) | Exit Flow (acfm) | Exit Flow (fps) | Easting (m) | Northing (m) | Base Elevation (m) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NCL Natural Resources LLC - Beech Creek | Compressor engine | BCH_CRK_1 | 0.04 | 0.16 | 0.93 | 4.07 | 8.0 | 0.3 | 1,094 | 989 | 192.7 | 268,831.5 | 4,568,311.0 | 670.0 | |
| | Compressor engine | BCH_CRK_2 | 0.04 | 0.16 | 0.95 | 4.15 | 8.0 | 0.4 | 1,040 | 1,061 | 127.6 | | | 670.0 | |
| NCL Natural Resources LLC - Tract 678 | Compressor engine | TRACT678 | N/A | N/A | 0.92 | 3.17 | 8.0 | 0.3 | 1,094 | 989 | 192.7 | 274,560.5 | 4,574,055.5 | 644.0 | |
| | Line Heater | DRY_RUN_1 | 0.01 | 0.04 | 0.15 | 0.66 | 8.0 | 0.3 | 460 | 290 | 56.5 | | | 539.0 | |
| | Compressor Engine | DRY_RUN_2 | 0.12 | 0.53 | 1.95 | 8.58 | 24.0 | 2.0 | 847 | 12,146 | 64.4 | | | 539.0 | |
| | Compressor Engine | DRY_RUN_3 | 0.12 | 0.53 | 1.95 | 8.58 | 24.0 | 2.0 | 847 | 12,146 | 64.4 | | | 539.0 | |
| Mountain Gathering LLC - Dry Run | Compressor Engine | DRY_RUN_4 | 0.12 | 0.53 | 1.95 | 8.58 | 24.0 | 2.0 | 847 | 12,146 | 64.4 | 276,617.5 | 4,583,130.5 | 539.0 | |
| | Compressor Engine | DRY_RUN_5 | 0.01 | 0.05 | 0.15 | 0.65 | 24.0 | 2.0 | 847 | 12,146 | 64.4 | | | 539.0 | |
| | Dehydrator | DRY_RUN_6 | 0.02 | 0.07 | 0.20 | 0.86 | 8.0 | 0.5 | 460 | 340 | 28.9 | | | 539.0 | |
| | Microturbine | DRY_RUN_7 | 0.12 | 0.53 | 1.95 | 8.58 | 12.0 | 1.0 | 535 | 17,572 | 372.9 | | | 539.0 | Outlet Flow - 11.7 lb/sec |
| | Boiler (039) | FFROCK_1 | 0.02 | 0.09 | 0.49 | 2.15 | 10.0 | 1.0 | 300 | | 30.0 | | | 535.0 | |
| | Boilers (042) | FFROCK_2 | 0.03 | 0.13 | 0.20 | 0.88 | 10.0 | 1.0 | 300 | | 30.0 | | | 535.0 | |
| | Boiler (043) | FFROCK_3 | 0.01 | 0.05 | 0.15 | 0.64 | 10.0 | 1.0 | 500 | 1,000 | 30.0 | | | 535.0 | |
| | Heater (044) | FFROCK_4 | 0.03 | 0.11 | 0.40 | 1.75 | 10.0 | 1.0 | 250 | 1,000 | 30.0 | | | 535.0 | |
| | Compressor Engine (P103) | FFROCK_5 | 0.09 | 0.39 | 7.28 | 31.87 | 24.0 | 1.0 | 900 | 7,995 | 169.7 | | | 535.0 | |
| | Compressor Engine (P104) | FFROCK_6 | 1.26 | 5.54 | 26.46 | 115.89 | 47.0 | 2.5 | 600 | 15,931 | 54.1 | | | 535.0 | |
| Dominion Transmission, Inc. - Finnefrock | Compressor Engine (P105) | FFROCK_7 | 1.90 | 8.32 | 39.70 | 173.89 | 53.0 | 3.0 | 650 | 48,015 | 113.2 | 261,256.0 | 4,589,933.0 | 535.0 | |
| | Compressor Engine (P106) | FFROCK_8 | 1.37 | 6.01 | 18.50 | 81.03 | 40.0 | 3.5 | 504 | 38,001 | 65.8 | | | 535.0 | |
| | Turbine Engine (P110) | FFROCK_9 | 0.02 | 0.07 | 7.51 | 32.88 | 20.0 | 1.0 | 950 | 25,000 | 60.0 | | | 535.0 | |
| | Turbine Engine (P111) | FFROCK_10 | 1.35 | 5.90 | 4.91 | 21.51 | 20.0 | 1.0 | 950 | 25,000 | 60.0 | | | 535.0 | |
| | Emergency Engine (P201) | FFROCK_11 | N/A | N/A | 3.43 | 0.43 | 10.0 | 1.0 | 950 | 2,500 | 100.0 | | | 535.0 | |
| | Emergency Engine (P202) | FFROCK_12 | 0.08 | 0.01 | 3.20 | 0.40 | 10.0 | 1.0 | 950 | 2,500 | 100.0 | | | 535.0 | |
| | Emergency Engine (P203) | FFROCK_13 | 0.03 | 0.002 | 0.35 | 0.02 | 10.0 | 1.0 | 950 | 2,500 | 100.0 | | | 535.0 | |
| | Bath Heaters (048A) | LEIDY_1 | 0.20 | 0.87 | 2.6 | 11.39 | 10.0 | 1.0 | 350 | 679 | 14.4 | | | 535.0 | |
| | Heaters (060) | LEIDY_2 | 0.16 | 0.72 | 1.42 | 6.20 | 10.0 | 1.0 | 350 | | 14.4 | | | 535.0 | |
| | Boilers (063) | LEIDY_3 | 0.31 | 1.34 | 11.51 | 50.40 | 10.0 | 1.0 | 350 | | 14.4 | | | 535.0 | |
| | Compressor Engine (P101) | LEIDY_4 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P102) | LEIDY_5 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P103) | LEIDY_6 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P104) | LEIDY_7 | 0.07 | 0.31 | 6.61 | 28.97 | 30.0 | 1.3 | 735 | 7,000 | 87.9 | | | 535.0 | |
| | Compressor Engine (P105) | LEIDY_8 | 0.07 | 0.31 | 6.61 | 28.97 | 30.0 | 1.3 | 735 | 7,000 | 87.9 | | | 535.0 | |
| | Compressor Engine (P106) | LEIDY_9 | 0.07 | 0.31 | 6.61 | 28.97 | 30.0 | 1.3 | 735 | 7,000 | 87.9 | | | 535.0 | |
| | Compressor Engine (P107) | LEIDY_10 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| Dominion Transmission, Inc. - Leidy | Compressor Engine (P108) | LEIDY_11 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | 261,706.0 | 4,590,223.0 | 535.0 | |
| | Compressor Engine (P109) | LEIDY_12 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P110) | LEIDY_13 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P111) | LEIDY_14 | 0.14 | 0.62 | 13.68 | 59.94 | 30.0 | 1.3 | 735 | 13,500 | 169.5 | | | 535.0 | |
| | Compressor Engine (P112) | LEIDY_15 | 0.23 | 1.00 | 22.49 | 98.49 | 30.0 | 1.7 | 700 | 29,999 | 220.3 | | | 535.0 | |
| | Compressor Engine (P113) | LEIDY_16 | 0.23 | 1.00 | 22.49 | 98.49 | 30.0 | 1.7 | 700 | 29,999 | 220.3 | | | 535.0 | |
| | Compressor Engine (P114) | LEIDY_17 | 0.70 | 1.00 | 8.81 | 12.57 | 30.0 | 1.7 | 700 | 29,999 | 220.3 | | | 535.0 | Limited to 2,855 hours in any 12 consecutive month period |
| | Gasoline-fired Engine (P212) | LEIDY_18 | 0.48 | 0.12 | 7.00 | 1.75 | 10.0 | 1.3 | 700 | | 100.0 | | | 535.0 | Limited to 500 hours in any 12 consecutive month period |
| | Diesel-fired Engines (P301) | LEIDY_19 | 0.43 | 0.16 | 3.76 | 1.41 | 10.0 | 0.5 | 180 | 100 | 100.0 | | | 535.0 | Limited to 750 hours in any 12 consecutive month period |
| | Misc Heaters | LEIDY_20 | 0.005 | 0.02 | 0.05 | 0.22 | 10.0 | 1.0 | 350 | | 14.4 | | | 535.0 | |

| Facility | Source | Source Model ID | Emission Limits PM2.5 (lb/hr) | PM2.5 (tpy) | NOx (lb/hr) | NOx (tpy) | Stack Height (ft) | Stack Diameter (ft) | Exit Temp (°F) | Exit Flow (acfm) | Exit Flow (fps) | Easting (m) | Northing (m) | Base Elevation (m) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boilers (037) | CGRENOVO_1 | 0.02 | 0.07 | 0.23 | 0.99 | *10.0* | *1.0* | 300 | | *30.0* | | | *221.0* | |
| | Catalytic Heaters (038) | CGRENOVO_2 | 0.002 | 0.01 | 0.04 | 0.18 | *10.0* | *1.0* | 300 | | *30.0* | | | *221.0* | |
| | Line Heater (039) | CGRENOVO_3 | 0.002 | 0.01 | 0.02 | 0.08 | *10.0* | *1.0* | 300 | | *30.0* | | | *221.0* | |
| | Heaters (040) | CGRENOVO_4 | 0.004 | 0.02 | 0.07 | 0.30 | *10.0* | *1.0* | 300 | | *30.0* | | | *221.0* | |
| Columbia Gas - Renovo | Compressor Engine (P101) | CGRENOVO_5 | 0.37 | 1.64 | 3.88 | 17.00 | 24.0 | 1.7 | 500 | 7,501 | 55.1 | *274,451.5* | *4,583,768.0* | *221.0* | |
| | Compressor Engine (P102) | CGRENOVO_6 | 0.37 | 1.64 | 3.88 | 17.00 | 24.0 | 1.7 | 500 | 7,501 | 55.1 | | | *221.0* | |
| | Compressor Engine (P104) | CGRENOVO_7 | 0.08 | 0.34 | 8.79 | 38.48 | 14.0 | 0.5 | 1,000 | 4,677 | 397.0 | | | *221.0* | |
| | Compressor Engine (P105) | CGRENOVO_8 | 0.08 | 0.34 | 8.79 | 38.48 | 14.0 | 0.5 | 1,000 | 4,677 | 397.0 | | | *221.0* | |
| | Emergency Engine (P106) | CGRENOVO_9 | 0.04 | 0.01 | 2.92 | 0.73 | 22.0 | 0.8 | 600 | 1,037 | 34.4 | | | *221.0* | Limited to 500 hours in any 12 consecutive month period |
| | Compressor Engine (P109) | CGRENOVO_10 | 0.06 | 0.28 | 2.85 | 12.50 | 20.0 | 1.3 | 797 | 4,751 | 59.7 | | | *221.0* | |
| | Heater (041) | GREENLICK_1 | 0.06 | 0.26 | 0.80 | 3.50 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (042) | GREENLICK_2 | 0.06 | 0.26 | 0.80 | 3.50 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (043) | GREENLICK_3 | 0.06 | 0.26 | 0.80 | 3.50 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (044) | GREENLICK_4 | 0.11 | 0.47 | 1.44 | 6.31 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (045) | GREENLICK_5 | 0.14 | 0.61 | 1.88 | 8.23 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (051) | GREENLICK_6 | 0.13 | 0.55 | 1.70 | 7.44 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (052) | GREENLICK_7 | 0.13 | 0.55 | 1.70 | 7.44 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (053) | GREENLICK_8 | 0.06 | 0.27 | 3.60 | 15.75 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (056) | GREENLICK_9 | 0.16 | 0.69 | 2.12 | 9.29 | *10.0* | *1.0* | *200* | | *30.0* | | | *556.0* | |
| | Heater (058) | GREENLICK_10 | 0.03 | 0.12 | 0.36 | 1.58 | *10.0* | *1.0* | 200 | | *30.0* | | | *556.0* | |
| | Heater (059) | GREENLICK_11 | 0.03 | 0.12 | 0.36 | 1.58 | *10.0* | *1.0* | 200 | | *30.0* | | | *556.0* | |
| Dominion - Greenlick | Boilers (070) | GREENLICK_12 | 0.01 | 0.03 | 0.08 | 0.35 | *10.0* | *1.0* | *200* | | *30.0* | 271,606.0 | 4,596,913.0 | *556.0* | |
| | Boilers (071) | GREENLICK_13 | 0.06 | 0.26 | 0.80 | 3.50 | *10.0* | *1.0* | 150 | | *30.0* | | | *556.0* | |
| | Compressor Engine (P101) | GREENLICK_14 | 1.04 | 4.56 | 21.84 | 95.66 | 36.0 | 2.0 | 850 | 24,945 | 132.3 | | | *556.0* | Based on RACT II requirments |
| | Compressor Engine (P102) | GREENLICK_15 | 1.10 | 4.82 | 9.65 | 42.27 | 36.0 | 2.0 | 850 | 24,945 | 132.3 | | | *556.0* | Based on RACT II requirments |
| | Compressor Engine (P103) | GREENLICK_16 | 1.03 | 4.51 | 16.02 | 70.17 | 36.0 | 2.0 | 850 | 24,945 | 132.3 | | | *556.0* | Based on RACT II requirments |
| | Compressor Engine (P104) | GREENLICK_17 | 1.14 | 4.99 | 16.41 | 71.88 | 36.0 | 2.0 | 850 | 24,945 | 132.3 | | | *556.0* | Based on RACT II requirments |
| | Compressor Engine (P105) | GREENLICK_18 | 0.03 | 0.15 | 6.35 | 16.96 | *36.0* | *2.0* | *850* | 9,999 | *132.3* | | | *556.0* | Source P105 and P106 limtied to a total combined 10,685 hours of |
| | Compressor Engine (P106) | GREENLICK_19 | 0.03 | 0.15 | 6.35 | 16.96 | *36.0* | *2.0* | *850* | 9,999 | *132.3* | | | *556.0* | operation per year |
| | Compressor Engine (P107) | GREENLICK_20 | 0.02 | 0.10 | 8.35 | 22.34 | *36.0* | *2.0* | *850* | 9,999 | *132.3* | | | *556.0* | Limited to 5,350 hours in any 12 consecutive month period |
| | Emergency Engine (P195) | GREENLICK_21 | 0.02 | 0.10 | 10.05 | 2.51 | *10.0* | *1.0* | *850* | 9,999 | *132.3* | | | *556.0* | Limited to 500 hours in any 12 consecutive month period |
| | Emergency Engine (P196) | GREENLICK_22 | N/A | N/A | 2.84 | 1.42 | *10.0* | *1.0* | *850* | 9,999 | *132.3* | | | *556.0* | Limited to 500 hours in any 12 consecutive month period |
| | Air Compressor Engine (P204) | GREENLICK_23 | N/A | N/A | 7.56 | 1.89 | *10.0* | *1.0* | *850* | | *132.3* | | | *556.0* | Limited to 500 hours in any 12 consecutive month period |

Note: Italicized values were developed using professional judgement, as information was not available from PaDEP.

# APPENDIX I MODELING INPUT AND OUTPUT FILES

Renovo Energy Center
Air Dispersion Modeling Protocol
Appendix I Filename Descriptions
February 2020

| Main Folder\Sub Folder(s) | Description |
|---|---|
| Appendix I\Terrain Data | Contains ArcGrid file downloaded from the National Map, as well as the converted Geotiff file |
| Appendix I\MET | Contains the AERMET-generated, site-specific meteorological data files that were used in all AERMOD runs. |
| Appendix I\Load Case Analysis\Aux Equip | AERMOD input files (in *.bst format) for load analyses of auxiliary equipment |
| Appendix I\Load Case Analysis\Aux Equip\BPIP | BPIP input and output files for auxiliary equipment load case analyses |
| Appendix I\Load Case Analysis\Aux Equip\Results | AERMOD output files for auxiliary equipment load case analyses |
| Appendix I\Load Case Analysis\CT SS | AERMOD input files (in *.bst format) for load analyses of combustion turbines in steady state conditions |
| Appendix I\Load Case Analysis\CT SS\BPIP | BPIP input and output files for combustion turbines in steady state conditions |
| Appendix I\Load Case Analysis\CT SS\Results | AERMOD output files for combustion turbines in steady state conditions |
| Appendix I\Load Case Analysis\CT SUSD | AERMOD input files (in *.bst format) for load analyses of combustion turbines in startup and shutdown conditions |
| Appendix I\Load Case Analysis\CT SUSD\BPIP | BPIP input and output files for combustion turbines in startup and shutdown conditions |
| Appendix I\Load Case Analysis\CT SUSD\Results | AERMOD output files for combustion turbines in startup and shutdown conditions |
| Appendix I\SIA\CO 1hr | AERMOD input file (in *.bst format) for 1-hr CO SIA analysis |
| Appendix I\SIA\CO 1hr\BPIP | BPIP input and output files for 1-hr CO SIA analysis |
| Appendix I\SIA\CO 1hr\Results | AERMOD output files for 1-hr CO SIA analysis |
| Appendix I\SIA\CO 8hr | AERMOD input file (in *.bst format) for 8-hr CO SIA analysis |
| Appendix I\SIA\CO 8hr\BPIP | BPIP input and output files for 8-hr CO SIA analysis |
| Appendix I\SIA\CO 8hr\Results | AERMOD output files for 8-hr CO SIA analysis |
| Appendix I\SIA\NO2 1hr | AERMOD input file (in *.bst format) for 1-hr $NO_2$ SIA analysis |
| Appendix I\SIA\NO2 1hr\BPIP | BPIP input and output files for 1-hr $NO_2$ SIA analysis |
| Appendix I\SIA\NO2 1hr\Results | AERMOD output files for 1-hr $NO_2$ SIA analysis |
| Appendix I\SIA\NO2 Annual | AERMOD input file (in *.bst format) for Annual $NO_2$ SIA analysis |
| Appendix I\SIA\NO2 Annual\BPIP | BPIP input and output files for Annual $NO_2$ SIA analysis |
| Appendix I\SIA\NO2 Annual\Results | AERMOD output files for Annual $NO_2$ SIA analysis |
| Appendix I\SIA\PM2.5 24hr | AERMOD input file (in *.bst format) for 24-hr $PM_{2.5}$ SIA analysis |
| Appendix I\SIA\ PM2.5 24hr\BPIP | BPIP input and output files for 24-hr $PM_{2.5}$ SIA analysis |
| Appendix I\SIA\ PM2.5 24hr\Results | AERMOD output files for 24-hr $PM_{2.5}$ SIA analysis |
| Appendix I\SIA\PM2.5 Annual | AERMOD input file (in *.bst format) for Annual $PM_{2.5}$ SIA analysis |
| Appendix I\SIA\ PM2.5 Annual\BPIP | BPIP input and output files for Annual $PM_{2.5}$ SIA analysis |
| Appendix I\SIA\ PM2.5 Annual\Results | AERMOD output files for Annual $PM_{2.5}$ SIA analysis |

