Wind River
Environmental Group LLC

June 17, 2014

Mr. Wayne D. Bixler
Environmental Engineering Specialist
Air Permit Section, New Source Review
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

Subject: Corrections to Chiricahua Wilderness Area Visibility Results, Bowie Power Station Air Quality Impact Analysis

Dear Mr. Bixler:

Attached please find a revised version of the Bowie Power Station Response to Modeling Comments document originally provided to you on Friday, June 13th. The visibility impacts shown in the Revised Table 7 for the Chiricahua Wilderness Area for 2001 and 2002 were incorrectly based on the Chiricahua National Monument, rather than the Chiricahua Wilderness Area, receptors. These have been corrected in the writeup and show lower impacts than those shown earlier. In addition, the background conditions used in CALPOST have been revised for all Class I areas to conform to the Federal Land Managers' Air Quality Related Values Work Group (FLAG) guidance. The revisions do not change the conclusions that all Class I visibility impacts from the Bowie Power Station at all Class I areas evaluated are below the 5% threshold of concern.

In addition, I have attached the revised CALPOST files that resulted in these corrected impacts. These will replace the CALPOST visibility files provided in April 2014.

Should you have questions, please contact me at (303) 670-9375 or by e-mail at Martha.Hyder@Windriverenvironmental.com.

Sincerely,

Martha Hyder

Martha Hyder
Wind River Environmental Group LLC

Attachments

c: Gary Crane, Bowie Power Station
Distribution list

# RESPONSE TO MODELING COMMENTS

## Bowie Power Station Class I Air Permit Application

## June 2014

### Comment

Please provide the data capture rate for the ozone monitoring data used in the AERMOD modeling.

### Response

The ozone monitoring data was collected by the National Park Service (NPS) at Chiricahua National Monument. The monitoring procedures used by NPS call for zero and span checks each day. As a result, ozone data for hours 21 and 22 (9 pm-11 pm) are missing each day due to these daily checks. The data obtained contained other short periods of missing data, as well as two extended periods of missing data including May 12 - May 15, 2001 and January 1 - January 8, 2002.

NPS protocols call for calculating data recovery per calendar quarter based on the number of valid measurements as compared with number of possible measurements, with data lost during calibrations, maintenance, and audits being considered "not possible." (*Gaseous Pollutant Monitoring Program Quality Assurance Project Plan*, NPS, January 2007) The minimum valid data recovery for the program is greater than 75% for all possible gaseous data. Using the period from April 25, 2001 through April 29th, 2002, which matches the period modeled, yields the data statistics shown in Table 1.

**Table 1. Meteorological Data Missing Data Statistics**

| | Time Period | | | | | |
|---|---|---|---|---|---|---|
| **Statistic** | **April 25, 2001-June 30, 2001 (Quarter)** | **July 1, 2001-September 30, 2001 (Quarter)** | **October 1, 2001-December 31, 2001 (Quarter)** | **January 1, 2001-March 31, 2002 (Quarter)** | **April 1, 2002-April 29, 2002 (Quarter)** | **April 25, 2001-April 29, 2002 (Period of Record)** |
| Total hours in period | 1,608 | 2,208 | 2,208 | 2,160 | 696 | 8,880 |
| Total missing hours | 202 (12.5%) | 241 (10.91%) | 214 (9.69%) | 357 (16.53%) | 67 (9.63%) | 1,081 (12.17%) |
| Daily calibration missing hours (% of total hours in period) | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% |
| All other missing hours (% of possible hours) | 68 (4.61%) | 57 (2.82%) | 30 (1.48%) | 177 (8.94%) | 9 (1.41%) | 341 (4.19%) |

### Comment

Suggest running the 1-hour nitrogen dioxide ($NO_2$) AERMOD analyses using the Ambient Ratio Method (ARM), rather than the Plume Volume Molar Ratio Method (PVMRM), to confirm that conclusions would remain the same using the simpler analysis.

