**ENGINEERING ANALYSIS**

Source Name: **Virginia Electric and Power Company – Brunswick Plant** Permit No.: **52404-003**

Source Location: **Route 58, Brunswick County, Virginia** Cnty-Plant ID #: **025-00037**

Date: **January 27, 2015** Permit Writer: **AMS**

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I. Introduction and Background

A. Company Background

The facility, as proposed, will be a new, combined-cycle, natural gas-fired, electrical power generating facility. The facility will be located on a 214-acre parcel just south of Route 58, approximately 1.3 miles northeast of Racume in Brunswick County. The nearest residence is approximately 0.5 miles to the east. The nearest schools are Brunswick Academy and Brunswick High School, approximately 5.5 to 6.5 miles away. The nearest hospital/medical center is over ten miles away in Emporia, as are the nearest senior care facilities. There are no Class I areas within 100 km of the proposed facility (see PSD section).

The area is in attainment for all pollutants. Since the source will be a major source, with emissions over 100 tons/yr of Nitrogen Oxides ($NO_x$), carbon monoxide (CO), volatile organic compounds (VOC), Particulate Matter less than 10 microns ($PM_{10}$), particulate matter less than 2.5 microns ($PM_{2.5}$), and greenhouse gas [GHG or $CO_2$ equivalents ($CO_2e$)] over 100,000 tons/yr, Prevention of Significant Deterioration (PSD) permitting for those pollutants - as well as sulfur dioxide ($SO_2$) and sulfuric acid mist ($H_2SO_4$) emissions - will be triggered. The turbines will not be major for hazardous air pollutants (HAP), and are not subject to a MACT for major sources, so the source will be subject to the State Toxics Rule (6-5).

This current permit action requests changes to the original application for which a permit was issued on March 12, 2013. See Proposed Project Summary in Section I.B. The permitted facility is currently under construction and has not yet started up.

Site Suitability:

The facility is located on a site which is suitable from an air pollution standpoint. The area is rural with a combination of undeveloped and transitional land (tree plantations and farms) with forest and wooded wetlands. Additionally, on July 16, 2014, the County of Brunswick certified that the location and operation of the facility are consistent with all applicable ordinances adopted pursuant to Chapter 22 (§15.2-2200 et seq.) of Title 15.2 of the Code of Virginia (see attached Local Governing Body Certification Form).

The following table (Table 1) shows the distances between the proposed plant site and the closest Class I areas. The Federal Land Managers were given the opportunity to comment on whether they will provide a finding of adverse impact on visibility in these Class I areas as a result of the proposed facility. No adverse impact on visibility was suggested.

Table 1 – Distance to Class I areas

| Class I area | Distance from project |
|---|---|
| Shenandoah National Park | 173 km |
| James River Face Wilderness Area | 180 km |
| Dolly Sods Wilderness Area | 290 km |
| Swanquarter National Wildlife Refuge | 187 km |

In accordance with Section 10.1-1307 E of the Air Pollution Control Law of Virginia, consideration has been given to the following facts and circumstances relevant to the reasonableness of the activity involved:

1. The character and degree of injury to, or interference with safety, health, or the reasonable use of property which is caused or threatened to be caused:

   The activities regulated in this permit have been evaluated consistent with 9 VAC 5-50-280 (Best Available Control Technology) and 9 VAC 5-60-320 (Toxics Rule) and have been determined to meet these standards where applicable. Please see Section III.C for a description of the Best Available Control Technology included in the permit. Please refer to Section III.B for more information on the applicability of the Toxics Rule to the proposed facility.

   As a major stationary source, undergoing a major modification, PSD permitting was triggered. In accordance with PSD regulations, air quality modeling was conducted to predict the maximum ambient impacts of criteria pollutants emitted by the proposed modification. Updated AERMOD and AERMET data were used, as well as more current background air concentrations.

   The updated modeling analysis included revised significant impact level (SIL) modeling for CO (1-hr, 8-hr), revised NAAQS modeling for $NO_2$ (1-hr) and $PM_{2.5}$ (24-hr and annual), revised PSD increment modeling for $PM_{2.5}$ (24-hr), and revised CO modeling for soils and vegetation impacts.

   Even though the source is not within 100 km of a Class I area (an area such as a national park or wildlife sanctuary), an analysis was done to determine compliance with PSD Class I PSD increment for $SO_2$, $PM_{10}$, $PM_{2.5}$, and $NO_2$. The CALPUFF maximum modeled concentrations of those pollutants were well below the Class I SILs so no addition air quality analysis was required for Class I area impact.

   For the Class II (all other areas not designated as Class I areas) AERMOD modeling analysis, predicted impacts from CO (8-hour averaging period) and $SO_2$ (1-hour, 3-hour, and 24-hour) were below applicable modeling SILs. No further analyses were required for these pollutants at the indicated averaging periods. However, modeled concentrations from startup and shutdown (SU/SD) and 100% load w/duct firing for CO (SU/SD 1-hour), $NO_2$ (SU/SD 1-hour and 100% load w/DF annual averaging period), $PM_{10}$ (SU/SD 24-hour averaging period), and $PM_{2.5}$ (SU/SD 24-hour and 100% load w/DF annual averaging period) exceeded the applicable SILs. Therefore, a cumulative impact analysis for these pollutants and averaging periods was necessary. The predicted impacts for CO, $NO_2$, $PM_{10}$, and $PM_{2.5}$ from the cumulative impact analysis were less than the applicable National Ambient Air Quality Standards (NAAQS). Hence, the proposed project does not cause or significantly contribute to a predicted violation of any applicable NAAQS or Class II area PSD increment.

   Accordingly, approval of the proposed project is not expected to cause injury to or interference with safety, health, or reasonable use of property.

   The emissions of toxic pollutants from electric generating units such as those proposed by Dominion are subject to the standards in 9 VAC 5-60-300 et seq. Dominion calculated the emissions of toxic pollutants from all of the emission units proposed for the site. Dominion modeled emissions of toxic pollutants for which proposed emissions exceeded the thresholds in 9 VAC 5-60-320 (acrolein, formaldehyde, beryllium, cadmium, chromium, lead, mercury, and nickel). Modeling demonstrated that proposed emissions of these toxics pollutants are well below the associated Significant Ambient Air Concentrations (SAACs).

   The results of an analysis to determine the impact of facility CO emissions on vegetation and soils has demonstrated that the maximum predicted concentration of CO was below the minimum reported levels at which damage or growth effects to vegetation may occur.

2. The social and economic value of the activity involved:

   The social and economic value of the facility submitting the application has been evaluated relative to local zoning requirements. The local government official has deemed this activity not inconsistent with local ordinances.

   The proposed Dominion Brunswick County power plant will generate electricity using only clean-burning natural gas. The availability of clean fuel electric generation facilities is necessary if operation of conventional coal-fired power plants is to be reduced or replaced. Construction of clean-burning, efficient generation plants such as the proposed Dominion-Brunswick facility creates the potential for regional $SO_2$ and $NO_x$ reductions resulting from displacement of older, more polluting forms of electricity generation.

   The Brunswick County Board of Supervisors and the Industrial Development Authority support the construction of the facility and anticipate the placement of the facility in this location will be an economic boon to the region in terms of jobs, taxes, and the availability of natural gas that wasn't previously available in the area.

3. The suitability of the activity to the area in which it is located:

   Consistent with the Board's Suitability Policy dated 9/11/87, the activities regulated in this permit are deemed suitable as follows:

   a. Air Quality characteristics and performance requirements defined by the State Air Pollution Control Board (SAPCB) regulations: This permit is written consistent with existing applicable regulations. The proposed facility is a source of toxics emissions and has been modeled and shows compliance with the applicable SAACs. The emissions for criteria pollutants associated with this permit have likewise been modeled and have been shown through modeling to not cause or contribute to a violation of the ambient air quality standards or allowable increments within any Class I or Class II areas.

   b. The health impact of air quality deterioration which might reasonably be expected to occur during the grace period allowed by the Regulations or the permit conditions to fix malfunctioning air pollution control equipment:

   c. Anticipated impact of odor on surrounding communities or violation of the SAPCB Odor Rule: No violation of Odor requirements is anticipated as a result of the proposed project.

4. The scientific and economic practicality of reducing or eliminating the discharge resulting from the activity: The permit contains a requirement to notify the Piedmont Regional Office within four business hours of the discovery of any malfunction of pollution control equipment (Condition 79).

   The state NSR program as well as the PSD and Non-Attainment programs require consideration of levels of control technology that are written into regulation to define the level of scientific and economic practicality for reducing or eliminating emissions. By properly implementing the Regulations through the issuance of the proposed permit, the staff has addressed the scientific and economic practicality of reducing or eliminating emissions associated with this project.

   The permit requires numerous pollution control strategies that will result in reduction of emissions from the combustion turbines and associated equipment. These include technologies such as the use of clean fuels with low sulfur content, good combustion practices, and clean-burning "low-$NO_x$" lean premix burners as well as add-on control (SCR for $NO_x$ removal and an Oxidation Catalyst for CO, VOC, and VOC toxic pollutant control). Other measures have been included in the draft permit, such as a requirement to use ultra-low sulfur diesel oil (no more than 0.0015 % by weight) or propane in emergency equipment

and to monitor equipment leaks in the circuit breakers. Feasibility of obtaining further emission reductions was reviewed through the rigorous "top-down" Best Available Control Technology (BACT) requirements of PSD review (discussed in Section III.C).

B. Proposed Project Summary

The proposed project will be to revisit the startup and shutdown emissions estimates in the current permit to allow for a maximum duration of cold start, warm start, hot start and shutdown, rather than an annual average. Additionally, the facility has requested the following changes to the capacity of some of the proposed equipment:

Table 2 – Proposed changes to equipment capacity

| Equipment | Previous permitted capacity | New proposed capacity |
|---|---|---|
| Cooling towers (4) (IC-1 through IC-4) | 690,000 gallons each | 570,000 gallons each |
| Auxiliary boiler (B-1) | 66.7 MMBtu/hr | 30.6 MMBtu/hr |
| Emergency propane generator (EG-2) | 80 kW | 100 kW |
| Emergency fire pump (FWP-1) | 305 hp | 376 hp |
| Delugeable auxiliary equipment cooler (AEC-1) | 1,160 gallons/minute | 1,620 gallons/minute |

Also, the stack parameters of the following equipment changed:

Table 3 – Proposed changes to stack parameters

| | Fuel use | | Stack ht (ft) | | Stack diam. (ft) | | Velocity (ft/sec) | | Flow rate (acfm) | | Temp. (°F) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Old | New | Old | New | Old | New | Old | New | Old | New | Old | New |
| B-1 | 66.7 MMBtu/hr | 30.6 MMBtu/hr | 155.0 | 155.0 | 2.5 | 2.0 | 67.9 | 44.5 | 20,000 | 8,381 | 300 | 300 |
| EG-1 | 147.4 gal/hr | 147.4 gal/hr | 12.0 | 14.9 | 1.5 | 1.5 | 145.0 | 188.0 | 15,400 | 19,935 | 900 | 880 |
| EG-2 | 12.1 gal/hr | 14.8 gal/hr | 20.0 | 20.0 | 0.4 | 0.3 | 150.0 | 221.0 | 900 | 876 | 1,250 | 1,250 |
| FWP-1 | 16.5 gal/hr | 18.8 gal/hr | 12.0 | 13.5 | 0.5 | 0.5 | 161.0 | 158.5 | 1,900 | 1,867 | 1,057 | 842 |
| GH-1, 2, 3 | 8.0 MMBtu/hr | 8.0 MMBtu/hr | 20.0 | 25.5 | 1.7 | 2.5 | 40.7 | 13.8 | 5,680 | 4,072 | 750 | 750 |

Table 4 - Expected emissions from the proposed facility are as follows:

| Pollutant | Previous Permitted Emissions (tons/yr) | Proposed Emissions (tons/yr) |
|---|---|---|
| $NO_x$ | 343.6 | 341.9 |
| CO | 477.9 | 598.6 |
| $SO_2$ | 51.1 | 51.0 |
| VOC | 314.2 | 335.8 |
| $PM_{10}$ | 218.0 | 216.8 |
| $PM_{2.5}$ | 217.6 | 216.4 |
| $CO_2e$ | 5,341,291.0 | 5,323,242.0 |
| Sulfuric acid mist ($H_2SO_4$) | 30.4 | 30.4 |
| Acrolein | 0.162 | 0.162 |
| Formaldehyde | 5.88 | 5.87 |
| Beryllium | | 0.00054 |
| Cadmium | 0.049 | 0.0491 |
| Chromium | 0.063 | 0.0623 |
| Lead | | 0.0223 |
| Mercury | | 0.0116 |
| Nickel | 0.094 | 0.0937 |

Note: Emissions of regulated toxic pollutants other than acrolein, formaldehyde, beryllium, cadmium, chromium, lead, mercury, and nickel are below permitting exemption thresholds and were therefore not included in Table 4.

C. Process and Equipment Description

**Combustion Turbine Generators with duct-fired Heat Recovery Steam Generators (T-1M, T-2M, and T-3M)**

Combustion Turbines (CT)

The source proposed the installation of three Mitsubishi M501 GAC class CTs in combined-cycle mode.

The gas turbine is the main component of a combined-cycle power system. First, air is filtered, cooled and compressed in a multiple stage axial flow compressor. Compressed air and fuel are mixed and combusted in the turbine combustion chamber. Lean pre-mix dry low-$NO_x$ combustors minimize $NO_x$ formation during natural gas combustion. Hot exhaust gases from the combustion chamber are expanded through a multi-stage power turbine that results in energy to drive both the air compressor and electric power generator.

The CTs are designed to operate in the dry low-$NO_x$ mode at loads from approximately 50 percent up to 100 percent rating. Operation at lower loads will only occur during start up and shutdown. The CTs will be periodically taken out of service for scheduled maintenance, or as dictated by economic or electrical demand conditions.

Heat Recovery Steam Generators (HRSG) with Duct Burners (DB)

The facility will use three HRSGs, one for each CT, which will use waste heat to produce additional electricity. Each HRSG will act as a heat exchanger to derive heat energy from the CT exhaust gas to produce steam that will be used to drive a Steam Turbine generator (ST). Exhaust gas entering the HRSG at approximately 1,100°F will be cooled to 180°F by the time it leaves the HRSG exhaust stack. Steam production in the HRSGs will be augmented using duct burners (DBs) that will be fired by natural gas. The proposed DBs will have a firing rate of 501 MMBtu/hr each. The heat recovered is used in the combined-cycle plant for additional steam generation and natural gas/feedwater heating. Each HRSG will include high-pressure superheaters, a high-pressure evaporator, high-pressure economizers, reheat sections (to reheat partially expanded steam), an intermediate-pressure superheater, an intermediate-pressure evaporator, an intermediate-pressure economizer, a low-pressure superheater, a low-pressure evaporator, and a low-pressure economizer. The dry condenser will condense the steam exhausting from the ST. As the steam is condensed, the condensate flows to the condensate receiver tank. Control devices such as selective catalytic reduction (SCR) will be installed, to control $NO_x$ emissions, and oxidation catalysts will be installed to control CO and VOC emissions.

