Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060

Web Address: www.dom.com

Dominion

September 16, 2015

BY: OVERNIGHT MAIL

Mr. William F. Durham, Director
WVDEP - Division of Air Quality
601 57th Street SE
Charleston, West Virginia 25304

RE: Construction/Major Modification Application (45CSR13)
Mockingbird Hill Compressor Station (Facility ID#017-00003)

Dear Mr. Durham,

Dominion Resources, Inc. is proposing to expand its interstate natural gas pipeline system that currently extends from Western Pennsylvania into West Virginia as part of the Supply Header Project. Enclosed is an application for the expansion of Mockingbird Hill Compressor Station, located in Wetzel County, West Virginia. The Mockingbird Hill Compressor Station expansion will include the following new equipment:

- Two Solar Titan 130 combustion turbines;
- Caterpillar auxiliary generator rated at 1,416 hp;
- Boiler rated at 7.2 MMBtu/hr;
- Accumulator tank with a capacity of 2,500 gallons; and
- Hydrocarbon waste tank with a capacity of 1,000 gallons.

Dominion Transmission, Inc. also plans to make the following modifications to the Hastings Compressor Station:

- Abandon in place of the two (2) Cooper GMXE-6 Reciprocating Engines, each rated at 500 hp;
- Installation of one (1) Ajax DPC-2803LE Reciprocating Engine rated at 600 hp; and
- Installation of one (1) Ajax DPC-2802LE Reciprocating Engine rated at 384 hp.

The application also includes various operational natural gas releases associated with station components and piping fugitive emissions related to equipment proposed at the Mockingbird Hill Compressor Station.

Enclosed with this permit application is the fee in the amount of $9,500.

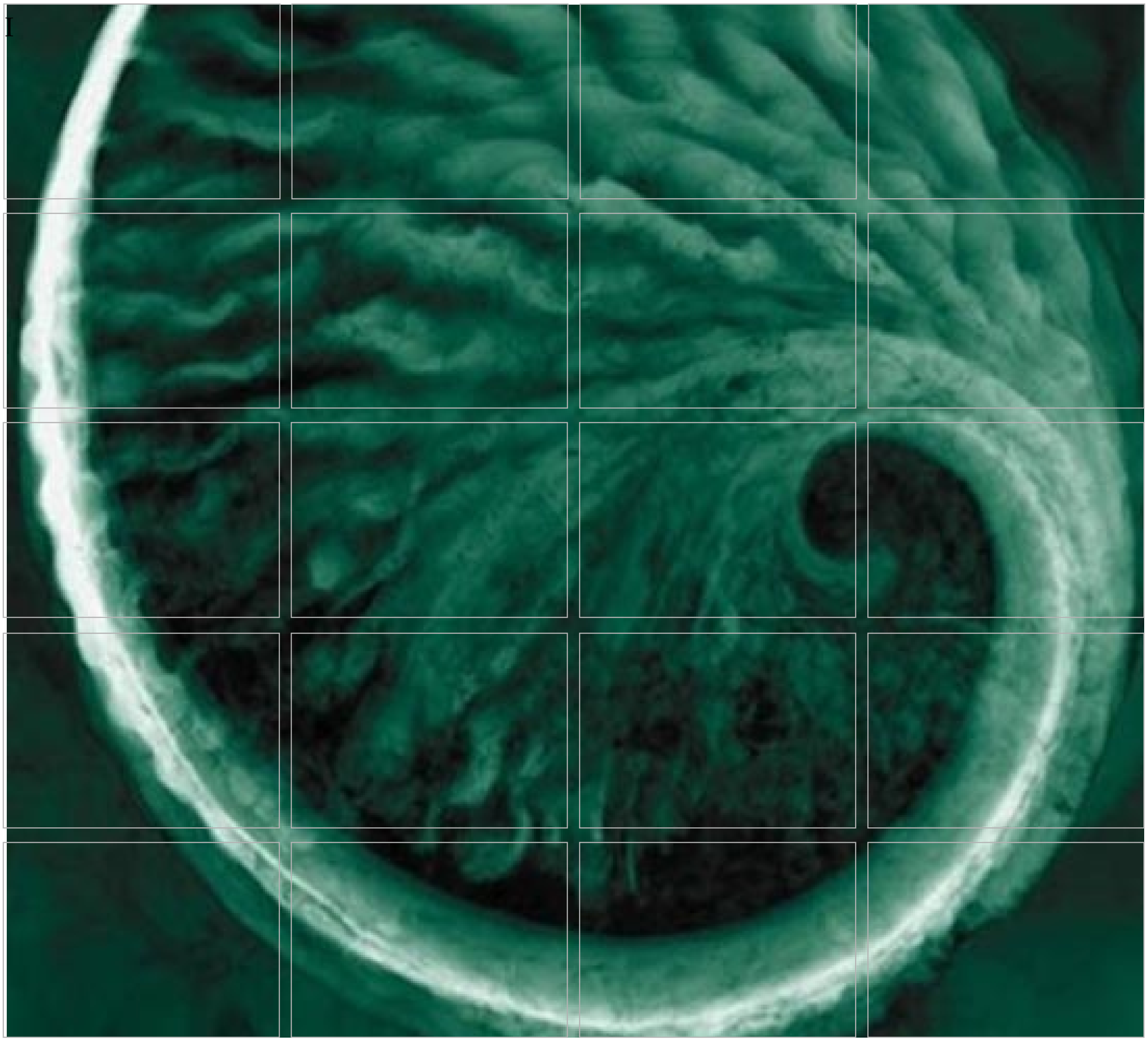
A legal advertisement will be published in the next few days and proof of publication will be forwarded as soon as it is received.

Should you have any questions or need additional information, please feel free to contact William Scarpinato at (804) 273-3019 or via email at william.a.scarpinato@dom.com.

Sincerely,

Robert M. Bisha

Robert M. Bisha
Project Director, Supply Header Project
Dominion Environmental Services



Prepared For:

Dominion Transmission, Inc.

Supply Header Pipeline Project
Permit Application (Rule 14)
Mockingbird Hill Compressor Station
Wetzel County, WV

September 2015

Environmental Resources Management
75 Valley Stream Parkway, Suite 200
Malvern, PA 19355

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1.0 INTRODUCTION

1.1 BACKGROUND

Dominion Resources, Inc. (Dominion) is proposing to expand its interstate natural gas pipeline system that currently extends from Western Pennsylvania into West Virginia. The Supply Header Project proposes to construct approximately 36.7 miles of additional pipeline and to modify existing compressor facilities in order to deliver approximately 1.5 billion standard cubic feet (per day (bscf/d) of natural gas for transportation to markets in other states.

Dominion Transmission, Inc. (DTI), a subsidiary of Dominion is the operator of the Mockingbird Hill Compressor Station. DTI proposes to modify the Mockingbird Hill Compressor Station in Pine Grove, Wetzel County, West Virginia to provide compression to support the transmission of natural gas. The Mockingbird Hill Compressor Station currently operates under permit number R30-10300006-2011, which became effective July 25, 2011.

DTI is also including in this application a modification to the Hastings Compressor Station. The Hastings Compressor Station is operated under the same Title V permit as the Mockingbird facility (and Lewis Wetzel facility). DTI will be replacing two older 500 horsepower (hp) reciprocating engines at the Hastings Compressor Station with newer engines.

1.2 APPLICATION OVERVIEW

The proposed project will require the construction of new equipment subject to the requirements of WV 45 CSR 14 – "*Permits for Construction and Major Modification of Major Stationary Sources for the Prevention of Significant Deterioration of Air Quality*". DTI submits this Rule 14 permit application to the West Virginia Department of Environmental Protections (WVDEP), Division of Air Quality (DAQ) for the authority to modify the Mockingbird Hill Compressor Station in Wetzel County, West Virginia. This permit application narrative is provided to add clarification and/or further detail to the permit application forms being provided to the DAQ for this project.

Concurrent with the submittal of this air quality application, other required environmental permits and approvals are being pursued with the appropriate regulatory agencies.

This section (Section 1) contains introductory information. Section 2 presents a description of existing equipment and proposed changes. The estimated emissions of regulated pollutants from the equipment and operating scenarios are presented in Section 3. Section 4 provides a Prevention of Significant

Deterioration review. Section 5 provides a Best Available Control Technology review. Section 6 is a review of federal regulatory requirements applicable to project sources and Section 7 addresses an evaluation of the applicability of State regulatory requirements. Section 8 provides DTI's proposed compliance demonstration methods.

The application contains the following appendices:

- Appendix A WVDAQ Permit Application Forms;
- Appendix B Air Modeling Results and Protocol; and
- Appendix C BACT Review Supporting Details.

2.0 FACILITY AND PROJECT DESCRIPTION

The Mockingbird Hill Compressor Station currently operates in Wetzel County, West Virginia to provide compression to support the transport of natural gas through interstate pipelines.

The proposed project will require the construction of new equipment subject to the requirements of WV 45 CSR 14 – "*Permits for Construction and Major Modification of Major Stationary Sources for the Prevention of Significant Deterioration of Air Quality*".

The Mockingbird Hill Compressor Station operates under Title V operating permit number R30-10300006-2011. The operating permit covers emission sources at the Mockingbird Hill Compressor Station, Lewis Wetzel Compressor Station, and Hastings Compressor Station.

DTI is currently authorized to operate the following:

Hastings Compressor Station

- Two (2) Cooper GMXE-6 Reciprocating Engines (001-01, 001-02), each rated at 500 bhp;
- One (1) Generac Model QT080 Auxiliary Generator (002-06) rated at 128 bhp;[i]
- *One (1) Dehydration Unit Still (004-02) rated at 7.5 MMscf/day;
- *One (1) Reboiler (005-06) rated at 0.55 MMBtu/hr;
- *One (1) Enclosed Combustion Device (DEHY1) rated at 32.8 Mscf/day;
- One (1) Heater (005-01) rated at 10.0 MMBtu/hr;
- Seven (7) aboveground storage tanks (TK1 – TK7) of various sizes for the storage of fluids; and
- Various fugitive components related to the operation of the equipment proposed at Hastings Compressor Station.

Lewis Wetzel Compressor Station

- One (1) Caterpillar Model 3612 Compressor Engine (001-03) rated at 3,550 bhp and equipped with a Catalytic Converter (CC1);
- One (1) Cummings Model KTA19G Auxiliary Generator (002-05) rated at 530 hp; and
- One (1) Bryan Model RV 450W-FDG Boiler (005-05) rated at 4.5 MMBtu/hr;

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i The Generac EG is actually located at the Hastings Station. This EG is assigned to the Mockingbird Hill Compressor Station in the current Title V.

- Three (3) Capstone Microturbines Auxiliary Generators (002-02, 002-03, 002-04), each rated at 80 bhp;
- One (1) Cleaver Brook MTF 700-1250-60 Boiler (005-04) rated at 1.25 MMBtu/hr);
- One (1) Solar Taurus 60 Combustion Turbine (006-02) rated at 8,175 bhp; and
- Three (3) storage tanks of various sizes for the storage of fluids.

As part of this project, DTI seeks authorization for the construction and operation of the following emission units at the Mockingbird Hill Compressor Station:

- Two (2) Solar Titan 130 Combustion Turbines (CT-1, CT-2) each rated at 20,500 hp (ISO);
- One (1) Caterpillar Auxiliary Generator (EG-1) rated at 1,416 hp;
- One (1) Boiler (WH-1) rated at 7.20 MMBtu/hr;
- One (1) Accumulator Tank (TK-1) with a capacity of 2,500 gallons;
- One (1) Hydrocarbon Waste Tank (TK-2) with a capacity of 1,000 gallons; and
- Various operational natural gas releases associated with station components (FUG-01) and piping fugitive emissions (FUG-02) related to equipment proposed at the Mockingbird Hill Compressor Station.

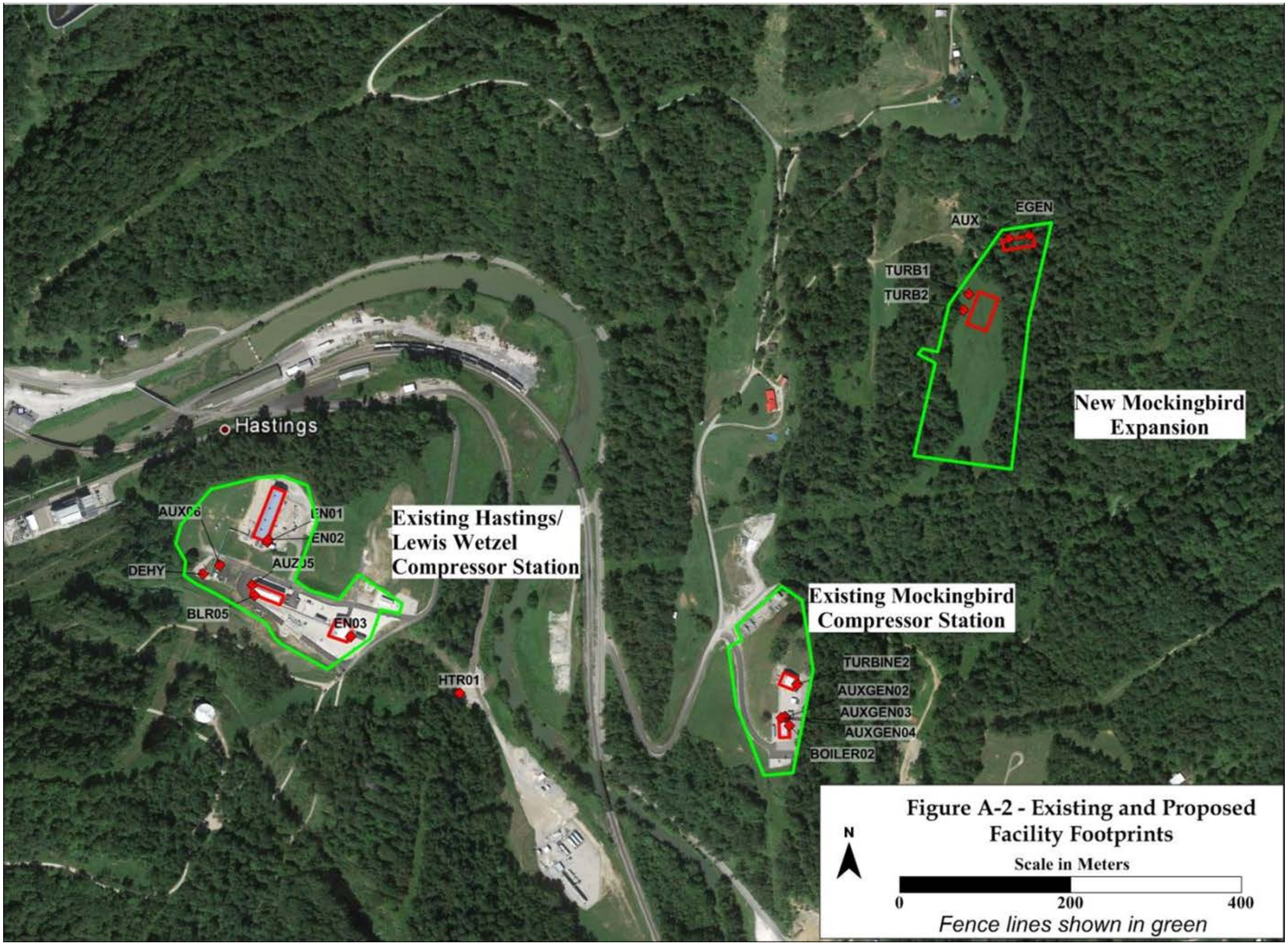
DTI also seeks the authorization to make the following changes at the Hastings Compressor Station:

- Removal of the two (2) Cooper GMXE-6 Reciprocating Engines (001-01, 001-02), each rated at 500 bhp;
- Replacement of the above engines by the installation of one (1) Ajax DPC-2803LE Reciprocating Engine (RICE-1) rated at 600 bhp; and one (1) Ajax DPC-2802LE Reciprocating Engine (RICE-2) rated at 384 bhp.

**Emission Units denoted with an asterisk (*) were included in a March 2015 permit modification submitted to the WVDAQ. This application to modify the permit is currently under review with the WVDAQ. These changes did not qualify as major modifications under 45 CSR 14.*

A map displaying the location of the Mockingbird Hill Compressor Station is provided in Figure 2.1 of this application.

FIGURE 2.1 MOCKINGBIRD HILL COMPRESSOR STATION LOCATION MAP



3.0 PROJECT EMISSIONS INFORMATION

As discussed in Section 2.1 of this application, DTI seeks the authority to construct and operate new emission sources. This section provides a description of the basis for the estimation of emissions from these sources.

3.1 SOLAR COMBUSTION TURBINES

The proposed natural gas-fired turbines to be installed at the Mockingbird Hill Compressor Station will be equipped with Solar's SoLoNOx dry low NO_x combustor technology for NO_x and add-on oxidation catalyst control for CO and VOC.

Emissions for the Solar Turbines assume that the units will operate up to 8,760 hours per year and up to 100% rated output. Pre-control (oxidation catalyst) emissions of nitrogen oxides (NOx), carbon monoxide (CO) and volatile organic compounds (VOC) are based on emission rates provided by Solar. VOC emissions are conservatively estimated as 10% of uncombusted hydrocarbon (UHC). Solar also provided emission estimates for UHC, carbon dioxide (CO_2), formaldehyde and total hazardous air pollutants.

The pre-control emission rates for normal operating conditions are as follows (all emissions rates are in terms of parts per million dry volume (ppmvd) @ 15% O_2):

- 9 ppmvd NOx;
- 25 ppmvd CO;
- 25 ppmvd unburned hydrocarbons (UHC); and
- 2.5 ppmvd VOC.

Per vendor estimates, the oxidation catalyst will provide 80% control for CO, to achieve 5 ppmvd CO @ 15% O_2. The catalyst will also control organic compound emissions and will provide an estimated 50% control for VOC and formaldehyde. Vendor estimates for oxidation catalyst performance are provided in Appendix A.

At very low load and cold temperature extremes, the turbine system must be controlled differently in order to assure stable operation. The required adjustments to the turbine controls at these conditions cause emissions of NO_x, CO and VOC to increase (emission rates of other pollutants are unchanged). Low-load operation (non-normal SoLoNOx operation) of the turbines is expected to occur only during periods of startup and shutdown. Solar has provided emissions estimates during start-up and shutdown (see Solar Product

Information Letter (PIL) 170, included as part of the vendor attachments to this application for more detail).

Similarly, Solar has provided emissions estimates for low temperature operation (inlet combustion air temperature less than 0° F and greater than -20° F). Table 3.1 provides estimated pre-control emissions from the turbines at low temperature conditions.

TABLE 3.1 PRE-CONTROL TURBINE LOW TEMPERATURE EMISSION RATES (< 0^0 F AND > -20^0 F)[1]

Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
50-100% load	120	150	50

1. Emissions Estimates from Table 2 of Solar Product Information Letter 167.

DTI reviewed historic meteorological data from the previous five years for the region to estimate the worst case number of hours per year under sub-zero (less than 0° F) conditions. The annual hours of operation during sub-zero conditions were conservatively assumed to be not more than 50 hours per year.

A summary of the controlled potential emissions of NO_X, CO, and VOC during normal operations and low temperature scenarios is provided in Table 3.2.

TABLE 3.2 TURBINE CONTROLLED SHORT-TERM EMISSION RATES

Pollutant	Operating Scenario	CT-01 & CT-02 Solar Titan 130 Turbine lb/hr
NO_x	Normal	5.70
	Low Temp.	76.0
CO	Normal	1.92
	Low Temp.	11.5
VOC	Normal	0.275
	Low Temp.	0.550

The emission rates presented in Table 3.2 are estimates based on the emissions factors provided by Solar multiplied by the control efficiency expected from the installation of the oxidation catalyst (approximately 50% VOC control and 80% CO control).Potential turbine emissions also include conservatively assumed uncontrolled potential emissions from start-up and shutdown events calculated using emission data provided by Solar. Although these emissions are provided as uncontrolled for the purposes of potential to emit estimations, DTI expects that some control may be achieved by the combustion turbine control devices during the start-up and shutdown events. Ton per year potential emission estimates are based on an assumed count of 100 start-up and 100 shutdown events per year. The duration of each start-up and shutdown is expected to be approximately 10 minutes per event. Thus, it is assumed that there will be approximately 33.3 hours of start-up and shutdown event time when the unit may not be operating in SoLoNOx mode. Table 3 of Solar PIL 170 was used as basis for emissions during these events.

A summary of the potential emissions during start-up and shutdown events is presented in Tables 3.3 and 3.4.

To practically track these events and associated emissions, DTI proposes to keep track of the total number of hours of non-SoLoNOx mode (a parameter monitored by the turbine control logic) and utilize an average start-up / shutdown emission rate (equivalent lb/hr based on 10 minutes per event). The proposed compliance demonstration is provided in Section 8 of this report.

TABLE 3.3 TURBINE POTENTIAL EMISSIONS DURING START-UP EVENTS

Pollutant	CT-01 & CT-02 Solar Titan 130 Turbine	
	lb/event	tpy
NO_x	1.90	0.0950
CO	177	8.85
VOC	2.02	0.101
CO_2	1161	58.1
CH_4	8.08	0.404
CO_2e	1363	68.2

TABLE 3.4 TURBINE POTENTIAL EMISSIONS DURING SHUTDOWN EVENTS

Pollutant	CT-01 & CT-02 Solar Titan 130 Turbine	
	lb/event	tpy
NO_x	2.40	0.120
CO	208	10.4
VOC	2.38	0.119
CO_2	1272	63.6
CH_4	9.52	0.476
CO_2e	1510	75.5

Table 3.5 includes the facility's potential emissions for the combustion turbines including normal continuous operation controlled by SoLoNOx mode and oxidation catalyst, low temperature operation controlled by oxidation catalyst as

well, as the uncontrolled emissions associated with start-up and shutdown events.