## Response

Both the 1-hour and annual AERMOD analyses for $NO_2$ were revised based on the recommended ARM for each averaging period (0.8 for 1-hour, 0.75 for annual). The results are shown in Table 2.

The results of the Class II preliminary analysis that modeled the Bowie Power Station alone indicated that a cumulative analysis was required for the 1-hour $NO_2$ averaging period but not for the annual averaging period. Impacts above the 1-hour significant impact level (SIL) were predicted out to approximately 50 kilometers (km) from the Bowie Power Station. Therefore, the same additional sources that were included in the PVMRM analysis were included in the revised cumulative analysis using the ARM.

The cumulative Class II 1-hour $NO_2$ assessment used the model (AERMOD), receptor grid, options, and meteorological data that were used for the Bowie Power Station preliminary analysis. The receptors modeled were limited to those that showed a maximum impact above the 1-hour $NO_2$ SIL in the preliminary (Bowie Power Station only) analysis.

The AERMOD model has incorporated options to allow modeling compliance with the 1-hour $NO_2$ standard. Specifying "NO2" as the pollutant to be modeled invokes these options. The 98th percentile (high, 8th high) of the daily maximum 1-hour values from the Bowie project plus other nearby sources was modeled. Background $NO_2$ concentrations that vary by season and hour of the day were added to the combined impact within the model. The total maximum 98th percentile (high, 8th high) of the daily maximum concentrations, including background, has been compared with the 1-hour $NO_2$ standard.

The results, shown in Table 1, indicate that total impacts could potentially exceed the 1-hour $NO_2$ National Ambient Air Quality Standard (NAAQS) limitation of approximately 188.7 micrograms per cubic meter ($\mu g/m^3$). The 1-hour $NO_2$ NAAQS would potentially be exceeded at one receptor. The largest contributor to the potential exceedance is the Apache Generating Station.

### Table 2. Revised $NO_2$ Analyses

| Averaging Period/ Pollutant | Maximum Predicted Impact ($\mu g/m^3$) | Modeling Significant Impact Level ($\mu g/m^3$) | Significant Monitoring Concentration ($\mu g/m^3$) |
|---|---|---|---|
| **Class II Bowie Power Station Only using Ambient Ratio Method** | | | |
| 1-hour $NO_2$ | 118.0 | 7.5 | NA |
| Annual $NO_2$ | 0.22 | 1 | 14 |
| **Class II Cumulative Analysis Results using Ambient Ratio Method** | | | |
| 1-hour $NO_2$ | 252.3 | Total, including Background Concentrations | |
| | 36.2 | Bowie Power Station Maximum Impact | |
| **Class I Chiricahua National Monument Bowie Power Station Only using Ambient Ratio Method** | | | |
| Annual $NO_2$ | 0.002 | 0.1 | NA |

Notes:
$\mu g/m^3$ = Micrograms per cubic meter
NA = Not applicable
$NO_2$ = Nitrogen dioxide

Bowie's contribution to impacts above 90% of the NAAQS was determined using the "MAXDCONT" option in AERMOD. There were no impacts with a total concentration (including background) that exceeded 90% of the 1-hour NAAQS where Bowie's contribution was greater than 3% of the total impact; therefore, no refined grids were developed.

The maximum 1-hour $NO_2$ concentration predicted by the model, including background, was 252.3 μg/m$^3$. A total of 16 hours were predicted to exceed the NAAQS and the largest contribution to any of the potential exceedances by the Bowie Power Station was 0.0678 μg/m$^3$, well below the SIL of 7.5 μg/m$^3$. The Bowie Power Station will not cause or contribute to any exceedance of the 1-hour $NO_2$ NAAQS.

The annual $NO_2$ preliminary analysis for the Class I Chiricahua National Monument (NM) was also revised using the ARM. The results are also shown in Table 1. The Bowie Power Station maximum annual $NO_2$ impact at the Class I area is well below the SIL and a cumulative increment consumption analysis is not required.