Steam Turbine (ST)

The facility includes one reheat, condensing steam turbine generator designed for variable pressure operation. The high-pressure portion of the steam turbine generator receives high-pressure superheated steam from the HRSGs, and exhausts to the reheat section of the HRSGs. The steam from the reheat section for the HRSGs is supplied to the intermediate-pressure section of the turbine, which expands to the low-pressure section. The low-pressure steam turbine generator also receives excess low-pressure superheated steam from the HRSGs and exhausts to the air-cooled condenser. The steam turbine generator set is designed to produce up to approximately 610 MW of electrical output at ISO conditions with duct firing. No pollutants are emitted from the steam turbine.

**Ancillary Equipment**

Turbine Inlet Air Chillers (IC-1 through IC-4)

Four mechanical draft cooling towers will be incorporated to provide air inlet chilling for the CTs. These devices will cool the inlet area during periods of high ambient temperature in order to increase power output and improve efficiency. Each of these units can process up to 570,000 gallons of water/hr. Particulate matter emissions from the cooling towers associated with the inlet air chillers will be controlled by high efficiency drift eliminators.

Auxiliary Boiler (B-1)

The proposed facility will include a 30.6 MMBtu/hr, natural gas-fired, auxiliary boiler. The auxiliary boiler will provide steam to the ST at start-up and at cold starts to warm up the ST rotor. The steam from the auxiliary boiler will not be used to augment the power generation of the CTs or ST. The boiler is proposed to operate 8760 hrs/yr (263 MMcf of natural gas/yr). $NO_x$ emissions from the boiler will be controlled by the use of ultra low $NO_x$ burners.

Fuel Gas Heaters (GH-1 through GH-3)

The proposed facility will include three 8.0 MMBtu/hr, natural gas-fired, fuel gas heaters. The heaters will be used to warm up the incoming natural gas fuel to prevent freezing of the gas regulating valves under certain gas system operating conditions. The heaters are proposed to operate 8760 hrs/yr. $NO_x$ emissions from the heaters will be controlled by the use of ultra low $NO_x$ burners.

Diesel-Fired Emergency Generator (EG-1)

The proposed facility will include a 2200 kW diesel-fired emergency generator that will be operated up to 500 hours per year (including 100 hrs of maintenance checks and readiness testing). The emergency generator will provide power in emergency situations for turning gears, lube oil pumps, auxiliary cooling water pumps and water supply pumps. The emergency diesel generator is not intended to provide sufficient power for a black start, peak shaving or non-emergency power.

Propane-Fired Emergency Generator (EG-2)

The proposed facility will include a 100 kW propane-fired emergency generator that will be operated up to 500 hours per year (including 100 hrs of maintenance checks and readiness testing). The emergency generator will provide power in emergency situations for the uninterruptible power supply for the control house in the switchyard. The emergency propane generator is not intended to provide sufficient power for a black start, peak shaving or non-emergency power.

Diesel-Fired Fire Water Pump (FWP-1)

The proposed project will include a 376 bhp diesel-fired fire water pump operated as a fire water pump driver. The unit will be limited to 500 hours per year, including monthly testing and maintenance (not to exceed 100 hours per year).

Distillate Oil Storage Tank (ST-1)

The proposed project will include a 6,000-gallon, fixed-roof, horizontal, distillate oil storage tank to provide fuel for the emergency generator (EG-1) and fire water pump (FWP-1).

Circuit Breakers (CB-1)

The proposed project will include circuit breakers holding 1,645 lbs of the greenhouse gas sulfur hexafluoride ($SF_6$) per unit. There will be a total of 11 circuit breakers located at the facility, with a total capacity of 18,095 lbs of $SF_6$. Maximum annual leakage rate for $SF_6$ is to be no more than 1%.

Delugeable Auxiliary Equipment Cooler (AEC-1)

Dominion proposes to construct a 12-bay delugeable auxiliary equipment cooler which will cool the lubricating oil for miscellaneous equipment. Forced-draft fans will be incorporated to provide the flow needed for the equipment cooler. The cooler will have six bays equipped with deluge water sprays for additional cooling during extremely hot weather, causing particulate matter emissions from drift. The cooler will process 97,200 gallons of water/hr.

D. Project Schedule

| | |
|---|---|
| Date permit application received in region | June 30, 2014 |
| Date application was deemed complete | November 17, 2014 (modeling submitted) |
| Proposed construction commencement date | January 2014 |
| Proposed start-up date | November 2015 |

II. Emissions Calculations (see attached spreadsheets for detailed emission calculations)

Proposed emissions are primarily products of combustion from the combined cycle units and duct burners. There are also emissions from the auxiliary boiler, fuel gas heater, emergency generators, emergency firewater pump, turbine inlet chillers, auxiliary equipment cooler, and circuit breakers. Permitted emission limits reflect BACT (see section III.C for BACT analysis). Individual unit emissions calculations can be found in the attached emission calculation spreadsheet.

Emissions from startup and shutdown were considered in the annual permit emissions limits for the combustion turbines, but separate limits will not be included. During startup and shutdown, some post-combustion controls are not working at the optimum level of control, however, during these periods, the turbines and duct burners are also not operating at their highest output and other emissions may be reduced for that reason. Therefore it is important to consider emissions during startup and shutdown in the annual total for emissions. Worst case annual emissions were based on either 8,760 hrs/yr with duct burning, or 6,941 hrs/yr with duct burning plus start up and shutdown (SU/SD) emissions. Condition 12 of the permit defines startup (cold, warm and hot) and shutdown and the duration of each. The facility was not given an annual limit on the total number of hours of start up and shutdown, but rather the estimated amount of time was factored into the annual emission limits and, therefore, must be complied with by showing compliance with the annual emission limits. BACT applies during startup and shutdown and BACT includes minimization of such SU/SD events.

Emissions from the auxiliary boiler were based on 8,760 hrs/yr operation. The emergency generators and fire water pump are permitted to operate not more than 500 hrs/yr.

Heavy metal emissions from the turbines were based on AP-42 §1.4, which is for natural gas-fired boilers. The numbers were converted from lb/mmcf to lb/mmBtu using a heating value for natural gas of 1020 mmBtu/mmcf. The AP-42 section for combustion turbines (§3.1) did not have emission factors for heavy metals from natural gas combustion.

III. Regulatory Review

PSD Permitting: The source had previously been determined to be PSD-major for $PM_{10}$, $PM_{2.5}$, $NO_x$, CO, VOC and $CO_2e$, in addition to being PSD for $SO_2$ and $H_2SO_4$ (see analysis for March 12, 2013 permit). Currently, the increase in CO from the proposed project (when comparing the original PTE to the proposed PTE, since the facility is not yet operating) makes this a major modification and triggers PSD permitting (see Table 5). BACT for CO is discussed in Section III.C.

Table 5- PSD Permitting applicability – for projects that do not have two years worth of emissions data, the Baseline Emissions are the prior Potential to Emit [40 CFR 52.21(b)(48)(iii)].

| Pollutant | Original Potential to Emit (TPY) | New Potential to Emit (TPY) | Net Emissions Change (TPY) | PSD Significance Rate (TPY)* | PSD Required? |
|---|---|---|---|---|---|
| $PM_{10}$ | 218.0 | 216.7 | -1.3 | 15 | No |
| $PM_{2.5}$ | 217.6 | 216.4 | -1.2 | 10 | No |
| $NO_x$ | 343.6 | 341.9 | -1.7 | 40 | No |
| CO | 477.9 | 598.5 | 120.6 | 100 | **Yes** |
| $SO_2$ | 51.1 | 50.9 | -0.2 | 40 | No |
| VOC | 314.2 | 335.7 | 21.5 | 40 | No |
| $CO_2e$ | 5,341,291.0 | 5,324,940 | -14,189 | 75,000 | No |
| Lead | 0.02 | 0.02 | 0.00 | 0.6 | No |
| $H_2SO_4$ | 30.4 | 30.3 | -0.1 | 7 | No |

*PSD significance values from definition of "significant" in 9 VAC 5-80-1615C

NSPS Requirements:

**Subpart KKKK**: The combustion turbines are subject to NSPS Subpart KKKK (Standards of Performance for Stationary Combustion Turbines) which requires the source to meet $NO_x$ and $SO_2$ standards. The source must meet a $NO_x$ limit of 25 ppm when burning natural gas. The source proposes the use of ultra low $NO_x$ burners and SCR to control $NO_x$ emissions. $NO_x$ emissions from the proposed combustion turbines are expected to be around 2.0 ppmvd when burning natural gas which is below the NSPS standard and is considered Best Available Control Technology (BACT). The source will put $NO_x$ CEMS on the turbine stacks to show compliance with the BACT limits.

The source proposes using low-sulfur fuel (natural gas) to control $SO_2$ from the turbines and duct burners. To be in compliance with NSPS KKKK, they must not exceed 0.06 lb $SO_2$/MMBtu from fuel burning. The source has proposed a BACT emission limit of 0.00112 lb $SO_2$/MMBtu. BACT is discussed in more detail in Section III.C. Turbines regulated under NSPS Subpart KKKK are not subject to NSPS Subpart GG, and HRSGs and duct burners regulated under NSPS Subpart KKKK are not subject to NSPS Subparts Da, Db, or Dc.

NSPS Subpart KKKK does not explicitly state that emissions from startup and shutdown (SU/SD) of the turbines must meet the short term NOx and $SO_2$ emission standards, however, good combustion practices (BACT) require that the SU/SD duration be minimized and that controls be operational as soon as possible during startup.

**Subpart Dc**: The 30.6 MMBtu/hr auxiliary boiler is subject to NSPS Subpart Dc Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units as a steam-generating unit between 10 and 100 MMBtu/hr. Since it will be burning natural gas only, it will be required to keep records of the amount of fuel burned each calendar month. The three 8 MMBtu/hr fuel gas heaters are not subject to this part.

**Subpart IIII**[1]: The emergency diesel fire water pump (FWP-1) and diesel emergency generator (EG-1) are subject to NSPS Subpart IIII. The 376 bhp diesel fire water pump is subject to a $NO_x$ + non-methane hydrocarbon (NMHC) limit of 3.9 g/kW-hr, a $PM_{10}$ limit of 0.26 g/kW-hr, a CO limit of 0.9 g/kW-hr, and a requirement to use ULSD with no more than 15 ppm sulfur content. The 2200 kW diesel emergency generator is subject to a $NO_x$ + NMHC limit of 6.4 g/kW-hr, a $PM_{10}$ limit of 0.4 g/kW-hr, a CO limit of 3.5 g/kW-hr, and a requirement to use ULSD with no more than 15 ppm sulfur content.

**Subpart JJJJ**[2]: The 100 kW emergency, propane-fired generator is subject to NSPS Subpart JJJJ for spark-ignition internal combustion engines, which has a requirement to use certified engines and maintain them properly.

**Subpart TTTT** (proposed). A new NSPS (Subpart TTTT) could possibly be in place before this source starts up the turbines (June 2015) so the turbines could be subject to that subpart. The proposed standard for a natural gas-fired unit is a $CO_2$ emission limit of 1,100 lb/MWh (gross annual average considering all operation). Expected emissions of $CO_2$ from the facility are around 920 lb/MWh at maximum operating capacity, so it is expected that, on an annual average, the source will be able to meet the proposed 1,100 lb/MW-hr $CO_2$ standard. When the source conducts Part 75 monitoring for Acid Rain, it will fulfill the proposed monitoring requirements for NSPS Subpart TTTT.

MACT Requirements:

**Subpart ZZZZ**[3]: The emergency diesel fire water pump and emergency generators are also subject to MACT Subpart ZZZZ (40 CFR 63.6590.c.1) for area sources of HAP. Compliance with this MACT is met by complying with NSPS Subpart IIII or NSPS Subpart JJJJ requirements, as applicable.

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1 *Although the source must be in compliance with the requirements for these emergency units, DEQ has not elected to receive delegation for enforcement of these regulations, so no requirements specific to this regulation will be included in this permit (but will be referenced in the permit cover letter). BACT limits will be used to ensure the NSPS standards are met.*

2 See footnote 1.

**Non-applicable Subparts:** As an area HAP source, the facility will not be subject to MACT Subpart YYYY for turbines or MACT Subpart Q for cooling towers (see Section III.B).

Other:

- Cross State Air Pollution Rule (CSAPR)/Clean Air Interstate Rule (CAIR)
  On August 21, 2012, the United States Court of Appeals for the D.C. Circuit vacated CSAPR but continued to leave CAIR in place pending EPA's promulgation of a replacement rule that complies with the courts' rulings. Virginia at this time will implement the CSAPR requirements through the federal implementation plan (FIP) as per Chapter 291 of the 2011 Virginia Acts of Assembly and 40 CFR 97.

- Title IV/Acid Rain Permit
  The source's initial Acid Rain permit was issued on March 25, 2014. The source will be subject to Article 3 Federal Operating (Title IV) permitting and must submit an application within a year of commencing operation.

**State New Source Review:**

Emissions subject to Major New Source Review (Article 8 – PSD) are not subject to Article 6 New Source Review as per 9 VAC 5-80-1100.H.1. Therefore CO, which triggered PSD review, is not subject to Article 6 review due to this project. All other criteria pollutants (except lead) were previously subject to PSD permitting and PSD BACT, the determination of which is not changing due to this modification. If units are subject to both Article 6 and Article 8, then the Article 8 requirements shall prevail (9 VAC 5-80-1100.H.3).

A. Criteria Pollutants

Criteria pollutant modeling was conducted to ensure that the facility will not violate the NAAQS (see section I.A above, under site suitability).

PSD increment
The PSD increment modeling showed that the concentrations for all pollutants and averaging periods were below the applicable PSD increments (see modeling memo attachment).

B. Toxic Pollutants

MACTs have been promulgated for Combustion Turbines that are major sources of HAP (Subpart YYYY National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines) and for cooling towers at major sources of HAP (Subpart Q National Emission Standards for Hazardous Air Pollutants For Industrial Process Cooling Towers). HAP emissions from this facility will be below major levels, so there will be no MACT requirements for the Combustion Turbines or Cooling Towers and, therefore, the State Toxics Rule (Rule 6-5, 9 VAC 5-60-300) will apply. The source will need to demonstrate that they are minor for HAPs.