TABLE 3.5 TURBINE POTENTIAL EMISSIONS

Pollutant	CT-01 & CT-02 Solar Titan 130 Turbine tpy
NO_x	26.8
CO	27.8
VOC	1.43
SO_2	2.58
PM_{-Filt}	4.36
$PM_{10-Filt}$	4.36
$PM_{2.5-Filt}$	4.36
PM_{-Cond}	10.8
CO_2	90,196
CH_4	7.40
N_2O	2.27
CO_2e	91,059
Total HAP	0.962
Formaldehyde	0.908

3.2 *EMERGENCY GENERATOR*

Emissions for the natural gas fired emergency generator assume 100 hours of operation per year and are calculated using vendor specification and EPA's AP-42 emission factors.

A summary of the emissions associated with the emergency generator is provided in Table 3.6.

TABLE 3.6 EMERGENCY GENERATOR POTENTIAL EMISSIONS

Pollutant	EG-01 Caterpillar 3516C Tpy
NO_x	0.312
CO	0.295
VOC	0.0375
SO_2	0.0003
PM_{-Filt}	0.0214
$PM_{10-Filt}$	0.0214
$PM_{2.5-Filt}$	0.0214

PM_{-Cond}	0.006
CO_2	77.9
CH_4	0.290
CO_2e	85.1
Total HAP	0.0584
Formaldehyde	0.009

3.3 BOILER

The proposed natural gas boiler will be used to provide building heat (space heating) only, and will have a maximum heat input capacity of 7.2 MMBtu/hr. The boiler is equipped with Low NOx Burners (LNB). Emissions for the proposed natural gas-fired Boiler are calculated using EPA's AP-42 emission factors for Natural Gas Combustion (Section 1.4) conservatively assuming 8,760 hours per year.

The potential emissions for the new boiler are provided in Table 3.7.

TABLE 3.7 BOILER POTENTIAL EMISSIONS

Pollutant	WH-01 Boiler tpy
NO_x	1.55
CO	2.60
VOC	0.170
SO_2	0.0186
PM_{-Filt}	0.0587
$PM_{10-Filt}$	0.0587
$PM_{2.5-Filt}$	0.0587
PM_{-Cond}	0.176
CO_2	3,710
CH_4	0.0711
N_2O	0.0680
CO_2e	3,732
Total HAP	0.0143
Formaldehyde	0.002
Hexane	0.0557

3.4 *FUGITIVE EMISSIONS*

The proposed project will include fugitive components including valves, flanges, pumps, etc. Emission factors for fugitive components were based on EPA's report on equipment leaks for oil and gas production facilities[ii]. It is expected that this facility will comply with recently proposed New Source Performance Standard Subpart OOOOa which incorporates leak detection monitoring. However, no credit for any reduced emissions has been taken in the numbers below.

Additionally, DTI has estimated emissions from blowdown events. DTI will minimize these events whenever possible, but blowdown of the machines and piping will sometimes occur for safety reasons and to ensure protection of equipment. DTI has also conservatively included estimated emissions from one site-wide blowdown event in these emissions. Such events are not routine, but do occur once every five years.

The total fugitive emissions are summarized in Table 3.8.

TABLE 3.8 POTENTIAL EMISSIONS ASSOCIATED WITH FUGITIVE COMPONENTS

Pollutant	FUG-01 Fugitive Leaks - Blowdowns tpy	FUG-02 Fugitive Leaks - Piping Tpy
VOC	12.9	13.5
CO_2	13.4	14.0
CH_4	442	462
CO_2e	11,060	11,567
Total HAP	0.731	0.764

3.5 *STORAGE TANKS*

The proposed modification to the Mockingbird Hill Compressor Station will include the operation of two (2) aboveground storage tanks (ASTs).

TK-1 (Accumulator Storage Tank) will have a capacity of 2,500 gallons and will receive and store pipeline liquids captured by the station's separators and filter-separators. The emissions associated with the operation of this accumulator storage tank are estimated using E&P Tanks to ensure capture of any flash emissions (which the EPA TANKS program cannot estimate). DTI has estimated that this storage tank will complete five (5) turnovers per year.

[ii] USEPA, 1995. *"Emission factors from Protocol for Equipment Leak Emission Estimates,"* EPA-453/R-95-017 *Table 2.4, Oil and Gas Production Operations Average Emission Factors.*

TK-2 (Hydrocarbon Waste Tank) will have a capacity of 1,000 gallons and will receive liquids from the compressor building and auxiliary building floor drains. The emissions associated with the operation of this hydrocarbon waste tank were calculated using EPA's TANKS program. DTI has estimated that this storage tank will complete five (5) turnovers per year.

The potential VOC emissions associated with the proposed new storage tanks is 0.35 tpy (0.08 lb/hr).

The Mockingbird Hill Compressor Station will occasionally require tank unloading operations for the unloading of the on-site ASTs. Emissions from tank unloading operations have been calculated using AP-42 Section 5.2, Transportation and Marketing of Petroleum Liquids. The potential VOC emissions associated with the proposed loading rack is 0.006 tpy (5.25 lb/hr).

3.6 PROJECT EMISSIONS

The emissions associated with the proposed new equipment at the Mockingbird Hill Compressor Station are summarized in Table 3.9 in tons per year. Detailed emission calculations are provided in Appendix A of this document.

TABLE 3.9 MOCKINGBIRD EXPANSION POTENTIAL EMISSIONS (TPY)

	Criteria Pollutants								Greenhouse Gases				Total
Unit ID	**NO_x**	**CO**	**VOC**	**SO_2**	**PM_{-Filt}**	**$PM_{10-Filt}$**	**$PM_{2.5-Filt}$**	**PM_{-Cond}**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**	**HAP**
CT-01	26.8	27.8	1.43	2.58	4.36	4.36	4.36	10.8	90,196	7.40	2.27	91,059	0.962
CT-02	26.8	27.8	1.43	2.58	4.36	4.36	4.36	10.8	90,196	7.40	2.27	91,059	0.962
EG-01	0.312	0.295	0.0375	0.0003	0.0214	0.0214	0.0214	0.006	77.9	0.290	0.00	85.1	0.0584
WH-01	1.55	2.60	0.170	0.0186	0.0587	0.0587	0.0587	0.176	3,710	0.0711	0.0680	3,732	0.0143
FUG-01	-	-	12.9	-	-	-	-	-	13.4	442		11,060	0.731
FUG-02	-	-	13.5	-	-	-	-	-	14.0	462	-	11,567	0.764
TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-
TK-2	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-
LR-01	-	-	0.006	-	-	-	-	-	-	-	-	-	5.77E-07
Total	55.5	58.6	29.9	5.17	8.81	8.81	8.81	21.8	184,208	919	4.62	208,563	3.49

3.7 HASTINGS ENGINE REPLACEMENT

DTI is planning to abandon in place the existing Cooper GMXE-6 engines at the Hastings Compressor Station (001-01, 001-02), each rated at 500 bhp, with one (1) Ajax DPC-2803LE Reciprocating Engine (RICE-1), rated at 600 bhp, and (1) one Ajax DPC-2802LE Reciprocating Engine (RICE-2), rated at 384 bhp. The net impact of this equipment change will be a reduction in NO_x emissions.

TABLE 3.10 POTENTIAL EMISSIONS FROM REPLACEMENT HASTINGS COMPRESSOR STATION ENGINES

Pollutant	RICE-1 Ajax DPC-2803LE tpy	RICE-2 Ajax DPC-2802LE tpy
NO_x	5.2	3.4
CO	10.5	6.7
VOC	3.7	2.4
SO_2	0.01	0.01
PM_{-Filt}	0.80	0.51
$PM_{10-Filt}$	0.80	0.51
$PM_{2.5-Filt}$	0.80	0.51
PM_{-Cond}	0.21	0.13
CO_2	2890	1850
CH_4	10.8	6.9
N_2O	0	0
CO_2e	3160	2022
Total HAP	0.03	0.02
Formaldehyde	0.4	0.30
Hexane	1.7E-04	1.1E-04

4.0 PREVENTION OF SIGNIFICANT DETRIORATION

The potential emissions from existing equipment at the Mockingbird Hill Compressor Station, when combined with the Lewis Wetzel Compressor Station and Hastings Compressor Station, as they are permitted under the current Title V permit, exceed the Prevention of Significant Deterioration (PSD) "major source" 250 tons per year (tpy) emission thresholds for NO_x and VOCs. As such, the facility is considered a major source under PSD and any modifications must be reviewed to determine if they are considered major modifications under the 45 CSR 14.

Per 45 CSR 14-2.74, a modification to a major source is considered to be major if it results in a net emission increase that would equal or exceed any of the following rates:

Pollutant	Pollutant Emission Rate (tons/year)
Carbon monoxide:	100 tpy
Nitrogen oxides:	40 tpy
Sulfur dioxide:	40 tpy
Particulate matter:	25 tpy
PM_{10}:	15 tpy
$PM_{2.5}$:	10 tpy of direct $PM_{2.5}$ emissions
$PM_{2.5}$:	40 tpy of SO_2 emissions
$PM_{2.5}$:	40 tpy of NO_X emissions (unless demonstrated not to be a $PM_{2.5}$ precursor under subsection 2.66).
Ozone:	40 tpy of VOC or NO_x
Lead:	0.6 tpy
Fluorides:	3 tpy
Sulfuric acid mist:	7 tpy
Hydrogen sulfide (H_2S):	10 tpy
Total reduced sulfur (including H_2S):	10 tpy
Reduced sulfur compounds (including H_2S):	10 tpy

Per 45 CSR 14-3.4, the determination of whether a project is a major modification is a two-step process. A project is a major modification for a regulated pollutant if it causes two types of emissions increases -- a significant emissions increase (as defined in subsection 2.75), and a significant net emissions increase (as defined in subsections 2.46 and 2.74).

The proposed project results in significant emissions increases for NO_x, PM_{10}, $PM_{2.5}$, and GHGs per totals in Table 3.10.

Project Emission Increases	NO_x	CO	VOC	SO_2	$PM_{10}/PM_{2.5}$ (total)	CO_2e
Mockingbird Expansion	55.5	58.6	29.9	5.17	30.6	208,563
Replacement Hastings Engines	8.6	17.2	6.1	0.02	1.65	5,182
Total	64.1	75.8	36.0	5.2	32.3	213,745
PSD Threshold	40	100	40	40	15/10	75,000
Significant Increase?	**Yes**	No	No	No	**Yes**	**Yes**

Since there are significant emissions increases, contemporaneous changes were next considered in determining PSD applicability, consistent with 45 CSR 14.2.46. Three projects are considered contemporaneous changes with respect to the proposed project - the construction of the Lewis Wetzel Compressor Station, the modification of the dehydration unit and associated equipment of the Hastings Compressor Station, and the planned replacement of the two reciprocating engines at the Hastings Compressor Station.

The Lewis Wetzel Compressor Station began operations in 2012. Emission units permitted at the Lewis Wetzel Compressor Station include one (1) Caterpillar Model 3612 Compressor Engine (001-03) rated at 3,550 bhp and equipped with a Catalytic Converter (CC1), one (1) Cummings Model KTA19G Auxiliary Generator (002-05) rated at 530 hp; one (1) Bryan Model RV 450W-FDG Boiler (005-05) rated at 4.5 MMBtu/hr.

As noted in Section 2.1 of this submittal, DTI applied for a permit to modify the Hastings Compressor Station, which included the replacement of the dehydration unit, associated reboiler, and the enclosed combustion device. The application for modification was filed in March of 2015 and is still under review by the WVDAQ.

Finally, as described in this application, DTI plans to abandon in place the two existing Hastings Compressor Station engines.

The net impact of the abandonment in place of the Cooper engines prior to the startup of the Ajax engines results in a decrease in NO_x emissions are described in Table 4.1.

TABLE 4.1 PSD APPLICABILITY – CONTEMPORANEOUS PROJECTS

Contemporaneous Change	NO_x Tpy
Construction of the Lewis Wetzel Compressor Station	19.6
Modification of the Hastings Compressor Station dehydration unit	-1.03
Abandonment in place of the two Hastings Compressor Station COOPER GMXE-6 engines (Average of 2013-2014 actual emissions)	-194
Total	-176

Table 4.2 provides a summary of the net emission increases following this project.

TABLE 4.2 PSD APPLICABILITY – NO_X NET EMISSIONS INCREASES (TPY)

Emissions Changes	NO_x
Application Increases	64.1
Contemporaneous Changes	-176
Net Emission Change	-112
PSD Threshold	40
Significant Net Increase?	**No**

When considering the contemporaneous emission changes, the net change in NO_x emissions is a decrease of 112 tpy and, thus, the project does cause a significant net emissions increase. Therefore, the NO_x emissions changes from the equipment added to the Mockingbird Hill Compressor Station do not trigger PSD requirements.

The net impact of the three above mentioned projects was an increase in GHG emissions, a small increase in particulate matter emissions. Because the contemporaneous changes for PM10, PM2.5, and GHGs were increases, the changes result in both a significant emissions increase and a significant net emissions increase for GHG, PM_{10}, and $PM_{2.5}$ and no further analysis is required as the project meets the definition of a major modification in regards to PM_{10} and $PM_{2.5}$. Additionally, since the project triggers PSD for particular matter and the increase in greenhouse gas (GHG) emissions is > 75,000 TPY CO_2e, the project is also subject to Best Available Control Technology ("BACT") review for GHG.

Section 5 provides a review of BACT for both GHG emissions and particulate matter emissions. Appendix B provides the ambient air quality evaluation for PM_{10} and $PM_{2.5}$.

5.0 BEST AVAILABLE CONTROL TECHNOLOGY EVALUATION

Best Available Control Technology (BACT) analysis is required as part of the PSD process. Estimated Project emissions trigger PSD BACT for greenhouse gases as well as PM_{10} and $PM_{2.5}$. 40 CFR 51.21(j) defines BACT as emission limits "based on maximum degree of reduction for each pollutant." BACT determinations are made on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs.

5.1 BACT FOR GREENHOUSE GASES (GHG)

The proposed changes at Mockingbird Hill Compressor Station will result in increased GHG emissions by more than 75,000 tpy (CO_2e). Mockingbird Hill Compressor Station (along with other stations in the interstate natural gas pipeline system), will serve as a source of compression for the proposed Atlantic Coast Pipeline (ACP) system connecting the Supply Header Project in Pennsylvania to the mainline pipeline. Natural gas is pressurized as it travels through interstate pipelines. In order to maintain design gas pressure, re-compression of this natural gas is required periodically along the pipeline at designated intervals.

Within the spectrum of fossil fuels, natural gas is the lowest in carbon emissions and capable of achieving the highest energy efficiency. As reported by the U.S. Energy Information Administration, for the first time in 2012 natural gas produced as much power in the U.S. as higher carbon emitting coal[iii], and the trend toward more reliance on natural gas is projected to continue[iv].

The Atlantic Coast Pipeline's purpose is to make additional domestically produced natural gas available to market, where it will be able to displace higher carbon emitting fuels and decrease the use of less efficient liquid fuels and coal. Thus, the Mockingbird Hill Compressor Station expansion project represents a significant part of our nation's GHG reduction strategy by allowing consumers greater access to low carbon emitting natural gas.

Per EPA's PSD and Title V Greenhouse Gas Tailoring Rule definitions, GHGs consist of the following gases:

- Carbon Dioxide (CO_2)
- Methane (CH_4)

[iii] *"Monthly Coal- and Natural Gas-fired Generation Equal for First Time in April 2012." Web log post. Today in Energy. U.S. Energy Information Administration, 6 July 2012. Web. 1 Aug. 2012.*

[iv] *"Annual Energy Outlook 2012." Web log post. Total Energy Supply, Disposition and Price Summary, Reference Case. U.S. Energy Information Administration, 2012. Web. 1 Aug. 2012.*

- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur Hexafluoride (SF_6)

To determine CO_2e emissions, mass flows of each individual gas are multiplied by the appropriate Global Warming Potential (GWP) as referenced in the Mandatory Greenhouse Gas Reporting Rule (40 CFR 98, Subpart A, Table A-1). The results are then summed to determine CO_2e emissions.

The combustion turbines, as well as the other, smaller combustion sources, will be fired with pipeline-quality natural gas, and efficient combustion of methane will result primarily in water and CO_2 by-products. Additionally, due to the presence of nitrogen in the combustion air, some N_2O will also be emitted. However, fugitive emissions—such as periodic venting of the pipeline for maintenance, methane leaks and trace emissions due to incomplete combustion will result in natural gas or CH_4 emissions.

Because BACT applies to "each pollutant subject to regulation under the Act," the BACT evaluation process is typically conducted for each regulated pollutant individually and not for a combination of pollutants.[v] This is not the case for GHG PSD applicability where the regulated NSR pollutant subject to regulation under the Clean Air Act (CAA) is the sum of six greenhouse gases. In the final Tailoring Rule preamble, EPA made clear that the combined pollutant approach for GHGs does not apply just to PSD applicability determinations but also to PSD BACT determinations. In this case, applicants must conduct a single GHG BACT evaluation based on CO_2e for emission sources that emit more than one GHG pollutant:

> *"However, we disagree with the commenter's ultimate conclusion that BACT will be required for each constituent gas rather than for the regulated pollutant, which is defined as the combination of the six well mixed GHGs. To the contrary, we believe that, in combination with the sum-of-six gases approach described above, the use of the CO2e metric will enable the implementation of flexible approaches to design and implement mitigation and control strategies that look across all six of the constituent gases comprising the air pollutant (e.g., flexibility to account for the benefits of certain CH4 control options, even though those options may increase CO2). Moreover, we believe that the CO2e metric is the best way to achieve this goal because it allows for tradeoffs among the constituent gases to be evaluated using a common currency.[vi]"*

v 40 CFR §52.21(b)(12)

vi 75 FR 31,531, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Final Rule, June 3, 2010.

Mockingbird Hill Compressor Station As defined in Subpart 1, Section 169.3 of the Clean Air Act, BACT is an "emission limitation," which means it is a performance requirement, not an emission rate reduction achieved through control equipment and based on an equipment standard. While BACT is predicated upon the application of technologies reflecting the best practical level of control (or emission reduction), the final result of a BACT determination is an emission limitation. Typically, when quantifiable and measurable, this limit would be expressed as an emission rate limit of a pollutant. In the case of GHG, EPA Guidance has indicated that GHG BACT limitations should be averaged over long-term timeframes such as a 30- or 365-day rolling average.[vii]

5.1.1 GHG BACT for Simple-Cycle Combustion Turbines

Definition of Source Being Permitted

The sources to be permitted consist of two 20,500 hp (ISO) simple-cycle combustion turbine mechanical compressor drive engines, both fired with pipeline quality natural gas. Mockingbird Hill Compressor Station is designed to maximize the regional natural gas supply's reliability using proven, commercially available equipment. Mockingbird Hill Compressor Station has no secondary use for thermal energy (steam or hot water) or bulk electricity generated on site. In keeping with GHG reduction principles, Mockingbird Hill Compressor Station operates as efficiently as practical.

Natural gas compressors are engine driven mechanical drive units that utilize the combustion of fuel (in this case, pipeline quality natural gas) to mechanical energy. For the proposed project, combustion turbine engines are to be installed, each driving a centrifugal compressor connected via rotating shaft.

In limited cases, some gas compressors are driven using an electric motor to turn the same type of centrifugal compressor – an arrangement that is less fuel-efficient and more carbon intensive than directly coupling the compressor to its energy production source. This type of compression does not require the use of natural gas to operate, but rather relies upon the fuel mix of the connected electrical grid to produce energy, which results in line losses and multiple energy conversion losses before arriving at the station. Such installations introduce another measure of gas supply unreliability since an electrical outage would also force a simultaneous natural gas supply outage.

Electric driven compressors are an option for Mockingbird Hill Compressor Station. However, when considering their entire carbon life cycle, electric driven compressors would represent a higher carbon emitting alternative than the proposed natural gas-fired combustion turbine engines drives. Since electric

[vii] *US EPA, PSD and Title V Permitting Guidance for Greenhouse Gases. EPA-457/B-11-001 (Mar. 2011), page 46 (hereinafter "2011 Guidance")*

drives in this instance are less fuel efficient, produce greater GHG emissions, and introduce natural gas reliability limitations, they were not considered in this GHG BACT analysis.

Top-Down BACT Process

According to the Guidance, BACT analysis for GHG emissions should be conducted in a manner consistent with the historical practice of BACT analyses, using the 5-step "top-down" approach originally laid out in EPA's Draft 1990 Workshop Manual. Given that most GHG emissions are a result of fossil fuel combustion, EPA suggests that a GHG BACT analyses should consider energy efficiency measures that reduce the need for fuel combustion, either by (a) combusting fuel more efficiently; (b) using the energy produced more efficiently; or (c) a combination of (a) and (b). These measures are especially relevant due to the relative lack of current "end-of-pipe" controls for GHG emissions.