## Comment

For the analysis of Class I particulate matter less than 2.5 micrometers and 10 micrometers ($PM_{2.5}$ and $PM_{10}$) increments using CALPUFF, the US Environmental Protection Agency (EPA) has indicated that the modeling should use the expected direct emission rates of these two pollutants, rather than the speciated emissions used for Air Quality Related Values (AQRV) analyses.

## Response

The Class I area $PM_{2.5}$ and $PM_{10}$ analyses that were conducted using CALPUFF have been revised using direct emission rates of $PM_{2.5}$ and $PM_{10}$. The emission rates were modeled in CALPUFF using the non-speciated $PM_{10}$ rates as coarse particulate (PMC) and the non-speciated $PM_{2.5}$ rates as fine particulate (PMF). In addition, direct nitrogen oxide emissions were included for each scenario modeled so that secondary $PM_{2.5}$ impacts could be considered.

For the 24-hour averaging period, stack parameters were varied seasonally and three potential worst-case scenarios were modeled representing: 1) 100% load with duct firing (maximum $PM_{10}$/$PM_{2.5}$ emissions), 2) minimum compliance load (worst-case dispersion conditions), and 3) a 24-hour scenario that included three hot starts, two shutdowns, and 100% load with duct firing for the remaining hours (maximum $NO_x$ emissions). The first two scenarios are consistent with the modeling performed for $PM_{2.5}$ and $PM_{10}$ using AERMOD for the Class II areas surrounding the Bowie Power Station, with paired $NO_x$ emissions. The third scenario is a variation using seasonal weighted average stack parameters of the scenario that was modeled to evaluate visibility impacts in Class I areas beyond 50 kilometers (km) from the Bowie Power Station. An annual scenario was also evaluated. The emissions and stack parameters for these three scenarios are shown in Attachment A.

For the 24-hour scenarios, five seasonal periods with differing turbine stack parameters were modeled for each of three years of meteorological data. The periods were January, February through May, June through September, October through November, and December. This produced a total of 15 CALPUFF input files for each year modeled and 30 CALPOST input files or a total of 45 CALPUFF input files and 90 CALPOST input files for the three modeled years of meteorological data (2001-2003). An annual input file was also run for each meteorological year to allow calculation of annual impacts.

The results were processed in CALPOST producing PMF and PMC ($PM_{2.5}$/$PM_{10}$), and nitrate ($HNO_3$) concentration values at each receptor in the eight Class I areas modeled. The higher of the PMF or PMC concentrations were used to represent $PM_{10}$. For total $PM_{2.5}$, including secondary $PM_{2.5}$, the results were summarized as follows:

- For the Chiricahua Wilderness Area (WA), which is the closest of the Class I areas evaluated using CALPUFF and which therefore showed the highest impacts, maximum 24-hour PMF impacts were determined for each scenario, season, and year and the corresponding (paired in time and space) nitrate value was added to each PMF to represent total $PM_{2.5}$. Maximum nitrate impacts were also determined and, where those differed from the receptor and time period that showed maximum PMF impacts, conservative estimates of total $PM_{2.5}$ impacts were calculated by adding each maximum nitrate concentration for each scenario and season to the maximum PMF impact for any season in the same scenario (note that in general, maximum nitrate impacts were substantially less than maximum PMF impacts). The highest of these total $PM_{2.5}$ impacts is summarized in Table 2.

- For the more distant Class I areas, maximum 24-hour PMF and nitrate impacts were determined over all seasons and years for each area. The maximum PMF for each Class I area was added to its paired (in time and space) nitrate value to represent total $PM_{2.5}$. These impacts are also shown in Table 2. In addition, the maximum nitrate concentrations for each year (any scenario, any of the more distant Class I areas) were determined and added to the maximum PMF concentration over all years/scenarios/Class I areas as a check to ensure all $PM_{2.5}$ concentrations at the more distant Class I areas were below the SIL.
- For the annual scenario, PMF and nitrate impacts were summed for each receptor and the maximum annual total $PM_{2.5}$ concentration at any receptor is shown in Table 2.