| Main Folder\Sub Folder(s) | Description |
|---|---|
| Appendix I\SIA\PM10 24hr | AERMOD input file (in *.bst format) for 24-hr $PM_{10}$ SIA analysis |
| Appendix I\SIA\ PM10 24hr\BPIP | BPIP input and output files for 24-hr $PM_{10}$ SIA analysis |
| Appendix I\SIA\ PM10 24hr\Results | AERMOD output files for 24-hr $PM_{10}$ SIA analysis |
| Appendix I\SIA\PM10 Annual | AERMOD input file (in *.bst format) for Annual PM10 SIA analysis |
| Appendix I\SIA\ PM10 Annual \BPIP | BPIP input and output files for Annual PM10 SIA analysis |
| Appendix I\SIA\ PM10 Annual \Results | AERMOD output files for Annual PM10 SIA analysis |
| Appendix I\SIA\SO2 1hr | AERMOD input file (in *.bst format) for 1-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 1hr\BPIP | BPIP input and output files for 1-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 1hr\Results | AERMOD output files for 1-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 3hr | AERMOD input file (in *.bst format) for 3-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 3hr\BPIP | BPIP input and output files for 3-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 3hr\Results | AERMOD output files for 3-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 24hr | AERMOD input file (in *.bst format) for 24-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 24hr\BPIP | BPIP input and output files for 24-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 24hr\Results | AERMOD output files for 24-hr $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 Annual | AERMOD input file (in *.bst format) for Annual $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 Annual \BPIP | BPIP input and output files for Annual $SO_2$ SIA analysis |
| Appendix I\SIA\SO2 Annual \Results | AERMOD output files for Annual $SO_2$ SIA analysis |
| Appendix I\PSD Class I | Contains receptor files provided by PaDEP, and subfolders for each pollutant and averaging period required to be included in the Class I PSD SIL analysis |
| Appendix I\Increment\NO2 Annual | BEEST input file for Annual $NO_2$ Increment analysis |
| Appendix I\Increment\NO2 Annual\BPIP | BPIP input/output files for Annual $NO_2$ Increment analysis |
| Appendix I\Increment\NO2 Annual\Results | AERMOD input/output files for Annual $NO_2$ Increment analysis |
| Appendix I\Increment\PM2.5 24hr | BEEST input file for 24-hr $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM2.5 24hr\BPIP | BPIP input/output files for 24-hr $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM2.5 24hr\Results | AERMOD input/output files for 24-hr $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM2.5 Annual | BEEST input file for Annual $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM2.5 Annual\BPIP | BPIP input/output files for Annual $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM2.5 Annual\Results | AERMOD input/output files for Annual $PM_{2.5}$ Increment analysis |
| Appendix I\Increment\PM10 24hr | BEEST input file for 24-hr $PM_{10}$ Increment analysis |
| Appendix I\Increment\PM10 24hr\BPIP | BPIP input/output files for 24-hr $PM_{10}$ Increment analysis |
| Appendix I\Increment\PM10 24hr\Results | AERMOD input/output files for 24-hr $PM_{10}$ Increment analysis |
| Appendix I\Increment\PM10 Annual | BEEST input file for Annual $PM_{10}$ Increment analysis |
| Appendix I\Increment\PM10 Annual \BPIP | BPIP input/output files for Annual $PM_{10}$ Increment analysis |
| Appendix I\Increment\PM10 Annual \Results | AERMOD input/output files for Annual $PM_{10}$ Increment analysis |
| Appendix I\NAAQS\CO 1hr | BEEST input file for 1-hour CO NAAQS analysis |
| Appendix I\NAAQS\CO 1hr\BPIP | BPIP input/output files for 1-hour CO NAAQS analysis |
| Appendix I\NAAQS\CO 1hr\Results | AERMOD input/output files for 1-hour CO NAAQS analysis |
| Appendix I\NAAQS\NO2 1hr | BEEST input file for 1-hour $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 1hr\BPIP | BPIP input/output files for 1-hour $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 1hr\Results | AERMOD input/output files for 1-hour $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 1hr\Subgrid | AERMAP and AERMOD input/output files for the 50-meter sub-grids used in the 1-hour $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 1hr\Significant Receptors.xlsx | Spreadsheet used to identify the “significant receptors” based on the 1-hour $NO_2$ SIA analysis. |

| Main Folder\Sub Folder(s) | Description |
|---|---|
| Appendix I\NAAQS\NO2 Annual | BEEST input file for Annual $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 Annual\BPIP | BPIP input/output files for Annual $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\NO2 Annual\Results | AERMOD input/output files for Annual $NO_2$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 24hr | BEEST input file for 24-hr $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 24hr\BPIP | BPIP input/output files for 24-hr $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 24hr\Results | AERMOD input/output files for 24-hr $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 24hr\Subgrid | AERMAP and AERMOD input/output files for the 50-meter sub-grid used in the 24-hour $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 Annual | BEEST input file for Annual $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 Annual\BPIP | BPIP input/output files for Annual $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 Annual\Results | AERMOD input/output files for Annual $PM_{2.5}$ NAAQS analysis |
| Appendix I\NAAQS\PM2.5 Annual\Subgrid | AERMOD input/output files for the 50-meter sub-grid used in the Annual $PM_{2.5}$ NAAQS analysis (AERMAP files located in PM2.5 24-hour folder) |
| Appendix I\NAAQS\PM10 24hr | BEEST input file for 24-hr $PM_{10}$ NAAQS analysis |
| Appendix I\NAAQS\PM10 24hr\BPIP | BPIP input/output files for 24-hr $PM_{10}$ NAAQS analysis |
| Appendix I\NAAQS\PM10 24hr\Results | AERMOD input/output files for 24-hr $PM_{10}$ NAAQS analysis |
| Appendix I\NAAQS\SO2 1hr | BEEST input file for 1-hour $SO_2$ NAAQS analysis |
| Appendix I\NAAQS\SO2 1hr\BPIP | BPIP input/output files for 1-hour $SO_2$ NAAQS analysis |
| Appendix I\NAAQS\SO2 1hr\Results | AERMOD input/output files for 1-hour $SO_2$ NAAQS analysis |

# APPENDIX J VISCREEN SUMMARY REPORTS

Visual Effects Screening Analysis for
Source: Renovo Energy Center - NG
Class I Area: Hyner View State Park

*** User-selected Screening Scenario Results ***

Input Emissions for

| | | |
|---|---|---|
| Particulates | 45.00 | LB /HR |
| NOx (as NO2) | 66.60 | LB /HR |
| Primary NO2 | 0.00 | LB /HR |
| Soot | 0.00 | LB /HR |
| Primary SO4 | 0.00 | LB /HR |

PARTICLE CHARACTERISTICS

| | Density | Diameter |
|---|---|---|
| Primary Part. | 2.5 | 6 |
| Soot | 2.0 | 1 |
| Sulfate | 1.5 | 4 |

Transport Scenario Specifications:

| | |
|---|---|
| Background Ozone: | 0.04 ppm |
| Background Visual Range: | 40.00 km |
| Source-Observer Distance: | 11.00 km |
| Min. Source-Class I Distance: | 11.00 km |
| Max. Source-Class I Distance: | 11.00 km |
| Plume-Source-Observer Angle: | 11.25 degrees |
| Stability: | 5 |
| Wind Speed: | 1.00 m/s |

R E S U L T S

Asterisks (*) indicate plume impacts that exceed screening criteria

Maximum Visual Impacts INSIDE Class I Area
Screening Criteria ARE Exceeded

| | | | | | Delta E | | Contrast | |
|---|---|---|---|---|---|---|---|---|
| Backgrnd | Theta | Azi | Distance | Alpha | Crit | Plume | Crit | Plume |
| SKY | 10. | 84. | 11.0 | 84. | 3.49 | 1.695 | 0.06 | 0.016 |
| SKY | 140. | 84. | 11.0 | 84. | 2.00 | 0.714 | 0.06 | -0.015 |

Visual Effects Screening Analysis for
Source: Renovo Energy Center - ULSD
Class I Area: Hyner View State Park

*** User-selected Screening Scenario Results ***

Input Emissions for

| | | |
|---|---|---|
| Particulates | 96.40 | LB /HR |
| NOx (as NO2) | 119.20 | LB /HR |
| Primary NO2 | 0.00 | LB /HR |
| Soot | 0.00 | LB /HR |
| Primary SO4 | 0.00 | LB /HR |

PARTICLE CHARACTERISTICS

| | Density | Diameter |
|---|---|---|
| Primary Part. | 2.5 | 6 |
| Soot | 2.0 | 1 |
| Sulfate | 1.5 | 4 |

Transport Scenario Specifications:

| | |
|---|---|
| Background Ozone: | 0.04 ppm |
| Background Visual Range: | 40.00 km |
| Source-Observer Distance: | 11.00 km |
| Min. Source-Class I Distance: | 11.00 km |
| Max. Source-Class I Distance: | 11.00 km |
| Plume-Source-Observer Angle: | 11.25 degrees |
| Stability: | 5 |
| Wind Speed: | 1.00 m/s |

R E S U L T S

Asterisks (*) indicate plume impacts that exceed screening criteria

Maximum Visual Impacts INSIDE Class I Area
Screening Criteria ARE Exceeded

| | | | | | Delta E | | Contrast | |
|---|---|---|---|---|---|---|---|---|
| Backgrnd | Theta | Azi | Distance | Alpha | Crit | Plume | Crit | Plume |
| SKY | 10. | 84. | 11.0 | 84. | 3.49 | 3.212 | 0.06 | 0.035 |
| SKY | 140. | 84. | 11.0 | 84. | 2.00 | 1.321 | 0.06 | -0.029 |

# APPENDIX K FEDERAL LAND MANAGER CORRESPONDENCE

POWER ENGINEERS, INC.

303 U.S. ROUTE ONE
FREEPORT, ME 04032 USA

PHONE 207-869-1200
FAX 207-869-1299

February 7, 2020

Ms. Holly Salazer
Northeast Regional Air Resource Coordinator
Air Resources Division
National Park Service
P.O. Box 25287
Denver, CO 80225

Subject: Renovo Energy Center LLC, Class I AQRV Notification

Dear Ms. Salazer:

On behalf of Renovo Energy Center LLC (REC), POWER Engineers, Inc. is submitting the following updated information for your review to determine whether a Class I Air Quality Related Value (AQRV) Analysis will be required for REC's potential impacts at Shenandoah National Park. This information has been revised due to a design reconfiguration of REC since its initial permitting in 2017, specifically the addition of duct firing.

REC is proposing to construct a 1,240 MW (nominal) power plant in Renovo, Pennsylvania, which is approximately 271 kilometers north of the northernmost point of Shenandoah National Park in Virginia. REC's proposed power plant will consist of two combined cycle power blocks equipped with combustion turbines that will fire primarily on natural gas and will utilize ultra-low sulfur diesel (ULSD) fuel as back-up in the event natural gas supply is interrupted. The combustion turbines' heat recovery steam generators will be equipped with natural gas-fired duct burners. The facility will also include ancillary combustion devices to support the operation of the plant.

REC has conducted a "Q/d" analysis to assess whether the potential emissions from REC will cause or contribute to impairment of AQRVs at Shenandoah National Park. The Q/d analysis is presented below:

| | |
|---|---|
| 24-hour Maximum Allowable NOx Emissions (lbs): | 3,328.3 |
| 24-hour Maximum Allowable $SO_2$ Emissions (lbs): | 336.0 |
| 24-hour Maximum Allowable $PM_{10}$ Emissions (lbs): | 2,313.6 |
| 24-hour Maximum Allowable $H_2SO_4$ Emissions (lbs): | 211.2 |
| Q (Based on 365 Days of 24-hour Maximums): | 1,129.5 tons |
| Distance to Shenandoah National Park (d): | 271 kilometers |
| Q/d: | 4.17 |

*NOx based on 1 ULSD cold start and shutdown, remaining hours on ULSD steady state emissions. $SO_2$, $PM_{10}$, and $H_2SO_4$ based on 24 hours of ULSD steady state emissions. ULSD firing represents the 24-hour maximum emissions scenario.*

Note that the most conservative assumptions were used in calculating Q: ULSD is expected to be used only in the event natural gas is unavailable, and REC is proposing permit restrictions of a maximum of 30 days of ULSD-firing per year. Calculations based on natural gas-firing would result in a Q/d value much lower than that for ULSD-firing.

Based on the results of the Q/d analysis, REC does not expect that further analysis of AQRVs at Shenandoah National Park is required and requests your concurrence. Please direct your response to:

Muhammad Zaman
Environmental Program Manager, Northcentral Regional Office
Pennsylvania Department of Environmental Protection
208 West Third St., Suite 101
Williamsport, PA 17701
mzaman@pa.gov

Please copy me and Andrew Fleck of the Pennsylvania Department of Environmental Protection (afleck@pa.gov) on your response as well, and do not hesitate to contact me if you require additional information or wish to discuss.

Sincerely,

Tom Rolfson

c: Muhammad Zaman, Pennsylvania DEP
Paul Waldman, Pennsylvania DEP
Andrew Fleck, Pennsylvania DEP
Daniel Roble, Pennsylvania DEP
Richard Franzese, Bechtel Development Corporation
Bill Bousquet, Innovative Power Solutions, LLC

POWER ENGINEERS

POWER ENGINEERS, INC.

303 U.S. ROUTE ONE
FREEPORT, ME 04032 USA

PHONE 207-869-1200
FAX 207-869-1299

February 7, 2020

Ms. Linda Geiser
National Air Program Manager
United States Forest Service
1400 Independence Ave, SW
Washington, DC 20250

Subject: Renovo Energy Center LLC, Class I AQRV Notification

Dear Ms. Geiser:

On behalf of Renovo Energy Center LLC (REC), POWER Engineers, Inc. is submitting the following updated information for your review to determine whether a Class I Air Quality Related Value (AQRV) Analysis will be required for REC's potential impacts at the Dolly Sods and Otter Creek Wilderness Areas. This information has been revised due to a design reconfiguration of REC since its initial permitting in 2017, specifically the addition of duct firing.

REC is proposing to construct a 1,240 MW (nominal) power plant in Renovo, Pennsylvania, which is approximately 289 and 298 kilometers north-northeast of the northernmost points of the Dolly Sods and Otter Creek Wilderness Areas, respectively. REC's proposed power plant will consist of two combined cycle power blocks equipped with combustion turbines that will fire primarily on natural gas and will utilize ultra-low sulfur diesel (ULSD) fuel as back-up in the event natural gas supply is interrupted. The combustion turbines' heat recovery steam generators will be equipped with natural gas-fired duct burners. The facility will also include ancillary combustion devices to support the operation of the plant.

REC has conducted a "Q/d" analysis to assess whether the potential emissions from REC will cause or contribute to impairment of AQRVs at the Dolly Sods and Otter Creek Wilderness Areas. The Q/d analysis is presented below:

| | |
|---|---|
| 24-hour Maximum Allowable NOx Emissions (lbs): | 3,328.3 |
| 24-hour Maximum Allowable $SO_2$ Emissions (lbs): | 336.0 |
| 24-hour Maximum Allowable $PM_{10}$ Emissions (lbs): | 2,313.6 |
| 24-hour Maximum Allowable $H_2SO_4$ Emissions (lbs): | 211.2 |
| Q (Based on 365 Days of 24-hour Maximums): | 1,129.5 tons |
| Distance to Dolly Sods Wilderness Area (d): | 289 kilometers |
| Q/d: | 3.91 |
| Distance to Otter Creek Wilderness Area (D): | 298 kilometers |
| Q/d: | 3.79 |

*NOx based on 1 ULSD cold start and shutdown, remaining hours on ULSD steady state emissions. $SO_2$, $PM_{10}$, and $H_2SO_4$ based on 24 hours of ULSD steady state emissions. ULSD firing represents the 24-hour maximum emissions scenario.*

Note that the most conservative assumptions were used in calculating Q: ULSD is expected to be used only in the event natural gas is unavailable, and REC is proposing permit restrictions of a maximum of 30 days of ULSD-firing per year. Calculations based on natural gas-firing would result in a Q/d value much lower than that for ULSD-firing.

February 7, 2020

Based on the results of the Q/d analysis, REC does not expect that further analysis of AQRVs at the Dolly Sods or Otter Creek Wilderness Areas are required and requests your concurrence. Please direct your response to:

Muhammad Zaman
Environmental Program Manager, Northcentral Regional Office
Pennsylvania Department of Environmental Protection
208 West Third St., Suite 101
Williamsport, PA 17701
mzaman@pa.gov

Please copy me and Andrew Fleck of the Pennsylvania Department of Environmental Protection (afleck@pa.gov) on your response as well, and do not hesitate to contact me if you require additional information or wish to discuss.

Sincerely,

Tom Rolfson

c: Muhammad Zaman, Pennsylvania DEP
Paul Waldman, Pennsylvania DEP
Andrew Fleck, Pennsylvania DEP
Daniel Roble, Pennsylvania DEP
Richard Franzese, Bechtel Development Corporation
Bill Bousquet, Innovative Power Solutions, LLC

# Request for Applicability of Class I Area Modeling Analysis
## Eastern Region, U.S. Forest Service

| | |
|---|---|
| *Facility Name (Company Name)* | Renovo Energy Center LLC |
| *New Facility or Modification?* | New Facility |
| *Source Type/BART Applicability* | Combined Cycle Power Plant (natural gas/ULSD fired turbines) |
| *Project Location (County/State/ Lat. & Long. in decimal degrees)* | Renovo, Pennsylvania (Clinton County); 41.329°N, 77.756°W |

## Application Contacts

| *Applicant* | | *Consultant* | | *Air Agency Permit Engineer* | |
|---|---|---|---|---|---|
| **Company** | Renovo Energy Center LLC | **Company** | POWER Engineers, Inc. | **Agency** | Pennsylvania DEP, North Central Regional Office |
| **Contact** | Rick Franzese | **Contact** | Tom Rolfson | **Contact** | Paul Waldman |
| **Address** | 12011 Sunset Hills Road<br>Suite 110-RO1<br>Reston, VA 20190 | **Address** | 303 U.S. Route One<br>Freeport, ME 04032 | **Address** | 208 West Third Street<br>Suite 101<br>Williamsport, PA 17701 |
| **Phone #** | (571) 392-6383 | **Phone #** | (207) 869-1418 | **Phone #** | (570) 327-3721 |
| **Email** | rfranzes@bechtel.com | **Email** | Tom.rolfson@powereng.com | **Email** | pwaldman@pa.gov |

## Briefly Describe the Proposed Project

Renovo Energy Center is a proposed 1,240 MW (nominal) combined-cycle natural-gas fired power plant, utilizing ULSD for backup fuel only during periods when natural gas supply is unavailable (proposed permit limit of a maximum of 720 hours per year). The plant will consist of two GE 7HA.02 combustion turbines with duct-fired HRSGs.