The BACT analysis for the GHG emissions from the new sources proposed for Mockingbird Hill Compressor Station follows the EPA suggested 5-step "top down" process:

- Step 1: Identify all available control technologies;
- Step 2: Eliminate technically infeasible options;
- Step 3: Rank remaining control technologies;
- Step 4: Evaluate most effective controls and document results; and
- Step 5: Select BACT.

Each of the above steps will be described in the following sections for the proposed Mockingbird Hill Compressor Station expansion.

Step 1 – Identify All Available Control Technologies

The first step in the top down BACT process is to identify all "available" control options. Available control options are those air pollution control technologies or techniques (including lower emitting processes and practices) that have the potential for practical application to the emissions unit and the regulated pollutant under evaluation.

The Guidance has placed potentially applicable control alternatives identified and evaluated in the BACT analysis into the following three categories:

- Inherently Lower Emitting Processes/Practices/Designs;
- Add On Controls; and
- Combinations of Inherently Lower Emitting Processes/Practices/Designs and Add On Controls.

EPA recommends that the BACT analysis should consider potentially applicable control techniques from all three categories.

The Guidance also specifies that while GHG BACT analyses can include control measures that can be used facility-wide, Step 1 of the process should not consider secondary emissions (for example: measures that reduce electrical demand from the grid at the facility, thereby resulting in reduced demand for fuel combustion at off-site electric generating units). However, these off-site effects could be considered in Step 4 as appropriate.[viii]

The following potential CO_2 control strategies for simple-cycle natural gas fired mechanical drive combustion turbines will be analyzed as part of this BACT analysis:

- Carbon capture from the turbine stacks and permanent sequestration;
- Selection of natural gas compression process efficiency improvements;
- Selection of low carbon fuel; and
- Good combustion/operating practices (to optimize operating efficiency).

Carbon Capture and Sequestration

Carbon capture and sequestration (CCS) falls under the category of add-on controls, which are air pollution control technologies that remove pollutants from a facility's emissions stream. EPA suggests that CCS is an add-on pollution control technology that is "available" for large CO_2 emitting facilities and industrial facilities with high purity CO_2 streams. As a result, EPA suggests that CCS be considered in Step 1 of the BACT analysis.

CCS is composed of three main components: CO_2 capture and/or compression, transport, and sequestration. It is useless to capture CO2 unless it can be prevented from re-entering the atmosphere permanently. Simply capturing and storing CO_2 for re-use or where it can be gradually re-released does not represent a real reduction in global GHG emissions. To deploy CCS successfully, the design must have a component of both capture and sequestration. In fact, CO_2 separation without permanent sequestration actually results in an increase in total CO_2 generation, since the separation system itself requires energy.

For the Solar simple-cycle combustion turbines, CCS would be technically infeasible and would fundamentally re-define the source being permitted. If CO_2 capture were installed at the compressor station, the Solar turbines would be incapable of delivering the required shaft horsepower to the compressors due

[viii] PSD and Title V Permitting Guidance for Greenhouse Gases. U.S. EPA, Office of Air and Radiation, March 2011, at p. 24. EPA-457/B-11-001

to increased backpressure. Further, Mockingbird Hill Compressor Station would require a high voltage transmission line and additional electrical load to operate the equipment – itself requiring upstream increases in CO_2 emissions (including those from higher carbon emitting coal or oil-fired power plants). Such a system, assuming amine scrubbing, would require the addition of a form of chemical plant. The facility would take on a substantial footprint, high visibility and would require additional staff to operate.

The CO_2e PTE from the proposed Solar turbines is projected to be 182,118 TPY. A summary of the individual GHG pollutant along with its global warming potential is provided in Table 5.1 below:

TABLE 5.1 MOCKINGBIRD HILL COMPRESSOR STATION PROJECT COMBUSTION TURBINE GREENHOUSE GAS AND CO_2E PTE

Greenhouse Gas	PTE Emissions (TPY)	GWP*	Combustion Turbines CO_2e PTE (TPY)
CO_2	180.393	1	180.393
CH_4	14.8	25	370
N_2O	4.55	298	1,355
TOTAL	-	-	182,118

***GWP: Global Warming Potentials from Table A–1 to Subpart A of Part 98**

In the IPCC Special Report on CCS, the cost to perform post combustion carbon capture on a combustion turbine was estimated to be $25-115 per ton CO_2 captured (net)[ix]. The cost to transport CO2 via pipeline from the site of capture to the site of sequestration is estimated at $1-8 per ton of CO2 transported and the cost for injection at $0.5-8 per ton[x]. These estimates do not include the costs associated with construction, operation, maintenance and other liabilities to the Project to implement CCS.

Even if CCS were to be technically feasible at the Mockingbird Hill Compressor Station project, determining an appropriate threshold cost for CO_2e is a challenge. In terms of PSD applicability, under the "Tailoring Rule," the USEPA considers 100,000 tons of CO_2e equal to 100 tons of a criteria pollutant.[xi] In comparing the threshold value of cost effectiveness for CO_2e, calculations must be based on the relative cost effectiveness of control of a criteria pollutant at some threshold value per ton of pollutant removed and the major source threshold of 100 TPY. USEPA's rulemaking construct supports this approach; if

[ix] *Herzog, Howard. "Bottom-up Cost Estimate: IPCC Special Report on CCS". Proc. of CCS Cost Workshop, Paris. N.p.: International Energy Agency, 2011. 40. Print.*

[x] *Herzog, 2011.*

[xi] *"Clean Air Act Permitting for Greenhouse Gas Emissions – Final Rules Fact Sheet." USEPA, 2011. <http://www.epa.gov/airquality/nsr/ghgdocs/20101223factsheet.pdf>.*

a criteria pollutant control has a cost effectiveness threshold of approximately \$8,000 per ton, then the equivalent cost effectiveness for CO_2e control should be \$8/ton (\$8,000 x 0.001). Given this cost analysis, implementation of CCS again proves infeasible.

Selection of the Most Efficient Compressor Drive

Multiple, smaller reciprocating engines coupled to multiple small gas compressors would be required to produce the same output as the combustion turbines that have been selected for the project. As a result, using reciprocating engines would not constitute a more efficient or lower carbon-emitting alternative and would redefine the source being permitted. Since no comparable single engine is commercially available in this size or for this application, reciprocating engines are not considered further in this analysis.

Selection of Low Carbon Fuel

The proposed Mockingbird Hill Compressor Station combustion turbines will be fired with pipeline-quality natural gas. The combustion of natural gas has the lowest emissions of GHGs of any fossil fuel and emits almost 30 percent less CO_2 than oil, and about 45 percent less CO_2 than coal.[xii] The exclusive use of pipeline natural gas to fuel the proposed gas compressor drive engines reflects a component of BACT for GHG from this particular application.

Good Combustion/Operating Practices

Good combustion and operating practices are considered to be a potential control option by improving the fuel efficiency of the combustion turbines. Good combustion practices also include proper maintenance and computer automation within manufacturer's specifications of combustion turbine operations. Combustion turbines are monitored and controlled automatically via computerized control systems set up and monitored by the Original Equipment Manufacturer (OEM). These systems constantly adjust turbine operation in real time to maintain safe, pre-programmed and highest efficiency operation. Should any monitored parameter stray from its design range, the operator (or a remote operator) will be notified by alarm. If the system deems the fault to be critical to safe operation, protection of the equipment or meeting regulatory requirements the control system will initiate a safe shutdown of the unit.

DTI has in place a maintenance program for all of its natural gas compressor stations. The Mockingbird Hill Compressor Station emission sources are operated under that program.

[xii] *Natural Gas and the Environment, www.naturalgas.org.*

Good combustion and operation is therefore integral to the proposed compressor engine and represents a component of GHG BACT for this application.

Step 2 – Eliminate Technically Infeasible Options

As discussed above, CCS or substitution of other types of process or engine are determined to be technically infeasible for control of GHG emissions from the sources being permitted. However, EPA guidance stipulates that CCS costs should be evaluated and therefore it will be carried through to Step 4.

The Guidance also notes that for BACT analysis for GHG control strategies, "it may be appropriate in some cases to assess the cost effectiveness of a control option in a less detailed quantitative (or even qualitative) manner"[xiii] as compared to BACT analyses for other regulated NSR pollutants.

Step 3 – Rank Remaining Control Technologies

Based on the discussion in Steps 1 and 2, the only technically feasible control options for GHGs are:

- Carbon capture and Sequestration;
- Selection of the most efficient compressor drive that meets the project definition;
- Selection of low carbon fuel; and
- Good combustion/operating practices.

Ranking the above control technologies is not necessary as DTI plans to implement all except for CCS at Mockingbird Hill Compressor Station.

Step 4 – Evaluate Most Effective Controls and Document Results

Under Step 4 of the top down BACT analysis, economic, energy, and environmental impacts must be evaluated for each option remaining under consideration.

DTI evaluated the cost effectiveness of CCS for the proposed project and found that CCS is not cost effective at $267/ton removed. Detailed calculations for cost-effectiveness of CCS may be found in Appendix C.

The Solar combustion turbines have been demonstrated to be one of the most efficient simple-cycle turbines for this application. The turbines will be fired with natural gas, which is the most carbon efficient fuel and will be operated and maintained using good combustion practices.

[xiii] *As above, at p. 42*

Step 5 – Select the BACT

In Step 5 of the BACT determination process, the most effective control option not eliminated in Step 4 should be selected as BACT for the pollutant and emissions unit under review and included in the permit.

The CCS option was eliminated in Step 2 as not technically feasible for the Project. Even though DTI's analysis eliminated CCS in Step 2, due to EPA guidance, DTI continued the evaluation through Step 4 of the BACT process where it was found to not be cost effective. Although EPA considers CCS as available, it is not commercially available. In fact, EPA recognizes that at present, CCS is an expensive technology, largely because of the costs associated with CO_2 capture and compression.

The Solar combustion turbines fueled with natural gas along with good combustion/operating practices is proposed as BACT for Mockingbird Hill Compressor Station.

EPA encourages the use of output-based BACT limits, where feasible and appropriate, and suggests that GHG BACT limits should focus on long-term averages based on the cumulative, rather than acute, environmental impact of GHG emissions.[xiv] In a mechanical drive compressor application there is no discreet, measureable product output. In this application, CO_2 emission limits must be based on mass emissions (lb) per heat input (MMBtu), or, more simply, annual average hourly tons of CO_2. Therefore, DTI proposes an efficiency based BACT emission limit for the proposed Mockingbird Hill Compressor Station turbines as follows:

Solar Titan 130. Output based BACT limit of 1.01 lbs. CO2e per horsepower hour on a 12-month rolling average. The BACT limit is based on the following calculation:

$$\frac{20{,}757\ lbs\ CO2e}{hour} \times \frac{hour}{20{,}500\ HP - hr} = \frac{1.01\ lbs\ CO2e}{HP - hr}$$

Additionally, DTI proposes an annual mass CO_2e permit limit for the new Mockingbird Hill Compressor Station turbines as follows:

$$\frac{20{,}757\ lbs\ CO2e}{hour} + \frac{20{,}757\ lbs\ CO2e}{hour} = \frac{41{,}514\ lbs\ CO2e}{hour}$$

[xiv] *As above, at p. 46*

$$\frac{41{,}514 lbs\ CO2e}{hour} \times \frac{ton}{2000\ lbs} \times \frac{8{,}760\ hours}{hour} = \frac{181{,}831\ tons\ CO2e}{year}$$

Compliance with the proposed BACT limit will be demonstrated through continuous monitoring of natural gas consumption and/or turbine output and EPA emission factors (methane, CH_4, contains a fixed amount of carbon per MMBtu). There are no benefits to CO2 stack testing; the results would be no more accurate than tracking natural gas usage using a calibrated gas meter.

5.1.2 GHG BACT for Replacement Hastings Compressor Station Engines and Natural Gas-Fired Boiler

The replacement Hastings Compressor Station engines and the proposed boiler will be fueled with natural gas. GHG emissions for natural gas combustion are 116.9 lb CO_2e/MMBtu compared to 163.6 lb CO_2/MMBtu for distillate fuel oil consumption.[xv] Therefore, firing natural gas generates less GHGs than firing oil.

The replacement engines and the proposed boiler represent less than 5% of the combustion GHG emissions from the project. The boiler is necessary for heating purposes during winter months. The actual GHG emissions from the boiler are expected to be considerably lower due to the inherent nature of its function.

Step 1 – Identify All Available Control Technologies

The first step in the top-down BACT process is to identify all "available" control options. Available control options are those air pollution control technologies or techniques (including lower emitting processes and practices) that have the potential for practical application to the emissions unit and regulated pollutant under evaluation. Use of low carbon fuel and energy efficient design has been identified as control technologies available to the boiler.

The proposed Mockingbird Hill Compressor Station engines and boiler will be fired with pipeline-quality natural gas. The combustion of natural gas has the lowest emissions of GHGs of any fossil fuel and emits almost 30 percent less CO_2 than oil, and about 45 percent less CO_2 than coal.[xvi]

In the GHG BACT guidance, EPA has stressed importance of energy efficiency for combustion sources. The proposed units maximize efficiency while meeting the required emissions standards.

Step 2 – Identification of Technically Feasible Control Alternatives

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xv Table C-1 to 40 CFR 98 Subpart C-- CO2 Emission Factors And High Heat Values For Various Types Of Fuel
xviNatural Gas and the Environment, www.naturalgas.org.

Under the second step of the top-down BACT analysis, a potentially applicable control technique listed in Step 1 may be eliminated from further consideration if it is not technically feasible for the specific source under review. EPA considers a technology to be potentially applicable if it has been demonstrated in practice or is available. The energy efficient use of the lowest carbon fuel (natural gas) used is considered to be the only technically feasible CO_2 control option for the engines and boiler.

Step 3 – Rank Remaining Control Technologies

After the list of all available controls is narrowed down to a list of the technically feasible control technologies in Step 2, Step 3 of the top down BACT process calls for the remaining control technologies to be listed in order of overall control effectiveness for the regulated New Source Review (NSR) pollutant under review. Based on the discussion in Steps 1 and 2, the only technically feasible control option for CO_2 from the engines and boiler is energy efficiency through the use of low carbon fuel (natural gas).

Step 4 – Evaluate Most Effective Controls and Document Results

In the top-down BACT analysis, the "top" control option should be established as BACT unless the applicant demonstrates, and the permitting authority agrees, that the energy, environmental, or economic impacts justify a conclusion that the most stringent technology is not "achievable" in that case. If the most stringent technology is eliminated in this fashion, then the next most stringent alternative is considered.

Step 5 – Select the BACT

In Step 5 of the BACT determination process, the most effective control option not eliminated in Step 4 should be selected as BACT for the pollutant and emissions unit under review and included in the permit.

Energy efficiency through the regulation of fuel used to meet the function is the only remaining and feasible control technology is selected as BACT for the GHG emissions from the engines and boiler. Additionally, the use of natural gas in the engines and boiler results in the lowest GHG emission practicable.

The Hastings Compressor Station engines are operated based on market demand. The boiler will be operated as needed to heat the station during the winter months ensuring no malfunctions due to freezing occur. Thus, fuel use is optimized resulting in lower GHG emissions than if the unit operated continuously.

The engines and boiler account for less than 5% percent of the total GHG emissions potential of the project with expected actual emissions to be even less.

The use of natural gas as fuel represents the best available option in controlling GHG emissions from the engines and boiler. This is consistent with the 40 CFR 52.21 definition of BACT, which provides for cases where the imposition of an emissions standard would be infeasible for an emission unit, that *"a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology."*

Due to the small amount of GHG emissions potential from the natural gas fired engines and boiler, a numerical GHG emission limit is not proposed.

5.1.3 GHG BACT for Fugitive Components

As discussed earlier, some fugitive components such as flanges, valves, open-ended lines (OELs), vents and pipeline within the facility boundary would be associated with the proposed combustion turbines. Natural gas release from fugitive components represents a potential source of GHG emissions from the facility in the form of methane contained in the natural gas.

As described in Section 6, DTI expects to comply with NSPS Subpart OOOOa when promulgated and proposes compliance with the applicable fugitive leak provisions of Subpart OOOOa as BACT.

5.2 BACT FOR PARTICULATE MATTER (PM10 AND PM2.5)

Particulate matter emissions result from the proposed combustion sources.

The following summarizes the BACT evaluation conducted for each significant piece of equipment with respect to PM, PM10, and PM2.5 emissions.

5.2.1 Combustion Turbines and Compressor Engines

The emissions of particulate matter emissions from gaseous fuel combustion have been estimated to be less than 1 micron in equivalent aerodynamic diameter, have filterable and condensable fractions, and usually consist of hydrocarbons of larger molecular weight that are not fully combusted[xvii]. Because the particulate matter typically is less than 2.5 microns in diameter, this BACT discussion assumes the control technologies for PM, PM_{10}, and $PM_{2.5}$ are the same.

As part of the step 1 analysis, searches of the RBLC database for similar units were conducted. Search results are provided in **Appendix C** showing

[xvii] USEPA, 2006 http://www.epa.gov/ttnchie1/conference/ei15/training/pm_training.pdf

comparable turbine units. For any instances where the emission rate is lower than what is proposed by DTI, comments have been provided detailing why the listed rate was not considered to be BACT.

Step 1 – Identify Potential Control Technologies

Pre-Combustion Control Technologies

The major sources of PM, PM_{10}, and $PM_{2.5}$ emissions from gaseous fuel-fired combustion turbines and reciprocating compressor engines are:

- The conversion of fuel sulfur to sulfates and ammonium sulfates;
- Unburned hydrocarbons that can lead to the formation of PM in the exhaust stack; and
- PM in the ambient air entering the combustion turbines through their inlet air filtration systems, and the aqueous ammonia dilution air.

The use of clean-burning, low-sulfur gaseous fuels will result in minimal formation of PM, PM_{10}, and $PM_{2.5}$ during combustion. Best combustion practices will ensure proper air/fuel mixing ratios to achieve complete combustion, minimizing emissions of unburned hydrocarbons that can lead to the formation of PM emissions. In addition to good combustion practices, the use of high-efficiency filtration on the inlet air will minimize the entrainment of PM into the combustion turbine exhaust streams.

Post-Combustion Control Technologies

There are several post-combustion PM control systems potentially feasible to reduce PM, PM_{10}, and $PM_{2.5}$ emissions including:

- Cyclones/centrifugal collectors;
- Fabric filters/baghouses;
- Electrostatic precipitators (ESPs); and
- Scrubbers.

Cyclones/centrifugal collectors are generally used in industrial applications to control large diameter particles (>10 microns). Cyclones impart a centrifugal force on the gas stream, which directs entrained particles outward. Upon contact with an outer wall, the particles slide down the cyclone wall, and are collected at the bottom of the unit. The design of a centrifugal collector provides for a means of allowing the clean gas to exit through the top of the device. However, cyclones are inefficient at removing small particles.

Fabric filters/baghouses use a filter material to remove particles from a gas stream. The exhaust gas stream flows through filters/bags onto which particles are collected. Baghouses are typically employed for industrial applications to provide particulate emission control at relatively high efficiencies.

ESPs are used on a wide variety of industrial sources, including certain boilers. ESPs use electrical forces to move particles out of a flowing gas stream onto collector plates. The particles are given an electric charge by forcing them to pass through a region of gaseous ion flow called a "corona." An electrical field generated by electrodes at the center of the gas stream forces the charged particles to ESP's collecting plates.

Removal of the particles from the collecting plates is required to maintain sufficient surface area to clean the flowing gas stream. Removal must be performed in a manner to minimize re-entrainment of the collected particles. The particles are typically removed from the plates by "rapping" or knocking them loose, and collecting the fallen particles in a hopper below the plates.

Scrubber technology may also be employed to control PM in certain industrial applications. With wet scrubbers, flue gas passes through a water (or other solvent) stream, whereby particles in the gas stream are removed through inertial impaction and/or condensation of liquid droplets on the particles in the gas stream.

<u>Step 2 - Eliminate Technically Infeasible Options</u>

<u>Pre-Combustion Control Technologies</u>

The pre-combustion control technologies identified above (i.e., clean-burning, low-sulfur fuels, good combustion practices, high-efficiency filtration of the combustion turbine inlet air system) are available and technically feasible for reducing PM emissions from the combustion turbine and reciprocating compressor engine exhaust streams.

<u>Post-Combustion Control Technologies</u>

Each of the post-combustion control technologies described above (i.e., cyclones, baghouses, ESPs, scrubbers) are generally available. However, none of these technologies is considered practical or technically feasible for installation on gaseous fuel-fired combustion turbines or reciprocating compressor engines since $PM_{2.5}$, which, as stated above, makes up the majority of PM emissions.

The particles emitted from gaseous fuel-firing are typically less than 1 micron in diameter. Cyclones are not effective on particles with diameters of 10 microns or less. Therefore, a cyclone/centrifugal collection device is not a technically feasible alternative.

Baghouses, ESPs, and scrubbers have never been applied to commercial combustion turbines or reciprocating compressor engines burning gaseous fuels. Baghouses, ESPs, and scrubbers are typically used on solid or liquid-fuel fired sources with high PM emission concentrations, and are not used in gaseous fuel-fired applications, which have inherently low PM emission concentrations. None of these control technologies is appropriate for use on gaseous fuel-fired combustion turbines or reciprocating compressor engines because of their very low PM emissions levels, and the small aerodynamic diameter of PM from gaseous fuel combustion. Review of the RBLC, as well as USEPA and State permit databases, indicates that post-combustion controls have not been required as BACT for gaseous fuel-fired fired combined-cycle combustion turbines or reciprocating compressor engines. Therefore, the use of baghouses, ESPs, and scrubbers are not considered technically feasible.

Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The use of clean-burning fuels, good combustion practices, and inlet air filtration are the technically feasible technologies to control PM, PM_{10}, and $PM_{2.5}$ emissions to no more than 0.02 lb/MMbtu from each turbine and 0.05 lb/MMbtu from the new Hastings Compressor Station engines.

Step 4 - Evaluate Most Effective Controls and Document Results

Based on the information presented in this BACT analysis, using the proposed good combustion practices and inlet air filtration to control PM, PM_{10}, and $PM_{2.5}$ emissions to no more than 0.02 lb/MMbtu from each turbine and 0.05 lb/MMbtu from the new Hastings Compressor Station engines. These values are consistent with BACT at other similar sources. Therefore, an assessment of the economic and environmental impacts is not necessary.

Step 5 – Select BACT

DTI proposes BACT for PM, PM_{10}, and $PM_{2.5}$ emissions from the combustion turbines and compressor engines is the use of clean-burning fuels, good combustion practices, and inlet air filtration to control PM, PM_{10}, and $PM_{2.5}$. Emissions will be limited to 0.02 lb/MMbtu from each turbine and 0.05 lb/MMbtu from the new Hastings Compressor Station reciprocating engines.

5.2.2 *Emergency Generator*

The emergency generator will be fueled exclusively by pipeline quality natural gas and hours of non-emergency operation are capped at 100 hours per year.

As an emergency source, DTI does not believe it is appropriate to subject the emergency generator to a BACT review.

A review of the RBLC as well as recent permits shows that add-on controls have not been employed for other similar sized engines which exclusively fire pipeline quality natural gas to control particulate matter. The combustion of natural gas, with a lower ash and sulfur content than other commonly used fuels (i.e., fuel oil, and coal), generates lower levels of particulate matter emissions compared to other fuels. Through this review, DTI determined that add-on controls are not considered commercially demonstrated for engines of a similar size firing natural gas only. DTI proposes the use of pipeline quality natural gas and good combustion practices as BACT for PM, PM_{10}, and $PM_{2.5}$.

5.2.3 Boiler

The boiler will be fueled exclusively by pipeline quality natural gas. The boiler emissions assume the unit will operate for 8,760 hours per year, but in reality, the boiler will only operate when needed for comfort heat.

A review of the RBLC as well as recent permits shows that add-on controls have not been employed for other similar sized auxiliary boilers which exclusively fire pipeline quality natural gas to control particulate matter. The combustion of natural gas, with a lower ash and sulfur content than other commonly used fuels (i.e., fuel oil, and coal), generates lower levels of particulate matter emissions compared to other fuels. Through this review, DTI determined that add-on controls are not considered commercially demonstrated for boilers of a similar size firing natural gas only. DTI proposes the use of pipeline quality natural gas and good combustion practices as BACT for PM, PM_{10}, and $PM_{2.5}$.

6.0 FEDERAL REGULATORY REQUIREMENTS

6.1 NEW SOURCE PERFORMANCE STANDARDS (NSPS)

New Source Performance Standards (NSPS) have been established by the EPA to limit air pollutant emissions from certain categories of new and modified stationary sources. The NSPS regulations are contained in 40 CFR Part 60 and cover many different source categories, and applicable categories are described below. The proposed project will also comply with the requirements of NSPS Subpart A – General Provisions.

6.1.1 40 CFR 60 Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

This regulation applies to steam generating units for which construction, modification, or reconstruction is commenced after June 9, 1989 and that have a maximum design heat capacity of 100 MMBtu/hr or less, but greater than or equal to 10 MMBtu/hr. The new boiler will have a heat input capacity of 7.2 MMBtu/hr and thus is not subject to this regulation.

6.1.2 40 CFR 60 Subpart Kb - Standards of Performance for Volatile Organic Liquid Storage Vessels

This regulation applies to volatile organic liquid storage vessels with storage capacities greater than or equal to 75 cubic meters (19,812 gallons) for which construction, reconstruction, or modification commenced after July 23, 1984. There are no petroleum storage vessels with capacities greater than 19,812 gallons planned at the Mockingbird Hill Compressor Station, and this regulation is therefore not applicable to the facility.

6.1.3 40 CFR 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

NSPS Subpart JJJJ was promulgated on Jan 8, 2008 and is applicable to new stationary spark ignition internal combustion engines depending upon model year and size category. The new emergency generator and the new Hastings Compressor Station engines are subject to the NO_x, CO and VOC requirements of this subpart and will comply with the emission standards under this subpart.

6.1.4 40 CFR 60 Subpart KKKK – Standards of Performance for Stationary Combustion Turbines

NSPS Subpart KKKK was promulgated on July 6, 2006, and applies to all new turbines with a heat input at peak load equal to or greater than 10 million Btu (MMBtu) per hour that commence construction, modification, or reconstruction after February 18, 2005. The proposed Solar turbines will be subject to the requirements of this subpart. Subpart KKKK specifies several subcategories of turbines, each with different requirements. The new turbines will fall within the "medium sized" (>50 MMBtu/hr, <850 MMBtu/hr) category for natural gas turbines. Under Subpart KKKK, "Medium sized" turbines must meet a NO_x emission limit of 25 ppm_v at 15% O_2 and minimize emissions consistent with good air pollution control practices during startup, shutdown and malfunction.

Solar provides an emissions guarantee of 9 parts per million volume dry (ppmvd) NO_x at 15 percent O_2 for the proposed $SoLoNO_x$ equipped units. These guarantees apply at all times except during periods of start-up and shutdown and periods with ambient temperatures below 0°F.

DTI plans to conduct stack tests for NO_x emissions to demonstrate compliance with the Subpart KKKK emissions limits.

The NSPS Subpart KKKK emission standard for SO_2 is the same for all turbines, regardless of size and fuel type. All new turbines are required to meet an emission limit of 110 nanogram per joule (ng/J) (0.90 pounds [lbs]/megawatt-hr) or a sulfur limit for the fuel combusted of 0.06 lbs/MMBtu. The utilization of natural gas as fuel ensures compliance with the SO_2 standard due to the low sulfur content of natural gas.

6.1.5 40 CFR 60 Subparts OOOO and OOOOa – Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution

Subpart OOOO currently applies to affected facilities that commenced construction, reconstruction, or modification after August 23, 2011. Subpart OOOO establishes emissions standards and compliance schedules for the control of VOCs and SO_2 emissions for affected facilities producing, transmitting, or distributing natural gas. Compressors located between the wellhead and the point of custody transfer to the natural gas transmission and storage segment are subject to this Subpart. Custody transfer is defined as the transfer of natural gas after processing and/or treatment in the producing operations. All compressor stations will be located after the point of custody transfer, and therefore centrifugal compressors driven by the proposed turbines are not currently subject to this regulation. Storage vessels located in the natural gas transmission and storage segment that have the potential for VOC emissions equal to or greater than 6 tpy are also subject to this Subpart. All storage vessels to be located at compressor stations will emit less than this threshold, and thus will not be subject to this regulation.

On August 18, 2015, EPA proposed amendments to 40 CFR 60, Subpart OOOO and proposed an entirely new Subpart OOOOa. If finalized, revisions proposed for Subpart OOOO would apply to oil and natural gas production, transmission, and distribution affected facilities that were constructed, reconstructed, and modified between August 23, 2011 and the Federal Register publication date (anticipated September 2015). Conversely, if finalized, Subpart OOOOa will apply to oil and natural gas production, transmission, and distribution affected facilities that are constructed, reconstructed, and modified after the Federal Register date. The proposed NSPS Subpart OOOOa would establish standards for both VOC and methane.

Based on the expected date of publication in the Federal Register, it is anticipated this project will be required to comply with the requirements of NSPS Subpart OOOOa. There is uncertainty if Subpart OOOOa will become final or what the final requirements will specifically include; however, the proposal contains provisions that would affect additional sources at the proposed facilities beyond Subpart OOOO. While storage tanks remain covered, Subpart OOOOa also includes provisions intended to reduce emissions from centrifugal compressors and equipment leaks from transmission and storage facilities. For centrifugal compressors, Subpart OOOOa proposes the use of dry seals or the control of emissions if wet seals are used. Dry seals are already planned for use in all proposed compressors. For equipment leaks, Subpart OOOOa proposes requiring periodic surveys using optical gas imaging (OGI) technology and subsequent repair of any identified leaks. The project will comply with all applicable leak detection provisions of proposed Subpart OOOOa.

6.2 MOCKINGBIRD HILL COMPRESSOR STATION NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP)

NESHAP regulations established in 40 CFR Part 61 and Part 63 regulate emission of air toxics. NESHAP standards primarily apply to major sources of Hazardous Air Pollutants (HAPs), though some Subparts of Part 63 have been revised to include area (non-major) sources. The NESHAP regulations under 40 CFR Part 61 establish emission standards on the pollutant basis whereas 40 CFR Part 63 establishes the standards on a source category basis. The determination of HAP major source status is determined based upon the designation of surface sites. In the current Title V Permit issued by the WVDAQ, the three stations aggregated under the permit are differentiated into two surface sites, based upon industry classification. The production operations at the Hastings Compressor Station constitute one surface site and the transmission operations at the Mockingbird Hill and Lewis Wetzel Compressor Stations constitute another surface site.

Based on the PTE for HAPs when considering the modifications proposed submitted with the permit application, the Hastings Compressor Station production operations are considered to be an area (minor) source of HAPs and Mockingbird Hill and Lewis Wetzel transmission operations are considered to be an area (minor) source of HAPs.

6.2.1 *40 CFR 63 Subpart HHH – National Emissions Standards for Hazardous Air Pollutants from Natural Gas Transmission and Storage Facilities*

This regulation applies to certain affected facilities at major HAP sources. The transmission operations at the Mockingbird and Lewis Wetzel Compressor Stations will remain area HAP source. Therefore, this regulation is not applicable.

6.2.2 *40 CFR 63 Subpart DDDDD – National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers And Process Heaters*

Industrial, commercial, or institutional boilers or process heaters located at a major source of HAPs are subject to this Subpart. The transmission operations at the Mockingbird and Lewis Wetzel Compressor Stations will remain area HAP source. Therefore, this regulation is not applicable.

6.2.3 *40 CFR 63 Subpart JJJJJJ – National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources*

This Subpart applies to area sources of HAPs. The Mockingbird Hill Compressor Station will be an area source of HAPs; however, gas-fired boilers as defined by this Subpart are not subject to any requirements under this rule. As such, this subpart does not apply.

6.2.4 *40 CFR 63 Subpart YYYY – National Emissions Standards for Hazardous Air Pollutants for Stationary Combustion Turbines*

The transmission operations at the Mockingbird and Lewis Wetzel Compressor Stations will remain area HAP source. Therefore, this regulation is not applicable.

6.2.5 *40 CFR 63 Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines*

The replacement engines at the Hastings Compressor Station and the emergency generator is subject to the NESHAP requirements under 40 CFR Part 63 Subpart ZZZZ (applies to both major and area sources of HAPs). However, the NESHAP refers to the NSPS for all applicable requirements. Therefore, compliance with the NSPS requirements ensures compliance with the NESHAP requirements.

6.3 TITLE V OPERATING PERMIT

The major source thresholds with respect to the West Virginia Title V operating permit program regulations are 10 tons per year (tpy) of a single HAP, 25 tpy of any combination of HAP, and 100 tpy of all other regulated pollutants.

The PTEs of VOCs, NOx, and CO are above the corresponding major source thresholds. The Hastings Compressor Station, Lewis Wetzel Compressor Station, and Mockingbird Hill Compressor Station qualify as major sources under the Title V program. The submission of this permit modification application will serve as the application for modification for the facilities' Title V Operating Permit. An additional electronic copy of this application is included with this submission for distribution to the WVDAQ Title V Permitting Group.

6.4 MAINTENANCE EMISSIONS AND FEDERAL ROUTINE MAINTENANCE, REPAIR AND REPLACEMENT PROVISIONS (RMRR)

As part of normal operations at the Mockingbird Hill Compressor Station, DTI will routinely conduct activities associated with maintenance and repair of the facility equipment. These maintenance and repair activities will include, but will not be limited to, compressor engine startup/shutdowns, calibrating equipment, changing orifice plates, deadweight testing, emergency power generator run times, changing equipment filters (e.g., oil filters, separator filters), compressor engine and auxiliary equipment inspecting and testing, and use of portable gas/diesel engines for air compressors and lube guns.

Furthermore, in order to ensure the reliability of natural gas deliveries to their customers, DTI may conduct equipment and component replacement activities that conform to the currently applicable federal laws and regulations.

6.5 CHEMICAL ACCIDENT PREVENTION AND RISK MANAGEMENT PROGRAMS (RMP)

The Station will not be subject to the Chemical Accident Prevention Provisions (40 CFR 68.1), as no chemicals subject to regulation under this Subpart will be present onsite.

6.6 ACID RAIN REGULATIONS

The Mockingbird Hill Compressor Station will not sell electricity and is a non-utility facility. Therefore, the facility will not be subject to the federal acid rain regulations found at 40 CFR Parts 72 through 77.

6.7 STRATOSPHERIC OZONE PROTECTION REGULATIONS

Subpart F, Recycling and Emissions Reductions, of 40 CFR Part 82, Protection of Stratospheric Ozone, generally requires that all repairs, service, and disposal of appliances containing Class I or Class II ozone depleting substances be conducted by properly certified technicians. The facility will comply with this regulation as applicable.

6.8 GREENHOUSE GAS REPORTING

On November 8, 2010, the USEPA finalized GHG reporting requirements under 40 CFR Part 98. Subpart W of 40 CFR Part 98 requires petroleum and natural gas facilities with actual annual GHG emissions equal to or greater than 25,000 metric tons CO_2e to report GHG from various processes within the facility. If the emissions threshold is met or exceeded, DTI will comply with the applicable GHG reporting requirements.

7.0 STATE REGULATORY APPLICABILITY

This section outlines the State air quality regulations that could be reasonably expected to apply to the Mockingbird Hill Compressor Station and makes an applicability determination for each regulation based on activities planned at the Station and the emissions of regulated air pollutants associated with this project. This review is presented to supplement and/or add clarification to the information provided in the WVDEP Rule 14 permit application forms.

The West Virginia State Regulations address federal regulations where West Virginia has been delegated authority of enforcement, including Prevention of Significant Deterioration permitting, Title V permitting, New Source Performance Standards, and National Emission Standards for Hazardous Air Pollutants. The regulatory requirements in reference to Mockingbird Hill Compressor Station are described in detail in Table 7.1 below.

TABLE 7.1 STATE REGULATORY APPLICABILITY

Regulatory Applicability	Applicable Requirement	Compliance Approach
Particulate Emissions (45 CSR 02)	The proposed modification at the Mockingbird Hill Compressor Station includes one (1) indirect heat exchanger (WH-1) rated at 7.20 MMBtu/hr that combusts natural gas. However, it is exempt from this regulation since the heat input capacity is less than 10 MMBtu/hr.	NA
Objectionable Odors (45 CSR 04)	Prevent the discharge of air pollutants that contribute to objectionable odors	Operations conducted at the compressor station are subject to this requirement. The facility is staffed and will use best practices to minimize odors.
Sulfur Oxides (45 CSR 10)	All fuel burning units will be subject to the weight emission standard for sulfur dioxide.	Compliance with this limit will be demonstrated by combustion pipeline quality natural gas. The maximum aggregate fuel usage for each engine will be monitored and recorded.
Stationary Source Permitting (45 CSR 13)	The proposed modifications at the Mockingbird Hill Compressor Station exceed the major modification threshold for a facility meeting the criteria of Prevention of Significant Deterioration. Based upon this, Rule 13 is not applicable to this	NA

Regulatory Applicability	Applicable Requirement	Compliance Approach
	modification.	
Construction and Major Modification of Major Sources for the Prevention of Significant Deterioration (45 CSR 14)	This permit application is being submitted for the major modification of the Mockingbird Hill Compressor Station.	See Section 4.0.
New Source Performance Standards (45 CSR 16)	The Station is required to comply with applicable NSPS Standards.	See Section 6.1
Construction and Major Modification of Major Source Causing or Contributing to Nonattainment (45 CSR 19)	Wetzel County, WV is in attainment for all pollutants with a National Ambient Air Quality Standard (NAAQS). Therefore, this regulation does not apply to the Mockingbird Hill Compressor Station.	NA
Hazardous Waste (45 CSR 25)	This Station does not qualify as a waste treatment, storage, and disposal facility and no hazardous waste will be burned at this Site; therefore, it is not subject to this hazardous waste rule.	NA
Title V Operating Permits (45 CSR 30)	The Mockingbird Hill Compressor Station is located in Pine Grove, Wetzel County, West Virginia and currently operates under permit number R30-10300006-2011.	See Section 6.3
NESHAP Rues (45 CSR 34)	The Station is required to comply with applicable NESAHP Rules.	See Section 6.2
Control of Annual Nitrogen Oxide Emissions (45 CSR 39)	Operation of equipment at this compressor station will exceed the PSD emission triggers. The Mockingbird Hill Compressor Station will operate fossil-fuel fired combustion turbines; however, these turbines will not be used for the production of electricity and are therefore exempt from this Rule.	NA
Control of Ozone Season Nitrogen Oxide Emissions (45 CSR 40)	Turbines will not be used for the production of electricity and are therefore exempt from this Rule.	NA
Control of Annual Sulfur Dioxide Emissions (45 CSR 41)	Turbines will not be used for the production of electricity and are therefore exempt from this Rule.	NA

8.0 PROPOSED COMPLIANCE DEMONSTRATIONS

The following methods are proposed for demonstrating ongoing compliance for the sources described in this application:

Compressor Turbines (CT-01 and CT-02)

NO_x

Annual stack testing (or semi-annual testing as allowed) will be completed to demonstrate compliance with the NSPS Subpart KKKK emissions limits (NO_2 emissions).

Compliance with the combustion turbines potential to emit will be demonstrated on a 12-month rolling total basis by the sum of the following emissions:

- Normal Operation: The average emission rate from the most recent stack test (lb/hour) times the number of hours operating in SoLoNOx mode (mode indication provided and recorded by control logic on turbine).
- Low Temperature (< 0^{o} F) Operation: The proposed controlled emission rates (lb/hr, see Table 3.2) determined using the Solar provided emissions factor multiplied by the number of hours when inlet combustion air for turbine was measured to be below 0 degrees F.
- Startup and Shutdown Emissions (< 50% load): The Solar-provided emission rates (see Tables 3.3 and 3.4) divided by Solar-assumed duration for startups and shutdowns (1/6 of an hour each) times the number of hours operating in non-SoLoNOx mode (mode indication provided and recorded by control logic on the turbine).

CO, VOC, $PM_{10}/PM_{2.5}$:

Initial stack testing will be completed to determine $PM_{10}/PM_{2.5}$ emission rates (lb/MMBtu). Fuel firing will be tracked and used to calculate annual (rolling 12-month total) ton per year emissions.

Initial stack testing will be competed to determine VOC and CO emission rates. Compliance with the combustion turbines potential to emit will be demonstrated on a 12-month rolling total basis by the sum of the following emissions:

- Normal Operation: The average emission rate from the most recent stack test (lb/hour) times the number of hours operating in SoLoNOx mode (mode indication provided and recorded by control logic on turbine).

- Low Temperature (< 0^{o} F) Operation: The proposed controlled emission rates (lb/hr, see Table 3.2) determined using the Solar provided emissions factor multiplied by the control efficiency of the oxidation catalyst times the number of hours when inlet combustion air for turbine was measured to be below 0 degrees F.

- Startup and Shutdown Emissions (< 50% load): The Solar-provided emission rates (see Tables 3.3 and 3.4) divided by Solar-assumed duration for startups and shutdowns (1/6 of an hour each) times the number of hours operating in non-SoLoNOx mode (mode indication provided and recorded by control logic on the turbine).

GHG:

Total annual fuel volume will be tracked to determine total MMBtu of firing. This value times the EPA Mandatory Reporting Rule natural gas emission factor (40 CFR Part 98 Subpart C) times the Global Warming Potential (40 CFR Part 98 Subpart A) will be used to calculate ton per year CO_2e emissions.

<u>Compressor Engines (Hastings Compressor Station):</u>

The units will conduct annual stack testing to demonstrate compliance with NSPS Subpart JJJJ. Emission rates from the most recent stack tests will be used to calculate to calculate annual (rolling 12-month total) ton per year emissions.

<u>Emergency Generator</u>

Records of the monthly emergency and non-emergency use will be maintained to confirm compliance with the annual limit for non-emergency operation. If a non-certified engine is installed or if a certified engine is installed but operated as non-certified an initial stack test and testing every 8760 operating hours or three years (whichever comes first) will be conducted.

<u>Other Combustion Sources</u>

If not otherwise specified above, the amount of fuel fired in units and/or hours of operation will be tracked and multiplied by the appropriate emission factor to calculate emissions on an annual basis.