With the exception of Chiricahua WA, all impacts shown are below the $PM_{2.5}$ and $PM_{10}$ 24-hour and annual SILs. Total 24-hour $PM_{2.5}$ impacts determined as outlined above were slightly above the 24-hour SIL at Chiricahua WA for a single day and receptor in 2003 under both Scenario 1 and Scenario 3 and for a second day and receptor in 2003 under Scenario 3. All other Chiricahua WA impacts were below the SILs.

## Table 2. Results of Revised Class I Significant Impact Analysis

| Class I Area | 24-hour $PM_{10}$ ($\mu g/m^3$)[a,b] | 24-hour $PM_{2.5}$ ($\mu g/m^3$)[a,b] | Annual $PM_{10}$ ($\mu g/m^3$)[c] | Annual $PM_{2.5}$ ($\mu g/m^3$)[c] |
|---|---|---|---|---|
| Class I Significant Impact Level | 0.3 | 0.07 | 0.2 | 0.06 |
| Class I Increment | 8 | 2 | 4 | 1 |
| Chiricahua Wilderness Area, Arizona | 0.076[d] | 0.076[d] | 0.005 | 0.006 |
| Galiuro Wilderness Area, Arizona | 0.05 | 0.05 | 0.004 | 0.004 |
| Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona | 0.02 | 0.03 | 0.0006 | 0.0007 |
| Gila Wilderness Area, New Mexico | 0.02 | 0.02 | 0.0006 | 0.0007 |
| Superstition Wilderness Area, Arizona | 0.01 | 0.01 | 0.0007 | 0.0009 |
| Sierra Ancha Wilderness Area, Arizona | 0.009 | 0.009 | 0.0003 | 0.0004 |
| Pine Mountain Wilderness Area, Arizona | 0.004 | 0.005 | 0.00008 | 0.0001 |
| Bosque del Apache National Wildlife Refuge, New Mexico | 0.003 | 0.004 | 0.0002 | 0.0002 |

[a] Not to be exceeded more than once per year.
[b] Maximum high, 1st high impact at any receptor over three years of meteorological data modeled (2001-2003) and over multiple operating scenarios.
[c] Maximum annual impact at any receptor over three years of meteorological data modeled (2001-2003).
[d] Exceeds 24-hour SIL for single day in 2003 for Scenario 1 and Scenario 3 and for a second day in 2003 for Scenario 3. Maximum impact shown.

Notes:

$\mu g/m^3$ = Micrograms per cubic meter
$PM_{10}$ = Particulate matter less than 10 micrometers diameter
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers diameter

## Comment

The Chiricahua Wilderness Area 2003 visibility impact shown in Table 7 of the April 2014 *Addendum to Modeling Report for the Bowie Power Station* doesn't appear to match the output files.

## Response

The output file provided in the April 2014 Addendum was the file containing impacts based on receptors associated with the Chiricahua National Monument Class I Area rather than the Chiricahua Wilderness Area Class I area. The correct value for the 24-hour 2003 visibility impacts for the Chiricahua Wilderness Area is 4.20 % rather than the 7.17 % as reported in Table 7 of the April 2014 Addendum. The 2001 and 2002 Chiricahua Wilderness Area table entries had the same error. The correct CALPOST output files are being provided. In addition, revisions have been made to the background conditions included in the CALPOST visibility runs for all Class I areas and those files are being provided as well. The corrected Tables 7 and 8 from the 2014 Addendum are provided below. With the correction, all impacts are below 5%. Federal Land Manager policy has generally considered impacts below 5% to be insignificant.