Please note that the maximum hourly emission rates provided below represent ULSD-firing. The maximum hourly emission rate for NOx is for steady-state operations, while the proposed annual value is based on the 24-hour maximum value, which includes one cold start and associated shutdown (elevated NOx emissions during SUSD).

## Proposed Emissions and BACT

| ***Criteria Pollutant*** | ***Emissions*** | | ***Emission Factor (AP-42, Stack Test, Other?)*** | ***Proposed BACT*** |
|---|---|---|---|---|
| | ***Maximum hourly (lb/hr)*** | ***Proposed Annual (tons/yr)*** | | |
| Nitrogen Oxides | 59.60 (each) | 607.4 (total) | Vendor guarantee | SCR |
| Sulfur Dioxide | 7.00 (each) | 61.3 (total) | Vendor guarantee | Low sulfur fuels (NG, ULSD) |
| Particulate Matter | 48.20 (each) | 422.2 (total) | Vendor guarantee | Clean, low sulfur fuels (NG, ULSD) |
| Sulfuric Acid Mist | 4.40 (each) | 38.5 (total) | Vendor guarantee | Low sulfur fuels (NG, ULSD) |

## Proximity to U.S. Forest Service Class I Areas

| *Class I Area* | Dolly Sods Wilderness | Otter Creek Wilderness | |
|---|---|---|---|
| *Distance from Facility (km)* | 289 km | 298 km | |

For Additional Information or Questions, Contact Ralph Perron
(802) 222-1444 or rperron@fs.fed.us

# Request for Applicability of Class I Area Modeling Analysis
## Eastern Region, U.S. Forest Service

| | |
|---|---|
| *Facility Name (Company Name)* | Renovo Energy Center LLC |
| *New Facility or Modification?* | New Facility |
| *Source Type/BART Applicability* | Combined Cycle Power Plant (natural gas/ULSD fired turbines) |
| *Project Location (County/State/ Lat. & Long. in decimal degrees)* | Renovo, Pennsylvania (Clinton County); 41.329°N, 77.756°W |

## Application Contacts

| *Applicant* | | *Consultant* | | *Air Agency Permit Engineer* | |
|---|---|---|---|---|---|
| **Company** | Renovo Energy Center LLC | **Company** | POWER Engineers, Inc. | **Agency** | Pennsylvania DEP, North Central Regional Office |
| **Contact** | Rick Franzese | **Contact** | Tom Rolfson | **Contact** | Paul Waldman |
| **Address** | 12011 Sunset Hills Road<br>Suite 110-RO1<br>Reston, VA 20190 | **Address** | 303 U.S. Route One<br>Freeport, ME 04032 | **Address** | 208 West Third Street<br>Suite 101<br>Williamsport, PA 17701 |
| **Phone #** | (571) 392-6383 | **Phone #** | (207) 869-1418 | **Phone #** | (570) 327-3721 |
| **Email** | rfranzes@bechtel.com | **Email** | Tom.rolfson@powereng.com | **Email** | pwaldman@pa.gov |

## Briefly Describe the Proposed Project

Renovo Energy Center is a proposed 1,240 MW (nominal) combined-cycle natural-gas fired power plant, utilizing ULSD for backup fuel only during periods when natural gas supply is unavailable (proposed permit limit of a maximum of 720 hours per year). The plant will consist of two GE 7HA.02 combustion turbines with duct-fired HRSGs.

Please note that the maximum hourly emission rates provided below represent ULSD-firing. The maximum hourly emission rate for NOx is for steady-state operations, while the proposed annual value is based on the 24-hour maximum value, which includes one cold start and associated shutdown (elevated NOx emissions during SUSD).

## Proposed Emissions and BACT

| ***Criteria Pollutant*** | ***Emissions*** | | ***Emission Factor (AP-42, Stack Test, Other?)*** | ***Proposed BACT*** |
|---|---|---|---|---|
| | ***Maximum hourly (lb/hr)*** | ***Proposed Annual (tons/yr)*** | | |
| Nitrogen Oxides | 59.60 (each) | 607.4 (total) | Vendor guarantee | SCR |
| Sulfur Dioxide | 7.00 (each) | 61.3 (total) | Vendor guarantee | Low sulfur fuels (NG, ULSD) |
| Particulate Matter | 48.20 (each) | 422.2 (total) | Vendor guarantee | Clean, low sulfur fuels (NG, ULSD) |
| Sulfuric Acid Mist | 4.40 (each) | 38.5 (total) | Vendor guarantee | Low sulfur fuels (NG, ULSD) |

## Proximity to U.S. Forest Service Class I Areas

| | | | |
|---|---|---|---|
| *Class I Area* | Dolly Sods Wilderness | Otter Creek Wilderness | |
| *Distance from Facility (km)* | 289 km | 298 km | |

For Additional Information or Questions, Contact Ralph Perron
(802) 222-1444 or rperron@fs.fed.us

**pennsylvania**
DEPARTMENT OF ENVIRONMENTAL PROTECTION

**MEMO**

| | |
|---|---|
| **TO** | Paul R. Waldman<br>Air Quality Engineer<br>New Source Review Section<br>Air Quality Program<br>Northcentral Regional Office |
| **FROM** | Daniel J. Roble DJR<br>Air Quality Program Specialist<br>Air Quality Modeling Section<br>Division of Air Resource Management |
| **THROUGH** | Andrew W. Fleck AWF<br>Environmental Group Manager<br>Air Quality Modeling Section<br>Division of Air Resource Management |
| **DATE** | August 3, 2020 |
| **RE** | Summary of Air Quality Analyses for Prevention of Significant Deterioration<br>Renovo Energy Center, LLC<br>Plan Approval Application 18-00033B<br>Reconfiguration of Proposed Renovo Energy Center<br>Renovo Borough, Clinton County |

Background

The Pennsylvania Department of Environmental Protection (DEP) received a Plan Approval Application[1,2] on December 30, 2019, and February 28, 2020, from Renovo Energy Center, LLC (REC) for the reconfiguration of the Renovo Energy Center, a proposed nominally rated 1,240 megawatt (net) dual fuel (natural gas and ultra-low sulfur diesel (ULSD)) combined cycle electric power generation facility in Renovo Borough, Clinton County. The Plan Approval Application was prepared by POWER Engineers, Inc., on behalf of REC. On January 6, 2020, the DEP Northcentral Regional Office's (NCRO) Air Quality Program notified REC that its Plan Approval Application, which did not include the required air quality analyses at the time, was administratively complete.[3] On March 3, 2020, the DEP Bureau of Air Quality's (BAQ) Air

[1] Renovo Energy Center, LLC. Plan Approval Application. Renovo, Clinton County, Pennsylvania. Prepared by: POWER Engineers, Inc., Freeport, ME. December 27, 2019.
[2] Renovo Energy Center, LLC. Refined Air Dispersion Modeling Report for Plant Reconfiguration. Prepared by: POWER Engineers, Inc., Freeport, ME. February 27, 2020.
[3] Letter from Muhammad Q. Zaman, NCRO Air Quality Program to Richard P. Franzese, Bechtel Development Company. January 6, 2020.

Quality Modeling Section notified NCRO that the air quality analyses portion of REC's Plan Approval Application was administratively complete.[4]

The DEP previously issued Plan Approval 18-00033A to REC on January 26, 2018, authorizing construction and temporary operation of the Renovo Energy Center. Plan Approval 18-00033A, however, expired on July 25, 2019.

PSD Requirements

REC's proposal to construct the Renovo Energy Center, a new major stationary source, is subject to the Prevention of Significant Deterioration (PSD) regulations codified in 40 CFR § 52.21. These federal PSD regulations are adopted and incorporated by reference in their entirety in 25 *Pa. Code* § 127.83 and the Commonwealth's State Implementation Plan (SIP) codified in 40 CFR § 52.2020.

The Renovo Energy Center's potential to emit would equal or exceed the PSD significant emission rates (SER)[5] for carbon monoxide (CO), nitrogen oxides ($NO_X$), particulate matter less than or equal to 2.5 micrometers in diameter (PM-2.5), particulate matter less than or equal to 10 micrometers in diameter (PM-10), sulfur dioxide ($SO_2$), and sulfuric acid mist ($H_2SO_4$). REC's Plan Approval Application therefore includes:

- Relevant to 40 CFR § 52.21(k) through (n), air quality analyses of the Renovo Energy Center's emissions of CO, $NO_X$, PM-2.5, PM-10, and $SO_2$;

- Relevant to 40 CFR § 52.21(o), additional impact analyses of the impairment to visibility, soils, and vegetation that would occur as a result of the Renovo Energy Center and associated growth; and

- Relevant to 40 CFR § 52.21(p), initial screening calculations for analyses of the Renovo Energy Center's emissions on air quality related values (AQRV) and visibility in nearby federal Class I areas.

Model Selection and Options

REC's air dispersion modeling utilized the American Meteorological Society (AMS) / U.S. Environmental Protection Agency's (EPA) Regulatory Model (AERMOD) v19191. AERMOD is the EPA's required near-field air dispersion model for a wide range of regulatory applications in all types of terrain and for aerodynamic building downwash.[6] REC utilized proprietary software, Providence/Oris BEEST Suite version 12.01, to execute AERMOD and provided a test case example to demonstrate that the modeled concentrations were not affected by using this software.

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[4] Memorandum from Daniel Roble, BAQ Air Quality Modeling Section to Paul Waldman, NCRO New Source Review Section. March 3, 2020.
[5] *Code of Federal Regulations*. 40 CFR § 52.21(b)(23)(i).
[6] *Code of Federal Regulations*. 40 CFR Part 51, Appendix W (Guideline on Air Quality Models). Subsection 4.2.2.1.

AERMOD was executed with regulatory default options to calculate ground-level concentrations for each applicable pollutant and averaging time.

In the analyses for nitrogen dioxide ($NO_2$), the Ambient Ratio Method 2 (ARM2) option was selected with default upper and lower limits on the ambient $NO_2/NO_X$ ratio applied to the modeled $NO_X$ concentration of 0.9 and 0.5, respectively.

Source Data Input

The Renovo Energy Center would consist of the following emission sources:

- Two General Electric 7HA.02 combined cycle combustion turbines fueled with natural gas and ULSD, each with a heat recovery steam generator with a duct burner both fueled with natural gas;
- Two auxiliary boilers fueled with natural gas;
- One dew point heater fueled with natural gas;
- Three offsite fuel gas heaters fueled with natural gas;
- One emergency generator fueled with ULSD; and
- One emergency fire water pump fueled with ULSD.

The Renovo Energy Center's emissions of CO, $NO_X$, PM-2.5, PM-10, and $SO_2$ would be emitted to the atmosphere via typical unobstructed vertical stacks which were characterized in AERMOD as point sources.

The emission rates and associated parameters entered in AERMOD for each source are consistent with those provided in REC's Plan Approval Application.

In the annual $NO_2$ analyses, the emission rate entered in AERMOD for each combustion turbine was based on 7,540 hours per year (hr/yr) of worst-case base load operation with natural gas, 720 hr/yr of worst-case base load operation with ULSD, 460 hr/yr of startup/shutdown with natural gas, and 40 hr/yr of startup/shutdown with ULSD. REC's Plan Approval should therefore contain conditions restricting the annual operation of the combustion turbines for these emission scenarios.

In the annual $NO_2$, annual PM-2.5, annual PM-10, and annual $SO_2$ analyses, the emission rates entered in AERMOD for each auxiliary boiler were based on 118,800 MMBtu/yr throughput (equivalent to 1,800 hr/yr of operation at maximum load). REC's Plan Approval should therefore contain a condition restricting the annual operation of the auxiliary boilers.

In all analyses, the three offsite fuel gas heaters were not included in AERMOD since REC considered these emission sources to be insignificant and due to the absence of some associated emission data, i.e., exit temperature and exit velocity, for these emission sources.

In the annual $NO_2$, annual PM-2.5, annual PM-10, and annual $SO_2$ analyses, the emission rates entered in AERMOD for the emergency generator and emergency fire water pump were based on 500 hr/yr of operation and 250 hr/yr of operation, respectively. REC's Plan Approval should therefore contain conditions restricting the annual operation of the emergency generator and emergency fire water pump.

According to the EPA's guidance,[7] an intermittent emission source or intermittent emission scenario would likely not be continuous enough or frequent enough to affect 1-hour $NO_2$ and 1-hour $SO_2$ design concentrations. In the 1-hour $NO_2$ and 1-hour $SO_2$ analyses, emission data associated with the emergency generator and emergency fire water pump, both considered to be an intermittent emission source, were not included in AERMOD. REC's Plan Approval should therefore contain conditions restricting the magnitude, duration, and frequency of the emergency generator's and emergency fire water pump's emissions during testing based on information provided in the Plan Approval Application. In the 1-hour $NO_2$ analyses, emission data associated with the combustion turbines' startup and shutdown were conservatively included in AERMOD, except cold startup with ULSD and simultaneous cold startup of both combustion turbines with natural gas, both considered to be an intermittent emission scenario. REC's Plan Approval should therefore contain conditions restricting the magnitude, duration, and frequency of the emissions associated with the combustion turbines' cold startup with ULSD and simultaneous cold startup of both combustion turbines with natural gas based on information provided in the Plan Approval Application.

In the 24-hour and annual PM-2.5 analyses, the AERMOD results were appropriately adjusted upward to account for secondary PM-2.5 formation due to the Renovo Energy Center's emissions of PM-2.5 precursors, i.e., $NO_X$ and $SO_2$, based on the EPA's guidance.[8]

The stack height entered in AERMOD for each Renovo Energy Center point source does not exceed Good Engineering Practice (GEP) stack height.[9] Direction-specific downwash parameters, calculated by the EPA's Building Profile Input Program for the Plume Rise Model Enhancements algorithm (BPIPPRM) v04274, were entered in AERMOD for each Renovo Energy Center point source.

In the National Ambient Air Quality Standards (NAAQS) analyses, background concentrations consisted of a monitored component and, in some cases, a modeled component.

The monitored components of the CO, $NO_2$, PM-2.5, PM-10, and $SO_2$ background concentrations were derived from conservatively representative data measured from January 1, 2016, through December 31, 2018, at existing DEP-operated ambient monitors listed later in the "Existing Ambient Air Quality" section of this memorandum. In the 1-hour CO, annual $NO_2$, and 24-hour PM-10 NAAQS analyses, the monitored components of the CO, $NO_2$, and PM-10 background were represented by the maximum concentration for each pollutant and averaging time, based on 3 years of data. In the 1-hour $NO_2$, 24-hour PM-2.5, annual PM-2.5, and 1-hour $SO_2$ NAAQS analyses, the monitored components of the $NO_2$, PM-2.5, and $SO_2$ background

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[7] Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour $NO_2$ National Ambient Air Quality Standard. EPA memorandum from Tyler Fox, Air Quality Modeling Group to Regional Air Division Directors. March 1, 2011. Pages 8-11.
[8] Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003, April 2019).
[9] "Good Engineering Practice stack height" defined in 40 CFR § 51.100(ii).

were represented by the design value for each pollutant and averaging time, based on 3 years of data.

In the 1-hour $NO_2$, 24-hour PM-2.5, and annual PM-2.5 NAAQS analyses, the modeled components of the $NO_2$ and PM-2.5 background concentrations were calculated by the inclusion in AERMOD of source data that represent existing nearby sources. In the 1-hour CO, annual $NO_2$, 24-hour PM-10, and 1-hour $SO_2$ NAAQS analyses, no existing nearby sources were identified for inclusion in AERMOD because of the Renovo Energy Center's small radius of significant impact.

In the annual $NO_2$, 24-hour PM-10, and annual PM-10 Class II PSD increment analyses, no increment affecting emissions were identified for inclusion in AERMOD.

The PM-2.5 minor source baseline date[10] was established as June 15, 2017,[11] for the PM-2.5 baseline area[12] consisting of all of Clinton County, by REC's application for Plan Approval 18-00033A. In the 24-hour PM-2.5 and annual PM-2.5 Class II PSD increment analyses, no actual emissions[13] from any major stationary source on which construction commenced after the major source baseline date of October 20, 2010,[14] or any actual emissions increases and decreases at any stationary source occurring after the minor source baseline date of June 15, 2017, that would affect PM-2.5 Class II PSD increment in the area that would be affected by the Renovo Energy Center were identified for inclusion in AERMOD.

Receptor Data Input

Receptors were entered in AERMOD at locations defined to be ambient air.[15,16] The extent and density of AERMOD's receptor domain were adequate to determine the location and magnitude of the maximum concentrations and design concentrations.

Receptor elevations and hill height scales were calculated by the AERMOD terrain preprocessor (AERMAP) v18081 using the U.S. Geological Survey's (USGS) 3D Elevation Program (3DEP) data.

Meteorological Data Input

AERMOD utilized a 1-year meteorological dataset consisting of hourly records from October 27, 2015, through October 26, 2016. This dataset was derived from primary surface data from

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[10] "Minor source baseline date" for PM-2.5 defined in 40 CFR § 52.21(b)(14)(ii).
[11] REC submitted a complete PSD application for Plan Approval 18-00033A on June 15, 2017. The date, July 5, 2017, stated in the October 13, 2017, memorandum from Daniel J. Roble, BAQ Air Quality Modeling Section to Paul R.Waldman, NCRO New Source Review Section as the minor source baseline date was incorrect and was the date that the BAQ Air Quality Modeling Section determined the air quality analyses portion of REC's application for Plan Approval 18-00033A to be administratively complete.
[12] "Baseline area" defined in 40 CFR § 52.21(b)(15)(i).
[13] "Actual emissions" defined in 40 CFR § 52.21(b)(21).
[14] "Major source baseline date" for PM-2.5 defined in 40 CFR § 52.21(b)(14(i)(c).
[15] "Ambient air" defined in 40 CFR § 50(e)(1).
[16] Revised Policy on Exclusions from "Ambient Air." EPA memorandum from Andrew R. Wheeler, Administrator to Regional Administrators. December 2, 2019.