APPENDICES

APPENDIX A

WVDAQ PERMIT APPLICATION FORMS

WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION **DIVISION OF AIR QUALITY** 601 57th Street, SE Charleston, WV 25304 (304) 926-0475 www.dep.wv.gov/daq	***APPLICATION FOR NSR PERMIT AND TITLE V PERMIT REVISION (OPTIONAL)***
PLEASE CHECK ALL THAT APPLY TO **NSR (45CSR13)** (IF KNOWN): ☐ **CONSTRUCTION** ☒ **MODIFICATION** ☐ **RELOCATION** ☐ **CLASS I ADMINISTRATIVE UPDATE** ☐ **TEMPORARY** ☐ **CLASS II ADMINISTRATIVE UPDATE** ☐ **AFTER-THE-FACT**	PLEASE CHECK TYPE OF **45CSR30 (TITLE V)** REVISION (IF ANY): ☐ **ADMINISTRATIVE AMENDMENT** ☐ **MINOR MODIFICATION** ☒ **SIGNIFICANT MODIFICATION** IF ANY BOX ABOVE IS CHECKED, INCLUDE TITLE V REVISION INFORMATION AS **ATTACHMENT S** TO THIS APPLICATION

FOR TITLE V FACILITIES ONLY: Please refer to "Title V Revision Guidance" in order to determine your Title V Revision options (Appendix A, "Title V Permit Revision Flowchart") and ability to operate with the changes requested in this Permit Application.

Section I. General

1. Name of applicant *(as registered with the WV Secretary of State's Office):* **Dominion Transmission, Inc.**	2. Federal Employer ID No. ***(FEIN):*** **550629203**
3. Name of facility *(if different from above):* **Mockingbird Hill Compressor Station** **Currently, the Mockingbird Hill Compressor Station Title V Permit aggregates the emissions from the Hastings Compressor Station, Mockingbird Hill Station, and the Lewis Wetzel Compressor Station. This permit application is for a major modification proposed at the Mockingbird Hill Station.**	4. The applicant is the: ☐ **OWNER** ☐**OPERATOR** ☒ **BOTH**
5A. Applicant's mailing address: **707 Main St.** **Richmond, VA 23219**	5B. Facility's present physical address: **P.O. Box 450, Route 20** **Pine Grove, WV 26419**

6. **West Virginia Business Registration.** Is the applicant a resident of the State of West Virginia? ☒ **YES** ☐ **NO**

- If **YES,** provide a copy of the **Certificate of Incorporation/Organization/Limited Partnership** (one page) including any name change amendments or other Business Registration Certificate as **Attachment A.**
- If **NO,** provide a copy of the **Certificate of Authority/Authority of L.L.C./Registration** (one page) including any name change amendments or other Business Certificate as **Attachment A.**

7. If applicant is a subsidiary corporation, please provide the name of parent corporation: **Dominion Transmission, Inc.**

8. Does the applicant own, lease, have an option to buy or otherwise have control of the *proposed site?* ☒ **YES** ☐ **NO**

- If **YES,** please explain: **The applicant is the owner of the site.**
- If **NO,** you are not eligible for a permit for this source.

9. Type of plant or facility (stationary source) to be **constructed, modified, relocated, administratively updated** or **temporarily permitted** (e.g., coal preparation plant, primary crusher, etc.): **Natural Gas Transmission Facility (Note: Hastings Compressor operations are considered production equipment with regards to MACT Rules)**	10. North American Industry Classification System **(NAICS)** code for the facility: **486210**

11A. DAQ Plant ID No. (for existing facilities only): **103-00006**	11B. List all current 45CSR13 and 45CSR30 (Title V) permit numbers associated with this process (for existing facilities only): **R30-10300006-2011, Issued July 2011 – Updated Nov. 2012** **R13-2555B, Issued September 2012** **R13-2870, Issued February 2011**

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

12A.

- For **Modifications, Administrative Updates** or **Temporary permits** at an existing facility, please provide directions to the *present location* of the facility from the nearest state road;
- For **Construction** or **Relocation permits,** please provide directions to the *proposed new site location* from the nearest state road. Include a **MAP** as **Attachment B**.

From Clarksburg, take Rt. 20 North for 37 miles to Hastings. The Station entrance is on the left side of the road.

12.B. New site address (if applicable): **N/A**	12C. Nearest city or town: **Pine Grove**	12D. County: **Wetzel**
12.E. UTM Northing (KM): **4,377.66**	12F. UTM Easting (KM): **528.64**	12G. UTM Zone: **17**

13. Briefly describe the proposed change(s) at the facility:
The proposed changes at the facility include the installation of two (2) Solar Titan 130 Combustion Turbines, one (1) CAT Emergency Generator, one (1) 7.2 MMBtu/hr Boiler, two (2) tanks of various sizes, and one (1) emission unit for liquid unloading operations.

14A. Provide the date of anticipated installation or change: **2018** – If this is an **After-The-Fact** permit application, provide the date upon which the proposed change did happen: **N/A**	14B. Date of anticipated Start-Up if a permit is granted: **2018**

14C. Provide a **Schedule** of the planned **Installation** of/**Change** to and **Start-Up** of each of the units proposed in this permit application as **Attachment C** (if more than one unit is involved).

15. Provide maximum projected **Operating Schedule** of activity/activities outlined in this application:
Hours Per Day **24** Days Per Week **7** Weeks Per Year **52**

16. Is demolition or physical renovation at an existing facility involved? ☒ **YES** ☐ **NO**

17**. Risk Management Plans.** If this facility is subject to 112(r) of the 1990 CAAA, or will become subject due to proposed changes (for applicability help see www.epa.gov/ceppo), submit your **Risk Management Plan (RMP)** to U. S. EPA Region III.

18**. Regulatory Discussion.** List all Federal and State air pollution control regulations that you believe are applicable to the proposed process *(if known).* A list of possible applicable requirements is also included in Attachment S of this application (Title V Permit Revision Information). Discuss applicability and proposed demonstration(s) of compliance *(if known).* Provide this information as **Attachment D.**

Section II. Additional attachments and supporting documents.

19. Include a check payable to WVDEP – Division of Air Quality with the appropriate **application fee** (per 45CSR22 and 45CSR13).

20. Include a **Table of Contents** as the first page of your application package.

21. Provide a **Plot Plan,** e.g. scaled map(s) and/or sketch(es) showing the location of the property on which the stationary source(s) is or is to be located as **Attachment E** (Refer to ***Plot Plan Guidance***) **.**

– Indicate the location of the nearest occupied structure (e.g. church, school, business, residence).

22. Provide a **Detailed Process Flow Diagram(s)** showing each proposed or modified emissions unit, emission point and control device as **Attachment F.**

23. Provide a **Process Description** as **Attachment G.**

– Also describe and quantify to the extent possible all changes made to the facility since the last permit review (if applicable).

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

24. Provide **Material Safety Data Sheets (MSDS)** for all materials processed, used or produced as **Attachment H.**

– For chemical processes, provide a MSDS for each compound emitted to the air.

25. Fill out the **Emission Units Table** and provide it as **Attachment I.**

26. Fill out the **Emission Points Data Summary Sheet (Table 1 and Table 2)** and provide it as **Attachment J.**

27. Fill out the **Fugitive Emissions Data Summary Sheet** and provide it as **Attachment K.**

28. Check all applicable **Emissions Unit Data Sheets** listed below:

☒ Bulk Liquid Transfer Operations	☐ Haul Road Emissions	☐ Quarry
☐ Chemical Processes	☐ Hot Mix Asphalt Plant	☐ Solid Materials Sizing, Handling and Storage Facilities
☐ Concrete Batch Plant	☐ Incinerator	☒ Storage Tanks
☐ Grey Iron and Steel Foundry	☒ Indirect Heat Exchanger	

☒ General Emission Unit, specify – **Combustion Turbines, Boiler, Emergency Generator**

Fill out and provide the **Emissions Unit Data Sheet(s)** as **Attachment L.**

29. Check all applicable **Air Pollution Control Device Sheets** listed below:

☐ Absorption Systems	☐ Baghouse	☐ Flare
☐ Adsorption Systems	☐ Condenser	☐ Mechanical Collector
☐ Afterburner	☐ Electrostatic Precipitator	☐ Wet Collecting System

☐ Other Collectors, specify **N/A**

Fill out and provide the **Air Pollution Control Device Sheet(s)** as **Attachment M.**

30. Provide all **Supporting Emissions Calculations** as **Attachment N,** or attach the calculations directly to the forms listed in Items 28 through 31.

31. **Monitoring, Recordkeeping, Reporting and Testing Plans.** Attach proposed monitoring, recordkeeping, reporting and testing plans in order to demonstrate compliance with the proposed emissions limits and operating parameters in this permit application. Provide this information as **Attachment O.**

➢ Please be aware that all permits must be practically enforceable whether or not the applicant chooses to propose such measures. Additionally, the DAQ may not be able to accept all measures proposed by the applicant. If none of these plans are proposed by the applicant, DAQ will develop such plans and include them in the permit.

32. **Public Notice.** At the time that the application is submitted, place a **Class I Legal Advertisement** in a newspaper of general circulation in the area where the source is or will be located (See 45CSR§13-8.3 through 45CSR§13-8.5 and ***Example Legal Advertisement*** for details). Please submit the **Affidavit of Publication** as **Attachment P** immediately upon receipt.

33. **Business Confidentiality Claims.** Does this application include confidential information (per 45CSR31)?

☐ **YES** ☒ **NO**

➢ If **YES,** identify each segment of information on each page that is submitted as confidential and provide justification for each segment claimed confidential, including the criteria under 45CSR§31-4.1, and in accordance with the DAQ's ***"Precautionary Notice – Claims of Confidentiality"*** guidance found in the ***General Instructions*** as **Attachment Q.**

Section III. Certification of Information

34. **Authority/Delegation of Authority.** Only required when someone other than the responsible official signs the application. Check applicable **Authority Form** below:

☐ Authority of Corporation or Other Business Entity
☐ Authority of Partnership
☐ Authority of Governmental Agency
☐ Authority of Limited Partnership

Submit completed and signed **Authority Form** as **Attachment R.**

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

35A. **Certification of Information.** To certify this permit application, a Responsible Official (per 45CSR§13-2.22 and 45CSR§30-2.28) or Authorized Representative shall check the appropriate box and sign below.

Certification of Truth, Accuracy, and Completeness

I, the undersigned ☒ **Responsible Official** / ☐ **Authorized Representative,** hereby certify that all information contained in this application and any supporting documents appended hereto, is true, accurate, and complete based on information and belief after reasonable inquiry I further agree to assume responsibility for the construction, modification and/or relocation and operation of the stationary source described herein in accordance with this application and any amendments thereto, as well as the Department of Environmental Protection, Division of Air Quality permit issued in accordance with this application, along with all applicable rules and regulations of the West Virginia Division of Air Quality and W.Va. Code § 22-5-1 et seq. (State Air Pollution Control Act). If the business or agency changes its Responsible Official or Authorized Representative, the Director of the Division of Air Quality will be notified in writing within 30 days of the official change.

Compliance Certification

Except for requirements identified in the Title V Application for which compliance is not achieved, I, the undersigned hereby certify that, based on information and belief formed after reasonable inquiry, all air contaminant sources identified in this application are in compliance with all applicable requirements.

SIGNATURE ______________ *(Please use blue ink)* DATE: 9/11/15 *(Please use blue ink)*

35B. Printed name of signee: Leslie Hartz		35C. Title: Vice President Pipeline Construction
35D. E-mail: Leslie.Hartz @dom .com	36E. Phone: (804) 771-4468	36F. FAX:
36A. Printed name of contact person (if different from above): William Scarpinato		36B. Title: Manager-Environmental Services
36C. E-mail: William.A.Scarpinato@dom.com	36D. Phone: (804) 273-3019	36E. FAX: 804-273-2601

PLEASE CHECK ALL APPLICABLE ATTACHMENTS INCLUDED WITH THIS PERMIT APPLICATION:

- ☒ **Attachment A: Business Certificate**
- ☒ **Attachment B: Map(s)**
- ☒ **Attachment C: Installation and Start Up Schedule**
- ☒ **Attachment D: Regulatory Discussion**
- ☒ **Attachment E: Plot Plan**
- ☒ **Attachment F: Detailed Process Flow Diagram(s)**
- ☒ **Attachment G: Process Description**
- ☒ **Attachment H: Material Safety Data Sheets (MSDS)**
- ☒ **Attachment I: Emission Units Table**
- ☒ **Attachment J: Emission Points Data Summary Sheet**
- ☒ **Attachment K: Fugitive Emissions Data Summary Sheet**
- ☒ **Attachment L: Emissions Unit Data Sheet(s)**
- ☒ **Attachment M: Air Pollution Control Device Sheet(s)**
- ☒ **Attachment N: Supporting Emissions Calculations**
- ☒ **Attachment O: Monitoring/Recordkeeping/Reporting/Testing Plans**
- ☒ **Attachment P: Public Notice**
- ☒ **Attachment Q: Business Confidential Claims**
- ☒ **Attachment R: Authority Forms**
- ☒ **Attachment S: Title V Permit Revision Information**
- ☒ **Application Fee**

Please mail an original and three (3) copies of the complete permit application with the signature(s) to the DAQ, Permitting Section, at the address listed on the first page of this application. Please DO NOT fax permit applications.

FOR AGENCY USE ONLY – IF THIS IS A TITLE V SOURCE:

- ☐ ***Forward 1 copy of the application to the Title V Permitting Group and:***
- ☐ ***For Title V Administrative Amendments:***
  - ☐ ***NSR permit writer should notify Title V permit writer of draft permit,***
- ☐ ***For Title V Minor Modifications:***
  - ☐ ***Title V permit writer should send appropriate notification to EPA and affected states within 5 days of receipt,***
  - ☐ ***NSR permit writer should notify Title V permit writer of draft permit.***
- ☐ ***For Title V Significant Modifications processed in parallel with NSR Permit revision:***
  - ☐ ***NSR permit writer should notify a Title V permit writer of draft permit,***
  - ☐ ***Public notice should reference both 45CSR13 and Title V permits,***
  - ☐ ***EPA has 45 day review period of a draft permit.***

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

Attachment A

WEST VIRGINIA
STATE TAX DEPARTMENT
BUSINESS REGISTRATION CERTIFICATE

ISSUED TO:
DOMINION TRANSMISSION INC
445 W MAIN ST
CLARKSBURG, WV 26301-2843

BUSINESS REGISTRATION ACCOUNT NUMBER: **1038-3470**

This certificate is issued on: 06/8/2011

This certificate is issued by
the West Virginia State Tax Commissioner
in accordance with Chapter 11, Article 12, of the West Virginia Code

The person or organization identified on this certificate is registered
to conduct business in the State of West Virginia at the location above.

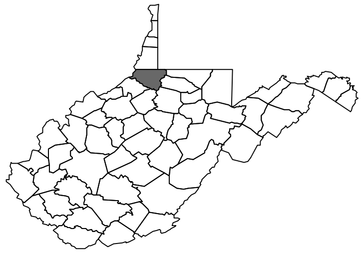
This certificate is not transferrable and must be displayed at the location for which issued.
This certificate shall be permanent until cessation of the business for which the certificate of registration was granted or until it is suspended, revoked or cancelled by the Tax Commissioner.

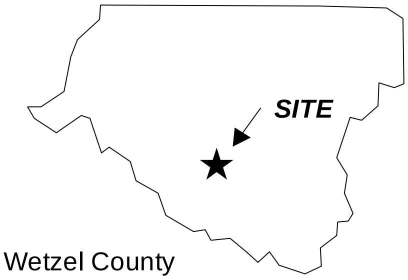
Change in name or change of location shall be considered a cessation of the business and a new certificate shall be required.

TRAVELING/STREET VENDORS: Must carry a copy of this certificate in every vehicle operated by them.
CONTRACTORS, DRILLING OPERATORS, TIMBER/LOGGING OPERATIONS: Must have a copy of this certificate displayed at every job site within West Virginia.

atL006 v.4
L0228957312

Attachment B





0 1,000 2,000 4,000 Feet

LAT. 39.54832 LON. -80.66574
WETZEL COUNTY
WEST VIRGINIA

N

USGS 1:24K 7.5' Quadrangle: Pine Grove, WV

SITE LOCATION MAP

Supply Header Project

Mockingbird Hill Station
Dominion Transmission, Inc
Wetzel County, West Virginia

ERM

GIS Review:

CHK'D:

0272413

Drawn By:
SRV 7/15/15

Environmental Resources Management

ATTACHMENT B

J:\GIS\Projects\Dominion Transmission Inc_MXD\AttachmentB_MockingbirdStation_SiteLocMap.mxd - 7/15/2015|SRV

Attachment C

Attachment C
Schedule of Installation

The Mockingbird Hill Station is scheduled to commence construction on the proposed modification in 2017. The anticipated start-up date is 2017.

Attachment D

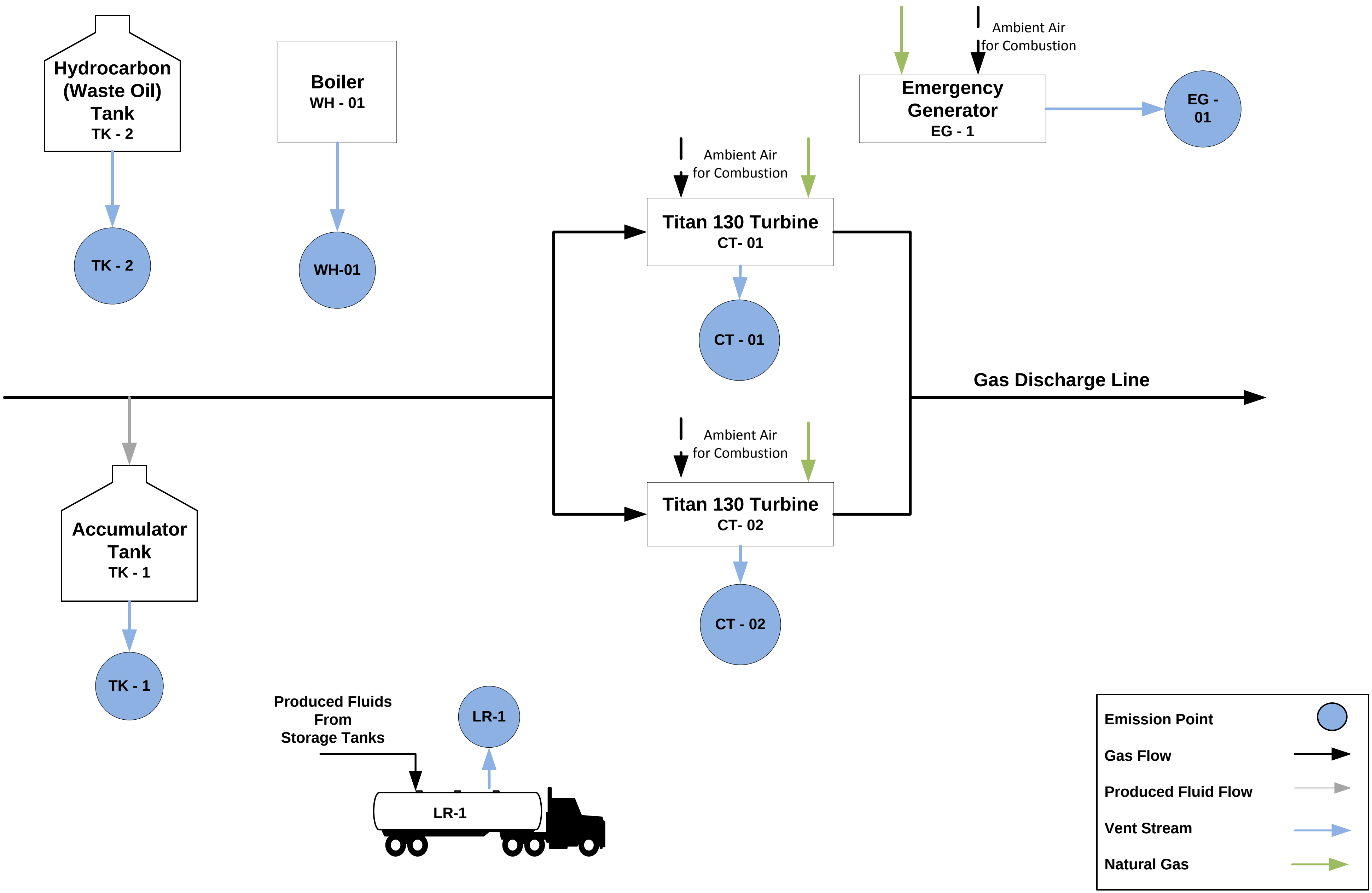
Attachment D - Regulatory Discussion

A state and federal regulatory discussion has been included in the narrative preceding the WVDAQ Permit Application Forms.

Attachment E

Attachment F

Attachment F ï Detailed Process Flow Diagram
Dominion Transmission, Inc. ï Mockingbird Hill Station ï Proposed Modifications



Attachment G

Attachment G

Process Description

Dominion Transmission, Inc. is submitting this Rule 14 Permit Application for the Mockingbird Hill Station to comply with the PSD permitting requirements of the state of West Virginia. Natural gas from the transmission pipeline is routed through this transmission station. The natural gas fueled internal combustion engines CT-01, and CT-02 provide the compression required for the transmission of natural gas along the Supply Header Project. The engines manufactured by Solar Turbines include two (2) Titan 130-20502S combustion turbines. The Mockingbird Hill Station will require an emergency generator (Caterpillar G3516) with a capacity of 1,416 bhp to provide backup power during emergency situations. A 7.2 MMBtu/hr boiler (WH-01) will be installed to provide process heat. Produced liquids are temporarily stored in the accumulator tank (TK-1) until they can be removed off-site by the tank truck (LR-1). A hydrocarbon (waste oil) tank (TK-2) is also proposed to be a part of the modification at the Mockingbird Hill Station.