The toxic pollutants that exceed the exemption rates in 9 VAC 5-60-300 are acrolein, formaldehyde, beryllium, cadmium, chromium, lead, mercury, and nickel. Lead is a criteria pollutant but it does not exceed the significance level in 9 VAC 5-80-1105D, so it is not subject to BACT. Since these limits do not need to be federally enforceable to keep the facility out of MACT, emission limits for these toxics will appear in a State Only section of the permit. Modeling has shown that emissions of these toxics will not exceed the Standard Ambient Air Concentration (SAAC) (see modeling memo attachment).

The emergency diesel fire water pump and emergency generators are subject to MACT Subpart ZZZZ as an area source as per the application submitted by Dominion. The requirements for this

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*3 DEQ has not elected to receive delegation to enforce this federal regulation so requirements for this specific regulation will not be included in the permit but will be referenced in the permit cover letter.*

unit will be to comply with NSPS Subpart IIII or NSPS Subpart JJJJ requirements, which will be enforced by EPA, not DEQ.

C. Control Technology

**PSD BACT**: Sources that are subject to PSD permitting, must apply BACT to those pollutants that triggered PSD permitting (see Table 5 in Section III). The determination of BACT usually involves a top-down method:

Step 1 – Identify all possible control technologies;
Step 2 – Eliminate technically infeasible options;
Step 3 – Rank the technically feasible control technologies based upon emission reduction potential;
Step 4 – Evaluate ranked controls based on energy, environmental, and/or economic considerations; and
Step 5 – Select BACT.

PSD procedures require that the BACT cost feasibility analysis be based upon recent permit determinations for similar facilities. Federal guidance is clear that there can be no fixed or "bright line" cost established as representative of BACT. Rather, the cost of reducing emissions, expressed in dollars per ton, is to be compared with the cost incurred by other sources of the same industry type. A listing of BACT determinations from the RACT/BACT/LAER Clearinghouse for similar facilities that have been made since the permit was first issued in 2013 is included in Table 6 below. BACT determinations for the facility are summarized in Table 7 below.

1. Greenhouse gasses: $CO_2e$ emissions from the proposed modification to the facility do not trigger PSD permitting so BACT will not be re-examined for $CO_2e$.

2. $NO_x$ Control: NOx emissions from the proposed modification to the facility do not trigger PSD permitting so BACT will not be re-examined for NOx

3. CO Control - CO emissions are formed in the exhaust of a combustion turbine as a result of incomplete combustion of the fuel. Similar to the generation of $NO_x$ emissions, the primary factors influencing the generation of CO emissions are temperature and residence time within the combustion zone. Variations in fuel carbon content have relatively little effect on overall CO emissions. Generally the effect of the combustion zone temperature and residence time on CO emissions generation is the exact opposite of their effect on $NO_x$ emissions generation. Higher combustion zone temperatures and residence times lead to more complete combustion and lower CO emissions, but higher $NO_x$ emissions.

   a. Combustion Turbines

      i. Possible Control Technologies (Step 1)

         - Oxidation Catalyst
         - Good Combustion Practices

      ii. Available and feasible (Step 2)

         An oxidation catalyst is a post-combustion technology that removes CO from the exhaust gas stream after formation in the combustion turbine. In the presence of a catalyst, CO will react with oxygen present in the exhaust stream, converting it to carbon dioxide. No supplementary reactant is used in conjunction with an oxidation catalyst. The oxidation of CO to $CO_2$ utilizes the excess air present in the turbine exhaust; and the activation energy required for the reaction to proceed is lowered in the presence of the catalyst. Technical factors relating to this technology include the catalyst reactor design, optimum operating temperature, back pressure loss to the

system, catalyst life, and potential collateral increases in emissions of $PM_{10}$ and $H_2SO_4$ emissions.

CO catalytic oxidation reactors operate in a relatively narrow temperature range. Optimum operating temperatures for these systems generally fall into the range of 700 °F to 1100 °F. At lower temperatures, CO conversion efficiency falls off rapidly. Above 1200 °F, catalyst sintering may occur, thus causing permanent damage to the catalyst. For this reason, the CO catalyst is strategically placed within the proper turbine exhaust lateral distribution (it is important to evenly distribute gas flow across the catalyst) and proper operating temperature at base load design conditions. Operation at partial load, or during startup/shutdown will result in less than optimum temperatures and reduced control efficiency.

Typical pressure losses across an oxidation catalyst reactor (including pressure loss due to ammonium salt formation) are in the range of 0.7 to 1.0 inches of water. Pressure drops in this range correspond roughly to a 0.15 percent loss in power output and fuel efficiency or approximately 0.1 percent loss in power output for each 1.0 inch of water pressure loss.

Catalyst systems are subject to loss of activity over time. Since the catalyst itself is the most costly part of the installation, the cost of catalyst replacement should be considered on an annualized basis. Catalyst life may vary from the manufacturer's typical 3-year guarantee to a 5- to 6-year predicted life. Periodic testing of catalyst material is necessary to predict annual catalyst life for a given installation.

Oxidation catalysts have been employed successfully for two decades on natural gas combustion turbines. An oxidation catalyst is considered to be technically feasible for application to this project.

Good combustion practices, consisting primarily of controlled fuel/air mixing and adequate temperature and gas residence time, are used to minimize the formation of CO. Minimization of startup and shutdown events and operating emission control equipment as soon as possible after a shutdown are part of these practices. Good combustion practices are technically feasible for this project.

iii. Ranking of technologies for CO control (Step 3)

The most effective technologies that are available for a large natural gas-fired, combined cycle power generating facility for controlling CO are good combustion practices to control the formation of CO, and oxidation catalyst as a post-combustion treatment.

iv. BACT (Step 4)

Dominion has proposed a combination of control options for CO: oxidation catalyst and good combustion practices. The draft permit proposes use of oxidation catalyst and good combustion practices to control CO emissions from the CTs to the following level (at 15% $O_2$):

- 1.5 ppmvd without duct burning
- 2.4 ppmvd with duct burning

Compliance with the limits is to be based on a one-hour block average.

As shown in EPA's RBLC in Table 6, except for Virginia Electric and Power Company Brunswick Plant, all other similar turbines using similar controls for CO have been permitted at CO emission rates of 2 ppmvd at 15% $O_2$ without duct burning and from

2.0 to 10.5 ppm with duct burning. The Brunswick Plant proposes limits that are at least as stringent as these facilities.

Table 6 – RBLC Summary for combined cycle gas turbines since March 2013

| Date Issued | Facility Name | BACT Emission limit | | Description of BACT |
|---|---|---|---|---|
| 12-Mar-13 | Virginia Electric and Power Company Brunswick VA | 1.5 | ppmvd at 15% $O_2$, 3 hr avg w/o duct burning | oxidation catalyst and good combustion practices |
| | | 2.4 | ppmvd at 15% $O_2$, 3 hr avg w/duct burning | |
| 23-Apr-13 | Hickory Run Energy PA | 2.0 | ppmvd at 15% $O_2$ with or without duct burning | CO catalyst |
| 23-Apr-13 | Midland Cogen MI | 9.0 | ppm 24-hr avg w/HRSG | good combustion practices |
| | | 3123 | lb/hr SU/SD emissions | good combustion practices |
| | | 10.5 | ppm with duct burning 24-hr avg | good combustion practices |
| 30-Apr-13 | Green Energy Partners VA | 2.0 | ppmvd at 15% $O_2$ with or without duct burning | catalytic oxidizer |
| 18-Jun-13 | Arcadis OH | 2.0 | ppmvd at 15% $O_2$ with or without duct burning | oxidation catalyst |
| 25-Jul-13 | Consumers Energy Co Thetford MI | 694 | tons/yr for SU/SD emissions | efficient combustion control plus catalytic oxidation system |
| | | 4.0 | ppmvd 24 hr avg every hour | efficient combustion control plus catalytic oxidation system |
| | | 3159 | lb/hr | efficient combustion control plus catalytic oxidation system |
| 12-Nov-13 | Pinecrest Energy TX | 2.0 | ppmvd 80-100% load | oxidation catalyst |
| | | 4.0 | ppmvd 60-80% load | oxidation catalyst |
| 4-Dec-13 | Holland Board of PW MI | 4.0 | ppmvd @ 15% $O_2$ not including SU/SD | oxidation catalyst and good combustion practices |
| | | 247 | lb/hr during startup | oxidation catalyst and good combustion practices |
| | | 551 | lb/hr during shutdown | oxidation catalyst and good combustion practices |
| | | 5.3 | lbs/hr not including SU/SD | oxidation catalyst and good combustion practices |
| 17-Dec-13 | Berks Hollow Energy PA | 211.9 | tons/yr | CO catalyst |
| 30-Mar-14 | Future Power PA | 3.0 | ppmvd | CO catalyst |
| | | 17.9 | lb/hr with duct burning | CO catalyst |
| | | 84 | tons/yr | CO catalyst |
| 24-Mar-14 | FGE Power LLC TX | 2.0 | ppmvd @ 15% $O_2$; 3-hr avg | oxidation catalyst |
| 14-Apr-14 | Interstate Power and Light IA | 2.0 | ppm 30-day average | CO catalyst |
| | | 552.4 | tons/yr | CO catalyst |

DEQ concurs that the proposed oxidation catalyst control, along with good combustion practices, constitute BACT for CO from the CTs.

b. Auxiliary Boiler and Fuel Gas Heaters

i. List of control technologies (Step 1)
- Good combustion practices
- Oxidation catalyst

ii. Technical feasibility and availability of CO Control (Step 2)
- Good combustion practices are feasible and available for these units
- Oxidation catalyst is feasible and available for these units

iii. Ranking of technologies (Step 3)

- Good combustion practices can result in emissions from the units of 0.037 lb/MMBtu
- Oxidation catalyst could reduce emissions further to about 0.006 lb/MMBtu

iv. BACT determination (Step 4)
- Oxidation catalyst used in conjunction with good combustion practices reduces CO emissions from the boiler by only 9 tons/yr at a cost of $10,000 per ton, and, for the fuel gas heaters, 1.1 tons/yr at $65,000 per ton, making it economically infeasible. (*Note: these emission reductions and cost/ton figures are from the 2012 permit application. The proposed auxiliary boiler emissions associated with this project are estimated to be half of what they were proposed to be in 2012 and the fuel gas heaters remain unchanged, so these estimates would be at least the same or even less economically feasible now).*
- Good combustion practices results in CO emissions that are consistent with BACT at similar facilities. DEQ concurs with Dominion that good combustion practices are BACT for CO from the auxiliary boiler and fuel gas heaters.

c. Emergency Generators and Fire Water Pump
The control of CO from the emergency units can be achieved without the use of add-on CO controls which can be problematic on stationary combustion units. The units can meet NSPS standards for engines through proper operation and maintenance of the units, and burning of cleaner fuels. Therefore BACT for CO from the emergency unit will be the use of clean fuel and the proper operation and maintenance of the units to keep CO emissions at 3.5 g/kW-hr for the diesel emergency generator, 0.9 g/kW-hr for the fire water pump, and 4.0 g/hp-hr for the propane unit.

4. $SO_2$ and sulfuric acid mist – $SO_2$ and sulfuric acid mist emissions from the proposed modification to the facility do not trigger PSD permitting so BACT will not be re-examined for $SO_2$ or sulfuric acid mist.

5. VOC – VOC emissions from the proposed modification to the facility do not trigger PSD permitting so BACT will not be re-examined for VOC.

6. $PM_{10}$ and $PM_{2.5}$, including condensables – $PM_{10}$ and $PM_{2.5}$ emissions from the proposed modification to the facility do not trigger PSD permitting so BACT will not be re-examined for $PM_{10}$ or $PM_{2.5}$.

Table 7 BACT summary for the facility. Only CO emissions were re-evaluated for BACT for this modification.

| Pollutant | Primary BACT | Control | Compliance |
|---|---|---|---|
| $NO_x$ | Turbine<br>2.0 ppmvd @ 15% $O_2$ (1-hour avg.) | DLN burners<br>SCR | Annual fuel throughput<br>Stack test<br>$NO_x$ CEMS |
| | Auxiliary Boiler and fuel gas heaters<br>9 ppmvd (0.011 lb/MMBtu) | DLN burners | Annual fuel throughput<br>Stack test |
| | Emergency Generators<br>FWP-1 3.9 g/kW-hr NOx+NMHC<br>EG-1 6.4 g/kW-hr $NO_x$+NMHC<br>EG-2 2.0 g/hp-hr | Good combustion practices | Annual hours of operation |
| $SO_2$ | Turbine<br>0.00112 lb/MMBtu | Low sulfur fuel (S ≤ 0.4 gr/100 scf) | Fuel monitoring, stack test |
| | Auxiliary boiler and fuel gas heaters<br>0.00112 lb/MMBtu | Low sulfur fuel (S ≤ 0.4 gr/100 scf) | Fuel monitoring |
| | Emergency generators<br>FWP-1 0.00156 lb/MMBtu<br>EG-1 0.00154 lb/MMBtu<br>EG-2 0.00059 lb/MMBtu | ULSD fuel with 15 ppm S<br>Or propane fuel | Fuel certification and hours of operation |
| $H_2SO_4$ | Turbine<br>0.00058 lb/MMBtu without DB<br>0.00067 lb/MMBtu with DB | Low sulfur fuel | Fuel monitoring, stack test |
| | Auxiliary boiler and fuel gas heaters<br>0.00857 lb/MMBtu | Pipeline quality natural gas and 5% oxidation of S to $H_2SO_4$ | Fuel monitoring |
| | Emergency generators | ULSD fuel with 15 ppm S | Fuel monitoring |

| Pollutant | Primary BACT | Control | Compliance |
|---|---|---|---|
| | FWP-1 0.000078 lb/MMBtu<br>EG-1 0.000118 lb/MMBtu<br>EG-2 0.000045 lb/MMBtu | Or propane fuel | |
| CO | Turbine<br>1.5 ppmvd without DB (3-hour avg.)<br>2.4 ppmvd with DB (3-hour avg.) | Oxidation catalyst<br>Good combustion practices | CO CEMS |
| | Auxiliary boiler and fuel gas heaters<br>50 ppmvd (0.037 lb/MMBtu) | Clean fuel and good combustion practices | Stack test |
| | Emergency generators<br>FWP-1 0.9 g/kW-hr<br>EG-1 3.5 g/kW-hr<br>EG-2 4.0 g/hp-hr | Good combustion practices | Fuel monitoring |
| $PM_{10}$ and $PM_{2.5}$ | Turbine<br>9.7 lbs/hr (0.0033 lb/MMBtu) without DB (3-hour avg.)<br>16.3 lbs/hr (0.0047 lb/MMBtu) with DB (3-hour avg.) | Low sulfur/carbon fuel and good combustion practices | Stack test |
| | Auxiliary boiler and fuel gas heaters<br>0.007 lb/MMBtu | Low sulfur/carbon fuel and good combustion practices | Fuel throughput |
| | Emergency generators<br>FWP-1 0.26 g/kW-hr<br>EG-1 0.40 g/kW-hr<br>EG-2 0.0194 g/hp-hr | Low sulfur fuel and good combustion practices | Hours of operation |
| | Turbine Chiller<br>Drift rate of 0.0005% of circulating water flow and TDS of no more than 1,000 mg/l | Low total dissolved solids (TDS) and drift eliminators | Weekly water quality testing for TDS |
| | Auxiliary Cooler<br>Drift rate of 0.01% and TDS content of no more than 300 mg/l | Low TDS | Weekly water quality testing for TDS |
| VOC | Turbine<br>0.7 ppmvd without DB (3-hour avg.)<br>1.6 ppmvd with DB (3-hour avg.) | Oxidation catalyst<br>Good combustion practices | stack test and CO CEMS compliance |
| | Auxiliary boiler and fuel gas heater<br>0.005 lb/MMBtu | Clean fuel and good combustion practices | Fuel throughput |
| | Emergency generators<br>FWP-1 0.1 g/kW-hr (as carbon)<br>EG-1 6.4 g/kW-hr (TOC)<br>EG-2 1.0 g/hp-hr | Good combustion practices | Hours of operation |
| $CO_2e$ | Turbine<br>7,500 Btu/kWh (HHV net) and 920 lb/MWh | Energy efficient combustion practices and low GHG fuels | ASME Performance Test Code on Overall Plant Performance (PTC 46) and $CO_2$ CEMS (Part 75) and maintenance. |
| | Auxiliary boiler and fuel gas heaters<br>116.9 lb/MMBtu | Pipeline quality natural gas and fuel-efficient design and operation | Manufacturer specifications and maintenance. |
| | Emergency Units<br>FWP-1 & EG-1 163.1 lb/MMBtu<br>EG-2 135.5 lb/MMBtu | Fuel-efficient design | fuel usage monitoring |
| | Electrical Circuit breakers<br><1% leakage rate | Enclosed-pressure type breaker and leak detection | Audible alarm with decreased pressure. |

The proposed control strategies are considered to be the Best Available Control Technology (BACT) for this source type and are more stringent than NSPS standards.