REC's meteorological monitoring site, secondary surface data from Williamsport Regional Airport (KIPT), and upper air data from Pittsburgh International Airport (KPIT). REC's meteorological monitoring program is described in detail in its meteorological monitoring plan[17] which was accepted by the DEP.[18]

The meteorological dataset was processed with the AERMOD meteorological preprocessor (AERMET) v19191 and its associated tool, AERSURFACE v13016. In AERMET, the surface friction velocity adjustment (ADJ_U*) option was used in regulatory default mode. This option is intended to address concerns regarding AERMOD's performance, i.e., overprediction of concentrations during stable low wind speed meteorological conditions, by adjusting the surface friction velocity based on Qian and Venkatram (2011).[19]

The fully processed dataset was appropriate for AERMOD to construct realistic boundary layer profiles to adequately represent plume transport and dispersion under both convective and stable conditions within the modeling domain.

Existing Ambient Air Quality

Existing ambient air quality was established for the area that the Renovo Energy Center's emissions would affect by utilizing conservatively representative CO, $NO_2$, PM-2.5, PM-10, and $SO_2$ data measured from January 1, 2016, through December 31, 2018, at the DEP-operated ambient monitors listed in the following table:

DEP Monitors for Establishing Existing Ambient Air Quality

| Pollutant | Monitor Site Name | Monitor Site ID |
|---|---|---|
| CO | Arendtsville | 42-001-0001 |
| $NO_2$ | Tioga County | 42-117-4000 |
| PM-2.5 | State College | 42-027-0100 |
| PM-10 | Montoursville | 42-081-0100 |
| $SO_2$ | Altoona | 42-013-0801 |

The data from these monitors were used for two purposes. First, if the impact of Renovo Energy Center's emissions was calculated by AERMOD to be less than a pollutant's NAAQS significant impact level (SIL), then these data were used to support the conclusion that the impact of the Renovo Energy Center's emissions of that pollutant would not cause or contribute to a violation of the NAAQS without having to conduct a cumulative impact analysis. Second, if the impact of the Renovo Energy Center's emissions was calculated by AERMOD to be greater than a pollutant's NAAQS SIL, then these data were used to characterize the monitored portion of the background concentration in a cumulative impact analysis.

[17] Meteorological Monitoring Plan for the Renovo Energy Center Renovo, PA Plant Site. Prepared by: Ambient Air Quality Services, Inc., Lincoln University, PA. Revised May 2015.
[18] Letter from Daniel J. Roble, BAQ Air Quality Modeling Section to Louis M. Militana, Ambient Air Quality Services, Inc. May 14, 2015.
[19] Qian, W., and A. Venkatram, 2011. Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions. *Boundary Layer Meteorology*, 138, 475-491.

REC should be exempted from the PSD pre-application ambient monitoring requirements[20] for $H_2SO_4$ since the EPA has not established a significant monitoring concentration (SMC) for $H_2SO_4$.[21]

Preliminary Analyses

REC conducted preliminary analyses with AERMOD to determine the load, i.e., operating condition, of the combustion turbines and auxiliary boilers that causes the maximum ground-level concentrations, i.e., worst-case impacts. The results of these preliminary analyses were used to determine the source data entered in AERMOD for the combustion turbines and auxiliary boilers in the SIL, NAAQS, and PSD increment analyses.

SIL Analyses Results

The impacts of the Renovo Energy Center's emissions were calculated by AERMOD to be less than the following:

- The EPA's 8-hour CO NAAQS SIL;[22]
- The EPA's 3-hour $SO_2$ NAAQS SIL;[23] and
- The EPA's 3-hour $SO_2$, 24-hour $SO_2$, and annual $SO_2$ Class II PSD increment SILs.[24]

Cumulative impact analyses were therefore not necessary for the 8-hour CO and 3-hour $SO_2$ NAAQS, and the 3-hour $SO_2$, 24-hour $SO_2$, and annual $SO_2$ Class II PSD increments.

The impacts of the Renovo Energy Center's emissions were calculated by AERMOD to be greater than the following:

- The EPA's 1-hour CO NAAQS SIL;[25]
- The EPA's 1-hour $NO_2$ interim NAAQS SIL;[26,27]
- The EPA's annual $NO_2$ NAAQS SIL;[28]
- The EPA's 24-hour PM-2.5 and annual PM-2.5 NAAQS SILs;[29]

[20] *Code of Federal Regulations*. 40 CFR § 52.21(m).
[21] *Code of Federal Regulations*. 40 CFR § 52.21(i)(5).
[22] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2).
[23] Ibid.
[24] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2). Based on long-standing EPA policy and guidance, these NAAQS SILs have also been applied to Class II PSD increments.
[25] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2).
[26] Guidance Concerning the Implementation of the 1-hour $NO_2$ NAAQS for the Prevention of Significant Deterioration Program. EPA memorandum from Stephen D. Page, OAQPS to Regional Air Division Directors. June 29, 2010. Pages 11-13.
[27] Interim 1-Hour Significant Impact Levels for Nitrogen Dioxide and Sulfur Dioxide. DEP memorandum from Andrew W. Fleck, BAQ Air Quality Modeling Section to Regional Air Program Managers. December 1, 2010.
[28] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2).
[29] Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. EPA memorandum from Peter Tsirigotis, OAQPS to Regional Air Division Directors. April 17, 2018. Pages 15-16.

- The EPA's 24-hour PM-10 NAAQS SIL;[30]
- The EPA's 1-hour $SO_2$ interim NAAQS SIL;[31,32]
- The EPA's annual $NO_2$ Class II PSD increment SIL;[33]
- The EPA's 24-hour PM-2.5 and annual PM-2.5 Class II PSD increment SILs;[34] and
- The EPA's 24-hour PM-10 and annual PM-10 Class II PSD increment SILs.[35]

Cumulative impact analyses were therefore necessary for the 1-hour CO, 1-hour $NO_2$, annual $NO_2$, 24-hour PM-2.5, annual PM-2.5, 24-hour PM-10, and 1-hour $SO_2$ NAAQS, and the annual $NO_2$, 24-hour PM-2.5, annual PM-2.5, 24-hour PM-10, and annual PM-10 Class II PSD increments.

The impacts of the Renovo Energy Center's emissions were conservatively calculated by AERMOD to be less than the following:

- The EPA's annual $NO_2$, 24-hour PM-10, annual PM-10, 3-hour $SO_2$, 24-hour $SO_2$, and annual $SO_2$ proposed Class I PSD increment SILs;[36] and
- The EPA's 24-hour PM-2.5 and annual PM-2.5 Class I PSD increment SILs.[37]

Cumulative impact analyses were therefore not necessary for the annual $NO_2$, 24-hour PM-2.5, annual PM-2.5, 24-hour PM-10, annual PM-10, 3-hour $SO_2$, 24-hour $SO_2$, and annual $SO_2$ Class I PSD increments.

NAAQS Analyses Results

The impacts of the Renovo Energy Center's emissions, in conjunction with emissions that represent existing nearby sources, if identified, were calculated by AERMOD to be less than the 1-hour CO, 1-hour $NO_2$, annual $NO_2$, 24-hour PM-2.5, annual PM-2.5, 24-hour PM-10, and 1-hour $SO_2$ NAAQS.

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[30] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2).
[31] Guidance Concerning the Implementation of the 1-hour $SO_2$ NAAQS for the Prevention of Significant Deterioration Program. EPA memorandum from Stephen D. Page, OAQPS to Regional Air Division Directors. August 23, 2010. Pages 4-6 of attached memorandum from Anna Marie Wood, OAQPS to Regional Air Division Directors.
[32] Interim 1-Hour Significant Impact Levels for Nitrogen Dioxide and Sulfur Dioxide. DEP memorandum from Andrew W. Fleck, BAQ Air Quality Modeling Section to Regional Air Program Managers. December 1, 2010.
[33] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2). Based on long-standing EPA policy and guidance, these NAAQS SILs have also been applied to Class II PSD increments.
[34] Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. EPA memorandum from Peter Tsirigotis, OAQPS to Regional Air Division Directors. April 17, 2018. Pages 16-17.
[35] *Code of Federal Regulations*. 40 CFR § 51.165(b)(2). Based on long-standing EPA policy and guidance, these NAAQS SILs have also been applied to Class II PSD increments.
[36] *Federal Register*. 61 FR 38249. Prevention of Significant Deterioration and Nonattainment New Source Review; Proposed Rule. July 23, 1996.
[37] Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. EPA memorandum from Peter Tsirigotis, OAQPS to Regional Air Division Directors. April 17, 2018. Pages 16-17.

PSD Increment Analyses Results

The impacts of the Renovo Energy Center's emissions were calculated by AERMOD to be less than the annual $NO_2$, 24-hour PM-2.5, annual PM-2.5, 24-hour PM-10, and annual PM-10 Class II PSD increments.

In accordance with 25 *Pa. Code* § 127.45(b)(4), the DEP's notice of proposed plan approval issuance in the *Pennsylvania Bulletin* must include, for sources subject to the PSD regulations, "the degree of increment consumption expected to result from the operation of the source or facility." To this end, the degree of Class II and Class I PSD increment consumption expected to result from the operation of the Renovo Energy Center is provided in the following tables:

Degree of Class II PSD Increment Consumption from Operation of the Renovo Energy Center

| Pollutant | Averaging Time | Degree of Class II PSD Increment Consumption | | Class II PSD Increment |
|---|---|---|---|---|
| | | micrograms per cubic meter | Percent of Class II PSD Increment | micrograms per cubic meter |
| $NO_2$ | Annual | < 1.27164 | < 5.09 % | 25 |
| PM-2.5 | 24-hour | < 8.39059 | < 93.23 % | 9 |
| | Annual | < 1.27313 | < 31.83 % | 4 |
| PM-10 | 24-hour | < 14.10192 | < 47.01 % | 30 |
| | Annual | < 1.26493 | < 7.45 % | 17 |
| $SO_2$ | 3-hour | < 8.15721 | < 1.60 % | 512 |
| | 24-hour | < 2.14058 | < 2.36 % | 91 |
| | Annual | < 0.19293 | < 0.97 % | 20 |

Degree of Class I PSD Increment Consumption from Operation of the Renovo Energy Center

| Pollutant | Averaging Time | Degree of Class I PSD Increment Consumption | | Class I PSD Increment |
|---|---|---|---|---|
| | | micrograms per cubic meter | Percent of Class I PSD Increment | micrograms per cubic meter |
| $NO_2$ | Annual | < 0.00670 | < 0.27 % | 2.5 |
| PM-2.5 | 24-hour | < 0.12904 | < 6.46 % | 2 |
| | Annual | < 0.01487 | < 1.49 % | 1 |
| PM-10 | 24-hour | < 0.01902 | < 0.24 % | 8 |
| | Annual | < 0.00667 | < 0.17 % | 4 |
| $SO_2$ | 3-hour | < 0.01258 | < 0.06 % | 25 |
| | 24-hour | < 0.00289 | < 0.06 % | 5 |
| | Annual | < 0.00103 | < 0.06 % | 2 |

Confirmation of Air Dispersion Modeling Results

The DEP confirmed the overall results of REC's air dispersion modeling by executing AERMOD upon reviewing the appropriateness of all model input, i.e., model options, emission data, downwash data, background concentration data, terrain data, and meteorological data.

Additional Impact Analyses

No impairment to visibility is expected from the Renovo Energy Center's emissions based on a plume visual impact screening analysis for Hyner View State Park using VISCREEN v13190 in accordance with the EPA's guidance.[38] REC conducted a Level-1 and a less conservative Level-2 plume visual impact screening analysis for the operation of the Renovo Energy Center with natural gas and ULSD, respectively.

No adverse impacts to soils and vegetation are expected from the Renovo Energy Center's emissions.

General commercial, residential, industrial, and other growth associated with the Renovo Energy Center is expected to be negligible.

The DEP notes that the secondary NAAQS were established to protect visibility and vegetation, among other things, and the impacts of the Renovo Energy Center's emissions were estimated by AERMOD to be less than the secondary NAAQS for the criteria pollutants subject to PSD review.

Class I Area Analyses for AQRVs and Visibility

REC provided written notice[39,40] of the proposed Renovo Energy Center to the Federal Land Managers (FLM) of the following nearby federal Class I areas: Dolly Sods Wilderness and Otter Creek Wilderness, both in West Virginia, and Shenandoah National Park in Virginia. The notice included initial screening calculations[41] to demonstrate that the Renovo Energy Center's emissions would not adversely impact AQRVs and visibility in these nearby federal Class I areas. The FLM of each nearby federal Class I area stated that no analyses for AQRVs and visibility would be necessary.[42,43]

Conclusions

The DEP's technical review concludes that REC's air quality analyses satisfy the requirements of the PSD regulations. Additionally, REC's air quality analyses are consistent with the methods and procedures described in REC's modeling protocol[44] established with the DEP.[45]

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[38] Workbook for Plume Visual Impact Screening and Analysis (Revised). October 1992. Publication No. EPA-454/R-92-023. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[39] Letter from Tom Rolfson, POWER Engineers to Linda Geiser, U.S. Forest Service. February 7, 2020.
[40] Letter from Tom Rolfson, POWER Engineers to Holly Salazer, National Park Service. February 7, 2020.
[41] U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service, 2010. Federal Land Managers' Air Quality Related Values Work Group (FLAG): Phase I Report – Revised (2010). Natural Resource Report NPS/NRPC/NRR – 2010/232. National Park Service, Denver, CO. Subsection 3.2.
[42] E-mail from Jeremy Ash, U.S. Forest Service to Tom Rolfson, POWER Engineers. February 27, 2020.
[43] E-mail from Holly Salazer, National Park Service to Tom Rolfson, POWER Engineers. February 20, 2020.
[44] Renovo Energy Center, LLC. Final Air Dispersion Modeling Protocol for Plant Reconfiguration. Prepared by: POWER Engineers, Inc., Freeport, ME. January 30, 2020.
[45] Letter from Daniel Roble, BAQ Air Quality Modeling Section to Tom Rolfson, POWER Engineers. February 3, 2020.

Furthermore, REC provided adequate responses[46,47] to the DEP's comments[48] on the air quality analyses.

In accordance with 40 CFR § 52.21(k), REC's source impact analyses demonstrate that the Renovo Energy Center's emissions would not cause or contribute to air pollution in violation of the NAAQS for CO, $NO_2$, PM-2.5, PM-10, or $SO_2$. Additionally, REC's source impact analyses demonstrate that the Renovo Energy Center's emissions would not cause or contribute to air pollution in violation of the Class II or Class I PSD increments for $NO_2$, PM-2.5, PM-10, or $SO_2$.

In accordance with 40 CFR § 52.21(l), REC's estimates of ambient concentrations are based on applicable air quality models, data bases, and other requirements specified in the EPA's *Guideline on Air Quality Models*[49] as well as the EPA's relevant air quality modeling policy and guidance.

In accordance with 40 CFR § 52.21(m), REC provided an analysis of existing ambient air quality in the area that the Renovo Energy Center would affect which included existing representative ambient monitoring data for CO, $NO_2$, PM-2.5, PM-10, and $SO_2$. REC should be exempted from the requirements of 40 CFR § 52.21(m) for $H_2SO_4$.

In accordance with 40 CFR § 52.21(n), REC provided all information necessary to perform the air quality analyses required by the PSD regulations, including all dispersion modeling data necessary to estimate the air quality impacts of the Renovo Energy Center's emissions.

In accordance with 40 CFR § 52.21(o), REC provided additional impact analyses of the impairment to visibility, soils, and vegetation that would occur as a result of the Renovo Energy Center and general commercial, residential, industrial, and other growth associated with the Renovo Energy Center.

In accordance with 40 CFR § 52.21(p), written notice of the proposed Renovo Energy Center has been provided to the FLMs of nearby federal Class I areas as well as initial screening calculations to demonstrate that the Renovo Energy Center's emissions would not adversely impact AQRVs and visibility in nearby federal Class I areas.

If you have any questions regarding REC's air quality analyses for PSD, you may contact me by e-mail at droble@pa.gov or by telephone at 717.705.7689. You may also contact Andrew Fleck, manager of the Air Quality Modeling Section, by e-mail at afleck@pa.gov or by telephone at 717.783.9243.

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[46] Letter with enclosures from Tom Rolfson, POWER Engineers to Daniel Roble, BAQ Air Quality Modeling Section. June 10, 2020.
[47] E-mail with link to electronic modeling data from Tom Rolfson, POWER Engineers to Daniel Roble, BAQ Air Quality Modeling Section. June 10, 2020.
[48] E-mail from Daniel Roble, BAQ Air Quality Modeling Section to Tom Rolfson, POWER Engineers. May 6, 2020.
[49] *Code of Federal Regulations*. 40 CFR Part 51, Appendix W.

cc: Viren Trivedi, BAQ Permits
Sean Wenrich, BAQ New Source Review
Muhammad Zaman, NCRO Air Quality
David Shimmel, NCRO New Source Review
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June 10, 2020

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Subject: DEP Comments on Air Quality Analyses for Prevention of Significant Deterioration
Renovo Energy Center, LLC
Plan Approval Application 18-00033B

Dear Daniel:

As discussed previously, on behalf of Renovo Energy Center LLC (REC), POWER Engineers, Inc. (POWER) is submitting the following responses to the Pennsylvania Department of Environmental Protection's (DEP) comments that were sent via email on May 6, 2020 on the Air Quality Analyses for Prevention of Significant Deterioration that was submitted on February 27, 2020 in support of REC's Plan Approval Application 18-00033B. The comments are shown in italics followed by REC's response.