Attachment H

Attachment H – Material Safety Data Sheets

This Permit Modification does not introduce any chemicals to the site. For this reason, an SDS is not included with this submission.

Attachment I

Attachment I

Emission Units Table

(includes all emission units and air pollution control devices that will be part of this permit application review, regardless of permitting status)

Emission Unit ID[1]	Emission Point ID[2]	Emission Unit Description	Year Installed/ Modified	Design Capacity	Type[3] and Date of Change	Control Device [4]
CT-01	CT-01	Turbine (Titan 130-20502S)	2018	21,765 bhp	New	SoLoNOx Ox Cat
CT-02	CT-02	Turbine (Titan 130-20502S)	2018	21,765 bhp	New	SoLoNOx Ox Cat
EG-01	EG-01	Emergency Generator (Caterpillar G3516)	2018	1,416 bhp	New	None
WH-1	WH-1	Boiler	2018	7.2 MMBtu/hr	New	None
TK-1	TK-1	Accumulator Tank	2018	2,500 gallons	New	None
TK-2	TK-2	Hydrocarbon (Waste Oil) Tank	2018	1,000 gallons	New	None
LR-1	LR-1	Tank Unloading	2018	N / A	New	None

[1] For Emission Units (or Sources) use the following numbering system:1S, 2S, 3S,... or other appropriate designation. [2] For Emission Points use the following numbering system:1E, 2E, 3E, ... or other appropriate designation. [3] New, modification, removal [4] For Control Devices use the following numbering system: 1C, 2C, 3C,... or other appropriate designation.

Attachment J

Attachment J
EMISSION POINTS DATA SUMMARY SHEET

Table 1: Emissions Data

Emission Point ID No. *(Must match Emission Units Table & Plot Plan)*	Emission Point Type[1]	Emission Unit Vented Through This Point *(Must match Emission Units Table & Plot Plan)*		Air Pollution Control Device *(Must match Emission Units Table & Plot Plan)*		Vent Time for Emission Unit *(chemical processes only)*		All Regulated Pollutants - Chemical Name/CAS[3] *(Speciate VOCs & HAPS)*	Maximum Potential Uncontrolled Emissions [4]		Maximum Potential Controlled Emissions [5]		Emission Form or Phase *(At exit conditions, Solid, Liquid or Gas/Vapor)*	Est. Method Used [6]	Emission Concentration [7] (mg/m^3)
		ID No.	Source	ID No.	Device Type	Short Term[2]	Max (hr/yr)		lb/hr	ton/yr	lb/hr	ton/yr			
CT-01	**Upward Vertical Stack**	**CT-01**	**Turbine**	**NA**	**NA**	**NA**	**NA**	**CO**	**9.93**	**43.09**	**6.36**	**27.84**	**Gas**	**AP-42, Vendor Estimates**	**NA**
								NO_x	**6.14**	**26.63**	**6.13**	**26.84**			
								SO_2	**0.59**	**2.58**	**0.59**	**2.58**			
								Total VOCs	**0.56**	**2.41**	**0.33**	**1.43**			
								$PM_{Filterable}$	**1.00**	**4.36**	**1.00**	**4.36**			
								$PM_{Condensable}$	**2.46**	**10.80**	**2.46**	**10.80**			
								$PM_{2.5}$	**1.00**	**4.36**	**1.00**	**4.36**			
								PM_{10}	**1.00**	**4.36**	**1.00**	**4.36**			
								Total HAPs	**0.22**	**0.96**	**0.22**	**0.96**			
								CO_2	**20,763**	**90,075**	**20,593**	**90,196**			
								CH_4	**1.50**	**6.52**	**1.69**	**7.40**			
								N_2O	**0.52**	**2.27**	**0.52**	**2.27**			
								CO_2e	**20,957**	**90,915**	**20,790**	**91,059**			
CT-02	**Upward Vertical Stack**	**CT-02**	**Turbine**	**NA**	**NA**	**NA**	**NA**	**CO**	**9.93**	**43.09**	**6.36**	**27.84**	**Gas**	**AP-42, Vendor Estimates**	**NA**
								NO_x	**6.14**	**26.63**	**6.13**	**26.84**			
								SO_2	**0.59**	**2.58**	**0.59**	**2.58**			
								Total VOCs	**0.56**	**2.41**	**0.33**	**1.43**			
								$PM_{Filterable}$	**1.00**	**4.36**	**1.00**	**4.36**			
								$PM_{Condensable}$	**2.46**	**10.80**	**2.46**	**10.80**			
								$PM_{2.5}$	**1.00**	**4.36**	**1.00**	**4.36**			
								PM_{10}	**1.00**	**4.36**	**1.00**	**4.36**			
								Total HAPs	**0.22**	**0.96**	**0.22**	**0.96**			
								CO_2	**20,763**	**90,075**	**20,593**	**90,196**			
								CH_4	**1.50**	**6.52**	**1.69**	**7.40**			
								N_2O	**0.52**	**2.27**	**0.52**	**2.27**			
								CO_2e	**20,957**	**90,915**	**20,790**	**91,059**			

EG-01	**Upward Vertical Stack**	**EG-01**	**Emergency Generator**	**NA**	**NA**	**NA**	**NA**	**CO NO_x Total VOCs $PM_{Filterable}$ $PM_{Condensable}$ $PM_{2.5}$ PM_{10} Total HAPs CO_2 CH_4 CO_2e**	**0.07 0.07 0.01 <0.01 <0.01 <0.01 <0.01 <0.01 17.95 0.07 19.62**	**0.29 0.31 0.04 0.02 0.006 0.02 0.02 0.06 78.87 0.29 85.12**	**0.07 0.07 0.01 <0.01 <0.01 <0.01 <0.01 <0.01 17.78 0.07 19.43**	**0.29 0.31 0.04 0.02 0.006 0.02 0.02 0.06 77.18 0.29 85.12**	**Gas**	**AP-42, Vendor Estimates**	**NA**
WH-01	**Upward Vertical Stack**	**WH-01**	**Boiler**	**NA**	**NA**	**NA**	**NA**	**CO NO_x Total VOCs $PM_{Filterable}$ $PM_{Condensable}$ $PM_{2.5}$ PM_{10} Total HAPs CO_2 CH_4 N_2O CO_2e**	**0.60 0.36 0.04 0.01 0.04 0.01 0.01 0.003 855.19 0.02 0.02 860.28**	**2.60 1.55 0.17 0.06 0.17 0.06 0.06 0.01 3,710 0.07 0.07 3,732**	**0.59 0.35 0.04 0.01 0.04 0.01 0.01 0.003 847.06 0.02 0.02 852.09**	**2.60 1.55 0.17 0.06 0.18 0.06 0.06 0.01 3,710 0.07 0.07 3,732**	**Gas**	**AP-42**	**NA**
LR-01	**Upward Vertical Stack**	**LR-1**	**Loading Rack**	**NA**	**NA**	**NA**	**NA**	**Total VOCs**	**0.001**	**0.006**	**0.001**	**0.006**	**Gas**	**AP-42**	**NA**
TK-01	**Upward Vertical Stack**	**TK-01**	**Accumulator Tank**	**NA**	**NA**	**NA**	**NA**	**Total VOCs**	**0.08**	**0.35**	**0.08**	**0.35**	**Gas**	**AP-42**	**NA**

The EMISSION POINTS DATA SUMMARY SHEET provides a summation of emissions by emission unit. Note that uncaptured process emission unit emissions are not typically considered to be fugitive and must be accounted for on the appropriate EMISSIONS UNIT DATA SHEET and on the EMISSION POINTS DATA SUMMARY SHEET. Please note that total emissions from the source are equal to all vented emissions, all fugitive emissions, plus all other emissions (e.g. uncaptured emissions). Please complete the FUGITIVE EMISSIONS DATA SUMMARY SHEET for fugitive emission activities.

[1] Please add descriptors such as upward vertical stack, downward vertical stack, horizontal stack, relief vent, rain cap, etc.

[2] Indicate by "C" if venting is continuous. Otherwise, specify the average short-term venting rate with units, for intermittent venting (ie., 15 min/hr). Indicate as many rates as needed to clarify frequency of venting (e.g., 5 min/day, 2 days/wk).

[3] List all regulated air pollutants. Speciate VOCs, including all HAPs. Follow chemical name with Chemical Abstracts Service (CAS) number. **LIST** Acids, CO, CS_2, VOCs, H_2S, Inorganics, Lead, Organics, O_3, NO, NO_2, SO_2, SO_3, all applicable Greenhouse Gases (including CO_2 and methane), etc. **DO NOT LIST** H_2, H_2O, N_2, O_2, and Noble Gases.

[4] Give maximum potential emission rate with no control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

[5] Give maximum potential emission rate with proposed control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

[6] Indicate method used to determine emission rate as follows: MB = material balance; ST = stack test (give date of test); EE = engineering estimate; O = other (specify).

[7] Provide for all pollutant emissions. Typically, the units of parts per million by volume (ppmv) are used. If the emission is a mineral acid (sulfuric, nitric, hydrochloric or phosphoric) use units of milligram per dry cubic meter (mg/m^3) at standard conditions (68 °F and 29.92 inches Hg) (see 45CSR7). If the pollutant is SO_2, use units of ppmv (See 45CSR10).

Attachment J
EMISSION POINTS DATA SUMMARY SHEET

Table 2: Release Parameter Data								
Emission Point ID No. *(Must match Emission Units Table)*	Inner Diameter (ft.)	Exit Gas			Emission Point Elevation (ft)		UTM Coordinates (km)	
		Temp. (^oF)	Volumetric Flow [1] (acfm) *at operating conditions*	Velocity (fps)	Ground Level *(Height above mean sea level)*	Stack Height [2] *(Release height of emissions above ground level)*	Northing	Easting
EG-01	**0.5**	**840**	**311.74**	**61.12**	**842**	**5.00**	**4,377.66**	**528.64**
WH-01	**0.67**	**838**	**5,179**	**247.30**	**842**	**18.00**	**4,377.66**	**528.64**
CT-01	**8**	**900**	**254,955**	**93.32**	**842**	**61.03**	**4,377.66**	**528.64**
CT-02	**8**	**900**	**254,955**	**93.32**	**842**	**61.03**	**4,377.66**	**528.64**

Attachment K

Attachment K

FUGITIVE EMISSIONS DATA SUMMARY SHEET

The FUGITIVE EMISSIONS SUMMARY SHEET provides a summation of fugitive emissions. Fugitive emissions are those emissions which could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening. Note that uncaptured process emissions are not typically considered to be fugitive, and must be accounted for on the appropriate EMISSIONS UNIT DATA SHEET and on the EMISSION POINTS DATA SUMMARY SHEET.

Please note that total emissions from the source are equal to all vented emissions, all fugitive emissions, plus all other emissions (e.g. uncaptured emissions).

APPLICATION FORMS CHECKLIST - FUGITIVE EMISSIONS
1.) Will there be haul road activities? ☐ Yes ☒ No ☐ If YES, then complete the HAUL ROAD EMISSIONS UNIT DATA SHEET.
2.) Will there be Storage Piles? ☐ Yes ☒ No ☐ If YES, complete Table 1 of the NONMETALLIC MINERALS PROCESSING EMISSIONS UNIT DATA SHEET.
3.) Will there be Liquid Loading/Unloading Operations? ☐ Yes ☒ No ☐ If YES, complete the BULK LIQUID TRANSFER OPERATIONS EMISSIONS UNIT DATA SHEET.
4.) Will there be emissions of air pollutants from Wastewater Treatment Evaporation? ☒ Yes ☐ No ☒ If YES, complete the GENERAL EMISSIONS UNIT DATA SHEET.
5.) Will there be Equipment Leaks (e.g. leaks from pumps, compressors, in-line process valves, pressure relief devices, open-ended valves, sampling connections, flanges, agitators, cooling towers, etc.)? ☒ Yes ☐ No ☐ If YES, complete the LEAK SOURCE DATA SHEET section of the CHEMICAL PROCESSES EMISSIONS UNIT DATA SHEET.
6.) Will there be General Clean-up VOC Operations? ☐ Yes ☒ No ☐ If YES, complete the GENERAL EMISSIONS UNIT DATA SHEET.
7.) Will there be any other activities that generate fugitive emissions? ☐ Yes ☒ No ☐ If YES, complete the GENERAL EMISSIONS UNIT DATA SHEET or the most appropriate form.
If you answered “NO” to all of the items above, it is not necessary to complete the following table, “Fugitive Emissions Summary.”

FUGITIVE EMISSIONS SUMMARY	All Regulated Pollutants - Chemical Name/CAS [1]	Maximum Potential Uncontrolled Emissions [2]		Maximum Potential Controlled Emissions [3]		Est. Method Used [4]
		lb/hr	ton/yr	lb/hr	ton/yr	
Haul Road/Road Dust Emissions Paved Haul Roads	N/A	N/A	N/A	N/A	N/A	N/A
Unpaved Haul Roads	N/A	N/A	N/A	N/A	N/A	N/.A
Storage Pile Emissions	N/A	N/A	N/A	N/A	N/A	N/A
Loading/Unloading Operations	VOCs	6.05	26.49	6.05	26.49	AP-42 Section 5.2
Wastewater Treatment Evaporation & Operations	N/A	N/A	N/A	N/A	N/A	N/A
Equipment Leaks	VOCs	0.001	0.006	0.001	0.006	EPA-453
General Clean-up VOC Emissions	N/A	N/A	N/A	N/A	N/A	N/A
Other	N/A	N/A	N/A	N/A	N/A	N/A

[1] List all regulated air pollutants. Speciate VOCs, including all HAPs. Follow chemical name with Chemical Abstracts Service (CAS) number. LIST Acids, CO, CS_2, VOCs, H_2S, Inorganics, Lead, Organics, O_3, NO, NO_2, SO_2, SO_3, all applicable Greenhouse Gases (including CO_2 and methane), etc. DO NOT LIST H_2, H_2O, N_2, O_2, and Noble Gases.
[2] Give rate with no control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).
[3] Give rate with proposed control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).
[4] Indicate method used to determine emission rate as follows: MB = material balance; ST = stack test (give date of test); EE = engineering estimate; O = other (specify).

Attachment L

Attachment L
EMISSIONS UNIT DATA SHEET
BULK LIQUID TRANSFER OPERATIONS

Furnish the following information for each new or modified bulk liquid transfer area or loading rack, as shown on the *Equipment List Form* and other parts of this application. This form is to be used for bulk liquid transfer operations such as to and from drums, marine vessels, rail tank cars, and tank trucks.

Identification Number (as assigned on *Equipment List Form*): **LR-01**	
1. Loading Area Name: **Tank Truck Loading Area**	
2. Type of cargo vessels accommodated at this rack or transfer point (check as many as apply): ☐ Drums ☐ Marine Vessels ☐ Rail Tank Car ☒ Tank Trucks	
3. Loading Rack or Transfer Point Data:	
Number of pumps	**1**
Number of liquids loaded	**1**
Maximum number of marine vessels, tank trucks, tank cars, and/or drums loading at one time	**1**
4. Does ballasting of marine vessels occur at this loading area? ☐ Yes ☐ No ☒ Does not apply	
5. Describe cleaning location, compounds and procedure for cargo vessels using this transfer point: **NA**	
6. Are cargo vessels pressure tested for leaks at this or any other location? ☐ Yes ☒ No If YES, describe:	

7. Projected Maximum Operating Schedule (for rack or transfer point as a whole):

Maximum	Jan. - Mar.	Apr. - June	July - Sept.	Oct. - Dec.
hours/day	**As Needed**			
days/week	**As Needed**			
weeks/quarter	**As Needed**			

8. Bulk Liquid Data *(add pages as necessary):*		
Pump ID No.		**NA**
Liquid Name		**Pipeline Fluids**
Max. daily throughput (1000 gal/day)		**0.03**
Max. annual throughput (1000 gal/yr)		**12.5**
Loading Method [1]		**BF**
Max. Fill Rate (gal/min)		**0.02**
Average Fill Time (min/loading)		**30 min**
Max. Bulk Liquid Temperature (°F)		**70 °F**
True Vapor Pressure [2]		**NA**
Cargo Vessel Condition [3]		**U**
Control Equipment or Method [4]		**NA**
Minimum control efficiency (%)		**NA**
Maximum Emission Rate	Loading (lb/hr)	**0.001**
	Annual (lb/yr)	**12.15**
Estimation Method [5]		**EPA AP-42**

[1] BF = Bottom Fill SP = Splash Fill SUB = Submerged Fill

[2] At maximum bulk liquid temperature

[3] B = Ballasted Vessel, C = Cleaned, U = Uncleaned (dedicated service), O = other (describe)

[4] List as many as apply (complete and submit appropriate *Air Pollution Control Device Sheets*):
CA = Carbon Adsorption LOA = Lean Oil Adsorption CO = Condensation
SC = Scrubber (Absorption) CRA = Compressor-Refrigeration-Absorption
TO = Thermal Oxidation or Incineration CRC = Compression-Refrigeration-Condensation
VB = Dedicated Vapor Balance (closed system) O = other (descibe)

[5] EPA = EPA Emission Factor as stated in AP-42
MB = Material Balance
TM = Test Measurement based upon test data submittal
O = other (describe)

<table>
<tr><td colspan="2">9. Proposed Monitoring, Recordkeeping, Reporting, and Testing
Please propose monitoring, recordkeeping, and reporting in order to demonstrate compliance with the proposed operating parameters. Please propose testing in order to demonstrate compliance with the proposed emissions limits.</td></tr>
<tr><td>MONITORING

Dominion Transmission, Inc. will comply with all monitoring requirements set forth in the permit that is issued.</td><td>RECORDKEEPING

Dominion Transmission, Inc. will comply with all recordkeeping requirements set forth in the permit that is issued.</td></tr>
<tr><td>REPORTING

Dominion Transmission, Inc. will comply with all reporting requirements set forth in the permit that is issued.</td><td>TESTING

Dominion Transmission, Inc. will comply with all testing requirements set forth in the permit that is issued.</td></tr>
<tr><td colspan="2">MONITORING. PLEASE LIST AND DESCRIBE THE PROCESS PARAMETERS AND RANGES THAT ARE PROPOSED TO BE MONITORED IN ORDER TO DEMONSTRATE COMPLIANCE WITH THE OPERATION OF THIS PROCESS EQUIPMENT OPERATION/AIR POLLUTION CONTROL DEVICE.</td></tr>
<tr><td colspan="2">RECORDKEEPING. PLEASE DESCRIBE THE PROPOSED RECORDKEEPING THAT WILL ACCOMPANY THE MONITORING.</td></tr>
<tr><td colspan="2">REPORTING. PLEASE DESCRIBE THE PROPOSED FREQUENCY OF REPORTING OF THE RECORDKEEPING.</td></tr>
<tr><td colspan="2">TESTING. PLEASE DESCRIBE ANY PROPOSED EMISSIONS TESTING FOR THIS PROCESS EQUIPMENT/AIR POLLUTION CONTROL DEVICE.</td></tr>
<tr><td colspan="2">10. Describe all operating ranges and maintenance procedures required by Manufacturer to maintain warranty

NA</td></tr>
</table>

Attachment L

Affected Sources Data

NATURAL GAS COMPRESSOR/GENERATOR ENGINE DATA SHEET

Source Identification Number[1]		EG-01	
Engine Manufacturer and Model		CATERPILLAR G3516	
Manufacturer's Rated bhp/rpm		1,416 BHP @1800 RPM	
Source Status[2]		New Source (NS)	
Date Installed/Modified/Removed[3]		2016	
Engine Manufactured/Reconstruction Date[4]		NA	
Is this a Certified Stationary Spark Ignition Engine according to 40CFR60 Subpart JJJJ? (Yes or No)[5]		No	
Engine, Fuel and Combustion Data	Engine Type[6]	LB4S	
	APCD Type[7]	NA	
	Fuel Type[8]	PG	
	H_2S (gr/100 scf)	0.25	
	Operating bhp/rpm	1,416 BHP @1800 RPM	
	BSFC (Btu/bhp-hr)	7,859	
	Fuel throughput (ft^3/hr)	12,300	
	Fuel throughput ($MMft^3$/yr)	6.15	
	Operation (hrs/yr)	500	
Reference[9]	Potential Emissions[10]	lbs/hr	tons/yr
Vendor Estimate	NO_X	0.07	0.31
Vendor Estimate	CO	0.07	43.09
Vendor Estimate	VOC	0.01	0.04
AP-42 Chapter 3.2	SO_2	<0.001	<0.001
AP-42 Chapter 3.2	PM_{10}	<0.001	0.02
Vendor Estimate	Formaldehyde	0.05	<0.001

Attachment L

Affected Sources Data

1. Enter the appropriate Source Identification Number for each natural gas-fueled reciprocating internal combustion compressor/generator engine located at the compressor station. Multiple compressor engines should be designated CE-1, CE-2, CE-3 etc. Generator engines should be designated GE-1, GE-2, GE-3 etc. If more than three (3) engines exist, please use additional sheets.

2. Enter the Source Status using the following codes:

NS	Construction of New Source (installation)	ES	Existing Source
MS	Modification of Existing Source	RS	Removal of Source

3. Enter the date (or anticipated date) of the engine's installation (construction of source), modification or removal.

4. Enter the date that the engine was manufactured, modified or reconstructed.

5. Is the engine a certified stationary spark ignition internal combustion engine according to 40CFR60 Subpart JJJJ. If so, the engine and control device must be operated and maintained in accordance with the manufacturer's emission-related written instructions. You must keep records of conducted maintenance to demonstrate compliance, but no performance testing is required. If the certified engine is not operated and maintained in accordance with the manufacturer's emission-related written instructions, the engine will be considered a non-certified engine and you must demonstrate compliance according to 40CFR§60.4243a(2)(i) through (iii), as appropriate.