IV. Initial Compliance Determination

A. Testing – stack testing is required for $NO_x$, $SO_2$, CO, VOC, $PM_{10}$, and $PM_{2.5}$ from the turbines and $NO_x$ and CO from the auxiliary boiler and fuel gas heaters to show compliance with the BACT limits. An initial compliance test using ASME Performance Test Code on Overall Plant Performance (ASME PTC 46-1996) (or equivalent) is to be conducted on the turbine power blocks to show compliance with the heat rate limit of 7,500 Btu/kWh (HHV net).

The permit allows the permittee to use the fuel quality characteristics in a current, valid purchase contract, tariff sheet or transportation contract for the fuel to verify that the sulfur content of the natural gas is 0.4 grain or less of total sulfur per 100 standard cubic feet. Alternatively, per 40

CFR 60.4370, the permit allows Dominion to determine the sulfur content of the natural gas by testing using two custom monitoring schedules or an EPA-approved schedule. The permit also requires the permittee to obtain fuel supplier certification for each shipment of distillate oil used in the emergency units.

B. VEEs – an initial VEE will be required for the combustion turbines.

V. Continuing Compliance Determination

A. CEMS – will be required for $NO_x$ (NSPS) and is also proposed for CO and $CO_2$. Requirements for CEMS performance evaluations, quality assurance, and excess emissions reports will be included in the permit.

The permit requires that the CT stacks be equipped with CEMS meeting the requirements of 40 CFR Part 75 (Acid Rain program) for $NO_x$. In addition to providing a means to demonstrate compliance with the permit $NO_x$ limits, the CEMS will satisfy the NSPS Subpart KKKK requirement to monitor $NO_x$ emissions using a CEMS. The permit also requires that the CT stacks be equipped with CEMS meeting the monitoring requirements in 40 CFR 60.13 for CO.

In addition to the CEMS, the draft permit requires Dominion to conduct extensive, continuous monitoring of key operational parameters on the control devices to assure proper operation and performance.

B. Recordkeeping – The following records will be kept by the permittee for the most recent five years:

1. Annual hours of operation of the emergency fire water pump (FWP-1) and emergency generators (EG-1 and EG-2) for emergency purposes and for maintenance checks and readiness testing, calculated monthly as the sum of each consecutive 12-month period. Compliance for the consecutive 12-month period shall be demonstrated monthly by adding the total for the most recently completed calendar month to the individual monthly totals for the preceding 11 months;

2. All fuel supplier certifications for the ULSD fuel used in the emergency units (EG-1and FWP-1);

3. Monthly and annual throughput of natural gas to the three combustion turbines and associated duct burners (T-1M, T-2M, and T-3M), calculated monthly as the sum of each consecutive 12-month period. Compliance for the consecutive 12-month period shall be demonstrated monthly by adding the total for the most recently completed calendar month to the individual monthly totals for the preceding 11 months;

4. Time, date and duration of each startup, shutdown, and malfunction period for each combustion turbine and associated duct burner (T-1M, T-2M, and T-3M);

5. Monthly and annual throughput of natural gas to the auxiliary boiler (B-1) and the fuel gas heaters (GH-1 through GH-3), calculated monthly as the sum of each consecutive 12-month period. Compliance for the consecutive 12-month period shall be demonstrated monthly by adding the total for the most recently completed calendar month to the individual monthly totals for the preceding 11 months;

6. Fuel quality records for natural gas combusted in the combustion turbine and associated duct burner (T-1M, T-2M, and T-3M);

7. Continuous monitoring system emissions data, calibrations and calibration checks, percent operating time, and excess emissions;

8. Operation and control device monitoring records for each SCR system and oxidation catalyst as required in Conditions 3 and 7;

9. Weekly logs of dissolved solids content of cooling water to the four inlet coolers (IC-1 through IC-4) and the auxiliary equipment chiller (AEC-1).

10. Scheduled and unscheduled maintenance, and operator training.

11. Results of all stack tests, visible emission evaluations, and performance evaluations.

12. Manufacturer's instructions for proper operation of equipment.

C. Further Testing

1. Annual testing for $SO_2$ can be done instead of fuel monitoring.

2. After the initial test for heat rate of the power block, an additional test is required every five years.

VI. Public Participation

The applicant held a public information session on September 22, 2014 at the Meherrin Library in Lawrenceville, Brunswick County to provide the community with information about the project.

Pursuant to 9 VAC 5-80-1775 (Article 8) of the Regulations, the proposed project was subject to a public comment period of 30 days, followed by a public hearing. EPA had a 30-day opportunity to submit comments.

An information meeting and public hearing was held on January 12, 2015 at the Meherrin Library, Brunswick Branch, followed by 15 more days of public comment. No one from the general public attended the hearing and no comments were received from EPA or the public during the public comment period.

The following documents are attached:

A. Public hearing notice

B. Public hearing opening statement

C. Public briefing handout

D. Virginia Register notice

E. Documents concerning public comment period

VII. Other Considerations

A. File Consistency Review – The prior permit action was reviewed for this project.

B. PRO Policy Consistency Review – A review of similar combustion turbine permits proposed or issued in the USA was conducted. The most recent boilerplate was used for this permit.

C. Confidentiality – The source has not claimed confidentiality of any data.

D. Permit History – This is the second permit issued for this source. This permit will supersede the permit issued on March 12, 2013.

VIII. Recommendations

Based on the information submitted, it is recommended that this permit be issued. Recommendations and limitations are provided in the draft permit letter.

Regional Engineer: _____ Date: 1/27/2015

Reviewing Engineer: Lisa A. Childress Date: 1/27/2015

Attachments:
- Permit application
- Local Governing Body Certification Form
- Calculation sheets
- Modeling Memo
- Public Participation documents

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emissions from EACH of the combustion turbines T-1M, T-2M, T-3M**

| Capacity | 310 MW | | |
|---|---|---|---|
| | 2941 MMBtu/hr | gas | 8760 hrs/yr |

| Natural Gas Combustion No Duct Firing | | Uncontrolled | | Controlled @ 8760 hours | | | |
|---|---|---|---|---|---|---|---|
| pollutant | EF (lb/MMBtu) | lb/hr | ton/yr | Control | % | lb/hr | tons/yr |
| PM10 | 0.0047 | 13.92 | 60.97 | None | 0 | 13.92 | 60.97 |
| PM2.5 | 0.0047 | 13.92 | 60.97 | None | 0 | 13.92 | 60.97 |
| CO | 0.0223 | 65.53 | 287.00 | Ox Cat | 85 | 9.83 | 43.05 |
| NOx | 0.0548 | 161.30 | 706.48 | SCR | 87.5 | 20.16 | 88.31 |
| SO2 | 0.0011 | 3.29 | 14.43 | None | 0 | 3.29 | 14.43 |
| VOC | 0.0013 | 3.74 | 16.36 | Ox Cat | 35 | 2.43 | 10.63 |
| H2SO | 0.00026 | 0.76 | 3.31 | | 0 | 0.76 | 3.31 |
| | | | | | | | |
| $CO_2$ | 116.89 | 343,772.61 | 1,505,724.05 | Efficiency | 0 | 343,772.61 | 1,505,724.05 |
| $CH_4$ | 0.0022 | 6.48 | 28.40 | Efficiency | 0 | 6.48 | 28.40 |
| N2O | 0.00022 | 0.65 | 2.84 | Efficiency | 0 | 0.65 | 2.84 |
| CO2-e | 117.01 | 344,127.93 | 1,507,280.32 | Efficiency | 0 | 344,127.93 | 1,507,280.32 |

Emissions based on engineering judgement and BACT determinations

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404 **HAP Emissions from each turbine**
**Eng** AMS

**Combustion Turbines** 2941 MMBtu/hr EACH (natural gas)

| **NATURAL GAS** | | **Uncontrolled** | | **Control** | **Controlled** | |
|---|---|---|---|---|---|---|
| **Pollutant** | **EF** | **Emissions** | | **efficiency** | **Emissions** | |
| | **(Lb/MMBtu)** | **lb/hr** | **tpy** | **%** | **lb/hr** | **tpy** |
| 1,3-Butadiene | 4.30E-07 | 1.26E-03 | 5.54E-03 | 35 | 8.22E-04 | 3.60E-03 |
| Acetaldehyde | 4.00E-05 | 1.18E-01 | 5.15E-01 | 35 | 7.65E-02 | 3.35E-01 |
| Acrolein | 6.40E-06 | 1.88E-02 | 8.24E-02 | 35 | 1.22E-02 | 5.36E-02 |
| Benzene | 1.20E-05 | 3.53E-02 | 1.55E-01 | 35 | 2.29E-02 | 1.00E-01 |
| Ethyl Benzene | 3.20E-05 | 9.41E-02 | 4.12E-01 | 35 | 6.12E-02 | 2.68E-01 |
| Formaldehyde* | 2.20E-04 | 6.47E-01 | 2.83E+00 | 35 | 4.21E-01 | 1.84E+00 |
| Naphthalene | 1.30E-06 | 3.82E-03 | 1.67E-02 | 35 | 2.49E-03 | 1.09E-02 |
| PAH | 2.20E-06 | 6.47E-03 | 2.83E-02 | 35 | 4.21E-03 | 1.84E-02 |
| Propylene Oxide | 2.90E-05 | 8.53E-02 | 3.74E-01 | 35 | 5.54E-02 | 2.43E-01 |
| Toluene | 1.30E-04 | 3.82E-01 | 1.67E+00 | 35 | 2.49E-01 | 1.09E+00 |
| Xylenes | 6.40E-05 | 1.88E-01 | 8.24E-01 | 35 | 1.22E-01 | 5.36E-01 |

*All emission factors are from AP-42 Table except formaldehyde which is based on manufacturer's information (91 ppbvd@15% O2 using dry low NOx combustion)

| **METALS** | | **Uncontrolled** | | **Control** | **Controlled** | |
|---|---|---|---|---|---|---|
| **Pollutant** | **EF** | **Emissions** | | **efficiency** | **Emissions** | |
| | **(Lb/MMBtu)** | **lb/hr** | **tpy** | **%** | **lb/hr** | **tpy** |
| Arsenic | 1.96E-07 | 5.76E-04 | 2.52E-03 | 0.00 | 5.76E-04 | 2.52E-03 |
| Beryllium | 1.18E-08 | 3.47E-05 | 1.52E-04 | 0.00 | 3.47E-05 | 1.52E-04 |
| cadmium | 1.08E-06 | 3.18E-03 | 1.39E-02 | 0.00 | 3.18E-03 | 1.39E-02 |
| chromium | 1.37E-06 | 4.03E-03 | 1.76E-02 | 0.00 | 4.03E-03 | 1.76E-02 |
| cobalt | 8.24E-08 | 2.42E-04 | 1.06E-03 | 0.00 | 2.42E-04 | 1.06E-03 |
| lead | 4.90E-07 | 1.44E-03 | 6.31E-03 | 0.00 | 1.44E-03 | 6.31E-03 |
| manganese | 3.73E-07 | 1.10E-03 | 4.80E-03 | 0.00 | 1.10E-03 | 4.80E-03 |
| mercury | 2.55E-07 | 7.50E-04 | 3.28E-03 | 0.00 | 7.50E-04 | 3.28E-03 |
| nickel | 2.06E-06 | 6.06E-03 | 2.65E-02 | 0.00 | 6.06E-03 | 2.65E-02 |
| selenium | 2.35E-08 | 6.91E-05 | 3.03E-04 | 0.00 | 6.91E-05 | 3.03E-04 |

Heavy metal emissions were calculated using AP-42 §1.4 for natural gas boilers because §3.1 for turbines did not have emission factors for metals from natural gas combustion.