1. *The ARM2 option in AERMOD determines the $NO_2/NO_x$ ambient ratio from the cumulative modeled $NO_x$ concentration based on the source group ALL. See page 22 of the September 20, 2013, "Ambient Ratio Method Version 2 (ARM2) for use with AERMOD for 1-hr $NO_2$ Modeling, Development and Evaluation Report" (https://www3.epa.gov/ttn/scram/models/aermod/ARM2_Development_and_Evaluation_Report-September_20_2013.pdf). In the 1-hour and annual $NO_2$ analyses, each load scenario should therefore be modeled separately so that the correct $NO_2/NO_x$ ambient ratio is determined by the ARM2 option.*

POWER has re-modeled all load scenarios for the 1-hour and annual $NO_2$ averaging periods using the suggested model options in order to determine the correct $NO_2$/NOx ambient ratio. Additionally, all subsequent 1-hour and annual $NO_2$ analyses were re-modeled to ensure that any changes in the significant impact area (including significant receptors for the 1-hour $NO_2$ NAAQS analysis) were accounted for. Presented below are updated tables from the February 27, 2020 Report (revisions are highlighted). Please note that several tables from the February 27, 2020 Report that display results from the $NO_2$ modeling did not warrant revision as the updated modeling did not result in a change in modeled concentrations displayed in the tables (i.e. changes less than one hundredth of a microgram per cubic meter) or did not change at all.

All electronic modeling files for the modeled revisions are included in Appendix A of this letter.

**TABLE 6 LOAD CASE ANALYSIS FOR CT STEADY STATE OPERATIONS, NATURAL GAS**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH OPERATING SCENARIO (µg/m³) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 15 | 16 | 17 | 18 | 19 |
| $SO_2$ | 1-hour | 9.14 | 8.84 | 9.64 | 8.82 | 6.88 | 6.74 | 6.22 | 13.17 | 11.46 | 12.75 | 11.86 | 12.22 |
| | 3-hour | 5.22 | 4.83 | 5.31 | 5.02 | 4.11 | 4.20 | 3.96 | 7.05 | 6.46 | 6.89 | 6.53 | 6.83 |
| | 24-hour | 1.05 | 0.99 | 1.08 | 1.01 | 1.08 | 1.05 | 1.01 | 1.44 | 1.33 | 1.40 | 1.33 | 1.38 |
| | Annual | 0.14 | 0.13 | 0.14 | 0.13 | 0.12 | 0.11 | 0.10 | 0.192 | 0.17 | 0.187 | 0.18 | 0.18 |
| $PM_{10}$ | 24-hour | 2.52 | 2.56 | 2.59 | 2.47 | 4.50 | 5.11 | 4.89 | 5.30 | 5.00 | 5.01 | 4.84 | 5.09 |
| | Annual | 0.34 | 0.34 | 0.35 | 0.33 | 0.48 | 0.52 | 0.50 | 0.71 | 0.66 | 0.67 | 0.65 | 0.68 |
| $PM_{2.5}$ | 24-hour | 1.31 | 1.37 | 1.38 | 1.28 | 1.88 | 2.06 | 1.98 | 2.88 | 2.67 | 2.72 | 2.57 | 2.67 |
| | Annual | 0.34 | 0.34 | 0.35 | 0.33 | 0.48 | 0.52 | 0.50 | 0.71 | 0.66 | 0.67 | 0.65 | 0.68 |
| $NO_2$ | 1-hour | 35.17 | 33.24 | 37.07 | 33.77 | 30.07 | 28.78 | 25.98 | 52.42 | 48.81 | 49.87 | 45.62 | 46.73 |
| | Annual | 1.10 | 1.07 | 1.13 | 1.06 | 1.27 | 1.30 | 1.24 | 1.37 | 1.31 | 1.34 | 1.29 | 1.32 |
| CO | 1-hour | 23.97 | 22.37 | 24.81 | 22.67 | 21.15 | 18.78 | 17.33 | 47.83 | 43.00 | 46.73 | 44.67 | 46.64 |
| | 8-hour | 6.05 | 5.63 | 6.20 | 5.80 | 4.63 | 4.60 | 4.12 | 11.83 | 10.63 | 11.60 | 11.18 | 11.68 |

Note: Results reflect statistical form of NAAQS. ARM2 was not applied to NO2 ambient impacts in order to condense the number of modeling runs. Bold/italics indicate maximum impacts per pollutant and averaging period.

**TABLE 7 LOAD CASE ANALYSIS FOR CT STEADY STATE OPERATIONS, ULSD**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH OPERATING SCENARIO (µg/m³) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 20 | 21 |
| $SO_2$ | 1-hour | 8.15 | 8.57 | 8.00 | 7.68 | 7.79 | 8.33 | 7.96 | 8.48 | 8.10 |
| | 3-hour | 5.23 | 5.66 | 5.81 | 5.45 | 4.78 | 4.56 | 4.31 | 5.76 | 5.24 |
| | 24-hour | 1.14 | 1.18 | 1.185 | 1.10 | 1.01 | 1.02 | 0.96 | 1.190 | 1.13 |
| | Annual | 0.13 | 0.139 | 0.1413 | 0.13 | 0.13 | 0.13 | 0.12 | 0.1410 | 0.13 |
| $PM_{10}$ | 24-hour | 7.87 | 8.13 | 8.263 | 8.264 | 8.47 | 10.00 | 9.87 | 8.20 | 7.96 |
| | Annual | 0.92 | 0.96 | 0.985 | 0.991 | 1.09 | 1.26 | 1.25 | 0.97 | 0.93 |
| $PM_{2.5}$ | 24-hour | 3.82 | 3.84 | 3.99 | 4.02 | 4.40 | 5.18 | 5.12 | 3.91 | 3.81 |
| | Annual | 0.92 | 0.96 | 0.985 | 0.991 | 1.09 | 1.26 | 1.25 | 0.97 | 0.93 |
| $NO_2$ | 1-hour | 52.79 | 55.12 | 53.99 | 51.02 | 51.91 | 52.87 | 49.06 | 55.34 | 52.31 |
| | Annual | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CO | 1-hour | 24.19 | 25.79 | 26.18 | 24.64 | 24.79 | 24.72 | 22.82 | 26.23 | 24.15 |
| | 8-hour | 8.22 | 8.39 | 8.45 | 7.91 | 6.56 | 6.33 | 5.87 | 8.51 | 8.10 |

Note: Results reflect statistical form of NAAQS. ARM2 was not applied to NO2 ambient impacts in order to condense the number of modeling runs. Bold/italics indicate maximum impacts per pollutant and averaging period.

**TABLE 8 STEADY STATE OPERATING SCENARIOS RESULTING IN WORST-CASE AMBIENT IMPACTS**

| POLLUTANT | AVERAGE PERIOD | WORST-CASE OPERATING SCENARIO | OPERATING SCENARIO AMBIENT TEMPERATURE | OPERATING SCENARIO COMBUSTION TURBINE CAPACITY |
|---|---|---|---|---|
| $SO_2$ | 1-hour | 15 | -20°F | 50% |
| | 3-hour | 15 | -20°F | 50% |
| | 24-hour | 15 | -20°F | 50% |
| | Annual | 15 | -20°F | 50% |
| $PM_{10}$ | 24-hour | 13 | 59°F | 50% |
| | Annual | 13 | 59°F | 50% |
| $PM_{2.5}$ | 24-hour | 13 | 59°F | 50% |
| | Annual | 13 | 59°F | 50% |
| $NO_2$ | 1-hour | 20 | 59°F | 100% |
| | Annual | 15 | -20°F | 50% |
| CO | 1-hour | 15 | -20°F | 50% |
| | 8-hour | 15 | -20°F | 50% |

Note: Operating scenario details are identified in Appendix B.

**TABLE 9 LOAD CASE ANALYSIS FOR CT SUSD OPERATIONS, NATURAL GAS**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH SUSD SCENARIO (µg/m³) | | | | | |
|---|---|---|---|---|---|---|---|
| | | | COLD/WARM STARTS | | | | |
| | | COLD STARTS | CT1 COLD CT2 WARM | CT1 WARM CT2 COLD | WARM STARTS | HOT STARTS | SHUT DOWNS |
| $NO_2$ | 1-hour | -- | 303.19 | 293.98 | 249.59 | 201.96 | 83.07 |
| CO | 1-hour | 3,539.75 | 2,190.47 | 2,318.64 | 969.36 | 1,057.78 | 1,124.07 |
| | 8-hour | 82.06 | 63.72 | 56.52 | 30.57 | 34.62 | 37.21 |

Note: Results reflect statistical form of NAAQS. ARM2 was not applied to NO2 ambient impacts in order to condense the number of modeling runs. Bold/italics indicate maximum impacts per pollutant and averaging period.

**TABLE 10 LOAD CASE ANALYSIS FOR CT SUSD OPERATIONS, ULSD**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH SUSD SCENARIO (µg/m³) | | | |
|---|---|---|---|---|---|
| | | COLD STARTS | WARM STARTS | HOT STARTS | SHUT DOWNS |
| $NO_2$ | 1-hour | -- | 332.53 | 276.39 | 185.80 |
| CO | 1-hour | 2,120.59 | 868.05 | 961.63 | 276.95 |
| | 8-hour | 62.58 | 30.54 | 35.45 | 15.87 |

Note: Results reflect statistical form of NAAQS. ARM2 was not applied to NO2 ambient impacts in order to condense the number of modeling runs. Bold/italics indicate maximum impacts per pollutant and averaging period.

**TABLE 12 LOAD CASE ANALYSIS FOR AUXILIARY SOURCE OPERATIONS**

| POLLUTANT | AVERAGE PERIOD | PREDICTED AMBIENT IMPACTS FROM EACH LOAD CASE SCENARIO (µg/m³) | | |
|---|---|---|---|---|
| | | 100% | 75% | 50% |
| $SO_2$ | 1-hour | 1.72 | 1.34 | 1.08 |
| | 3-hour | 1.19 | 0.97 | 0.83 |
| | 24-hour | 0.209 | 0.20 | 0.211 |
| | Annual | 0.010 | 0.011 | 0.013 |
| $PM_{10}$ | 24-hour | 4.08 | 4.09 | 4.14 |
| | Annual | 0.045 | 0.049 | 0.054 |
| $PM_{2.5}$ | 24-hour | 1.85 | 1.88 | 1.87 |
| | Annual | 0.045 | 0.049 | 0.054 |
| $NO_2$ | 1-hour | 25.81 | 20.57 | 16.06 |
| | Annual | 1.24 | 1.27 | 1.26 |
| CO | 1-hour | 435.06 | 444.33 | 390.62 |
| | 8-hour | 101.50 | 102.04 | 102.17 |

Note: Results reflect statistical form of NAAQS. ARM2 was not applied to NO2 ambient impacts in order to condense the number of modeling runs.
Bold/italics indicate maximum impacts per pollutant and averaging period.

**TABLE 19 OPERATING SCENARIOS USED IN SIA ANALYSIS**

| POLLUTANT | AVERAGE PERIOD | WORST-CASE SCENARIO | | DESIGN SCENARIO | |
|---|---|---|---|---|---|
| | | COMBUSTION TURBINE OPERATING SCENARIO | AUXILIARY EQUIPMENT OPERATING SCENARIO | COMBUSTION TURBINE OPERATING SCENARIO | AUXILIARY EQUIPMENT OPERATING SCENARIO |
| $SO_2$ | 1-hour | 15 (NG) | 100% | 17 (NG) | 100% |
| | 3-hour | 15 (NG) | 100% | 17 (NG) | 100% |
| | 24-hour | 15 (NG) | 50% | 17 (NG) | 100% |
| | Annual | 15 (NG) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $PM_{10}$ | 24-hour | 13 (ULSD) | 50% | 17 (NG) | 100% |
| | Annual | 13 (ULSD) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $PM_{2.5}$ | 24-hour | 13 (ULSD) | 75% | 17 (NG) | 100% |
| | Annual | 13 (ULSD) | 50% (Annual) | 17 (NG) | 100% (Annual) |
| $NO_2$ | 1-hour | 20 (ULSD) | 100% | 17 (NG) | 100% |
| | Annual | 15 (NG) | 75% (Annual) | 17 (NG) | 100% (Annual) |
| CO | 1-hour | Cold Starts (NG) | 75% | 17 (NG) | 100% |
| | 8-hour | Cold Starts (NG) | 50% | 17 (NG) | 100% |

**TABLE 20 SIA ANALYSIS RESULTS**

| POLLUTANT | AVERAGE PERIOD | SIL (µg/m³) | RADIUS OF IMPACT (km) WORST-CASE SCENARIO | DESIGN SCENARIO |
|---|---|---|---|---|
| $SO_2$ | 1-hour | 7.8 | 3.48 | 3.48 |
| | 3-hour | 25 | n/a[1] | n/a[1] |
| | 24-hour | 5 | n/a[1] | n/a[1] |
| | Annual | 1 | n/a[1] | n/a[1] |
| $PM_{10}$ | 24-hour | 5 | 3.20 | 2.01 |
| | Annual | 1 | 0.93 | n/a[1] |
| $PM_{2.5}$ | 24-hour | 1.2 | 17.01 | 9.01 |
| | Annual | 0.2 | 16.47 | 6.98 |
| $NO_2$ | 1-hour | 7.5 | 23.50 | 17.16 |
| | Annual | 1 | 0.95 | 0.93 |
| CO | 1-hour | 2,000 | 2.62 | n/a[1] |
| | 8-hour | 500 | n/a[1] | n/a[1] |

[1]Impacts below SIL.

2. *After reviewing the May 6, 2020, "Renovo Energy Center 18-00033B Technical Deficiency Letter" from David M. Shimmel, DEP, to Tim Donnelly, POWER Engineers, Inc., please make appropriate revisions, if warranted, to the modeling files and report.*

Revisions to the modeling files and report are not warranted after a review of the Letter. REC is proposing to reduce the CO and VOC emission limits from the combustion turbines and duct burners following consultation with the original equipment manufacturer; however, the resulting revisions to the exhaust stack discharge parameters are limited solely to the emission rates of CO and VOC. Exhaust gas discharge temperatures and flow rates were unaffected. Thus, the model-predicted CO impacts from the February 27, 2020 Report are considered conservative.

Included in Appendix B of this letter are the revised emission calculations related to the reduced CO and VOC emission limits as well as the exhaust temperature and flow rates.

Please do not hesitate to contact me if you require additional information.

Sincerely,

Tom Rolfson
Environmental Engineer

c: Paul Waldman
Rick Franzese
Bill Bousquet

Appendix A: Revised Electronic Modeling Files
Appendix B: Revised Emission Calculations for the Power Blocks

# Appendix A

Renovo Energy Center
Air Dispersion Modeling Addendum
Appendix A Filename Descriptions
June 2020

| Main Folder\Sub Folder(s) | Description |
|---|---|
| Appendix A\Load Case Analysis\Aux Equip\NO2_REV | Revised AERMOD input and output files for $NO_2$ load analyses of auxiliary equipment |
| Appendix A\Load Case Analysis\CT SS\NO2_REV | Revised AERMOD input and output files for $NO_2$ load analyses of combustion turbines in steady state conditions |
| Appendix A\Load Case Analysis\CT SUSD\NO2_REV | Revised AERMOD input and output files for $NO_2$ load analyses of combustion turbines in startup and shutdown conditions |
| Appendix A\SIA\NO2 1hr\REV | Revised AERMOD input and output files for 1-hr $NO_2$ SIA analysis |
| Appendix A\SIA\NO2 Annual\REV | Revised AERMOD input and output files for Annual $NO_2$ SIA analysis |
| Appendix A\PSD Class I\NO2 Annual\REV | Revised AERMOD input and output files for Annual $NO_2$ Class I PSD SIL analysis |
| Appendix A\Increment\NO2 Annual\REV | Revised AERMOD input and output files for Annual $NO_2$ Increment analysis |
| Appendix A\NAAQS\NO2 1hr\REV | Revised AERMOD input and output files for 1-hour $NO_2$ NAAQS analysis |
| Appendix A\NAAQS\NO2 Annual\REV | Revised AERMOD input and output files for Annual $NO_2$ NAAQS analysis |

# Appendix B

Renovo Energy Center
Facility-Wide Maximum Potential Emissions
Tons Per Year

| Pollutant | Power-blocks | Auxiliary Boilers | Diesel Generator | Diesel Fire Pump | Heater | ULSD storage tank | Circuit Breakers | Facility-Wide Total |
|---|---|---|---|---|---|---|---|---|
| NOx | 355.17 | 0.87 | 5.45 | 0.18 | 2.72 | --- | --- | 364.4 |
| CO | 325.86 | 5.23 | 1.50 | 0.059 | 5.93 | --- | --- | 338.6 |
| $PM_{10}$ | 211.92 | 0.28 | 0.16 | 0.0065 | 0.27 | --- | --- | 212.6 |
| VOC | 102.43 | 0.29 | 0.97 | 0.0065 | 0.73 | 0.042 | --- | 104.5 |
| $SO_2$ | 53.48 | 0.084 | 0.0055 | 0.00032 | 0.084 | --- | --- | 53.6 |
| $NH_3$ | 277.36 | --- | --- | --- | --- | --- | --- | 277.4 |
| Lead | 0.042 | --- | --- | --- | --- | --- | --- | 0.042 |
| $CO_2$ | 5,413,496 | 16,949 | 582.92 | 33.44 | 16,852 | --- | --- | 5,447,914 |
| $CH_4$ | 82.26 | 0.32 | 0.024 | 0.0014 | 0.32 | --- | --- | 82.9 |
| $N_2O$ | 10.21 | 0.032 | 0.0047 | 0.00027 | 0.032 | --- | --- | 10.3 |
| $SF_6$ | --- | --- | --- | --- | --- | --- | 0.0080 | 0.0080 |
| $CO_{2e}$ | 5,418,594 | 16,967 | 584.92 | 33.55 | 16,869 | --- | 182.97 | 5,453,232 |
| $H_2SO_4$ | 35.40 | 0.013 | --- | --- | --- | --- | --- | 35.4 |
| HAPs | 19.87 | 0.27 | 0.014 | 0.00078 | 0.27 | --- | --- | 20.4 |
| Hexane[1] | 7.36 | 0.26 | --- | --- | 0.25 | --- | --- | 7.9 |