   Provide a manufacturer's data sheet for all engines being registered.

6. Enter the Engine Type designation(s) using the following codes:

LB2S	Lean Burn Two Stroke	RB4S	Rich Burn Four Stroke
LB4S	Lean Burn Four Stroke		

7. Enter the Air Pollution Control Device (APCD) type designation(s) using the following codes:

A/F	Air/Fuel Ratio	IR	Ignition Retard
HEIS	High Energy Ignition System	SIPC	Screw-in Precombustion Chambers
PSC	Prestratified Charge	LEC	Low Emission Combustion
NSCR	Rich Burn & Non-Selective Catalytic Reduction	SCR	Lean Burn & Selective Catalytic Reduction

8. Enter the Fuel Type using the following codes:

PQ	Pipeline Quality Natural Gas	RG	Raw Natural Gas

9. Enter the Potential Emissions Data Reference designation using the following codes. Attach all referenced data to this *Compressor/Generator Data Sheet(s)*.

MD	Manufacturer's Data	AP	AP-42
GR	GRI-HAPCalc™	OT	Other __________________ (please list)

10. Enter each engine's Potential to Emit (PTE) for the listed regulated pollutants in pounds per hour and tons per year. PTE shall be calculated at manufacturer's rated brake horsepower and may reflect reduction efficiencies of listed Air Pollution Control Devices. Emergency generator engines may use 500 hours of operation when calculating PTE. PTE data from this data sheet shall be incorporated in the *Emissions Summary Sheet*.

Attachment L
EMISSIONS UNIT DATA SHEET
GENERAL

To be used for affected sources other than asphalt plants, foundries, incinerators, indirect heat exchangers, and quarries.

Identification Number (as assigned on *Equipment List Form*): **WH-01**

1.	Name or type and model of proposed affected source: **Boiler** **7.2 MMBtu/hr**
2.	On a separate sheet(s), furnish a sketch(es) of this affected source. If a modification is to be made to this source, clearly indicated the change(s). Provide a narrative description of all features of the affected source which may affect the production of air pollutants.
3.	Name(s) and maximum amount of proposed process material(s) charged per hour: **NA**
4.	Name(s) and maximum amount of proposed material(s) produced per hour: **NA**
5.	Give chemical reactions, if applicable, that will be involved in the generation of air pollutants: **NA**

* The identification number which appears here must correspond to the air pollution control device identification number appearing on the *List Form*.

6. Combustion Data (if applicable):

(a) Type and amount in appropriate units of fuel(s) to be burned:

Natural Gas Fuel – As Required

(b) Chemical analysis of proposed fuel(s), excluding coal, including maximum percent sulfur and ash:

NA

(c) Theoretical combustion air requirement (ACF/unit of fuel):

NA @ **NA** °F and **NA** psia.

(d) Percent excess air: **NA**

(e) Type and BTU/hr of burners and all other firing equipment planned to be used:

NA

(f) If coal is proposed as a source of fuel, identify supplier and seams and give sizing of the coal as it will be fired:

NA

(g) Proposed maximum design heat input: **NA** $\times 10^6$ BTU/hr.

7. Projected operating schedule:

Hours/Day	**24**	Days/Week	**7**	Weeks/Year	**52**

8. Projected amount of pollutants that would be emitted from this affected source if no control devices were used:				
@ NA	°F and		Ambient	psia
a. NO_X	0.35	lb/hr	NA	grains/ACF
b. SO_2	<0.01	lb/hr	NA	grains/ACF
c. CO	0.59	lb/hr	NA	grains/ACF
d. $PM/PM_{10}/PM_{2.5}$	0.01	lb/hr	NA	grains/ACF
e. Hydrocarbons	NA	lb/hr	NA	grains/ACF
f. VOCs	0.04	lb/hr	NA	grains/ACF
g. Pb	NA	lb/hr	NA	grains/ACF
h. Specify other(s)				
CO_{2e}	852.09	lb/hr	NA	grains/ACF
Total HAPs	0.01	lb/hr	NA	grains/ACF
PM Condensable	0.04	lb/hr	NA	grains/ACF
PM Filterable	0.01	lb/hr	NA	grains/ACF

NOTE: (1) An Air Pollution Control Device Sheet must be completed for any air pollution device(s) used to control emissions from this affected source.

(2) Complete the Emission Points Data Sheet.

9. Proposed Monitoring, Recordkeeping, Reporting, and Testing Please propose monitoring, recordkeeping, and reporting in order to demonstrate compliance with the proposed operating parameters. Please propose testing in order to demonstrate compliance with the proposed emissions limits.	
MONITORING **See Attachment O**	RECORDKEEPING **See Attachment O**
REPORTING **See Attachment O**	TESTING **See Attachment O**

MONITORING. PLEASE LIST AND DESCRIBE THE PROCESS PARAMETERS AND RANGES THAT ARE PROPOSED TO BE MONITORED IN ORDER TO DEMONSTRATE COMPLIANCE WITH THE OPERATION OF THIS PROCESS EQUIPMENT OPERATION/AIR POLLUTION CONTROL DEVICE.

RECORDKEEPING. PLEASE DESCRIBE THE PROPOSED RECORDKEEPING THAT WILL ACCOMPANY THE MONITORING.

REPORTING. PLEASE DESCRIBE THE PROPOSED FREQUENCY OF REPORTING OF THE RECORDKEEPING.

TESTING. PLEASE DESCRIBE ANY PROPOSED EMISSIONS TESTING FOR THIS PROCESS EQUIPMENT/AIR POLLUTION CONTROL DEVICE.

10. Describe all operating ranges and maintenance procedures required by Manufacturer to maintain warranty

NA

Attachment L
EMISSIONS UNIT DATA SHEET
GENERAL

To be used for affected sources other than asphalt plants, foundries, incinerators, indirect heat exchangers, and quarries.

Identification Number (as assigned on *Equipment List Form*): **CT-01**

1. Name or type and model of proposed affected source: **Solar Turbines,** **Titan 130-20502S** **170 MMBtu/hr**
2. On a separate sheet(s), furnish a sketch(es) of this affected source. If a modification is to be made to this source, clearly indicated the change(s). Provide a narrative description of all features of the affected source which may affect the production of air pollutants.
3. Name(s) and maximum amount of proposed process material(s) charged per hour: **NA**
4. Name(s) and maximum amount of proposed material(s) produced per hour: **NA**
5. Give chemical reactions, if applicable, that will be involved in the generation of air pollutants: **NA**

* The identification number which appears here must correspond to the air pollution control device identification number appearing on the *List Form*.

6. Combustion Data (if applicable):

(a) Type and amount in appropriate units of fuel(s) to be burned:

Natural Gas Fuel – As Required

(b) Chemical analysis of proposed fuel(s), excluding coal, including maximum percent sulfur and ash:

NA

(c) Theoretical combustion air requirement (ACF/unit of fuel):

NA @ **NA** °F and **NA** psia.

(d) Percent excess air: **NA**

(e) Type and BTU/hr of burners and all other firing equipment planned to be used:

NA

(f) If coal is proposed as a source of fuel, identify supplier and seams and give sizing of the coal as it will be fired:

NA

(g) Proposed maximum design heat input: **NA** $\times 10^6$ BTU/hr.

7. Projected operating schedule:

Hours/Day	**24**	Days/Week	**7**	Weeks/Year	**52**

8. Projected amount of pollutants that would be emitted from this affected source if no control devices were used:				
@ **NA** °F and **Ambient** psia				
a. NO_X	**6.13**	lb/hr	**NA**	grains/ACF
b. SO_2	**0.59**	lb/hr	**NA**	grains/ACF
c. CO	**6.36**	lb/hr	**NA**	grains/ACF
d. $PM/PM_{10}/PM_{2.5}$	**2.60**	lb/hr	**NA**	grains/ACF
e. Hydrocarbons	**NA**	lb/hr	**NA**	grains/ACF
f. VOCs	**0.33**	lb/hr	**NA**	grains/ACF
g. Pb	**NA**	lb/hr	**NA**	grains/ACF
h. Specify other(s)				
CO_{2e}	**20,593**	lb/hr	**NA**	grains/ACF
Total HAPs	**1.69**	lb/hr	**NA**	grains/ACF
		lb/hr	**NA**	grains/ACF
		lb/hr	**NA**	grains/ACF

NOTE: (1) An Air Pollution Control Device Sheet must be completed for any air pollution device(s) used to control emissions from this affected source.

(2) Complete the Emission Points Data Sheet.

9. Proposed Monitoring, Recordkeeping, Reporting, and Testing
Please propose monitoring, recordkeeping, and reporting in order to demonstrate compliance with the proposed operating parameters. Please propose testing in order to demonstrate compliance with the proposed emissions limits.

MONITORING	RECORDKEEPING
See Attachment O	**See Attachment O**
REPORTING	TESTING
See Attachment O	**See Attachment O**

MONITORING. PLEASE LIST AND DESCRIBE THE PROCESS PARAMETERS AND RANGES THAT ARE PROPOSED TO BE MONITORED IN ORDER TO DEMONSTRATE COMPLIANCE WITH THE OPERATION OF THIS PROCESS EQUIPMENT OPERATION/AIR POLLUTION CONTROL DEVICE.

RECORDKEEPING. PLEASE DESCRIBE THE PROPOSED RECORDKEEPING THAT WILL ACCOMPANY THE MONITORING.

REPORTING. PLEASE DESCRIBE THE PROPOSED FREQUENCY OF REPORTING OF THE RECORDKEEPING.

TESTING. PLEASE DESCRIBE ANY PROPOSED EMISSIONS TESTING FOR THIS PROCESS EQUIPMENT/AIR POLLUTION CONTROL DEVICE.

10. Describe all operating ranges and maintenance procedures required by Manufacturer to maintain warranty

NA

Attachment L
EMISSIONS UNIT DATA SHEET
GENERAL

To be used for affected sources other than asphalt plants, foundries, incinerators, indirect heat exchangers, and quarries.

Identification Number (as assigned on *Equipment List Form*): **CT-02**

1.	Name or type and model of proposed affected source: **Solar Turbines,** **Titan 130-20502S** **170 MMBtu/hr**
2.	On a separate sheet(s), furnish a sketch(es) of this affected source. If a modification is to be made to this source, clearly indicated the change(s). Provide a narrative description of all features of the affected source which may affect the production of air pollutants.
3.	Name(s) and maximum amount of proposed process material(s) charged per hour: **NA**
4.	Name(s) and maximum amount of proposed material(s) produced per hour: **NA**
5.	Give chemical reactions, if applicable, that will be involved in the generation of air pollutants: **NA**

* The identification number which appears here must correspond to the air pollution control device identification number appearing on the *List Form*.

6. Combustion Data (if applicable):

(a) Type and amount in appropriate units of fuel(s) to be burned:

Natural Gas Fuel – As Required

(b) Chemical analysis of proposed fuel(s), excluding coal, including maximum percent sulfur and ash:

NA

(c) Theoretical combustion air requirement (ACF/unit of fuel):

NA @ **NA** °F and **NA** psia.

(d) Percent excess air: **NA**

(e) Type and BTU/hr of burners and all other firing equipment planned to be used:

NA

(f) If coal is proposed as a source of fuel, identify supplier and seams and give sizing of the coal as it will be fired:

NA

(g) Proposed maximum design heat input: **NA** $\times 10^6$ BTU/hr.

7. Projected operating schedule:

Hours/Day	**24**	Days/Week	**7**	Weeks/Year	**52**

8. Projected amount of pollutants that would be emitted from this affected source if no control devices were used:

@ **NA** °F and **Ambient** psia

a.	NO_X	**6.13**	lb/hr	**NA**	grains/ACF
b.	SO_2	**0.59**	lb/hr	**NA**	grains/ACF
c.	CO	**6.36**	lb/hr	**NA**	grains/ACF
d.	$PM/PM_{10}/PM_{2.5}$	**2.46**	lb/hr	**NA**	grains/ACF
e.	Hydrocarbons	**NA**	lb/hr	**NA**	grains/ACF
f.	VOCs	**0.33**	lb/hr	**NA**	grains/ACF
g.	Pb	**NA**	lb/hr	**NA**	grains/ACF
h.	Specify other(s)				
	CO_{2e}	**20,593**	lb/hr	**NA**	grains/ACF
	Total HAPs	**0.22**	lb/hr	**NA**	grains/ACF
			lb/hr	**NA**	grains/ACF
			lb/hr	**NA**	grains/ACF

NOTE: (1) An Air Pollution Control Device Sheet must be completed for any air pollution device(s) used to control emissions from this affected source.

(2) Complete the Emission Points Data Sheet.

9. Proposed Monitoring, Recordkeeping, Reporting, and Testing
Please propose monitoring, recordkeeping, and reporting in order to demonstrate compliance with the proposed operating parameters. Please propose testing in order to demonstrate compliance with the proposed emissions limits.

MONITORING **See Attachment O**	RECORDKEEPING **See Attachment O**
REPORTING **See Attachment O**	TESTING **See Attachment O**

MONITORING. PLEASE LIST AND DESCRIBE THE PROCESS PARAMETERS AND RANGES THAT ARE PROPOSED TO BE MONITORED IN ORDER TO DEMONSTRATE COMPLIANCE WITH THE OPERATION OF THIS PROCESS EQUIPMENT OPERATION/AIR POLLUTION CONTROL DEVICE.

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REPORTING. PLEASE DESCRIBE THE PROPOSED FREQUENCY OF REPORTING OF THE RECORDKEEPING.

TESTING. PLEASE DESCRIBE ANY PROPOSED EMISSIONS TESTING FOR THIS PROCESS EQUIPMENT/AIR POLLUTION CONTROL DEVICE.

10. Describe all operating ranges and maintenance procedures required by Manufacturer to maintain warranty

NA

Attachment L
EMISSIONS UNIT DATA SHEET
STORAGE TANKS

Provide the following information for <u>each</u> new or modified bulk liquid storage tank as shown on the *Equipment List Form* and other parts of this application. A tank is considered modified if the material to be stored in the tank is different from the existing stored liquid.

> IF USING US EPA'S TANKS EMISSION ESTIMATION PROGRAM (AVAILABLE AT **www.epa.gov/tnn/tanks.html**), APPLICANT MAY ATTACH THE SUMMARY SHEETS IN LIEU OF COMPLETING SECTIONS III, IV, & V OF THIS FORM. HOWEVER, SECTIONS I, II, AND VI OF THIS FORM MUST BE COMPLETED. US EPA'S AP-42, SECTION 7.1, "ORGANIC LIQUID STORAGE TANKS," MAY ALSO BE USED TO ESTIMATE VOC AND HAP EMISSIONS (**http://www.epa.gov/tnn/chief/**).

I. GENERAL INFORMATION (required)

1. Bulk Storage Area Name **Tank Area**	2. Tank Name **Pipeline Liquids Storage Tank**
3. Tank Equipment Identification No. (as assigned on *Equipment List Form*) **TK-1**	4. Emission Point Identification No. (as assigned on *Equipment List Form*) **NA**
5. Date of Commencement of Construction (for existing tanks) **2018**	
6. Type of change ☒ New Construction ☐ New Stored Material ☐ Other Tank Modification	
7. Description of Tank Modification (if applicable) **NA**	
7A. Does the tank have more than one mode of operation? ☐ Yes ☒ No (e.g. Is there more than one product stored in the tank?)	
7B. If YES, explain and identify which mode is covered by this application (Note: A separate form must be completed for each mode). **NA**	
7C. Provide any limitations on source operation affecting emissions, any work practice standards (e.g. production variation, etc.): **NA**	

II. TANK INFORMATION (required)

8. Design Capacity (specify barrels or gallons). Use the internal cross-sectional area multiplied by internal height. **2,500 gal**	
9A. Tank Internal Diameter (ft) **4.61**	9B. Tank Internal Height (or Length) (ft) **20**
10A. Maximum Liquid Height (ft) **18**	10B. Average Liquid Height (ft) **10**
11A. Maximum Vapor Space Height (ft) **18**	11B. Average Vapor Space Height (ft) **10**
12. Nominal Capacity (specify barrels or gallons). This is also known as "working volume" and considers design liquid levels and overflow valve heights. **2,500 gallons**	

13A. Maximum annual throughput (gal/yr) **12,500 gal**	13B. Maximum daily throughput (gal/day) **34.25 gal**

14. Number of Turnovers per year (annual net throughput/maximum tank liquid volume)
5

15. Maximum tank fill rate (gal/min) **0.024**

16. Tank fill method ☒ Submerged ☐ Splash ☐ Bottom Loading

17. Complete 17A and 17B for Variable Vapor Space Tank Systems ☒ Does Not Apply

17A. Volume Expansion Capacity of System (gal) **NA**	17B. Number of transfers into system per year **NA**

18. Type of tank (check all that apply):

☒ Fixed Roof ___vertical X horizontal ___ flat roof ___ cone roof ___ dome roof
___ other (describe)
☐ External Floating Roof ___ pontoon roof ___ double deck roof
☐ Domed External (or Covered) Floating Roof
☐ Internal Floating Roof ___ vertical column support ___ self-supporting
☐ Variable Vapor Space ___ lifter roof ___ diaphragm
☐ Pressurized ___ spherical ___ cylindrical
☐ Underground
☐ Other (describe)

III. TANK CONSTRUCTION & OPERATION INFORMATION (optional if providing TANKS Summary

19. Tank Shell Construction:
☐ Riveted ☐ Gunite lined ☐ Epoxy-coated rivets ☒ Other (describe) Welded

20A. Shell Color **Light Grey**	20B. Roof Color **Light Grey**	20C. Year Last Painted **2018**

21. Shell Condition (if metal and unlined):
☒ No Rust ☐ Light Rust ☐ Dense Rust ☐ Not applicable

22A. Is the tank heated? ☐ YES ☒ NO

22B. If YES, provide the operating temperature (°F)

22C. If YES, please describe how heat is provided to tank.

23. Operating Pressure Range (psig):

24. Complete the following section for **Vertical Fixed Roof Tanks** ☒ Does Not Apply

24A. For dome roof, provide roof radius (ft)

24B. For cone roof, provide slope (ft/ft)

25. Complete the following section for **Floating Roof Tanks** ☒ Does Not Apply

25A. Year Internal Floaters Installed:

25B. Primary Seal Type: (check one) ☐ Metallic (Mechanical) Shoe Seal ☐ Liquid Mounted Resilient Seal ☐ Vapor Mounted Resilient Seal ☐ Other (describe):

25C. Is the Floating Roof equipped with a Secondary Seal? ☐ YES ☐ NO

25D. If YES, how is the secondary seal mounted? (check one) ☐ Shoe ☐ Rim ☐ Other (describe):

25E. Is the Floating Roof equipped with a weather shield? ☐ YES ☐ NO

<table>
<tr><td colspan="6">25F. Describe deck fittings; indicate the number of each type of fitting:</td></tr>
<tr><td colspan="6" align="center">ACCESS HATCH</td></tr>
<tr><td colspan="2">BOLT COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">AUTOMATIC GAUGE FLOAT WELL</td></tr>
<tr><td colspan="2">BOLT COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">COLUMN WELL</td></tr>
<tr><td colspan="2">BUILT-UP COLUMN – SLIDING COVER, GASKETED:</td><td colspan="2">BUILT-UP COLUMN – SLIDING COVER, UNGASKETED:</td><td colspan="2">PIPE COLUMN – FLEXIBLE FABRIC SLEEVE SEAL:</td></tr>
<tr><td colspan="6" align="center">LADDER WELL</td></tr>
<tr><td colspan="3">PIP COLUMN – SLIDING COVER, GASKETED:</td><td colspan="3">PIPE COLUMN – SLIDING COVER, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">GAUGE-HATCH/SAMPLE PORT</td></tr>
<tr><td colspan="3">SLIDING COVER, GASKETED:</td><td colspan="3">SLIDING COVER, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">ROOF LEG OR HANGER WELL</td></tr>
<tr><td colspan="2">WEIGHTED MECHANICAL ACTUATION, GASKETED:</td><td colspan="2">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td><td colspan="2">SAMPLE WELL-SLIT FABRIC SEAL (10% OPEN AREA)</td></tr>
<tr><td colspan="6" align="center">VACUUM BREAKER</td></tr>
<tr><td colspan="3">WEIGHTED MECHANICAL ACTUATION, GASKETED:</td><td colspan="3">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">RIM VENT</td></tr>
<tr><td colspan="3">WEIGHTED MECHANICAL ACTUATION GASKETED:</td><td colspan="3">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td></tr>
<tr><td colspan="6" align="center">DECK DRAIN (3-INCH DIAMETER)</td></tr>
<tr><td colspan="3">OPEN:</td><td colspan="3">90% CLOSED:</td></tr>
<tr><td colspan="6" align="center">STUB DRAIN</td></tr>
<tr><td colspan="6">1-INCH DIAMETER:</td></tr>
<tr><td colspan="6" align="center">OTHER (DESCRIBE, ATTACH ADDITIONAL PAGES IF NECESSARY)</td></tr>
</table>