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emissions from EACH of the three duct burners associated with the turbines**

Capacity

| 501 MMBtu/hr | gas | 8760 hrs/yr |
|---|---|---|

| Natural Gas Combustion | | Uncontrolled @ 8760 hrs/yr | | Controlled @ 8760 hours | | | |
|---|---|---|---|---|---|---|---|
| pollutant | EF (lb/MMBtu) | lb/hr | ton/yr | Control | % | lb/hr | tons/yr |
| PM10 | 0.0047 | 2.37 | 10.39 | None | 0 | 2.37 | 10.39 |
| PM2.5 | 0.0047 | 2.37 | 10.39 | None | 0 | 2.37 | 10.39 |
| CO | 0.1000 | 50.10 | 219.44 | Ox Cat | 85 | 7.52 | 32.92 |
| NOx | 0.080 | 40.0439 | 175.39 | SCR | 87.5 | 5.01 | 21.92 |
| SO2 | 0.0011 | 0.56 | 2.46 | None | 0 | 0.56 | 2.46 |
| VOC | 0.0120 | 6.01 | 26.33 | Ox Cat | 35 | 3.91 | 17.12 |
| H2SO4* | 0.0002 | 0.51 | 2.25 | | 0 | 1.56 | 6.81 |
| | | | | | | | |
| $CO_2$ | 116.89 | 58,561.48 | 256,499.29 | Efficiency | 0 | 58,561.48 | 256,499.29 |
| $CH_4$ | 0.0022 | 1.10 | 4.84 | Efficiency | 0 | 1.10 | 4.84 |
| N2O | 0.0002 | 0.11 | 0.48 | Efficiency | 0 | 0.11 | 0.48 |
| CO2-e | 117.01 | 58,622.01 | 256,764.40 | Efficiency | 0 | 58,622.01 | 256,764.40 |

*H2SO4 emissions include those from OC and SCR

GHG emission factors from Part 98 - Mandatory Greenhouse Gas Reporting, Section C

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404 **HAP Emissions from Duct Burner**
**Eng** AMS

**Duct Burners (each)** 501 MMBtu/hr EACH (natural gas)
8760 hrs/yr
All emission factors are from AP-42 Table

| NATURAL GAS | | Uncontrolled Emissions | | Control efficiency | Controlled Emissions | |
|---|---|---|---|---|---|---|
| **Pollutant** | **EF (Lb/MMBtu)** | **lb/hr** | **tpy** | | **lb/hr** | **tpy** |
| 2-methylnapthalene | 2.35E-08 | 1.18E-05 | 5.16E-05 | 35 | 7.65E-06 | 3.35E-05 |
| 3-methylchloranthren | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| 7,12-Dimethylbenz(a)a | 1.57E-08 | 7.87E-06 | 3.45E-05 | 35 | 5.11E-06 | 2.24E-05 |
| Acenaphthene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Acenaphthylene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Anthracene | 2.35E-09 | 1.18E-06 | 5.16E-06 | 35 | 7.65E-07 | 3.35E-06 |
| Benz(a)anthracene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Benzene | 2.06E-06 | 1.03E-03 | 4.52E-03 | 35 | 6.71E-04 | 2.94E-03 |
| Benzo(a)pyrene | 1.18E-09 | 5.91E-07 | 2.59E-06 | 35 | 3.84E-07 | 1.68E-06 |
| Benzo(b)flouoranthen | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Benzo(g,h,l)perylene | 1.18E-09 | 5.91E-07 | 2.59E-06 | 35 | 3.84E-07 | 1.68E-06 |
| Benzo(k)fluoranthene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Chrysene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Dibenzo(ah)anthracen | 1.18E-09 | 5.91E-07 | 2.59E-06 | 35 | 3.84E-07 | 1.68E-06 |
| Dichlorobenzene | 1.18E-06 | 5.91E-04 | 2.59E-03 | 35 | 3.84E-04 | 1.68E-03 |
| Fluoranthene | 2.94E-09 | 1.47E-06 | 6.45E-06 | 35 | 9.57E-07 | 4.19E-06 |
| Fluorenen | 2.75E-09 | 1.38E-06 | 6.03E-06 | 35 | 8.96E-07 | 3.92E-06 |
| Formaldehyde | 7.35E-05 | 3.68E-02 | 1.61E-01 | 35 | 2.39E-02 | 1.05E-01 |
| Hexane | 1.76E-03 | 8.82E-01 | 3.86E+00 | 35 | 5.73E-01 | 2.51E+00 |
| Indeno(123-cd)pyrene | 1.76E-09 | 8.82E-07 | 3.86E-06 | 35 | 5.73E-07 | 2.51E-06 |
| Naphthalene | 5.98E-07 | 3.00E-04 | 1.31E-03 | 35 | 1.95E-04 | 8.53E-04 |
| Phenanathrene | 1.67E-08 | 8.37E-06 | 3.66E-05 | 35 | 5.44E-06 | 2.38E-05 |
| Pyrene | 4.90E-09 | 2.45E-06 | 1.08E-05 | 35 | 1.60E-06 | 6.99E-06 |
| Toluene | 3.33E-06 | 1.67E-03 | 7.31E-03 | 35 | 1.08E-03 | 4.75E-03 |

**Totals**
Total annual HAP based on 8760 hrs on natural gas

| METALS | | Uncontrolled Emissions | |
|---|---|---|---|
| **Pollutant** | **EF (Lb/MMBtu)** | **lb/hr** | **tpy** |
| Arsenic | 1.96E-07 | 9.82E-05 | 4.30E-04 |
| Beryllium | 1.18E-08 | 5.91E-06 | 2.59E-05 |
| cadmium | 1.08E-06 | 5.41E-04 | 2.37E-03 |
| chromium | 1.37E-06 | 6.86E-04 | 3.01E-03 |
| cobalt | 8.24E-08 | 4.13E-05 | 1.81E-04 |
| lead | 4.90E-07 | 2.45E-04 | 1.08E-03 |
| manganese | 3.73E-07 | 1.87E-04 | 8.19E-04 |
| mercury | 2.55E-07 | 1.28E-04 | 5.60E-04 |
| nickel | 2.06E-06 | 1.03E-03 | 4.52E-03 |
| selenium | 2.35E-08 | 1.18E-05 | 5.16E-05 |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Start Up/Shut down Emissions**
**Average per turbine**

| | Start up | | Shut down | | Totals | |
|---|---|---|---|---|---|---|
| Pollutant | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY |
| NOx | 43.00 | 3.90 | 28.20 | 1.40 | 43.00 | 5.30 |
| CO | 858.70 | 93.30 | 852.30 | 41.50 | 858.70 | 134.80 |
| VOC | 746.40 | 56.20 | 630.00 | 30.70 | 746.40 | 86.90 |
| PM10/2.5 | 16.30 | 1.35 | 12.80 | 0.62 | 16.30 | 1.97 |
| SO2 | 3.85 | 0.16 | 1.60 | 0.08 | 3.85 | 0.24 |

Emissions were calculated based on estimated duration and frequency of cold start, warm start, hot start and shutdowns, as estimated by Black and Veatch Environmental Consultants. See application, Section B, pages B-7 and B-8 for more detailed calculations.

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emissions from Control Equipment**

**SCR**

| | | |
|---|---|---|
| H2SO4 | 0.111 | lb/hr |
| NH3 | 9.32 | lb/hr |
| Amm Sulfa | 3.11 | lb/hr |

**Oxidation Catalyst**

| | | |
|---|---|---|
| H2SO4 | 0.93 | lb/hr |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Total Emissions from each turbine including duct burning and su/sd**

| | Turbine (each) | | duct burners | | SU/SD | | Totals (worst case)* | |
|---|---|---|---|---|---|---|---|---|
| pollutant | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY |
| PM10 | 13.92 | 60.97 | 2.37 | 10.39 | 16.30 | 1.97 | 16.29 | 71.35 |
| PM2.5 | 13.92 | 60.97 | 2.37 | 10.39 | 16.30 | 1.97 | 16.29 | 71.35 |
| CO | 9.83 | 43.05 | 7.52 | 32.92 | 858.70 | 134.80 | 17.34 | 194.99 |
| NOx | 20.16 | 88.31 | 5.01 | 21.92 | 43.00 | 5.30 | 25.17 | 110.23 |
| SO2 | 3.29 | 14.43 | 0.56 | 2.46 | 3.85 | 0.24 | 3.86 | 16.89 |
| VOC | 2.43 | 10.63 | 3.91 | 17.12 | 746.40 | 86.90 | 6.34 | 108.89 |
| H2SO | 0.76 | 3.31 | 1.56 | 6.81 | -- | -- | 2.31 | 10.12 |
| | | | | | | | | |
| $CO_2$ | 3.44E+05 | 1.51E+06 | 5.86E+04 | 2.56E+05 | | | 4.02E+05 | 1.76E+06 |
| $CH_4$ | 6.48E+00 | 2.84E+01 | 1.10E+00 | 4.84E+00 | | | 7.59E+00 | 3.32E+01 |
| N2O | 6.48E-01 | 2.84E+00 | 1.10E-01 | 4.84E-01 | | | 7.59E-01 | 3.32E+00 |
| CO2-e | 3.44E+05 | 1.51E+06 | 5.86E+04 | 2.57E+05 | | | 4.03E+05 | 1.76E+06 |

*Worst case annual emissions are based on either the hourly emissions from the turbine + duct burner x 8760 hrs/yr **or** the hourly emissions from the turbine + duct burner x 6941 hrs/yr + annual SU/SD emissions

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emergency Diesel Generator EG-1**

| | |
|---|---|
| 2200 kW | 500 hrs/yr operation |
| 453.59 g/lb | 135 MMBtu/kgal |
| 7000 Btu/hp-hr | |
| 135 MMBtu/kgal | 19.9 MMBtu/hr HHV |

| Pollutant | EF | unit | Emissions lb/hr | tons/yr |
|---|---|---|---|---|
| $PM_{10}$ | 0.400 | g/kW-hr | 1.94 | 0.49 |
| $PM_{2.5}$ | 0.400 | g/kW-hr | 1.94 | 0.49 |
| CO | 3.5 | g/kW-hr | 16.98 | 4.24 |
| NOx | 6.4 | g/kW-hr | 31.04 | 7.76 |
| $SO_2$ | 0.00154 | lb/MMBtu | 0.0306 | 0.0077 |
| VOC | 6.4 | g/kW-hr | 31.04 | 7.76 |
| $H_2SO_4$ | 1.18E-04 | lb/MMBtu | 2.34E-03 | 5.86E-04 |
| $CO_2$ | 163.054 | lb/MMBtu | 3244.78 | 811.19 |
| $CH_4$ | 0.00661 | lb/MMBtu | 0.13 | 0.03 |
| $N_2O$ | 0.0013 | lb/MMBtu | 0.03 | 0.01 |
| $CO_2e$ | 163.614 | lb/MMBtu | 3255.91 | 813.98 |

| |
|---|
| PM, CO, and NOx/TOC EF from NSPS Subpart IIII, Table 1 |
| SO2 based on fuel sulfur content of 0.0015% |
| GHG EF from 40 CFR Part 98, Table C-1 |
| $H_2SO_4$ is based on a 7.7% conversion of $SO_2$ to $SO_3$ and 100% conversion of $SO_3$ to $H_2SO_4$ |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emergency Diesel Generator EG-1 HAP Emissions**

| | | | | |
|---|---|---|---|---|
| 2200 kW | | 500 hrs/yr operation | | |
| 453.59 g/lb | | 135 MMBtu/kgal | | |
| 7000 Btu/hp-hr | | | | |
| 135 MMBtu/kg | | 19.9 MMBtu/hr HHV | | |
| | | | Emissions | |
| Pollutant | EF | unit | lb/hr | tons/yr |
| 1,3 - dichloropropene | 3.91E-05 | lb/MMBtu | 7.78E-04 | 1.95E-04 |
| acenaphthene | 4.68E-06 | lb/MMBtu | 9.31E-05 | 2.33E-05 |
| acenaphthylene | 9.23E-06 | lb/MMBtu | 1.84E-04 | 4.59E-05 |
| acetaldehyde | 2.52E-05 | lb/MMBtu | 5.01E-04 | 1.25E-04 |
| acrolein | 7.88E-06 | lb/MMBtu | 1.57E-04 | 3.92E-05 |
| anthracene | 1.23E-06 | lb/MMBtu | 2.45E-05 | 6.12E-06 |
| benz(a)anthracene | 6.22E-07 | lb/MMBtu | 1.24E-05 | 3.09E-06 |
| benzene | 7.76E-04 | lb/MMBtu | 1.54E-02 | 3.86E-03 |
| benzopyrene | 2.57E-07 | lb/MMBtu | 5.11E-06 | 1.28E-06 |
| benzo(b)fluoranthene | 1.11E-06 | lb/MMBtu | 2.21E-05 | 5.52E-06 |
| benzo(ghl)perylene | 5.56E-07 | lb/MMBtu | 1.11E-05 | 2.77E-06 |
| benzo(k)fluoranthene | 2.18E-07 | lb/MMBtu | 4.34E-06 | 1.08E-06 |
| chrysene | 1.53E-06 | lb/MMBtu | 3.04E-05 | 7.61E-06 |
| dibenzo anthracene | 3.46E-07 | lb/MMBtu | 6.89E-06 | 1.72E-06 |
| fluoranthene | 4.03E-06 | lb/MMBtu | 8.02E-05 | 2.00E-05 |
| fluorene | 1.28E-05 | lb/MMBtu | 2.55E-04 | 6.37E-05 |
| formaldehyde | 7.89E-05 | lb/MMBtu | 1.57E-03 | 3.93E-04 |
| indeno (123-cd)pyrene | 4.14E-07 | lb/MMBtu | 8.24E-06 | 2.06E-06 |
| naphthalene | 1.30E-04 | lb/MMBtu | 2.59E-03 | 6.47E-04 |
| phenanthrene | 4.08E-05 | lb/MMBtu | 8.12E-04 | 2.03E-04 |
| pyrene | 3.71E-06 | lb/MMBtu | 7.38E-05 | 1.85E-05 |
| toluene | 2.81E-04 | lb/MMBtu | 5.59E-03 | 1.40E-03 |
| xylene | 1.93E-04 | lb/MMBtu | 3.84E-03 | 9.60E-04 |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emergency Generator EG-2 (propane)**

| | | | |
|---|---|---|---|
| 162 | hp* | 500 | hrs/yr operation |
| 453.59 | g/lb | 97 | MMBtu/kgal |
| 7000 | Btu/hp-hr | | |
| 91 | MMBtu/kgal | 1.35 | MMBtu/hr HHV |

| Pollutant | EF | unit | Emissions lb/hr | Emissions tons/yr |
|---|---|---|---|---|
| $PM_{10}$ | 0.019 | g/hp-hr | 0.0069 | 0.0017 |
| $PM_{2.5}$ | 0.019 | g/hp-hr | 0.0069 | 0.0017 |
| CO | 4 | g/hp-hr | 1.43 | 0.36 |
| NOx | 2 | g/hp-hr | 0.71 | 0.18 |
| $SO_2$ | 5.88E-04 | lb/MMBtu | 7.94E-04 | 1.98E-04 |
| VOC | 1 | g/hp-hr | 0.36 | 0.09 |
| $H_2SO_4$ | 4.50E-05 | lb/MMBtu | 6.07E-05 | 1.52E-05 |
| $CO_2$ | 135.500 | lb/MMBtu | 182.93 | 45.73 |
| $CH_4$ | 0.00661 | lb/MMBtu | 8.92E-03 | 2.23E-03 |
| $N_2O$ | 0.0013 | lb/MMBtu | 1.78E-03 | 4.46E-04 |
| $CO_2e$ | 136.059 | lb/MMBtu | 183.68 | 45.92 |

* unit output is 100 kW with a power output of 121 kW (162 hp)

CO, NOx, and VOC EF from Manufacturer performance data

$PM_{10}$, $PM_{2.5}$, $SO_2$ ($H_2SO_4$) EF from AP-42 Table 3.2-3

GHG EF from 40 CFR Part 98, Table C-1

$H_2SO_4$ is based on a 7.7% conversion of $SO_2$ to $SO_3$ and 100% conversion of $SO_3$ to $H_2SO_4$.