### Table 7 Revised. Visibility Analysis Maximum Change

| Change in Light Extinction | Maximum % Change 2001 | Maximum % Change 2002 | Maximum % Change 2003 |
|---|---|---|---|
| Chiricahua Wilderness Area, Arizona | 2.43 | 2.36 | 4.20 |
| Galiuro Wilderness Area, Arizona | 2.88 | 2.52 | 2.60 |
| Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona | 0.74 | 1.32 | 1.35 |
| Gila Wilderness Area. New Mexico | 0.62 | 1.02 | 0.56 |
| Superstition Wilderness Area, Arizona | 0.73 | 0.65 | 0.89 |
| Sierra Ancha Wilderness Area, Arizona | 0.49 | 0.60 | 0.53 |
| Pine Mountain Wilderness Area, Arizona | 0.26 | 0.12 | 0.21 |
| Bosque del Apache National Wildlife Refuge | 0.20 | 0.20 | 0.24 |

Note:
% = Percent

**Table 8 Revised. Visibility Analysis Results**

| Change in Light Extinction | Days >5%/10% Change 2001 | Days >5%/10% Change 2002 | Days >5%/10% Change 2003 |
|---|---|---|---|
| Chiricahua Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Galiuro Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Gila Wilderness Area. New Mexico | 0/0 | 0/0 | 0/0 |
| Superstition Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Sierra Ancha Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Pine Mountain Wilderness Area, Arizona | 0/0 | 0/0 | 0/0 |
| Bosque del Apache National Wildlife Refuge | 0/0 | 0/0 | 0/0 |

Note:
% = Percent

## ATTACHMENT A

## Emissions and Weighted Average Stack Parameter Calculations for Revised Class I $PM_{10}$ and $PM_{2.5}$ Modeling

## BOWIE POWER STATION

| | | |
|---|---|---|
| Base Elevation | 1139.00 | meters |

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOx | Annual | Class I PM2.5 Increment | Turbines and Duct Burners | 15.86 | 2.00E+00 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters 59°F ambient |
| | | | Auxiliary Boiler | 0.03 | 3.56E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | |
| | | | Emergency Fire Pump | 0.01 | 1.81E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| PM10 | 24-hour (Scenario 1) | Class I Increment | Turbines and Duct Burners | 8.50 | 1.07E+00 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.50 | 1.07E+00 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 8.50 | 1.07E+00 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90°F (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Operation for 24 hours | |
| | 24-hour (Scenario 2) | Class I Increment | Turbines and Duct Burners | 6.50 | 8.19E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 6.50 | 8.19E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 6.50 | 8.19E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Operation for 24 hours | |
| | Annual | Class I Increment | Turbines and Duct Burners | 7.14 | 9.00E-01 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters 59°F ambient |
| | | | Auxiliary Boiler | 0.02 | 2.27E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | |
| | | | Emergency Fire Pump | 0.0008 | 9.73E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Annual average | |

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PM2.5 | 24-hour (Scenario 1) | Class I Increment | Turbines and Duct Burners | 8.50 | 1.07E+00 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.50 | 1.07E+00 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 8.50 | 1.07E+00 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90°F (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | [redacted] |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.05 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |
| | 24-hour (Scenario 2) | Class I Increment | Turbines and Duct Burners | 6.50 | 8.19E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 6.50 | 8.19E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 6.50 | 8.19E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | [redacted] |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.05 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |
| | Annual | Class I Increment | Turbines and Duct Burners | 7.14 | 9.00E-01 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters 59°F ambient |
| | | | Auxiliary Boiler | 0.02 | 2.27E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | [redacted] |
| | | | Emergency Fire Pump | 0.0008 | 9.73E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| | | | Cooling Tower[a] | 0.046 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Annual average | |