[1] *Hexane is the single HAP with the highest potential emissions.*

| OPERATING POINT | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ambient Temperature | °F | -20 | 95.8 | 59 | 95.8 | -0.7 | 59 | 95.8 | -20 | 35 | 59 | 95.8 | -0.7 | 59 | 95.8 | -20 | 95.8 | 59 | 95.8 | -20 | 59 | 95.8 |
| Ambient Pressure | psia | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 |
| Ambient Relative Humidity | % | 60 | 35 | 60 | 35 | 60 | 60 | 35 | 60 | 60 | 60 | 35 | 60 | 60 | 35 | 60 | 35 | 60 | 35 | 60 | 60 | 35 |
| PLANT STATUS | | | | | | | | | | | | | | | | | | | | | | |
| SCR/CO Catalyst | | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating | Operating |
| Evaporative Cooler State[1] | on/off | Off | Off | On | On | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | On | On | Off | On | On |
| Gas Turbine Load | % | 100% | 100% | 100% | 100% | 38% | 30% | 32% | 100% | 100% | 100% | 100% | 60% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Duct Burner Status | on/off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | Off | On | On | On | On | On | Off | Off |
| Turbine Diluent Injection Type | | None | None | None | None | None | None | None | Water | Water | Water | Water | Water | Water | Water | None | None | None | None | None | Water | Water |
| Diluent Injection Flow | klb/hr | -- | -- | -- | -- | -- | -- | -- | 260.8 | 266.4 | 266.4 | 249.8 | 151.8 | 120.1 | 109.8 | -- | -- | -- | -- | -- | 266.4 | 254.2 |
| FUEL DATA | | | | | | | | | | | | | | | | | | | | | | |
| Fuel Type | | NG | NG | NG | NG | NG | NG | NG | DO | DO | DO | DO | DO | DO | DO | NG | NG | NG | NG | NG | DO | DO |
| HHV | Btu/lb | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 20,130 | 23,607 | 23,607 | 23,607 | 23,607 | 23,607 | 20,130 | 20,130 |
| LHV | Btu/lb | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 18,300 | 21,292 | 21,292 | 21,292 | 21,292 | 21,292 | 18,300 | 18,300 |
| Fuel Molecular Weight | lb/lbmole | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 16.52 | 16.52 | 16.52 | 16.52 | 16.52 | n/a | n/a |
| Fuel Bound Nitrogen | Wt % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | ≤ 0.015% | 0 | 0 | 0 | 0 | 0 | ≤ 0.015% | ≤ 0.015% |
| Fuel Sulfur Content | ppmw | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | 15 | 15 |
| GT Heat Consumption[2] | MMBtu/hr HHV | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 1,837.7 | 1,516.3 | 1,470.6 | 3,940.4 | 3,892.8 | 3,848.4 | 3,588.7 | 2,646.6 | 2,258.0 | 2,109.7 | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 3,523.8 | 3,914.6 | 3,824.7 |
| DB Heat Consumption[2] | MMBtu/hr HHV | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,001.9 | 821.6 | 906.8 | 878.2 | 1,005.3 | 0.0 | 0.0 |
| Total Heat Consumption | MMBtu/hr HHV | 3,523.8 | 3,230.1 | 3,541.1 | 3,459.2 | 1,837.7 | 1,516.3 | 1,470.6 | 3,940.4 | 3,892.8 | 3,848.4 | 3,588.7 | 2,646.6 | 2,258.0 | 2,109.7 | 4,525.7 | 4,051.7 | 4,447.9 | 4,337.4 | 4,529.1 | 3,914.6 | 3,824.7 |
| HRSG EXIT EXHAUST GAS | | | | | | | | | | | | | | | | | | | | | | |
| Stack N2 mole fraction | - | 0.7474 | 0.7326 | 0.7374 | 0.7266 | 0.75 | 0.7445 | 0.7377 | 0.7058 | 0.7001 | 0.6947 | 0.6889 | 0.7147 | 0.7113 | 0.7071 | 0.738 | 0.7244 | 0.7289 | 0.7184 | 0.738 | 0.6938 | 0.6862 |
| Stack O2 mole fraction | - | 0.1149 | 0.1115 | 0.1108 | 0.1086 | 0.1233 | 0.126 | 0.1262 | 0.09819 | 0.09532 | 0.09332 | 0.09369 | 0.1035 | 0.103 | 0.1052 | 0.08825 | 0.08783 | 0.08635 | 0.0846 | 0.08816 | 0.09297 | 0.09254 |
| Stack AR mole fraction | - | 0.0089 | 0.008724 | 0.008781 | 0.008653 | 0.008932 | 0.008865 | 0.008785 | 0.008406 | 0.008338 | 0.008274 | 0.008205 | 0.008511 | 0.008471 | 0.008422 | 0.008788 | 0.008626 | 0.008679 | 0.008554 | 0.008788 | 0.008263 | 0.008172 |
| Stack H2O mole fraction | - | 0.0852 | 0.1039 | 0.09875 | 0.1122 | 0.07808 | 0.0831 | 0.09079 | 0.1243 | 0.132 | 0.1391 | 0.1459 | 0.1121 | 0.1163 | 0.1205 | 0.1092 | 0.125 | 0.1206 | 0.1335 | 0.1093 | 0.1402 | 0.1496 |
| Stack CO2 mole fraction | - | 0.04344 | 0.04314 | 0.04418 | 0.04381 | 0.03958 | 0.03744 | 0.03641 | 0.06314 | 0.06407 | 0.06444 | 0.06312 | 0.06111 | 0.06083 | 0.05857 | 0.05561 | 0.05397 | 0.05533 | 0.05478 | 0.05565 | 0.06453 | 0.0634 |
| Molecular Weight | lb/lbmole | 28.42 | 28.21 | 28.28 | 28.13 | 28.46 | 28.39 | 28.29 | 28.27 | 28.19 | 28.12 | 28.03 | 28.38 | 28.33 | 28.26 | 28.26 | 28.08 | 28.14 | 27.99 | 28.26 | 28.11 | 28.00 |
| Temperature | °F | 185.2 | 190.5 | 181.4 | 194 | 163.1 | 160.3 | 166.9 | 291.5 | 284.5 | 280 | 288.3 | 259.6 | 243.4 | 251.2 | 172.8 | 178.6 | 176.3 | 182.2 | 180.5 | 281.3 | 293.8 |
| Mass Flow | lb/hr | 6,111,200 | 5,598,900 | 6,007,200 | 5,885,500 | 3,505,200 | 3,050,800 | 3,032,500 | 6,366,300 | 6,181,400 | 6,059,300 | 5,751,100 | 4,436,300 | 3,795,900 | 3,674,700 | 6,155,800 | 5,635,400 | 6,047,500 | 5,924,500 | 6,155,900 | 6,152,600 | 6,093,500 |
| Volume Flow | scf/hr (60°F) | 81,604,584 | 75,312,363 | 80,617,373 | 79,407,353 | 46,734,281 | 40,781,955 | 40,670,960 | 85,461,030 | 83,198,246 | 81,767,914 | 77,853,532 | 59,317,047 | 50,841,652 | 49,342,117 | 82,647,962 | 76,167,998 | 81,561,722 | 80,321,905 | 82,651,494 | 83,061,790 | 82,598,636 |
| | acf/hr | 103,700,000 | 96,501,000 | 101,850,000 | 102,280,000 | 57,353,000 | 49,823,000 | 50,219,000 | 126,510,000 | 122,010,000 | 119,190,000 | 114,760,000 | 84,074,000 | 70,446,000 | 69,122,000 | 103,010,000 | 95,811,000 | 102,230,000 | 101,600,000 | 104,270,000 | 121,290,000 | 122,650,000 |
| | acf/min | 1,728,333 | 1,608,350 | 1,697,500 | 1,704,667 | 955,883 | 830,383 | 836,983 | 2,108,500 | 2,033,500 | 1,986,500 | 1,912,667 | 1,401,233 | 1,174,100 | 1,152,033 | 1,716,833 | 1,596,850 | 1,703,833 | 1,693,333 | 1,737,833 | 2,021,500 | 2,044,167 |
| | fps | 75.778 | 70.517 | 74.426 | 74.740 | 41.910 | 36.408 | 36.697 | 92.446 | 89.157 | 87.097 | 83.860 | 61.436 | 51.478 | 50.510 | 75.273 | 70.013 | 74.703 | 74.243 | 76.194 | 88.631 | 89.625 |
| HRSG EXIT EXHAUST GAS EMISSIONS | | | | | | | | | | | | | | | | | | | | | | |
| NOx (pre-control)[3] | ppmvd @ 15% $O_2$ | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 25 | 25 | 25 | 25 | 25 | 42 | 42 |
| | lb/hr as $NO_2$ | 320.00 | 292.50 | 321.25 | 313.75 | 166.25 | 137.50 | 133.75 | 745.00 | 736.25 | 727.50 | 678.75 | 500.00 | 426.25 | 398.75 | 416.25 | 371.25 | 408.75 | 397.50 | 416.25 | 740.00 | 722.50 |
| NOx (post-control) | ppmvd @ 15% $O_2$ | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 4 |
| | lb/MMBtu | 0.0073 | 0.0072 | 0.0073 | 0.0073 | 0.0072 | 0.0073 | 0.0073 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.0074 | 0.0073 | 0.0074 | 0.0073 | 0.0074 | 0.015 | 0.015 |
| | lb/hr as $NO_2$ | 25.6 | 23.4 | 25.7 | 25.1 | 13.3 | 11 | 10.7 | 59.6 | 58.9 | 58.2 | 54.3 | 40 | 34.1 | 31.9 | 33.3 | 29.7 | 32.7 | 31.8 | 33.3 | 59.2 | 57.8 |
| CO (pre-control)[3] | ppmvd @ 15% $O_2$ | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 9 | 9 | 9 | 9 | 9 | 25 | 25 |
| | lb/hr | 31.50 | 28.80 | 31.50 | 31.05 | 16.65 | 13.50 | 13.05 | 81.45 | 80.55 | 79.65 | 74.25 | 54.90 | 46.80 | 43.65 | 68.40 | 61.20 | 67.05 | 65.25 | 68.40 | 81.00 | 79.20 |
| CO (post-control) | ppmvd @ 15% $O_2$ | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 2 | 2 |
| | lb/MMBtu | 0.0020 | 0.0020 | 0.0020 | 0.0020 | 0.0020 | 0.0020 | 0.0020 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0046 | 0.0034 | 0.0034 | 0.0033 | 0.0033 | 0.0034 | 0.0046 | 0.0046 |
| | lb/hr | 7.00 | 6.40 | 7.00 | 6.90 | 3.70 | 3.00 | 2.90 | 18.10 | 17.90 | 17.70 | 16.50 | 12.20 | 10.40 | 9.70 | 15.20 | 13.60 | 14.90 | 14.50 | 15.20 | 18.00 | 17.60 |
| VOC (pre-control)[3] | ppmvd @ 15% $O_2$ | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.5 | 3.5 |
| | lb/hr as methane | 6.20 | 5.80 | 6.20 | 6.20 | 3.20 | 2.60 | 2.60 | 18.20 | 18.03 | 17.68 | 16.63 | 12.25 | 10.50 | 9.80 | 19.18 | 17.12 | 18.77 | 18.36 | 19.18 | 18.03 | 17.68 |
| VOC (post-control) | ppmvd @ 15% $O_2$ | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 2 | 2 |
| | lb/MMBtu | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0026 | 0.0026 | 0.0026 | 0.0026 | 0.0026 | 0.0027 | 0.0027 | 0.0021 | 0.0020 | 0.0020 | 0.0021 | 0.0021 | 0.0026 | 0.0026 |
| | lb/hr as methane | 3.10 | 2.90 | 3.10 | 3.10 | 1.60 | 1.30 | 1.30 | 10.40 | 10.30 | 10.10 | 9.50 | 7.00 | 6.00 | 5.60 | 9.30 | 8.30 | 9.10 | 8.90 | 9.30 | 10.30 | 10.10 |
| $CO_2$ | lb/hr | 432,000 | 396,000 | 434,000 | 424,000 | 225,000 | 186,000 | 180,000 | 657,000 | 649,000 | 642,000 | 598,000 | 441,000 | 377,000 | 352,000 | 560,000 | 501,000 | 550,000 | 536,000 | 560,000 | 653,000 | 638,000 |
| | lb/MMBtu w/margin | 134.9 | 134.9 | 134.8 | 134.8 | 134.7 | 134.9 | 134.6 | 183.4 | 183.4 | 183.5 | 183.3 | 183.3 | 183.7 | 183.5 | 136.1 | 136.0 | 136.0 | 135.9 | 136.0 | 183.5 | 183.5 |
| | lb/hr w/10% margin[4] | 475,200 | 435,600 | 477,400 | 466,400 | 247,500 | 204,600 | 198,000 | 722,700 | 713,900 | 706,200 | 657,800 | 485,100 | 414,700 | 387,200 | 616,000 | 551,100 | 605,000 | 589,600 | 616,000 | 718,300 | 701,800 |
| | lb/MW-hr | 836 | 819 | 813 | 821 | 931 | 953 | 979 | 1,259 | 1,228 | 1,223 | 1,235 | 1,282 | 1,283 | 1,315 | 894 | 874 | 872 | 876 | 892 | 1,210 | 1,220 |
| $NH_3$ | ppmvd @ 15% $O_2$ | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | lb/MMBtu | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0067 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0068 | 0.0068 | 0.0068 | 0.0068 | 0.0068 | 0.0070 | 0.0070 |
| | lb/hr | 23.7 | 21.7 | 23.8 | 23.2 | 12.3 | 10.2 | 9.9 | 27.6 | 27.2 | 26.9 | 25.1 | 18.5 | 15.8 | 14.8 | 30.8 | 27.5 | 30.2 | 29.5 | 30.8 | 27.4 | 26.8 |
| | lb/hr w/5% margin[4] | 24.89 | 22.79 | 24.99 | 24.36 | 12.92 | 10.71 | 10.40 | 28.98 | 28.56 | 28.25 | 26.36 | 19.43 | 16.59 | 15.54 | 32.34 | 28.88 | 31.71 | 30.98 | 32.34 | 28.77 | 28.14 |
| SOx[5] | lb/hr as $SO_2$ (+20%) | 4.70 | 4.30 | 4.70 | 4.60 | 2.40 | 2.00 | 2.00 | 7.00 | 7.00 | 6.90 | 6.40 | 4.70 | 4.00 | 3.80 | 6.10 | 5.40 | 6.00 | 5.80 | 6.10 | 7.00 | 6.80 |
| PM | lb/hr | 11.3 | 11.1 | 11.3 | 11.3 | 10.0 | 9.7 | 9.7 | 48.2 | 48.2 | 48.1 | 47.9 | 39.6 | 39.2 | 39.0 | 22.5 | 20.3 | 21.5 | 21.1 | 22.5 | 48.2 | 48.1 |
| | lb/MMBtu | 0.0032 | 0.0034 | 0.0032 | 0.0033 | 0.0054 | 0.0064 | 0.0066 | 0.0122 | 0.0124 | 0.0125 | 0.0133 | 0.0150 | 0.0174 | 0.0185 | 0.0050 | 0.0050 | 0.0048 | 0.0049 | 0.0050 | 0.0123 | 0.0126 |
| $H_2SO_4$ | lb/hr | 2.60 | 2.40 | 2.70 | 2.60 | 1.40 | 1.10 | 1.10 | 4.00 | 3.90 | 3.90 | 3.60 | 2.70 | 2.30 | 2.10 | 3.70 | 3.30 | 3.70 | 3.60 | 3.70 | 3.90 | 3.90 |
| | lb/hr w/10% margin[4] | 2.86 | 2.64 | 2.97 | 2.86 | 1.54 | 1.21 | 1.21 | 4.40 | 4.29 | 4.29 | 3.96 | 2.97 | 2.53 | 2.31 | 4.07 | 3.63 | 4.07 | 3.96 | 4.07 | 4.29 | 4.29 |
| $CH_2O$[6] | ppbvd @ 15% $O_2$ | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 | 45.5 |
| | lb/MMBtu | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 | 0.00012 |
| | lb/hr | 0.42 | 0.38 | 0.42 | 0.41 | 0.22 | 0.18 | 0.17 | 0.47 | 0.46 | 0.46 | 0.43 | 0.31 | 0.27 | 0.25 | 0.54 | 0.48 | 0.53 | 0.52 | 0.54 | 0.46 | 0.45 |
| | lb/hr w/10% margin[4] | 0.46 | 0.42 | 0.46 | 0.45 | 0.24 | 0.20 | 0.19 | 0.51 | 0.51 | 0.50 | 0.47 | 0.35 | 0.30 | 0.28 | 0.59 | 0.53 | 0.58 | 0.57 | 0.59 | 0.51 | 0.50 |

Notes

[1] Operating points included list evaporative coolers as "off," however evaporative coolers may be operated when firing ULSD.

[2] The heat consumption provided by G.E. included a ~5% margin to account for equipment degradation and site variability.

[3] Pre-control emissions rates when firing natural gas were provided by G.E. on a ppm basis. The same control efficiency for ppm values was used for the lb/hr pre-control emission rates.  For emission rates when firing ULSD, the same control efficiency as determined for natural gas emissions was used to determine pre-control emissions when firing ULSD.

[4] A 10% margin was added to lb/hr emission values of $CO_2$, $H_2SO_4$, $NH_3$, and $CH_2O$ to account for equipment degradation and site variability.

[5] SOx emission rates provided by G.E. included a margin of 20% to account for fuel and site variability.

[6] $CH_2O$ emission rate of 91 ppb @ 15% $O_2$ is the turbine outlet concentration provided by G.E. (91 ppb) with a 50% control efficiency applied for the oxidation catalyst.