LPG is considered natural gas in NSPS IIII standards

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Emergency Propane Generator EG-2 HAP Emissions**

| | | | |
|---|---|---|---|
| 100 kW | | 500 hrs/yr operation | |
| 453.59 g/lb | | 135 MMBtu/kgal | |
| 7000 Btu/hp-hr | | | |
| 135 MMBtu/kg | | 1.34 MMBtu/hr HHV | |

| | | | Emissions | |
|---|---|---|---|---|
| Pollutant | EF | unit | lb/hr | tons/yr |
| 1,1,2,2-tetrachloroethane | 2.53E-05 | lb/MMBtu | 3.39E-05 | 8.48E-06 |
| 1,2,-trichloroethane | 1.53E-05 | lb/MMBtu | 2.05E-05 | 5.13E-06 |
| 1,3-butadiene | 6.63E-04 | lb/MMBtu | 8.88E-04 | 2.22E-04 |
| 1,3,-dichloropropene | 1.27E-05 | lb/MMBtu | 1.70E-05 | 4.25E-06 |
| acetaldehyde | 2.79E-03 | lb/MMBtu | 3.74E-03 | 9.35E-04 |
| acrolein | 2.63E-03 | lb/MMBtu | 3.52E-03 | 8.81E-04 |
| benzene | 1.58E-03 | lb/MMBtu | 2.12E-03 | 5.29E-04 |
| carbon tetrachloride | 1.77E-05 | lb/MMBtu | 2.37E-05 | 5.93E-06 |
| chlorobenzene | 1.29E-05 | lb/MMBtu | 1.73E-05 | 4.32E-06 |
| chloroform | 1.37E-05 | lb/MMBtu | 1.84E-05 | 4.59E-06 |
| ethylbenzene | 2.48E-05 | lb/MMBtu | 3.32E-05 | 8.31E-06 |
| ethyldibromide | 2.13E-05 | lb/MMBtu | 2.85E-05 | 7.14E-06 |
| formaldehyde | 2.05E-02 | lb/MMBtu | 2.75E-02 | 6.87E-03 |
| methanol | 3.06E-03 | lb/MMBtu | 4.10E-03 | 1.03E-03 |
| methylene chloride | 4.12E-05 | lb/MMBtu | 5.52E-05 | 1.38E-05 |
| naphthalene | 9.71E-05 | lb/MMBtu | 1.30E-04 | 3.25E-05 |
| PAH | 1.41E-04 | lb/MMBtu | 1.89E-04 | 4.72E-05 |
| styrene | 1.19E-05 | lb/MMBtu | 1.59E-05 | 3.99E-06 |
| toluene | 5.58E-04 | lb/MMBtu | 7.48E-04 | 1.87E-04 |
| vinyl chloride | 7.18E-06 | lb/MMBtu | 9.62E-06 | 2.41E-06 |
| xylene | 1.95E-04 | lb/MMBtu | 2.61E-04 | 6.53E-05 |

AP-42 Table 3.2-3 Uncontrolled emission factors for 4-stroke rich-burn engines

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Diesel Fire Water Pump (FWP-1)**

| | |
|---|---|
| 376 bhp | 280.4 kW |
| 453.59 g/lb | |
| 7000 Btu/hp-hr | 500 hrs/yr operation |
| 135 MMBtu/kgal | 2.54 MMBtu/hr HHV |

| Pollutant | EF | unit | Emissions lb/hr | Emissions tons/yr |
|---|---|---|---|---|
| PM | 0.096941 | g/hp-hr | 0.08 | 0.0201 |
| $PM_{10}$ | 0.194 | g/hp-hr | 0.16 | 0.0402 |
| $PM_{2.5}$ | 0.194 | g/hp-hr | 0.16 | 0.0402 |
| CO | 0.67113 | g/hp-hr | 0.56 | 0.1391 |
| NOx | 2.83366 | g/hp-hr | 2.35 | 0.5872 |
| $SO_2$ | 0.00156 | lb/MMBtu | 0.0040 | 0.0010 |
| TOC | 0.07457 | g/hp-hr | 0.06 | 0.0155 |
| $H_2SO_4$ | 7.80E-05 | lb/MMBtu | 1.98E-04 | 4.95E-05 |
| $CO_2$ | 163.055 | lb/MMBtu | 414.1590 | 103.540 |
| $CH_4$ | 0.007 | lb/MMBtu | 0.0168 | 0.004 |
| $N_2O$ | 0.001 | lb/MMBtu | 0.0034 | 0.001 |
| $CO_2e$ | 163.614 | lb/MMBtu | 415.5803 | 103.895 |

| |
|---|
| PM, CO, and NOx/TOC EF from NSPS Subpart IIII, Table 1 |
| $SO_2$ based on fuel sulfur content of 0.0015% |
| GHG EF from 40 CFR Part 98, Table C-1 |
| $H_2SO_4$ is based on a 5% conversion of $SO_2$ to $SO_3$ and 100% conversion of $SO_3$ to $H_2SO_4$ |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Diesel Fire Water Pump FP-1 HAP Emissions**

| | | | |
|---|---|---|---|
| 376 | hp | 500 | hrs/yr operation |
| 0.45359 | kg/lb | 135 | MMBtu/kgal |
| 7000 | Btu/hp-hr | | |
| 135 | MMBtu/kgal | 2.54 | MMBtu/hr HHV |

| | | | Emissions | |
|---|---|---|---|---|
| Pollutant | EF | unit | lb/hr | tons/yr |
| 1,3-butadiene | 3.91E-05 | lb/MMBtu | 9.93E-05 | 2.48E-05 |
| acenaphthene | 1.42E-06 | lb/MMBtu | 3.61E-06 | 9.02E-07 |
| acenaphthylene | 5.06E-06 | lb/MMBtu | 1.29E-05 | 3.21E-06 |
| acetaldehyde | 7.67E-04 | lb/MMBtu | 1.95E-03 | 4.87E-04 |
| acrolein | 9.25E-05 | lb/MMBtu | 2.35E-04 | 5.87E-05 |
| anthracene | 1.87E-06 | lb/MMBtu | 4.75E-06 | 1.19E-06 |
| benz(a)anthracene | 1.68E-06 | lb/MMBtu | 4.27E-06 | 1.07E-06 |
| benzene | 9.33E-04 | lb/MMBtu | 2.37E-03 | 5.92E-04 |
| benzopyrene | 1.88E-07 | lb/MMBtu | 4.78E-07 | 1.19E-07 |
| benzo(b)fluoranthene | 9.91E-08 | lb/MMBtu | 2.52E-07 | 6.29E-08 |
| benzo(k)fluoranthene | 1.55E-07 | lb/MMBtu | 3.94E-07 | 9.84E-08 |
| chrysene | 3.53E-07 | lb/MMBtu | 8.97E-07 | 2.24E-07 |
| dibenzo anthracene | 5.83E-07 | lb/MMBtu | 1.48E-06 | 3.70E-07 |
| fluoranthene | 7.61E-06 | lb/MMBtu | 1.93E-05 | 4.83E-06 |
| fluorene | 2.92E-05 | lb/MMBtu | 7.42E-05 | 1.85E-05 |
| formaldehyde | 1.18E-03 | lb/MMBtu | 3.00E-03 | 7.49E-04 |
| indeno pyrene | 3.75E-07 | lb/MMBtu | 9.53E-07 | 2.38E-07 |
| naphthalene | 8.48E-05 | lb/MMBtu | 2.15E-04 | 5.38E-05 |
| phenanthrene | 2.94E-05 | lb/MMBtu | 7.47E-05 | 1.87E-05 |
| pyrene | 4.78E-06 | lb/MMBtu | 1.21E-05 | 3.04E-06 |
| toluene | 4.09E-04 | lb/MMBtu | 1.04E-03 | 2.60E-04 |
| xylene | 2.85E-04 | lb/MMBtu | 7.24E-04 | 1.81E-04 |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Three Fuel Gas Heaters GH-1, GH-2, GH-3 (EACH)**

| | | |
|---|---|---|
| BTU Rating: | 8.0 | MMBtu/hr |
| Fuel Rating | 0.0078 | MMcf/hr |
| Process Throughput: | 68.706 | MMcf/yr |
| Fuel Sulfur Content: | 0.40 | gr/dscf |
| Heat Content: | 1020.00 | MMBtu/mmcf |

Natural Gas

| Pollutant | Emission Factor lb/MMBtu | Reference | UNCONTROLLED EMISSIONS Hourly (lb/hr) | 8760 hrs (ton/yr) | Thruput (ton/yr) | Control Technology | Control Eff. % | PERMIT EMISSION LIMITS (lb/hr) | (ton/yr) |
|---|---|---|---|---|---|---|---|---|---|
| Criteria Pollutants | | | | | | | | | |
| PM | 0.007 | (1) | 0.06 | 0.26 | 0.26 | None | 0.00 | 0.06 | 0.2558 |
| PM10 | 0.007 | (1) | 0.06 | 0.26 | 0.26 | None | 0.00 | 0.06 | 0.26 |
| PM2.5 | 0.007 | (1) | 0.06 | 0.26 | 0.26 | None | 0.00 | 0.06 | 0.26 |
| CO | 0.037 | (2) | 0.30 | 1.30 | 1.30 | None | 0.00 | 0.30 | 1.30 |
| NOx | 0.011 | (2) | 0.09 | 0.39 | 0.39 | None | 0.00 | 0.09 | 0.39 |
| SO2 | 0.00112 | (3) | 0.01 | 0.04 | 0.04 | None | 0.00 | 0.01 | 0.04 |
| VOC Total | 0.005 | (2) | 0.04 | 0.18 | 0.18 | None | 0.00 | 0.04 | 0.18 |
| H2SO4 | 8.57E-05 | (4) | 6.86E-04 | 3.00E-03 | 3.00E-03 | None | 0.00 | 6.86E-04 | 3.00E-03 |
| CO2 | 116.89 | (5) | 9.35E+02 | 4.10E+03 | 4.10E+03 | None | 0.00 | 9.35E+02 | 4.10E+03 |
| CH4 | 0.0022 | (5) | 1.76E-02 | 7.73E-02 | 7.73E-02 | None | 0.00 | 1.76E-02 | 7.73E-02 |
| N20 | 0.00022 | (5) | 1.76E-03 | 7.73E-03 | 7.73E-03 | None | 0.00 | 1.76E-03 | 7.73E-03 |
| CO2-e | 117.01 | (5) | 9.36E+02 | 4.10E+03 | 4.10E+03 | None | 0.00 | 9.36E+02 | 4.10E+03 |

1. PM emissions from AP-42 Section 1.4
2. BACT
3. SO2 based on fuel sulfur content
4. H2SO4 based on 7.7% conversion of SO2 to SO3 and 100% of SO3 to H2SO4
5. GHG emissions from EPA "Mandatory Reporting of Greenhouse Gases" FR Vol. 74, No. 209, Part 98 (October 2009)

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**HAP from Fuel Gas Heater GH-1, GH-2, GH-3 (each)**
BTU Rating: 8.0 MMBtu/hr

| | EF | Emissions | |
|---|---|---|---|
| Pollutant | lb/MMBtu | lb/hr | TPY |
| 2-methylnapthalene | 2.35E-08 | 1.88E-07 | 8.23E-07 |
| 3-methylchloranthrene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| 7,12-Dimethylbenz(a)anthra | 1.57E-08 | 1.26E-07 | 5.50E-07 |
| Acenaphthene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Acenaphthylene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Anthracene | 2.35E-09 | 1.88E-08 | 8.23E-08 |
| Benz(a)anthracene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Benzene | 2.06E-06 | 1.65E-05 | 7.22E-05 |
| Benzo(a)pyrene | 1.18E-09 | 9.44E-09 | 4.13E-08 |
| Benzo(b)flouoranthene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Benzo(g,h,l)perylene | 1.18E-09 | 9.44E-09 | 4.13E-08 |
| Benzo(k)fluoranthene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Chrysene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Dibenzo(ah)anthracene | 1.18E-09 | 9.44E-09 | 4.13E-08 |
| Dichlorobenzene | 1.18E-06 | 9.44E-06 | 4.13E-05 |
| Fluoranthene | 2.94E-09 | 2.35E-08 | 1.03E-07 |
| Fluorene | 2.75E-09 | 2.20E-08 | 9.64E-08 |
| Formaldehyde | 7.35E-05 | 5.88E-04 | 2.58E-03 |
| Hexane | 1.76E-03 | 1.41E-02 | 6.17E-02 |
| Indeno(123-cd)pyrene | 1.76E-09 | 1.41E-08 | 6.17E-08 |
| Naphthalene | 5.98E-07 | 4.78E-06 | 2.10E-05 |
| Phenanathrene | 1.67E-08 | 1.34E-07 | 5.85E-07 |
| Pyrene | 4.90E-09 | 3.92E-08 | 1.72E-07 |
| Toluene | 3.33E-06 | 2.66E-05 | 1.17E-04 |

METALS

| | | | |
|---|---|---|---|
| Arsenic | 1.96E-07 | 1.568E-06 | 6.87E-06 |
| Beryllium | 1.18E-08 | 9.44E-08 | 4.13E-07 |
| cadmium | 1.08E-06 | 8.64E-06 | 3.78E-05 |
| chromium | 1.37E-06 | 1.10E-05 | 4.8E-05 |
| cobalt | 8.24E-08 | 6.59E-07 | 2.89E-06 |
| lead | 4.90E-07 | 3.92E-06 | 1.72E-05 |
| manganese | 3.73E-07 | 2.98E-06 | 1.31E-05 |
| mercury | 2.55E-07 | 2.04E-06 | 8.94E-06 |
| nickel | 2.06E-06 | 1.65E-05 | 7.22E-05 |
| selenium | 2.35E-08 | 1.88E-07 | 8.23E-07 |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Auxilliary Boiler B-1**