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOx | 24-hour (Scenario 3) | Class I PM2.5 Increment - Seasonal | Turbines and Duct Burners | 22.00 | 2.77E+00 | 54.86 | 352.90 | 20.94 | 5.49 | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10oF ambient | Weighted average stack parameters duct firing 10oF ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 20.17 | 2.54E+00 | | 353.12 | 19.43 | | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 59oF ambient | Weighted average stack parameters duct firing 10oF ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 19.94 | 2.51E+00 | | 354.18 | 18.55 | | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 102oF ambient | Weighted average stack parameters duct firing 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.28 | 3.46E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.21 | 2.65E-02 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| PM2.5 | | | Turbines and Duct Burners | 8.33 | 1.05E+00 | 54.86 | 352.90 | 20.94 | 5.49 | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10oF ambient | Weighted average stack parameters duct firing 10oF ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.33 | 1.05E+00 | | 353.12 | 19.43 | | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 59oF ambient | Weighted average stack parameters duct firing 10oF ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.33 | 1.05E+00 | | 354.18 | 18.55 | | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 102oF ambient | Weighted average stack parameters duct firing 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.05 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |
| PM10 | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 54.86 | 352.90 | 0.00 | 5.49 | Normal Operation | |

[a]There are 9 cooling tower cells. Data shown are for each cell individually.

**BOWIE POWER STATION**
**TURBINE AND DUCT BURNER WEIGHTED AVERAGE STACK PARAMETERS**

**Annual**

| **Ambient Temperature** | | 59°F | | | |
|---|---|---|---|---|---|
| **Configuration** | **Load** | **Stack Temperature (K)** | **Exit Velocity (meters/sec)** | **Hours per Year** | |
| Cold Startup | Startup | 356.04 | 15.94 | 325 | |
| Turbine + Duct Firing | 100% | 352.87 | 19.81 | 4224.0 | |
| Turbine | 80% | 357.87 | 16.46 | 3681.8 | Assumed for all turbine-only hours |
| Turbine | Shutdown | 355.32 | 13.11 | 91.3 | Use for shutdown hours |
| Weighted Average | | **355.23** | **18.10** | | |
| | | **°F** | **feet/sec** | | |
| | | 179.75 | 59.40 | | |

**Three Hot Starts, Two Shutdowns + Turbine Operation at 100% Load + Duct Firing**

| | 10°F | | 59°F | | 102°F | | | |
|---|---|---|---|---|---|---|---|---|
| | **Stack Temperature (K)** | **Exit Velocity (meters/sec)** | **Stack Temperature (K)** | **Exit Velocity (meters/sec)** | **Stack Temperature (K)** | **Exit Velocity (meters/sec)** | **Duration (hours)** | |
| Three Hot Starts | 354.76 | 17.04 | 356.04 | 15.94 | 359.04 | 15.12 | 1.50 | Use Cold Start Data |
| Two Shutdowns | 356.09 | 15.24 | 355.32 | 13.11 | 358.21 | 13.72 | 0.50 | Use Minimum Compliance Load Data |
| Normal Operation with Duct Firing | 352.71 | 21.33 | 352.87 | 19.81 | 353.76 | 18.90 | 22.00 | |
| Weighted Average | **352.90** | **20.94** | **353.12** | **19.43** | **354.18** | **18.55** | | |

Stack data is from "Turbine Stack Parameters" spreadsheet

Hours per year are from "Turbine and Duct Burner Annual" spreadsheet

Startup and shutdown durations are from "Turbine Startup Emissions" spreadsheet

$$\text{Weighted Average Temperature} = \frac{\Sigma(\text{Configuration Temperature} \times \text{Configuration Hours})}{\text{Total Hours}}$$

$$\text{Weighted Average Exit Velocity} = \frac{\Sigma(\text{Configuration Exit Velocity} \times \text{Configuration Hours})}{\text{Total Hours}}$$

$$°F = ((K - 273.15) \times \frac{9}{5}) + 32$$

$$\frac{\text{feet}}{\text{second}} = \frac{\text{meters}}{\text{second}} \times \frac{3.281 \text{ feet}}{\text{meters}}$$