Renovo Energy Center
Determination of Maximum Potential Emissions
Powerblocks- Turbines, HRSGs firing Natural Gas

| | | | |
|---|---|---|---|
| Maximum Fuel Flow Rate: | 150,002 | lb/hr each | |
| Fuel Gross Heating Value: | 23,607 | Btu/lb | |
| Maximum GT heat input capacity: | 3,541 | MMBtu/hr each | |
| Maximum GT+DB heat input capacity: | 4,529 | MMBtu/hr each | |
| Annual capacity factor: | 100 | % | |
| Maximum emissions scenario operating hours: | 7,540 | hours each | *(not including SUSD or ULSD operations)* [1] |
| Maximum emissions scenario annual heat input: | 34,149,414 | MMBtu/yr each | *(not including SUSD or ULSD operations)* |

Maximum annual emissions calculated based on maximum potential operating hours.
Values below represent emissions from each individual unit.

| Pollutant[2] | Emission Factor (ppmvd @ 15% $O_2$) | Maximum Short-term Emission Rate (GT only) (lb/hr) | Maximum Short-term Emission Rate (GT+DB) (lb/hr) | Maximum Potential Annual Emissions[5] (ton/yr) |
|---|---|---|---|---|
| NOx | 2 | 25.70 | 33.30 | 125.54 |
| CO | 0.9 (GT); 1.5 (GT+DB) | 7.00 | 15.20 | 57.30 |
| $PM_{10}$ | -- | 11.30 | 22.50 | 84.83 |
| VOC | 0.7 (GT); 1.6 (GT+DB) | 3.10 | 9.30 | 35.06 |
| $SO_2$ | -- | 4.70 | 6.10 | 23.00 |
| $NH_3$ | 5 | 24.99 | 32.34 | 121.92 |
| $H_2SO_4$ | -- | 2.97 | 4.07 | 15.34 |
| *GHGs* [3] | (kg/MMBtu) | (lb/hr) | (lb/hr) | (ton/yr) |
| $CO_2$ | -- | 477,400 | 616,000 | 2,322,320 |
| $CH_4$ | 1.0E-03 | 7.81 | 7.81 | 29.43 |
| $N_2O$ | 1.0E-04 | 0.78 | 0.78 | 2.94 |
| $CO_{2equivalent}$ | | 477,827.8 | 616,427.8 | 2,323,933 |
| *HAPs* [4] | GT (lb/MMBtu) | DB (lb/MMscf) | GT+DB (lb/hr) | (ton/yr) |
| 1,3-butadiene | 2.2E-07 | 0 | 7.6E-04 | 0.0029 |
| acetaldehyde | 2.0E-05 | 0 | 7.0E-02 | 0.27 |
| acrolein | 3.2E-06 | 0 | 1.1E-02 | 0.043 |
| benzene | 6.0E-06 | 1.2E-03 | 2.2E-02 | 0.08 |
| dichlorobenzene | 0 | 6.6E-04 | 6.5E-04 | 0.0025 |
| ethyl benzene | 1.6E-05 | 0 | 5.6E-02 | 0.21 |
| formaldehyde[2] | -- | -- | 5.9E-01 | 2.23 |
| hexane | 0 | 9.9E-01 | 9.8E-01 | 3.68 |
| naphthalene | 6.5E-07 | 3.4E-04 | 2.6E-03 | 0.010 |
| PAH | 1.1E-06 | 0 | 3.9E-03 | 0.015 |
| POM | 0 | 4.9E-05 | 4.8E-05 | 0.00018 |
| propylene oxide | 1.5E-05 | 0 | 5.1E-02 | 0.19 |
| toluene | 6.5E-05 | 1.9E-03 | 2.3E-01 | 0.87 |
| xylenes | 3.3E-05 | 0 | 1.1E-01 | 0.43 |

| *HAPs* [4] | GT (lb/MMBtu) | DB (lb/MMscf) | GT+DB (lb/hr) | (ton/yr) |
|---|---|---|---|---|
| arsenic | 0 | 2.0E-04 | 2.0E-04 | 0.00074 |
| beryllium | 0 | 1.2E-05 | 1.2E-05 | 0.000045 |
| cadmium | 0 | 1.1E-03 | 1.1E-03 | 0.0041 |
| chromium | 0 | 1.4E-03 | 1.4E-03 | 0.0052 |
| cobalt | 0 | 8.4E-05 | 8.3E-05 | 0.00031 |
| lead | 0 | 0 | 0 | 0 |
| manganese | 0 | 3.8E-04 | 3.7E-04 | 0.0014 |
| mercury | 0 | 2.6E-04 | 2.6E-04 | 0.00097 |
| nickel | 0 | 2.1E-03 | 2.1E-03 | 0.0078 |
| selenium | 0 | 0 | 2.4E-05 | 0.000089 |
| TOTAL HAPs | | 1.00 | 2.14 | 8.06 |

[1]Maximum potential operating hours not including SUSD or ULSD operations was used to estimate emissions.

[2]Emission factors provided by vendor. The maximum emissions rate from all available operating scenarios was used to calculate maximum potential emissions.

[3]Emission factor for $CO_2$ provided by vendor. Emission factors for $CH_4$ and $N_2O$ obtained from 40 CFR 98.

[4]HAP emission factors for GT obtained from EPA's AP-42, Table 3.1-3 and reflect control level of 50% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from the vendor. HAP emission factors for DB obtained from EPA's AP-42, Tables 1.4-3 and 1.4-4 and reflect control level of 45% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from vendor.

[5]Potential annual emissions based on the GT + DB scenario, as this is considered worst-case.

Renovo Energy Center
Determination of Maximum Potential Emissions
Powerblocks- Turbines firing ULSD

| | | | |
|---|---|---|---|
| Maximum Fuel Flow Rate: | 195,748 | lb/hr each | |
| Fuel Gross Heating Value: | 20,130 | Btu/lb | |
| Maximum heat input capacity: | 3,940 | MMBtu/hr each | |
| Annual capacity factor: | 100 | % | |
| Maximum potential operating hours: | 720 | hours each | *(not including SUSD)* [1] |
| Maximum annual heat input: | 2,837,088 | MMBtu/yr | *(not including SUSD)* |

Maximum annual emissions calculated based on maximum potential operating hours.
Values below represent emissions from each individual unit.

| Pollutant[2] | Emission Factor (ppmvd @ 15% $O_2$) | Maximum Short-Term Emission Rate (lb/hr) | Maximum Potential Annual Emissions (ton/yr) |
|---|---|---|---|
| NOx | 4 | 59.60 | 21.46 |
| CO | 2 | 18.10 | 6.52 |
| $PM_{10}$ | -- | 48.20 | 17.35 |
| VOC | 2 | 10.40 | 3.74 |
| $SO_2$ | -- | 7.00 | 2.52 |
| $NH_3$ | 5 | 28.98 | 10.43 |
| $H_2SO_4$ | -- | 4.40 | 1.58 |
| *GHGs* [3] | (kg/MMBtu) | (lb/hr) | (ton/yr) |
| $CO_2$ | -- | 722,700 | 260,172 |
| $CH_4$ | 3.0E-03 | 26.06 | 9.38 |
| $N_2O$ | 6.0E-04 | 5.21 | 1.88 |
| $CO_{2equivalent}$ | -- | 724,904.8 | 260,966 |
| *HAPs* [4] | (lb/MMBtu) | (lb/hr) | (ton/yr) |
| 1,3-butadiene | 1.1E-05 | 4.4E-02 | 0.016 |
| acetaldehyde | 0 | 0 | 0 |
| acrolein | 0 | 0 | 0 |
| benzene | 3.9E-05 | 1.5E-01 | 0.055 |
| dichlorobenzene | 0 | 0 | 0 |
| ethyl benzene | 0 | 0 | 0 |
| formaldehyde[2] | -- | 5.1E-01 | 0.19 |
| hexane | 0 | 0 | 0 |
| naphthalene | 2.5E-05 | 9.7E-02 | 0.035 |
| PAH | 2.8E-05 | 1.1E-01 | 0.040 |
| POM | 0 | 0 | 0 |
| propylene oxide | 0 | 0 | 0 |
| toluene | 0 | 0 | 0 |
| xylenes | 0 | 0 | 0 |
| arsenic | 1.1E-05 | 4.3E-02 | 0.016 |
| beryllium | 3.1E-07 | 1.2E-03 | 0.00044 |
| cadmium | 4.8E-06 | 1.9E-02 | 0.0068 |
| chromium | 1.1E-05 | 4.3E-02 | 0.016 |
| cobalt | 0 | 0 | 0 |
| lead | 1.4E-05 | 5.5E-02 | 0.020 |

| *HAPs* [4] | (lb/MMBtu) | (lb/hr) | (ton/yr) |
|---|---|---|---|
| manganese | 7.9E-04 | 3.11 | 1.12 |
| mercury | 1.2E-06 | 4.7E-03 | 0.0017 |
| nickel | 4.6E-06 | 1.8E-02 | 0.0065 |
| selenium | 2.5E-05 | 9.9E-02 | 0.035 |
| TOTAL HAPs | | 4.31 | 1.55 |

[1]Maximum potential operating hours not including SUSD was used to estimate emissions.

[2]Emission factors provided by vendor. The maximum emissions rate from all available operating scenarios was used to calculate maximum potential emissions.

[3]Emission factor for $CO_2$ provided by vendor. Emission factors for $CH_4$ and $N_2O$ obtained from 40 CFR 98.

[4]HAP emission factors obtained from EPA's AP-42, Tables 3.1-4 and 3.1-5 and reflect control level of 30% by the oxidation catalyst for organic HAPs, except for formaldehyde, which was obtained from the vendor.

Renovo Energy Center
Startup and Shutdown Operations Emissions Data
Natural Gas Firing

| SUSD Parameter | Amount per Event - GE Provided | Pro-Rated Amount per Hour | Amount per Event with Time Increase[1] |
|---|---|---|---|
| **Cold Start** | | | |
| Time from Ignition until Compliance (minutes) | 45 | -- | 60 |
| Fuel Consumed (lb) | 39,451 | 52,602 | 52,602 |
| Fuel Consumed (MMBtu LHV) | 840 | 1,120 | 1,120 |
| Fuel Consumed (MMBtu HHV) | 931 | 1,242 | 1,242 |
| Maximum Potential NOx Emissions (lb) | 123.0 | 164.0 | 164.0 |
| Maximum Potential CO Emissions (lb) | 699.0 | 932.0 | 932.0 |
| Maximum Potential VOC Emissions (lb) | 53.0 | 70.7 | 70.7 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 8.3 | 11.1 | 11.1 |
| **Warm Start** | | | |
| Time from Ignition until Compliance (minutes) | 40 | -- | 55 |
| Fuel Consumed (lb) | 38,277 | 57,416 | 52,631 |
| Fuel Consumed (MMBtu LHV) | 815 | 1,223 | 1,121 |
| Fuel Consumed (MMBtu HHV) | 904 | 1,355 | 1,242 |
| Maximum Potential NOx Emissions (lb) | 81.0 | 121.5 | 111.4 |
| Maximum Potential CO Emissions (lb) | 190.0 | 285.0 | 261.3 |
| Maximum Potential VOC Emissions (lb) | 24.0 | 36.0 | 33.0 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 7.3 | 11.0 | 10.0 |
| **Hot Start** | | | |
| Time from Ignition until Compliance (minutes) | 20 | -- | 35 |
| Fuel Consumed (lb) | 15,264 | 45,792 | 26,712 |
| Fuel Consumed (MMBtu LHV) | 325 | 975 | 569 |
| Fuel Consumed (MMBtu HHV) | 360 | 1,081 | 631 |
| Maximum Potential NOx Emissions (lb) | 53.0 | 159.0 | 92.8 |
| Maximum Potential CO Emissions (lb) | 177.0 | 531.0 | 309.8 |
| Maximum Potential VOC Emissions (lb) | 22.0 | 66.0 | 38.5 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 4.0 | 12.0 | 7.0 |
| **Shutdown from 50% load** | | | |
| Time to Shutdown (minutes) | 12 | -- | 27 |
| Fuel Consumed (lb) | 9,393 | 46,966 | 21,135 |
| Fuel Consumed (MMBtu LHV) | 200 | 1,000 | 450 |
| Fuel Consumed (MMBtu HHV) | 222 | 1,109 | 499 |
| Maximum Potential NOx Emissions (lb) | 14.0 | 70.0 | 31.5 |
| Maximum Potential CO Emissions (lb) | 152.0 | 760.0 | 342.0 |
| Maximum Potential VOC Emissions (lb) | 19.0 | 95.0 | 42.8 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 3.0 | 15.0 | 6.8 |

| Annual Totals[2] | | |
|---|---|---|
| Total SUSD Operating Hour Limitation Per Unit: | 460 | hrs |
| Total Annual SUSD Fuel Consumption Per Unit: | 25,302,027 | lbs |
| Total Annual SUSD Heat Input Per Unit: | 538,731 | MMBtu LHV |
| Total Annual SUSD Heat Input Per Unit: | 597,305 | MMBtu HHV |
| Total Maximum Potential NOx Emissions Per Unit: | 25.2 | tons |
| Total Maximum Potential CO Emissions Per Unit: | 90.8 | tons |
| Total Maximum Potential VOC Emissions Per Unit: | 11.4 | tons |
| Total Maximum Potential $PM_{10/2.5}$ Emissions Per Unit: | 2.7 | tons |

May 2020

Renovo Energy Center
Startup and Shutdown Operations Emissions Data
ULSD Firing

| SUSD Parameter | Amount per Event - GE Provided | Pro-Rated Amount per Hour | Amount per Event with Time Increase[1] |
|---|---|---|---|
| **Cold Start** | | | |
| Time from Ignition until Compliance (minutes) | 45 | -- | 60 |
| Fuel Consumed (lb) | 54,208 | 72,277 | 72,277 |
| Fuel Consumed (MMBtu LHV) | 992 | 1,323 | 1,323 |
| Fuel Consumed (MMBtu HHV) | 1,100 | 1,466 | 1,466 |
| Maximum Potential NOx Emissions (lb) | 221.0 | 294.7 | 294.7 |
| Maximum Potential CO Emissions (lb) | 704.0 | 938.7 | 938.7 |
| Maximum Potential VOC Emissions (lb) | 141.0 | 188.0 | 188.0 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 36.0 | 48.0 | 48.0 |
| **Warm Start** | | | |
| Time from Ignition until Compliance (minutes) | 40 | -- | 55 |
| Fuel Consumed (lb) | 54,645 | 81,967 | 75,137 |
| Fuel Consumed (MMBtu LHV) | 1,000 | 1,500 | 1,375 |
| Fuel Consumed (MMBtu HHV) | 1,109 | 1,663 | 1,525 |
| Maximum Potential NOx Emissions (lb) | 172.0 | 258.0 | 236.5 |
| Maximum Potential CO Emissions (lb) | 286.0 | 429.0 | 393.3 |
| Maximum Potential VOC Emissions (lb) | 33.0 | 49.5 | 45.4 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 32.0 | 48.0 | 44.0 |
| **Hot Start** | | | |
| Time from Ignition until Compliance (minutes) | 20 | -- | 35 |
| Fuel Consumed (lb) | 18,579 | 55,738 | 32,514 |
| Fuel Consumed (MMBtu LHV) | 340 | 1,020 | 595 |
| Fuel Consumed (MMBtu HHV) | 377.0 | 1,131 | 660 |
| Maximum Potential NOx Emissions (lb) | 112.0 | 336.0 | 196.0 |
| Maximum Potential CO Emissions (lb) | 273.0 | 819.0 | 477.8 |
| Maximum Potential VOC Emissions (lb) | 30.0 | 90.0 | 52.5 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 16.0 | 48.0 | 28.0 |
| **Shutdown from 50% load** | | | |
| Time to Shutdown (minutes) | 8 | -- | 23 |
| Fuel Consumed (lb) | 7,213 | 54,098 | 20,738 |
| Fuel Consumed (MMBtu LHV) | 132 | 990 | 380 |
| Fuel Consumed (MMBtu HHV) | 146 | 1,098 | 421 |
| Maximum Potential NOx Emissions (lb) | 43.0 | 322.5 | 123.6 |
| Maximum Potential CO Emissions (lb) | 48.0 | 360.0 | 138.0 |
| Maximum Potential VOC Emissions (lb) | 7.0 | 52.5 | 20.1 |
| Maximum Potential $PM_{10}/_{2.5}$ Emissions (lb) | 10.0 | 75.0 | 28.8 |

| Annual Totals[2] | | |
|---|---|---|
| Total SUSD Operating Hour Limitation Per Unit: | 40 | hrs |
| Total Annual SUSD Fuel Consumption Per Unit: | 3,092,896 | lbs |
| Total Annual SUSD Heat Input Per Unit: | 56,600 | MMBtu LHV |
| Total Annual SUSD Heat Input Per Unit: | 62,755 | MMBtu HHV |
| Total Maximum Potential NOx Emissions Per Unit: | 5.4 | tons |
| Total Maximum Potential CO Emissions Per Unit: | 8.4 | tons |
| Total Maximum Potential VOC Emissions Per Unit: | 1.0 | tons |
| Total Maximum Potential $PM_{10/2.5}$ Emissions Per Unit: | 1.1 | tons |

May 2020

Notes

[1] REC is proposing to add 15 minutes of margin to each SUSD scenario in order to allow operational flexibility in order to ensure that the SUSD can be completed in the permitted length of time. All heat input and emission parameters have been pro-rated for the increased time.

[2] Annual totals are based on warm starts and the corresponding amount of shutdowns. For the natural gas scenarios, 460 hours of SUSD corresponds to 308.5 hours of warm starts and 151.5 hours of shutdowns. For the ULSD scenarios, 40 hours of SUSD corresponds to 28.2 hours of warm starts and 11.8 hours of shutdowns.

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

NOx: 1-hour Averaging Period

| SUSD Scenario | Natural Gas[1] | | | | ULSD[2] | | | |
|---|---|---|---|---|---|---|---|---|
| | Cold Start | Warm Start | Hot Start | Shut Down | Cold Start | Warm Start | Hot Start | Shut Down |
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| NOx per event (lb) | 164.00 | 111.38 | 92.75 | 31.50 | 294.67 | 236.50 | 196.00 | 123.63 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Low Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 10.70 | | *Operating Point #7* | | 31.90 | | *Operating Point #14* | |
| Stack Temperature (°F) | 166.9 | | | | 251.2 | | | |
| Exhaust Flow Rate (acfm) | 836,983 | | | | 1,152,033 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 33.30 | | *Operating Point #19* | | 59.60 | | *Operating Point #8* | |
| Stack Temperature (°F) | 180.5 | | | | 291.5 | | | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Steady State Average Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 22 | | | | 45.75 | | | |
| Stack Temperature (°F) | 173.7 | | | | 271.35 | | | |
| Exhaust Flow Rate (acfm) | 1,287,408 | | | | 1,630,267 | | | |
| Remaining Duration of Hour (minutes) | 0 | 5 | 25 | 33 | 0 | 5 | 25 | 37 |
| SS Contribution (lb) | 0.00 | 1.83 | 9.17 | 12.10 | 0.00 | 3.81 | 19.06 | 28.21 |
| Hourly Emission Rate for Modeling (lb/hr) | 164.00 | 113.21 | 101.92 | 43.60 | 294.67 | 240.31 | 215.06 | 151.84 |
| Average Stack Temperature for Modeling (°F) | 174.00 | 173.98 | 173.88 | 173.84 | 270.00 | 270.11 | 270.56 | 270.83 |
| Average Flow Rate for Modeling (acfm) | 942,329 | 971,086 | 1,086,112 | 1,132,123 | 1,190,426 | 1,227,079 | 1,373,693 | 1,461,661 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

NOx: Annual Averaging Period

| Operating Point[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS NG Emission Rate (lb/hr) | 25.6 | 23.4 | 25.7 | 25.1 | 13.3 | 11 | 10.7 | 33.3 | 29.7 | 32.7 | 31.8 | 33.3 |
| SS NG Duration (hrs) | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 | 7,540 |
| Maximum SS ULSD Emission Rate (lb/hr) | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 | 59.60 |
| Maximum SS ULSD Duration (hrs) | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 |
| Maximum NG SUSD Emission Rate (lb/hr) | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 | 164.0 |
| Maximum NG SUSD Duration (hrs) | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 | 460 |
| Maximum ULSD SUSD Emission Rate (lb/hr) | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 | 294.7 |
| Maximum ULSD SUSD Duration (hrs) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Hourly Emission Rate for Modeling (lb/hr) | 36.89 | 35.00 | 36.98 | 36.46 | 26.30 | 24.32 | 24.07 | 43.52 | 40.42 | 43.00 | 42.23 | 43.52 |

[1]The stack temperature and flow rate from each operating point as numbered in the raw data will be used for these scenarios, as the majority of the duration (~86%) is spent at that operating point.