Natural Gas

| | | |
|---|---|---|
| BTU Rating: | 30.6 | MMBtu/hr |
| Fuel Rating | 0.030 | MMcf/hr |
| Process Throughput: | 262.80 | MMcf/yr |
| Fuel Sulfur Content: | 0.40 | gr/dscf |
| Heat Content: | 1020.00 | MMBtu/mmcf |

| Pollutant | Emission Factor lb/MMBtu | Reference | UNCONTROLLED EMISSIONS Hourly (lb/hr) | 8760 hrs (ton/yr) | Thruput (ton/yr) | Control Technology | Control Eff. % | PERMIT EMISSION LIMITS (lb/hr) | (ton/yr) |
|---|---|---|---|---|---|---|---|---|---|
| Criteria Pollutants | | | | | | | | | |
| PM (incl. condensable) | 0.0075 | (1) | 0.23 | 1.00 | 1.00 | None | 0.00 | 0.23 | 1.00 |
| PM10 (incl. condensable) | 0.0075 | (1) | 0.23 | 1.00 | 1.00 | None | 0.00 | 0.23 | 1.00 |
| PM2.5 | 0.0075 | (1) | 0.23 | 1.00 | 1.00 | None | 0.00 | 0.23 | 1.00 |
| CO | 0.037 | (2) | 1.13 | 4.96 | 4.96 | None | 0.00 | 1.13 | 4.96 |
| NOx | 0.011 | (2) | 0.34 | 1.47 | 1.47 | None | 0.00 | 0.34 | 1.47 |
| SO2 | 0.00112 | (3) | 0.03 | 0.15 | 0.15 | None | 0.00 | 0.03 | 0.15 |
| VOC Total | 0.005 | (1) | 0.15 | 0.67 | 0.67 | None | 0.00 | 0.15 | 0.67 |
| H2SO4 | 8.57E-05 | (3) | 2.62E-03 | 1.15E-02 | 1.15E-02 | None | 0.00 | 2.62E-03 | 1.15E-02 |
| CO2 | 116.89 | (4) | 3576.81 | 15666.42 | 15666.42 | None | 0.00 | 3576.81 | 15666.42 |
| CH4 | 0.0022 | (4) | 0.07 | 0.30 | 0.30 | None | 0.00 | 0.07 | 0.30 |
| N20 | 0.00022 | (4) | 0.01 | 0.03 | 0.03 | None | 0.00 | 0.01 | 0.03 |
| CO2-e | 117.00 | (2) | 3580.32 | 15681.79 | 15681.79 | None | 0.00 | 3580.32 | 15681.79 |

Notes:
(1) AP-42 Section 1.4
(2) BACT determination
(3) sulfur content of 0.4 gr/100 dscf
(4) EPA Rule "Mandatory Reporting of Greenhouse Gases", Federal Register Vol. 74, NO. 209, October 2009

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**HAP from Auxilliary boiler B-1** Heat rating on natural gas
30.6 MMBtu/hr
8760 hrs/yr

| | EF lb/MMBtu | lb/hr | TPY |
|---|---|---|---|
| 2-methylnapthalene | 2.35E-08 | 7.19E-07 | 3.15E-06 |
| 3-methylchloranthrene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| 7,12-Dimethylbenz(a)anthracene | 1.57E-08 | 4.80E-07 | 2.10E-06 |
| Acenaphthene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Acenaphthylene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Anthracene | 2.35E-09 | 7.19E-08 | 3.15E-07 |
| Benz(a)anthracene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Benzene | 2.06E-06 | 6.30E-05 | 2.76E-04 |
| Benzo(a)pyrene | 1.18E-09 | 3.61E-08 | 1.58E-07 |
| Benzo(b)flouoranthene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Benzo(g,h,I)perylene | 1.18E-09 | 3.61E-08 | 1.58E-07 |
| Benzo(k)fluoranthene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Chrysene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Dibenzo(ah)anthracene | 1.18E-09 | 3.61E-08 | 1.58E-07 |
| Dichlorobenzene | 1.18E-06 | 3.61E-05 | 1.58E-04 |
| Fluoranthene | 2.94E-09 | 9.00E-08 | 3.94E-07 |
| Fluorene | 2.75E-09 | 8.42E-08 | 3.69E-07 |
| Formaldehyde | 7.35E-05 | 2.25E-03 | 9.85E-03 |
| Hexane | 1.76E-03 | 5.39E-02 | 2.36E-01 |
| Indeno(123-cd)pyrene | 1.76E-09 | 5.39E-08 | 2.36E-07 |
| Naphthalene | 5.98E-07 | 1.83E-05 | 8.01E-05 |
| Phenanathrene | 1.67E-08 | 5.11E-07 | 2.24E-06 |
| Pyrene | 4.90E-09 | 1.50E-07 | 6.57E-07 |
| Toluene | 3.33E-06 | 1.02E-04 | 4.46E-04 |
| METALS | | | |
| Arsenic | 1.96E-07 | 6.00E-06 | 2.63E-05 |
| Beryllium | 1.18E-08 | 3.61E-07 | 1.58E-06 |
| cadmium | 1.08E-06 | 3.30E-05 | 1.45E-04 |
| chromium | 1.37E-06 | 4.19E-05 | 1.84E-04 |
| cobalt | 8.24E-08 | 2.52E-06 | 1.10E-05 |
| lead | 4.90E-07 | 1.50E-05 | 6.57E-05 |
| manganese | 3.73E-07 | 1.14E-05 | 5.00E-05 |
| mercury | 2.55E-07 | 7.80E-06 | 3.42E-05 |
| nickel | 2.06E-06 | 6.30E-05 | 2.76E-04 |
| selenium | 2.35E-08 | 7.19E-07 | 3.15E-06 |

Emission Factors from AP-42 Section 1.4

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Auxiliary Equipment Cooler AEC-1**

| Water Flow Rate[1] (gpm) | Total Dissolved Solids (mg/L) | Liquid Drift Loss (%) | Drift Mass Flow Rate[3] (lb/hr) | Total PM Emission Rate[4, 5] (lb/hr) | (tpy) | Total PM10 Emission Rate[4, 5, 6] (lb/hr) | (tpy) | Total PM2.5 Emission Rate[4, 5, 7] (lb/hr) | (tpy) |
|---|---|---|---|---|---|---|---|---|---|
| 1,620 | 300 | 0.010% | 81.116 | 2.43E-02 | 1.07E-03 | 2.43E-02 | 1.07E-03 | 2.43E-02 | 1.07E-03 |

Footnotes

[1]Cooling Tower water flow rate is for all four units combined

[2]Based on *Effects of Pathogenic and Toxic Material Transport Via Cooling Device Drift - Vol 1* Technical Report EPA 600 7-79-251a, November 1979.

[3]Drift mass flow rate (lb/hr) = Cooling Tower capacity (gpm) x Density of water (8.34 lb/gal) x 60 (min/hr) x Drift loss (%)

[4]Hourly PM/PM10/PM2.5 emission rate (lb/hr) = Drift mass flow rate (lb/hr) x TDS (mg/L)/1000000

[5]Annual PM/PM10/pm2.5 emission rate (ton/yr) = Hourly rate (lb/hr) x 8760 hrs/yr /2000 lb/ton x 1% actual annual operating time

[6]Hourly PM10 emission rate (lb/hr) = 100% x PM rate

[7]Hourly PM2.5 emission rate (lb/hr) = 100% x PM rate

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**4 Inlet chillers (IC-1 through IC-4) (each)**

| Water Flow Rate[1] (gpm) | Total Dissolved Solids (mg/L) | Liquid Drift Loss (%) | Drift Mass Flow Rate[3] (lb/hr) | Total PM Emission Rate[4, 5] (lb/hr) | (tpy) | Total PM10 Emission Rate[4, 5, 6] (lb/hr) | (tpy) | Total PM2.5 Emission Rate[4, 5, 7] (lb/hr) | (tpy) |
|---|---|---|---|---|---|---|---|---|---|
| 9,500 | 1000 | 0.0005% | 23.784105 | 0.0238 | 0.1042 | 0.02 | 0.09 | 7.14E-05 | 3.13E-04 |

Footnotes

[1]Cooling Tower water flow rate is for all four units combined

[2]Based on *Effects of Pathogenic and Toxic Material Transport Via Cooling Device Drift - Vol 1* Technical Report EPA 600 7-79-251a, November 1979.

[3]Drift mass flow rate (lb/hr) = Cooling Tower capacity (gpm) x Density of water (8.34 lb/gal) x 60 (min/hr) x Drift loss (%)

[4]Hourly PM/PM10/PM2.5 emission rate (lb/hr) = Drift mass flow rate (lb/hr) x TDS (mg/L)/1000000

[5]Annual PM/PM10/pm2.5 emission rate (ton/yr) = Hourly rate (lb/hr) x 8760 hrs/yr /2000 lb/ton

[6]Hourly PM10 emission rate (lb/hr) = 90% x PM rate

[7]Hourly PM2.5 emission rate (lb/hr) = 0.3% x PM rate

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**ULSD Oil Tank ST-1**

6,000 gallon capacity
10 ft diameter
22 ft length

TANKS 4.0.9d
Emissions Report - Brief Format
Individual Summaries

Emissions Report for: Annual
ST-1 - Horizontal Tank

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Distillate fuel oil no. 2 | 1.48 | 4.64 | 6.12 |

The source used slightly higher values than the default values for distillate fuel oil in TANKS 4.0.9d, therefore their estimated emissions were slightly higher than estimated here. They estimated annual emissions from working loss and breathing loss to be 7.53 lbs/yr. This difference is too small to affect overall plant-wide emissions.

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Eleven Electical Circuit Breakers CB-1 combined**

1645 lb of SF6/breaker
11 breakers
1.0% leakage rate
180.95 lb/yr leakage
0.090475 tpy SF6
2162.353 tpy CO2-e (@ 23,900 GWP)

Leakage will be monitored by
gas density gauges on the breakers

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

| Total HAP | Turbines w/duct firing | | Auxilliary Boiler | | Fuel Gas Heater | | Emergency Fire Water Pump | | Emergency Generators | | Totals for all units | | Exemption Levels | | Exempt ? | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | lb/hr | TPY | hourly | annual |
| 1,1,2,2-tetrachloroethane | | | | | | | | | 3.39E-05 | 8.48E-06 | 3.39E-05 | 8.48E-06 | 0.4554 | 1.0005 | Yes | Yes |
| 1,2,-trichloroethane | | | | | | | | | 2.05E-05 | 5.13E-06 | 2.05E-05 | 5.13E-06 | 3.63 | 7.975 | Yes | Yes |
| 1,3-Butadiene | 2.47E-03 | 1.08E-02 | | | | | 9.93E-05 | 2.47E-04 | 8.88E-04 | 2.22E-04 | 3.45E-03 | 1.13E-02 | 1.452 | 3.19 | Yes | Yes |
| 1,3,-dichloropropene | | | | | | | | | 1.70E-05 | 4.25E-06 | 1.70E-05 | 4.25E-06 | 0.297 | 0.6525 | Yes | Yes |
| 2-methylnaphthalene | 2.30E-05 | 1.01E-04 | 7.19E-07 | 3.15E-06 | 5.64E-07 | 2.47E-06 | | | | | 2.42E-05 | 1.06E-04 | | - | Yes | Yes |
| 3-methylchloranthrene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | | | | | 1.82E-06 | 7.95E-06 | | | Yes | Yes |
| 7,12-Dimethylbenz(a)anthracene | 1.53E-05 | 6.72E-05 | 4.80E-07 | 2.10E-06 | 3.77E-07 | 1.65E-06 | | | | | 1.62E-05 | 7.09E-05 | | | Yes | Yes |
| Acenaphthene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 3.61E-06 | 9.02E-07 | 9.31E-05 | 2.33E-05 | 9.86E-05 | 3.21E-05 | | | Yes | Yes |
| Acenaphthylene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 1.29E-05 | 3.21E-06 | 1.84E-04 | 4.59E-05 | 1.98E-04 | 5.71E-05 | | | Yes | Yes |
| Acetaldehyde | 2.29E-01 | 1.00E+00 | | | | | 1.95E-03 | 4.87E-04 | 4.24E-03 | 1.06E-03 | 2.36E-01 | 1.01E+00 | 8.91 | 26.1 | Yes | Yes |
| Acrolein | 3.67E-02 | 1.61E-01 | | | | | 2.35E-04 | 5.87E-05 | 3.68E-03 | 9.20E-04 | 4.06E-02 | 1.62E-01 | 0.02277 | 0.03335 | No | No |
| Anthracene | 2.30E-06 | 1.01E-05 | 7.19E-08 | 3.15E-07 | 5.64E-08 | 2.47E-07 | 4.75E-06 | 1.19E-06 | 2.45E-05 | 6.12E-06 | 3.17E-05 | 1.79E-05 | | | Yes | Yes |
| Benz(a)anthracene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 4.27E-06 | 1.07E-06 | 1.24E-05 | 3.09E-06 | 1.85E-05 | 1.21E-05 | | | Yes | Yes |
| Benzene | 7.08E-02 | 3.10E-01 | 6.30E-05 | 2.76E-04 | 4.94E-05 | 2.17E-04 | 2.37E-03 | 5.92E-04 | 1.76E-02 | 4.39E-03 | 9.09E-02 | 3.16E-01 | 2.112 | 4.64 | Yes | Yes |
| Benzo(a)pyrene | 1.15E-06 | 5.05E-06 | 3.61E-08 | 1.58E-07 | 2.83E-08 | 1.24E-07 | 4.78E-07 | 1.19E-07 | 5.11E-06 | 1.28E-06 | 6.81E-06 | 6.73E-06 | | | Yes | Yes |
| Benzo(b)flouoranthene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 2.52E-07 | 6.29E-08 | 2.21E-05 | 5.52E-06 | 2.42E-05 | 1.35E-05 | | | Yes | Yes |
| Benzo(g,h,i)perylene | 1.15E-06 | 5.05E-06 | 3.61E-08 | 1.58E-07 | 2.83E-08 | 1.24E-07 | | | 1.11E-05 | 2.77E-06 | 1.23E-05 | 8.10E-06 | | | Yes | Yes |
| Benzo(k)fluoranthene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 3.94E-07 | 9.84E-08 | 4.34E-06 | 1.08E-06 | 6.55E-06 | 9.13E-06 | | | Yes | Yes |
| Carbon tetrachloride | | | | | | | | | 2.37E-05 | 5.93E-06 | 2.37E-05 | 5.93E-06 | 2.046 | 4.495 | Yes | Yes |
| Chlorobenzene | | | | | | | | | 1.73E-05 | 4.32E-06 | 1.73E-05 | 4.32E-06 | 3.036 | 6.67 | Yes | Yes |
| Chloroform | | | | | | | | | 1.84E-05 | 4.59E-06 | 1.84E-05 | 4.59E-06 | 3.234 | 7.105 | Yes | Yes |
| Chrysene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 8.97E-07 | 2.24E-07 | 3.04E-05 | 7.61E-06 | 3.32E-05 | 1.58E-05 | | | Yes | Yes |
| Dibenzo(ah)anthracene | 1.15E-06 | 5.05E-06 | 3.61E-08 | 1.58E-07 | 2.83E-08 | 1.24E-07 | 1.48E-06 | 3.70E-07 | 6.89E-06 | 1.72E-06 | 9.58E-06 | 7.42E-06 | | | Yes | Yes |
| Dichlorobenzene | 1.15E-03 | 5.05E-03 | 3.61E-05 | 1.58E-04 | 2.83E-05 | 1.24E-04 | | | | | 1.22E-03 | 5.33E-03 | 21.813 | 65.395 | Yes | Yes |
| Ethylbenzene | 1.84E-01 | 8.04E-01 | | | | | | | 3.32E-05 | 8.31E-06 | 1.84E-01 | 8.04E-01 | 17.919 | 62.93 | Yes | Yes |
| Ethyl dibromide | | | | | | | | | 2.85E-05 | 7.14E-06 | 2.85E-05 | 7.14E-06 | 0.033 | 0.05017 | Yes | Yes |
| Fluoranthene | 2.87E-06 | 1.26E-05 | 9.00E-08 | 3.94E-07 | 7.06E-08 | 3.09E-07 | 1.93E-05 | 4.83E-06 | 8.02E-05 | 2.00E-05 | 1.03E-04 | 3.82E-05 | | | Yes | Yes |
| Fluorene | 2.69E-06 | 1.18E-05 | 8.42E-08 | 3.69E-07 | 6.60E-08 | 2.89E-07 | 7.42E-05 | 1.85E-05 | 2.55E-04 | 6.37E-05 | 3.32E-04 | 9.46E-05 | | | Yes | Yes |
| Formaldehyde | 1.33E+00 | 5.84E+00 | 2.25E-03 | 9.85E-03 | 1.76E-03 | 7.73E-03 | 3.00E-03 | 7.49E-04 | 2.90E-02 | 7.26E-03 | 1.37E+00 | 5.87E+00 | 0.0825 | 0.174 | No | No |
| Hexane | 1.72E+00 | 7.53E+00 | 5.39E-02 | 2.36E-01 | 4.22E-02 | 1.85E-01 | | | | | 1.82E+00 | 7.95E+00 | 11.616 | 25.52 | Yes | Yes |
| Indeno(123-cd)pyrene | 1.72E-06 | 7.53E-06 | 5.39E-08 | 2.36E-07 | 4.22E-08 | 1.85E-07 | 9.53E-07 | 2.38E-07 | 8.24E-06 | 2.06E-06 | 1.10E-05 | 1.02E-05 | | | Yes | Yes |
| Methanol | | | | | | | | | 4.10E-03 | 1.03E-03 | 4.10E-03 | 1.03E-03 | 10.824 | 37.99 | Yes | Yes |
| Methylene chloride | | | | | | | | | 5.52E-05 | 1.38E-05 | 5.52E-05 | 1.38E-05 | 11.484 | 25.23 | Yes | Yes |
| Naphthalene | 8.04E-03 | 3.52E-02 | 1.83E-05 | 8.01E-05 | 1.44E-05 | 6.29E-05 | 2.15E-04 | 5.38E-05 | 2.72E-03 | 6.79E-04 | 1.10E-02 | 3.61E-02 | 2.607 | 7.54 | Yes | Yes |
| PAHs | 1.26E-02 | 5.53E-02 | | | | | | | | | 1.26E-02 | 5.53E-02 | | | Yes | Yes |
| Phenanathrene | 1.63E-05 | 7.15E-05 | 5.11E-07 | 2.24E-06 | 4.01E-07 | 1.76E-06 | 7.47E-05 | 1.87E-05 | 8.12E-04 | 2.03E-04 | 9.04E-04 | 2.97E-04 | | | Yes | Yes |
| Propylene Oxide | 1.66E-01 | 7.28E-01 | | | | | | | | | 1.66E-01 | 7.28E-01 | 3.168 | 6.96 | Yes | Yes |
| Pyrene | 4.79E-06 | 2.10E-05 | 1.50E-07 | 6.57E-07 | 1.18E-07 | 5.15E-07 | 1.21E-05 | 3.04E-06 | 7.38E-05 | 1.85E-05 | 9.10E-05 | 4.36E-05 | | | Yes | Yes |
| Styrene | | | | | | | | | 1.59E-05 | 3.99E-06 | 1.59E-05 | 3.99E-06 | 14.058 | 30.885 | Yes | Yes |
| Toluene | 7.49E-01 | 3.28E+00 | 1.02E-04 | 4.46E-04 | 7.99E-05 | 3.50E-04 | 1.04E-03 | 2.60E-04 | 6.34E-03 | 1.58E-03 | 7.56E-01 | 3.28E+00 | 18.645 | 54.665 | Yes | Yes |
| Vinyl chloride | | | | | | | | | 9.62E-06 | 2.41E-06 | 9.62E-06 | 2.41E-06 | 0.858 | 1.885 | Yes | Yes |
| Xylene | 3.67E-01 | 1.61E+00 | | | | | 7.24E-04 | 1.81E-04 | 4.10E-03 | 1.03E-03 | 3.72E-01 | 1.61E+00 | 21.483 | 62.93 | Yes | Yes |
| | | | | | | | | | | | | | | | Yes | Yes |
| Arsenic | 2.02E-03 | 8.86E-03 | 6.00E-06 | 2.63E-05 | 4.70E-06 | 2.06E-05 | | | | | 2.03E-03 | 8.91E-03 | 0.0132 | 0.029 | Yes | Yes |
| Beryllium | 1.22E-04 | 5.34E-04 | 3.61E-07 | 1.58E-06 | 2.83E-07 | 1.24E-06 | | | | | 1.22E-04 | 5.37E-04 | 0.000132 | 0.00029 | Yes | No |
| cadmium | 1.12E-02 | 4.88E-02 | 3.30E-05 | 1.45E-04 | 2.59E-05 | 1.14E-04 | | | | | 1.12E-02 | 4.91E-02 | 0.033 | 0.00725 | Yes | No |
| chromium | 1.41E-02 | 6.20E-02 | 4.19E-05 | 1.84E-04 | 3.29E-05 | 1.44E-04 | | | | | 1.42E-02 | 6.23E-02 | 0.0033 | 0.00725 | No | No |
| cobalt | 8.51E-04 | 3.73E-03 | 2.52E-06 | 1.10E-05 | 1.98E-06 | 8.66E-06 | | | | | 8.55E-04 | 3.75E-03 | 0.0033 | 0.00725 | Yes | Yes |
| lead | 5.06E-03 | 2.22E-02 | 1.50E-05 | 6.57E-05 | 1.18E-05 | 5.15E-05 | | | | | 5.09E-03 | 2.23E-02 | 0.0099 | 0.02175 | Yes | No |
| manganese | 3.85E-03 | 1.69E-02 | 1.14E-05 | 5.00E-05 | 8.95E-06 | 3.92E-05 | | | | | 3.87E-03 | 1.70E-02 | 0.33 | 0.725 | Yes | Yes |
| mercury | 2.63E-03 | 1.15E-02 | 7.80E-06 | 3.42E-05 | 6.12E-06 | 2.68E-05 | | | | | 2.65E-03 | 1.16E-02 | 0.0033 | 0.00725 | Yes | No |
| nickel | 2.13E-02 | 9.32E-02 | 6.30E-05 | 2.76E-04 | 4.94E-05 | 2.17E-04 | | | | | 2.14E-02 | 9.37E-02 | 0.0066 | 0.0145 | No | No |
| selenium | 2.43E-04 | 1.06E-03 | 7.19E-07 | 3.15E-06 | 5.64E-07 | 2.47E-06 | | | | | 2.44E-04 | 1.07E-03 | 0.0132 | 0.029 | Yes | Yes |

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

This permit action is to update some of the parameters for the auxiliary equipment.

| Pollutant | Original Potential to Emit (TPY)* | New Potential to Emit (TPY) | Net Emissions Change (TPY) | PSD Significance Rate (TPY)** | PSD Required? |
|---|---|---|---|---|---|
| $PM_{10}$ | 218 | 216.73 | -1.27 | 15 | No |
| $PM_{2.5}$ | 217.6 | 216.36 | -1.24 | 10 | No |
| $NO_x$ | 343.6 | 341.86 | -1.74 | 40 | No |
| CO | 477.9 | 598.56 | 120.66 | 100 | Yes |
| $SO_2$ | 51.1 | 50.93 | -0.17 | 40 | No |
| VOC | 314.2 | 335.72 | 21.52 | 40 | No |
| $CO_2e$ | 5,341,291.00 | 5,323,242 | -18,048.79 | 75,000 | No |
| Lead | 0.02 | 0.02 | 0.00 | 0.6 | No |
| $H_2SO_4$ | 30.4 | 30.39 | -0.01 | 7 | No |

* See March 12, 2013 permit for Original PTE

**PSD significance values from definition of "significant" in 9 VAC 5-80-1615C

**Facility** Dominion Brunswick Co.
**Location** Brunswick Co.
**Reg. No.** 52404
**Eng** AMS

**Totals**

| | T-1M | | T-2M | | T-3M | | DB | | Combined DB & Turbine | | each turbine SU/SD* | | EG-1 | | EG-2 | | FWP-1 | | GH 1, 2, 3 | | B-1 | | AEC-1 | | IC-1, 2, 3, 4 | | ST-1 | | CB-1 | | Facility | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbine | | Turbine | | Turnbine | | each Duct Burner | | one T+DB | | start up/shut down | | Em Generator | | Em Generator | | Fire Water Pump | | 3 Fuel Gas Htrs | | Aux Boiler | | Cooler | | 4 Chillers | | oil tank | | Circuit Breaker | | Totals | |
| pollutant | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | lb/hr | tpy | | tpy | lb/hr | tpy |
| PM10 | 13.92 | 60.97 | 13.92 | 60.97 | 13.92 | 60.97 | 2.37 | 10.39 | 16.29 | 71.35 | -- | 1.97 | 1.94 | 0.49 | 0.01 | 0.00 | 0.16 | 0.04 | 0.18 | 0.77 | 0.23 | 1.00 | 2.43E-02 | 1.07E-03 | 8.56E-02 | 3.75E-01 | -- | -- | -- | -- | 51.49 | 216.73 |
| PM2.5 | 13.92 | 60.97 | 13.92 | 60.97 | 13.92 | 60.97 | 2.37 | 10.39 | 16.29 | 71.35 | -- | 1.97 | 1.94 | 0.49 | 0.01 | 0.00 | 0.16 | 0.04 | 0.18 | 0.77 | 0.23 | 1.00 | 2.43E-02 | 1.07E-03 | 2.85E-04 | 1.25E-03 | -- | -- | -- | -- | 51.41 | 216.36 |
| CO | 9.83 | 43.05 | 9.83 | 43.05 | 9.83 | 43.05 | 7.52 | 32.92 | 17.34 | 75.97 | -- | 134.80 | 16.98 | 4.24 | 1.43 | 0.36 | 0.56 | 0.14 | 0.89 | 3.89 | 1.13 | 4.96 | -- | -- | -- | -- | -- | -- | -- | -- | 73.01 | 598.56 |
| NOx | 20.16 | 88.31 | 20.16 | 88.31 | 20.16 | 88.31 | 5.01 | 21.92 | 25.17 | 110.23 | -- | 5.30 | 31.04 | 7.76 | 0.71 | 0.18 | 2.35 | 0.59 | 0.26 | 1.16 | 0.34 | 1.47 | -- | -- | -- | -- | -- | -- | -- | -- | 109.49 | 341.86 |
| SO2 | 3.29 | 14.43 | 3.29 | 14.43 | 3.29 | 14.43 | 0.56 | 2.46 | 3.86 | 16.89 | -- | 0.24 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.12 | 0.03 | 0.15 | -- | -- | -- | -- | -- | -- | -- | -- | 11.66 | 50.93 |
| VOC | 2.43 | 3.31 | 2.43 | 3.31 | 2.43 | 3.31 | 3.91 | 17.12 | 6.34 | 27.75 | -- | 86.90 | 31.04 | 7.76 | 0.36 | 0.09 | 0.06 | 0.02 | 0.12 | 0.53 | 0.15 | 0.67 | -- | -- | -- | -- | 3.49E-07 | 0.00306 | -- | -- | 50.38 | 335.72 |
| H2SO4 | 0.76 | 3.31 | 0.76 | 3.31 | 0.76 | 3.31 | 1.56 | 6.81 | 2.31 | 10.12 | -- | -- | 2.34E-03 | 5.86E-04 | 6.07E-05 | 1.52E-05 | 1.98E-04 | 4.95E-05 | 2.06E-03 | 9.01E-03 | 2.62E-03 | 1.15E-02 | -- | -- | -- | -- | -- | -- | -- | -- | 6.94 | 30.39 |
| $CO_2$ | 3.44E+05 | 1.51E+06 | 3.44E+05 | 1.51E+06 | 3.44E+05 | 1.51E+06 | 1.76E+05 | 2.56E+05 | 5.19E+05 | 1.76E+06 | -- | -- | 3.24E+03 | 8.11E+02 | 1.83E+02 | 4.57E+01 | 4.14E+02 | 1.04E+02 | 2.81E+03 | 1.23E+04 | 3.58E+03 | 1.57E+04 | -- | -- | -- | -- | -- | -- | -- | -- | 1.57E+06 | 5.32E+06 |
| $CH_4$ | 6.48E+00 | 2.84E+01 | 6.48E+00 | 2.84E+01 | 6.48E+00 | 2.84E+01 | 3.31E+00 | 4.84E+00 | 9.80E+00 | 3.32E+01 | -- | -- | 1.32E-01 | 3.29E-02 | 8.92E-03 | 2.23E-03 | 1.68E-02 | 4.20E-03 | 5.29E-02 | 2.32E-01 | 6.75E-02 | 2.95E-01 | -- | -- | -- | -- | -- | -- | -- | -- | 2.97E+01 | 1.00E+02 |
| N2O | 6.48E-01 | 2.84E+00 | 6.48E-01 | 2.84E+00 | 6.48E-01 | 2.84E+00 | 3.31E-01 | 4.84E-01 | 9.80E-01 | 3.32E+00 | -- | -- | 2.63E-02 | 6.58E-03 | 1.78E-03 | 4.46E-04 | 3.36E-03 | 8.40E-04 | 5.29E-03 | 2.32E-02 | 6.75E-03 | 2.95E-02 | -- | -- | -- | -- | -- | -- | -- | -- | 2.98E+00 | 1.00E+01 |
| SF6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9.05E-02 | -- | 9.05E-02 |
| CO2-e | 3.44E+05 | 1.51E+06 | 3.44E+05 | 1.51E+06 | 3.44E+05 | 1.51E+06 | 1.76E+05 | 2.57E+05 | 5.20E+05 | 1.76E+06 | -- | -- | 3.26E+03 | 8.14E+02 | 1.84E+02 | 4.59E+01 | 4.16E+02 | 1.04E+02 | 2.81E+03 | 1.23E+04 | 3.58E+03 | 1.57E+04 | -- | -- | -- | -- | -- | -- | -- | 2.16E+03 | 1.22E+06 | 5.32E+06 |

*SU/SD emissions are only included in the total if they represent the worst case annual operating scenario [({turbines + duct burner} x 6941 hrs/yr + SU/SD) vs. ({duct burner + turbine} x 8760 hrs/yr without SU/SD]