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

CO: 1-hour Averaging Period

| | Natural Gas[1] | | | | ULSD[2] | | | |
|---|---|---|---|---|---|---|---|---|
| SUSD Scenario | Cold Start | Warm Start | Hot Start | Shut Down | Cold Start | Warm Start | Hot Start | Shut Down |
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| CO per event (lb) | 932.00 | 261.25 | 309.75 | 342.00 | 938.67 | 393.25 | 477.75 | 138.00 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Low Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 2.90 | | *Operating Point #7* | | 9.70 | | *Operating Point #14* | |
| Stack Temperature (°F) | 166.9 | | | | 251.2 | | | |
| Exhaust Flow Rate (acfm) | 836,983 | | | | 1,152,033 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 15.20 | | *Operating Point #19* | | 18.10 | | *Operating Point #8* | |
| Stack Temperature (°F) | 180.5 | | | | 291.5 | | | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Steady State Average Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 9.05 | | | | 13.9 | | | |
| Stack Temperature (°F) | 173.7 | | | | 271.35 | | | |
| Exhaust Flow Rate (acfm) | 1,287,408 | | | | 1,630,267 | | | |
| Remaining Duration of Hour (minutes) | 0 | 5 | 25 | 33 | 0 | 5 | 25 | 37 |
| SS Contribution (lb) | 0.00 | 0.75 | 3.77 | 4.98 | 0.00 | 1.16 | 5.79 | 8.57 |
| Hourly Emission Rate for Modeling (lb/hr) | 932.00 | 262.00 | 313.52 | 346.98 | 938.67 | 394.41 | 483.54 | 146.57 |
| Average Stack Temperature for Modeling (°F) | 174.00 | 173.98 | 173.88 | 173.84 | 270.00 | 270.11 | 270.56 | 270.83 |
| Average Flow Rate for Modeling (acfm) | 942,329 | 971,086 | 1,086,112 | 1,132,123 | 1,190,426 | 1,227,079 | 1,373,693 | 1,461,661 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Startup and Shutdown Emission Parameters for Modeling Purposes
Natural Gas and ULSD Firing

CO: 8-hour Averaging Period

| | Natural Gas[1] | | | | ULSD[2] | | | |
|---|---|---|---|---|---|---|---|---|
| SUSD Scenario | Cold Start | Warm Start | Hot Start | Shut Down | Cold Start | Warm Start | Hot Start | Shut Down |
| Duration (minutes) | 60 | 55 | 35 | 27 | 60 | 55 | 35 | 23 |
| CO per event (lb) | 932.00 | 261.25 | 309.75 | 342.00 | 938.67 | 393.25 | 477.75 | 138.00 |
| Stack Temperature (°F) | 174 | | | | 270 | | | |
| Stack Flow Rate (acfm) | 942,329 | | | | 1,190,426 | | | |
| Steady State Max Load Parameters | | | | | | | | |
| Emission Rate (lb/hr) | 15.2 | | *Operating Point #19* | | 18.1 | | *Operating Point #8* | |
| Stack Temperature (°F) | 180.5 | | | | 291.5 | | | |
| Exhaust Flow Rate (acfm) | 1,737,833 | | | | 2,108,500 | | | |
| Remaining Duration of Hour (minutes) | 420 | 425 | 445 | 453 | 420 | 425 | 445 | 457 |
| SS Contribution (lb) | 106.40 | 107.67 | 112.73 | 114.76 | 126.70 | 128.21 | 134.24 | 137.86 |
| Hourly Emission Rate for Modeling (lb/hr) | 129.80 | 46.11 | 52.81 | 57.10 | 133.17 | 65.18 | 76.50 | 34.48 |
| Average Stack Temperature for Modeling (°F) | 179.69 | 179.76 | 180.03 | 180.13 | 288.81 | 289.04 | 289.93 | 290.47 |
| Average Flow Rate for Modeling (acfm) | 1,638,395 | 1,646,682 | 1,679,828 | 1,693,086 | 1,993,741 | 2,003,304 | 2,041,557 | 2,064,509 |

[1]For natural gas SUSD scenarios, the average stack temperature will be 174°F when the LP economizer is in service, and 214°F when bypassed. The average stack flow rate for all scenarios will be 960 lb/second (equivalent to 942,329 acfm for 174°F stack temperature, and 1,101,782 acfm for 214°F stack temperature.

[2]For ULSD SUSD scenarios, the average stack temperature will be 270°F, assuming the LP economizer is bypassed. The average stack flow rate for all scenarios will be 1,050 lb/second (equivalent to 1,190,426 acfm).

Renovo Energy Center
Summary of Worst-Case Maximum Potential Annual Emissions Scenario
Powerblocks- Turbines, HRSGs

| | | |
|---|---|---|
| ULSD Normal Operating Hours: | 720 | each powerblock |
| ULSD SUSD Operating Hours: | 40 | each powerblock |
| Natural Gas Normal Operating Hours: | 7,540 | each powerblock |
| Natural Gas SUSD Operating Hours: | 460 | each powerblock |
| Total Operating Hours: | 8,760 | each powerblock |

| Pollutant | Annual Emissions from ULSD Firing[1] (tons) | Annual Emissions from ULSD SUSD[2] (tons) | Annual Emissions from NG Firing[3] (tons) | Annual Emissions from Natural Gas SUSD[4] (tons) | Total Maximum Potential Annual Emissions from Both Powerblocks (tons) | Total Maximum Potential Annual Emissions from Each Powerblock (tons) |
|---|---|---|---|---|---|---|
| NOx | 42.91 | 10.75 | 251.08 | 50.42 | 355.17 | 177.58 |
| CO | 13.03 | 16.70 | 114.61 | 181.52 | 325.86 | 162.93 |
| $PM_{10}$ | 34.70 | 2.10 | 169.65 | 5.47 | 211.92 | 105.96 |
| VOC | 7.49 | 2.00 | 70.12 | 22.82 | 102.43 | 51.22 |
| $SO_2$ | 5.04 | 0.28 | 45.99 | 2.16 | 53.48 | 26.74 |
| $NH_3$ | 20.87 | 1.16 | 243.84 | 11.50 | 277.36 | 138.68 |
| $H_2SO_4$ | 3.17 | 0.18 | 30.69 | 1.37 | 35.40 | 17.70 |
| *GHGs* | | | | | | |
| $CO_2$ | 520,344 | 28,908 | 4,644,640 | 219,604 | 5,413,496 | 2,706,748 |
| $CH_4$ | 18.76 | 1.04 | 58.86 | 3.59 | 82.26 | 41.13 |
| $N_2O$ | 3.75 | 0.21 | 5.89 | 0.36 | 10.21 | 5.10 |
| $CO_{2equivalent}$ | 521,931 | 28,996 | 4,647,866 | 219,801 | 5,418,594 | 2,709,297 |
| *HAPs* | | | | | | |
| 1,3-butadiene | 0.032 | 0.0018 | 0.0057 | 0.00035 | 0.040 | 0.020 |
| acetaldehyde | 0 | 0 | 0.53 | 0.033 | 0.56 | 0.28 |
| acrolein | 0 | 0 | 0.085 | 0.0052 | 0.09 | 0.045 |
| benzene | 0.11 | 0.0061 | 0.17 | 0.010 | 0.29 | 0.15 |
| dichlorobenzene | 0 | 0 | 0.0049 | 0 | 0.0049 | 0.0025 |

Renovo Energy Center
Summary of Worst-Case Maximum Potential Annual Emissions Scenario
Powerblocks- Turbines, HRSGs

| Pollutant | Annual Emissions from ULSD Firing[1] (tons) | Annual Emissions from ULSD SUSD[2] (tons) | Annual Emissions from NG Firing[3] (tons) | Annual Emissions from Natural Gas SUSD[4] (tons) | Total Maximum Potential Annual Emissions from Both Powerblocks (tons) | Total Maximum Potential Annual Emissions from Each Powerblock (tons) |
|---|---|---|---|---|---|---|
| ethyl benzene | 0 | 0 | 0.43 | 0.026 | 0.45 | 0.23 |
| formaldehyde | 0.37 | 0.021 | 4.46 | 0.21 | 5.06 | 2.53 |
| hexane | 0 | 0 | 7.36 | 0 | 7.36 | 3.68 |
| naphthalene | 0.070 | 0.0039 | 0.020 | 0.0011 | 0.09 | 0.047 |
| PAH | 0.079 | 0.0044 | 0.029 | 0.0018 | 0.11 | 0.057 |
| POM | 0 | 0 | 0.00036 | 0 | 0.00036 | 0.00018 |
| propylene oxide | 0 | 0 | 0.39 | 0.024 | 0.41 | 0.20 |
| toluene | 0 | 0 | 1.74 | 0.11 | 1.85 | 0.92 |
| xylenes | 0 | 0 | 0.86 | 0.053 | 0.92 | 0.46 |
| arsenic | 0.031 | 0.0017 | 0.0015 | 0 | 0.034 | 0.017 |
| beryllium | 0.00088 | 0.000049 | 0.000089 | 0 | 0.0010 | 0.00051 |
| cadmium | 0.014 | 0.00076 | 0.0082 | 0 | 0.023 | 0.011 |
| chromium | 0.031 | 0.0017 | 0.010 | 0 | 0.043 | 0.022 |
| cobalt | 0 | 0 | 0.00062 | 0 | 0.00062 | 0.00031 |
| lead | 0.040 | 0.0022 | 0 | 0 | 0.042 | 0.021 |
| manganese | 2.24 | 0.12 | 0.0028 | 0 | 2.37 | 1.18 |
| mercury | 0.0034 | 0.00019 | 0.0019 | 0 | 0.0055 | 0.0028 |
| nickel | 0.013 | 0.00073 | 0.016 | 0 | 0.029 | 0.015 |
| selenium | 0.071 | 0.0039 | 0.00018 | 0 | 0.075 | 0.038 |
| TOTAL HAPs | 3.11 | | 16.12 | | 19.87 | 9.93 |

[1]Annual Emissions from ULSD Firing based on 720 nornal operating hours on ULSD for each powerblock.

[2]Annual Emissions from ULSD SUSD based on 40 SUSD hours per powerblock when firing ULSD, using emission rates for Warm Starts and Shutdowns for emissions of NOx, CO, PM, and VOC. All other pollutant emissions based on the maximum emission rate for all operating loads when firing ULSD.

[3]Annual Emissions from Natural Gas Firing based on 7,540 normal operating hours firing natural gas in the CT and DB for each powerblock.

[4]Annual Emissions from Natural Gas SUSD based on 460 SUSD hours per powerblock when firing natural gas, using emission rates for Warm Starts and Shutdowns for emissions of NOx, CO, PM, and VOC. All other pollutant emissions based on the maximum emission rate for all operating loads when firing natural gas.

| | |
|---|---|
| **From:** | tom.rolfson@powereng.com |
| **To:** | Roble, Daniel |
| **Cc:** | tim.donnelly@powereng.com; Zaman, Muhammad; Shimmel, David; Waldman, Paul R; Trivedi, Viren; Wenrich, Sean; Dalal, Kirit; Fleck, Andrew |
| **Subject:** | [External] RE: Renovo Energy Center, LLC / DEP Comments on PSD Air Quality Analyses |
| **Date:** | Wednesday, May 6, 2020 3:39:02 PM |

***ATTENTION:*** *This email message is from an external sender. Do not open links or attachments from unknown sources. To report suspicious email, forward the message as an attachment to CWOPA_SPAM@pa.gov.*

Hi Daniel,

Thank you for sending over these comments. We will review and let you know of any questions.

Tom

TOM ROLFSON, P.E.
207-869-1418 (o)
207-841-8538 (c)

**POWER Engineers, Inc.**
www.powereng.com

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**From:** Roble, Daniel <droble@pa.gov>
**Sent:** Wednesday, May 06, 2020 3:20 PM
**To:** Rolfson, Tom <tom.rolfson@powereng.com>
**Cc:** Donnelly, Tim <tim.donnelly@powereng.com>; Zaman, Muhammad <mzaman@pa.gov>; Shimmel, David <dshimmel@pa.gov>; Waldman, Paul R <pwaldman@pa.gov>; Trivedi, Viren <vtrivedi@pa.gov>; Wenrich, Sean <sewenrich@pa.gov>; Dalal, Kirit <kdalal@pa.gov>; Fleck, Andrew <afleck@pa.gov>
**Subject:** [EXTERNAL] Renovo Energy Center, LLC / DEP Comments on PSD Air Quality Analyses



Tom,

The DEP's comments on the Prevention of Significant Deterioration (PSD) air quality analyses for Renovo Energy Center, LLC's Plan Approval Application 18-00033B are listed below.

6.1 - CT Steady State Operations

1. The ARM2 option in AERMOD determines the $NO_2/NO_X$ ambient ratio from the cumulative modeled $NO_x$ concentration based on the source group ALL. See page 22 of the September 20, 2013, "Ambient Ratio Method Version 2 (ARM2) for use with AERMOD for 1-hr NO2 Modeling, Development and Evaluation Report" (https://www3.epa.gov/ttn/scram/models/aermod/ARM2_Development_and_Evaluation_Report-September_20_2013.pdf). In the 1-hour and annual $NO_2$ analyses, each load scenario should therefore be modeled separately so that the correct $NO_2/NO_X$ ambient ratio is determined by the ARM2 option.

General

2. After reviewing the May 6, 2020, “Renovo Energy Center 18-00033B Technical Deficiency Letter” from David M. Shimmel, DEP, to Tim Donnelly, Power Engineers, Inc., please make appropriate revisions, if warranted, to the modeling files and report.

If you have any questions, feel free to contact me. We can set up a call to discuss these comments as well.

Daniel

**Daniel Roble |** Air Quality Program Specialist
Department of Environmental Protection | Bureau of Air Quality
Rachel Carson State Office Building
400 Market Street | Harrisburg, PA 17105
Phone: 717.705.7689 | Fax: 717.772.2303
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pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF AIR QUALITY

February 3, 2020

Tom Rolfson, P.E.
Environmental Engineer
POWER Engineers, Inc.
303 U.S. Route One
Freeport, ME 04032

Re: DEP Acceptance of Air Quality Modeling Protocol
Air Quality Analyses for Prevention of Significant Deterioration
Renovo Energy Center, LLC
Reconfiguration of Proposed Renovo Energy Center, Renovo Borough, Clinton County

Dear Mr. Rolfson:

The Pennsylvania Department of Environmental Protection (DEP) received a final version of the air quality modeling protocol[1] on January 30, 2020, for Renovo Energy Center, LLC's (REC) reconfiguration of the Renovo Energy Center, a proposed nominally rated 1,240 megawatt (net) dual fuel (natural gas and ultra-low sulfur diesel) combined cycle electric power generation facility in Renovo Borough, Clinton County.

REC's proposed project is subject to the Prevention of Significant Deterioration (PSD) regulations codified in 40 CFR § 52.21. These federal PSD regulations are adopted and incorporated by reference in their entirety in 25 *Pa. Code* § 127.83 and the Commonwealth's State Implementation Plan (SIP) codified in 40 CFR § 52.2020.

The DEP reviewed REC's protocol to ensure consistency with the PSD requirements codified in paragraphs (k) through (p) of 40 CFR § 52.21, the U.S. Environmental Protection Agency's (EPA) *Guideline on Air Quality Models*,[2] and the EPA's relevant air quality modeling policy and guidance. The DEP's review concludes that REC's protocol establishes adequate methods and procedures for conducting the required air quality analyses to be included with REC's Plan Approval Application for its proposed project.

The methods and procedures established in REC's protocol and the DEP's acceptance of REC's protocol are not intended to supersede or conflict with the PSD requirements, the EPA's *Guideline on Air Quality Models*, or the EPA's relevant air quality modeling policy and guidance. In addition, the DEP's acceptance of REC's protocol does not preclude the DEP from issuing comments resulting from the technical review of the air quality analyses. Moreover, the

[1] Renovo Energy Center, LLC. Final Air Dispersion Modeling Protocol for Plant Reconfiguration. POWER Engineers, Inc. January 30, 2020.
[2] *Code of Federal Regulations*. 40 CFR Part 51, Appendix W.

DEP reserves the right to require the methods and procedures set forth in REC's protocol to be revised or modified in appropriate circumstances.

Please submit a printed copy of the air quality analyses report to the DEP's Northcentral Regional Office (NCRO). Additionally, please provide me with access to download an electronic version of the air quality analyses report and supporting data.

We look forward to reviewing REC's air quality analyses for this project. If you have any questions regarding REC's air quality analyses, you may contact me by e-mail at droble@pa.gov or by telephone at 717.705.7689. You may also contact Andrew Fleck, manager of the Air Quality Modeling Section, by e-mail at afleck@pa.gov or by telephone at 717.783.9243.

Sincerely,

Daniel J Roble

Daniel J. Roble
Air Quality Program Specialist
Air Quality Modeling Section
Division of Air Resource Management

cc: Rick Franzese, Renovo Energy Center, LLC
Bill Bousquet, Innovative Power Solutions, LLC
Tim Donnelly, POWER Engineers, Inc.
Amy Austin, POWER Engineers, Inc.
Muhammad Zaman, DEP/NCRO Air Quality
David Shimmel, DEP/NCRO New Source Review
Paul Waldman, DEP/NCRO New Source Review
Viren Trivedi, DEP/BAQ Acting Director
Sean Wenrich, DEP/BAQ New Source Review
Kirit Dalal, DEP/BAQ Air Resource Management
Andrew Fleck, DEP/BAQ Air Quality Modeling
AQ Modeling Correspondence File