26. Complete the following section for Internal Floating Roof Tanks ☒ Does Not Apply	
26A. Deck Type: ☐ Bolted ☐ Welded	
26B. For Bolted decks, provide deck construction:	
26C. Deck seam: ☐ Continuous sheet construction 5 feet wide ☐ Continuous sheet construction 6 feet wide ☐ Continuous sheet construction 7 feet wide ☐ Continuous sheet construction 5 × 7.5 feet wide ☐ Continuous sheet construction 5 × 12 feet wide ☐ Other (describe)	
26D. Deck seam length (ft)	26E. Area of deck (ft^2)
For column supported tanks: 26F. Number of columns:	26G. Diameter of each column:

IV. SITE INFORMANTION (optional if providing TANKS Summary Sheets)

27. Provide the city and state on which the data in this section are based. **Charleston, WV**
28. Daily Average Ambient Temperature (°F) **70 °F**
29. Annual Average Maximum Temperature (°F) **65.5 °F**
30. Annual Average Minimum Temperature (°F) **44.0 °F**
31. Average Wind Speed (miles/hr) **18 mph**
32. Annual Average Solar Insulation Factor (BTU/(ft^2·day)) **1,123**
33. Atmospheric Pressure (psia) **14.70**

V. LIQUID INFORMATION (optional if providing TANKS Summary Sheets)

34. Average daily temperature range of bulk liquid: Ambient	
34A. Minimum (°F)	34B. Maximum (°F)
35. Average operating pressure range of tank:	
35A. Minimum (psig)	35B. Maximum (psig)
36A. Minimum Liquid Surface Temperature (°F)	36B. Corresponding Vapor Pressure (psia)
37A. Average Liquid Surface Temperature (°F)	37B. Corresponding Vapor Pressure (psia)
38A. Maximum Liquid Surface Temperature (°F)	38B. Corresponding Vapor Pressure (psia)

39. Provide the following for each liquid or gas to be stored in tank. Add additional pages if necessary.

39A. Material Name or Composition	**Pipeline Fluids**		
39B. CAS Number	**NA**		
39C. Liquid Density (lb/gal)	**5.47**		
39D. Liquid Molecular Weight (lb/lb-mole)	**84.91**		
39E. Vapor Molecular Weight (lb/lb-mole)	**84.91**		

Maximum Vapor Pressure 39F. True (psia) 39G. Reid (psia)	**NA** **NA**		
Months Storage per Year 39H. From 39I. To	**January** **December**		

VI. EMISSIONS AND CONTROL DEVICE DATA (required)

40. Emission Control Devices (check as many as apply): ☒ Does Not Apply

- ☐ Carbon Adsorption[1]
- ☐ Condenser[1]
- ☐ Conservation Vent (psig)
  - Vacuum Setting   Pressure Setting
- ☐ Emergency Relief Valve (psig)
- ☐ Inert Gas Blanket of
- ☐ Insulation of Tank with
- ☐ Liquid Absorption (scrubber)[1]
- ☐ Refrigeration of Tank
- ☐ Rupture Disc (psig)
- ☐ Vent to Incinerator[1]
- ☐ Other[1] (describe):

41. Expected Emission Rate (submit Test Data or Calculations here or elsewhere in the application).

Material Name & CAS No.	Breathing Loss (lb/hr)	Working Loss		Annual Loss (lb/yr)	Estimation Method[1]
		Amount	Units		
***See calculations included in Attachment N.**					

[1] EPA = EPA Emission Factor, MB = Material Balance, SS = Similar Source, ST = Similar Source Test, Throughput Data, O = Other (specify)

☒ Remember to attach emissions calculations, including TANKS Summary Sheets if applicable.

Attachment L
EMISSIONS UNIT DATA SHEET
STORAGE TANKS

Provide the following information for each new or modified bulk liquid storage tank as shown on the *Equipment List Form* and other parts of this application. A tank is considered modified if the material to be stored in the tank is different from the existing stored liquid.

IF USING US EPA'S TANKS EMISSION ESTIMATION PROGRAM (AVAILABLE AT **www.epa.gov/tnn/tanks.html**), APPLICANT MAY ATTACH THE SUMMARY SHEETS IN LIEU OF COMPLETING SECTIONS III, IV, & V OF THIS FORM. HOWEVER, SECTIONS I, II, AND VI OF THIS FORM MUST BE COMPLETED. US EPA'S AP-42, SECTION 7.1, "ORGANIC LIQUID STORAGE TANKS," MAY ALSO BE USED TO ESTIMATE VOC AND HAP EMISSIONS (**http://www.epa.gov/tnn/chief/**).

I. GENERAL INFORMATION (required)

1. Bulk Storage Area Name **Tank Area**	2. Tank Name **Used Oil Storage Tank**
3. Tank Equipment Identification No. (as assigned on *Equipment List Form*) **TK-2**	4. Emission Point Identification No. (as assigned on *Equipment List Form*) **NA**
5. Date of Commencement of Construction (for existing tanks) **2018**	
6. Type of change ☒ New Construction ☐ New Stored Material ☐ Other Tank Modification	
7. Description of Tank Modification (if applicable) **NA**	
7A. Does the tank have more than one mode of operation? (e.g. Is there more than one product stored in the tank?) ☐ Yes ☒ No	
7B. If YES, explain and identify which mode is covered by this application (Note: A separate form must be completed for each mode). **NA**	
7C. Provide any limitations on source operation affecting emissions, any work practice standards (e.g. production variation, etc.): **NA**	

II. TANK INFORMATION (required)

8. Design Capacity (specify barrels or gallons). Use the internal cross-sectional area multiplied by internal height. **1,000 gal**	
9A. Tank Internal Diameter (ft) **4.12**	9B. Tank Internal Height (or Length) (ft) **10**
10A. Maximum Liquid Height (ft) **8**	10B. Average Liquid Height (ft) **5**
11A. Maximum Vapor Space Height (ft) **8**	11B. Average Vapor Space Height (ft) **5**
12. Nominal Capacity (specify barrels or gallons). This is also known as "working volume" and considers design liquid levels and overflow valve heights. **1,000**	

13A. Maximum annual throughput (gal/yr) **5,000 gal**	13B. Maximum daily throughput (gal/day) **13.70 gal**
14. Number of Turnovers per year (annual net throughput/maximum tank liquid volume) **5**	
15. Maximum tank fill rate (gal/min) **0.01**	
16. Tank fill method ☐ Submerged ☒ Splash ☐ Bottom Loading	
17. Complete 17A and 17B for Variable Vapor Space Tank Systems ☒ Does Not Apply	
17A. Volume Expansion Capacity of System (gal) **NA**	17B. Number of transfers into system per year **NA**

18. Type of tank (check all that apply):

☒ Fixed Roof ___vertical X horizontal ___ flat roof ___ cone roof ___ dome roof ___ other (describe)

☐ External Floating Roof ___ pontoon roof ___ double deck roof

☐ Domed External (or Covered) Floating Roof

☐ Internal Floating Roof ___ vertical column support ___ self-supporting

☐ Variable Vapor Space ___ lifter roof ___ diaphragm

☐ Pressurized ___ spherical ___ cylindrical

☐ Underground

☐ Other (describe)

III. TANK CONSTRUCTION & OPERATION INFORMATION (optional if providing TANKS Summary

19. Tank Shell Construction: ☐ Riveted ☐ Gunite lined ☐ Epoxy-coated rivets ☒ Other (describe) Welded		
20A. Shell Color **Light Grey**	20B. Roof Color **Light Grey**	20C. Year Last Painted **2018**
21. Shell Condition (if metal and unlined): ☒ No Rust ☐ Light Rust ☐ Dense Rust ☐ Not applicable		
22A. Is the tank heated? ☐ YES ☒ NO		
22B. If YES, provide the operating temperature (°F)		
22C. If YES, please describe how heat is provided to tank.		
23. Operating Pressure Range (psig):		
24. Complete the following section for **Vertical Fixed Roof Tanks** ☒ Does Not Apply		
24A. For dome roof, provide roof radius (ft)		
24B. For cone roof, provide slope (ft/ft)		
25. Complete the following section for **Floating Roof Tanks** ☒ Does Not Apply		
25A. Year Internal Floaters Installed:		
25B. Primary Seal Type: (check one) ☐ Metallic (Mechanical) Shoe Seal ☐ Vapor Mounted Resilient Seal ☐ Liquid Mounted Resilient Seal ☐ Other (describe):		
25C. Is the Floating Roof equipped with a Secondary Seal? ☐ YES ☐ NO		
25D. If YES, how is the secondary seal mounted? (check one) ☐ Shoe ☐ Rim ☐ Other (describe):		
25E. Is the Floating Roof equipped with a weather shield? ☐ YES ☐ NO		

<table>
<tr><td colspan="6">25F. Describe deck fittings; indicate the number of each type of fitting:</td></tr>
<tr><td colspan="6">ACCESS HATCH</td></tr>
<tr><td colspan="2">BOLT COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, UNGASKETED:</td></tr>
<tr><td colspan="6">AUTOMATIC GAUGE FLOAT WELL</td></tr>
<tr><td colspan="2">BOLT COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, GASKETED:</td><td colspan="2">UNBOLTED COVER, UNGASKETED:</td></tr>
<tr><td colspan="6">COLUMN WELL</td></tr>
<tr><td colspan="2">BUILT-UP COLUMN – SLIDING COVER, GASKETED:</td><td colspan="2">BUILT-UP COLUMN – SLIDING COVER, UNGASKETED:</td><td colspan="2">PIPE COLUMN – FLEXIBLE FABRIC SLEEVE SEAL:</td></tr>
<tr><td colspan="6">LADDER WELL</td></tr>
<tr><td colspan="3">PIP COLUMN – SLIDING COVER, GASKETED:</td><td colspan="3">PIPE COLUMN – SLIDING COVER, UNGASKETED:</td></tr>
<tr><td colspan="6">GAUGE-HATCH/SAMPLE PORT</td></tr>
<tr><td colspan="3">SLIDING COVER, GASKETED:</td><td colspan="3">SLIDING COVER, UNGASKETED:</td></tr>
<tr><td colspan="6">ROOF LEG OR HANGER WELL</td></tr>
<tr><td colspan="2">WEIGHTED MECHANICAL ACTUATION, GASKETED:</td><td colspan="2">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td><td colspan="2">SAMPLE WELL-SLIT FABRIC SEAL (10% OPEN AREA)</td></tr>
<tr><td colspan="6">VACUUM BREAKER</td></tr>
<tr><td colspan="3">WEIGHTED MECHANICAL ACTUATION, GASKETED:</td><td colspan="3">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td></tr>
<tr><td colspan="6">RIM VENT</td></tr>
<tr><td colspan="3">WEIGHTED MECHANICAL ACTUATION GASKETED:</td><td colspan="3">WEIGHTED MECHANICAL ACTUATION, UNGASKETED:</td></tr>
<tr><td colspan="6">DECK DRAIN (3-INCH DIAMETER)</td></tr>
<tr><td colspan="3">OPEN:</td><td colspan="3">90% CLOSED:</td></tr>
<tr><td colspan="6">STUB DRAIN</td></tr>
<tr><td colspan="6">1-INCH DIAMETER:</td></tr>
<tr><td colspan="6">OTHER (DESCRIBE, ATTACH ADDITIONAL PAGES IF NECESSARY)</td></tr>
</table>

26. Complete the following section for Internal Floating Roof Tanks	☒ Does Not Apply		
26A. Deck Type: ☐ Bolted ☐ Welded			
26B. For Bolted decks, provide deck construction:			
26C. Deck seam: ☐ Continuous sheet construction 5 feet wide ☐ Continuous sheet construction 6 feet wide ☐ Continuous sheet construction 7 feet wide ☐ Continuous sheet construction 5 × 7.5 feet wide ☐ Continuous sheet construction 5 × 12 feet wide ☐ Other (describe)			
26D. Deck seam length (ft)	26E. Area of deck (ft²)		
For column supported tanks: 26F. Number of columns:	26G. Diameter of each column:		

IV. SITE INFORMANTION (optional if providing TANKS Summary Sheets)

27. Provide the city and state on which the data in this section are based. **Charleston, WV**	
28. Daily Average Ambient Temperature (°F) **70 °F**	
29. Annual Average Maximum Temperature (°F) **65.5 °F**	
30. Annual Average Minimum Temperature (°F) **44.0 °F**	
31. Average Wind Speed (miles/hr) **18 mph**	
32. Annual Average Solar Insulation Factor (BTU/(ft^2·day)) **1,123**	
33. Atmospheric Pressure (psia) **14.70**	

V. LIQUID INFORMATION (optional if providing TANKS Summary Sheets)

34. Average daily temperature range of bulk liquid:	Ambient
34A. Minimum (°F)	34B. Maximum (°F)
35. Average operating pressure range of tank:	
35A. Minimum (psig)	35B. Maximum (psig)
36A. Minimum Liquid Surface Temperature (°F)	36B. Corresponding Vapor Pressure (psia)
37A. Average Liquid Surface Temperature (°F)	37B. Corresponding Vapor Pressure (psia)
38A. Maximum Liquid Surface Temperature (°F)	38B. Corresponding Vapor Pressure (psia)

39. Provide the following for <u>each</u> liquid or gas to be stored in tank. Add additional pages if necessary.

39A. Material Name or Composition	**Used Oil**		
39B. CAS Number	**NA**		
39C. Liquid Density (lb/gal)			
39D. Liquid Molecular Weight (lb/lb-mole)	**380.00**		
39E. Vapor Molecular Weight (lb/lb-mole)	**200.00**		

Maximum Vapor Pressure 39F. True (psia) 39G. Reid (psia)	**NA** **NA**		
Months Storage per Year 39H. From 39I. To	**January** **December**		

VI. EMISSIONS AND CONTROL DEVICE DATA (required)

40. Emission Control Devices (check as many as apply): ☒ Does Not Apply

- ☐ Carbon Adsorption[1]
- ☐ Condenser[1]
- ☐ Conservation Vent (psig)
  - Vacuum Setting Pressure Setting
- ☐ Emergency Relief Valve (psig)
- ☐ Inert Gas Blanket of
- ☐ Insulation of Tank with
- ☐ Liquid Absorption (scrubber)[1]
- ☐ Refrigeration of Tank
- ☐ Rupture Disc (psig)
- ☐ Vent to Incinerator[1]
- ☐ Other[1] (describe):

41. Expected Emission Rate (submit Test Data or Calculations here or elsewhere in the application).

Material Name & CAS No.	Breathing Loss (lb/hr)	Working Loss		Annual Loss (lb/yr)	Estimation Method[1]
		Amount	Units		
***See calculations included in Attachment N.**					

[1] EPA = EPA Emission Factor, MB = Material Balance, SS = Similar Source, ST = Similar Source Test, Throughput Data, O = Other (specify)

☒ Remember to attach emissions calculations, including TANKS Summary Sheets if applicable.

Attachment M

Attachment M
Air Pollution Control Devices

There are no proposed air pollution control devices at the Mockingbird Hill Station owned by Dominion Transmission, Inc. The combustion turbine will utilize ultra-low NO_x burners (SoLoNOx) and an oxidation catalyst on the combustion turbines. These components are considered integral to the design of the equipment.

Attachment N

__Table N-1 Permit to Construct Application Project Equipment List__

SHP Mockingbird Hill Compressor Station - West Virginia

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Titan 130-20502S	21,765 hp
CT-02	Compressor Turbine	Solar Turbines	Titan 130-20502S	21,765 hp
EG-01	Emergency Generator	Caterpillar	G3516	1,416 hp
WH-01	Boiler	TBD	TBD	7.2 MMBtu/hr
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	1,000 gal
LR-01	Truck Loading Rack	--	--	90 gal/min

Table N-2 Potential Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - West Virginia

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr)	8,760

Generator Operational Parameters:

Normal Hours of Operation:	100

Boiler Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	21,765	hp	Natural Gas	26.6	43.1	2.41	2.58	4.36	4.36	4.36	10.8	90,075	6.52	2.27	90,915	0.962
Solar Titan 130 Turbine	21,765	hp	Natural Gas	26.6	43.1	2.41	2.58	4.36	4.36	4.36	10.8	90,075	6.52	2.27	90,915	0.962
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.312	0.295	0.0375	0.0003	0.0214	0.0214	0.0214	0.006	77.9	0.290	0	85.1	0.0584
Boiler	7.2	MMBtu/hr	Natural Gas	1.55	2.60	0.170	0.0186	0.0587	0.0587	0.0587	0.176	3,710	0.0711	0.0680	3,732	0.0143
Total (tons/yr)				**55.1**	**89.1**	**5.03**	**5.17**	**8.81**	**8.81**	**8.81**	**21.77**	**183,937**	**13.4**	**4.62**	**185,648**	**1.997**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	21,765	hp	Natural Gas	26.6	8.62	1.21	2.58	4.36	4.36	4.36	10.8	90,075	6.52	2.27	90,915	0.96
Solar Titan 130 Turbine	21,765	hp	Natural Gas	26.6	8.62	1.21	2.58	4.36	4.36	4.36	10.8	90,075	6.52	2.27	90,915	0.96
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.312	0.295	0.0375	0.0003	0.0214	0.0214	0.0214	0.006	77.9	0.290	0	85.1	0.0584
Boiler	7.2	MMBtu/hr	Natural Gas	1.55	2.60	0.170	0.0186	0.0587	0.0587	0.0587	0.176	3,710	0.0711	0.0680	3,732	0.0143
Total (tons/yr)				**55.1**	**20.1**	**2.62**	**5.17**	**8.81**	**8.81**	**8.81**	**21.77**	**183,937**	**13.4**	**4.62**	**185,648**	**1.997**

Notes:

(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Emergency Generator emissions are calculated by the following formula: Power Rating * Run Hours * EF / 2000
Power Rating = Engine hp rating (hp)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/hp-hr)
2000 = the amount of lbs in a ton
(3) Boiler emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF)
Power Rating = Boiler Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with oxidation catalyst for control of CO (80%) and VOC (50%)
(5) Emergency generator engine hp taken from manufacturer data
(6) Boiler assumed to have low-NOx burners
(7) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(8) See Emissions Factors table for Emissions Factors for each operating scenario.
(9) Each start-up/shut-down event assumed to last 10 minutes

Table N-3 Event Based Potential Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - West Virginia

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy) NOx	CO	VOC	GHG Emissions (tpy) CO2	CH4	CO2e
Solar Titan 130 Turbine	21,765	hp	Natural Gas	100	0.0950	8.85	0.101	58.1	0.404	68.2
Solar Titan 130 Turbine	21,765	hp	Natural Gas	100	0.0950	8.85	0.101	58.1	0.404	68.2
Total (tons/yr)					**0.190**	**17.7**	**0.202**	**116.1**	**0.808**	**136.3**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy) NOx	CO	VOC	GHG Emissions (tpy) CO2	CH4	CO2e
Solar Titan 130 Turbine	21,765	hp	Natural Gas	100	0.120	10.4	0.119	63.6	0.476	75.5
Solar Titan 130 Turbine	21,765	hp	Natural Gas	100	0.120	10.4	0.119	63.6	0.476	75.5
Total (tons/yr)					**0.240**	**20.8**	**0.238**	**127**	**0.952**	**151.0**

	NOx	CO	VOC	CO2	CH4	CO2e
Total SUSD Emissions (tons/yr)	**0.430**	**38.5**	**0.440**	**243.3**	**1.760**	**287**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy) CO2	CH4	CO2e	HAPs
Solar Titan 130 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Titan 130 Turbine	100	2.216	2.293	75.634	1,893	0.125
Total (tons/yr)		**4.433**	**4.586**	**151**	**3,786**	**0.250**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy) CO2	CH4	CO2e	HAPs
Solar Titan 130 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Titan 130 Turbine	100	3.675	3.80	125.39	3,139	0.207
Total (tons/yr)		**7.349**	**7.60**	**251**	**6,277**	**0.415**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy) CO2	CH4	CO2e	HAPs
SHP-M	1	1.17	1.21	39.8	996	0.0658
Total (tons/yr)		**1.17**	**1.21**	**39.8**	**996**	**0.0658**

	VOC	CO2	CH4	CO2e	HAPs
Total Blowdown Emissions (tons/yr)	**12.9**	**13.4**	**442**	**11,060**	**0.731**

Table N-4 Combustion Source Criteria Pollutant Emission Factors
SHP Mockingbird Hill Compressor Station - West Virginia

Solar Turbine Normal Operation Emission Factors (lb/hr)														
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Solar Titan 130 Turbine	Natural Gas	lb/hr	5.70	9.60	0.550	0.59	1.00	1.00	1.00	2.46	20565	1.49	0.52	20757

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(5) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Titan 130 Turbine	Natural Gas	lb/hr	76.0	57.6	1.10	44.33	3,840	22.0

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Titan 130 Turbine	Natural Gas	lb/event	1.90	177	2.02	1161	8.08	1363	2.40	208	2.38	1272	9.52	1510

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors														
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713
Engine 2 SLB	Natural Gas	lb/MMBtu	3.17	0.386	0.12	0.000588	0.0384	0.0384	0.0384	0.00991	110	1.45	0	146
1000 KW Caterpillar Egen	Natural Gas	lb/hp-hr	0.004408	0.004166	0.000529	4.62E-06	0.0003018	0.00030179	0.000302	7.79E-05	1.0998	0.0041	0	1

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) Emission Factors for 2 SLB engine taken from AP-42 Table 3.2-1
(4) NOx, CO, VOC, CO2, and CH4 emission factors for Caterpillar Egens taken from Caterpillar Manufacturer data
(5) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Caterpillar Egens taken from AP-42 Table 3.2-1 and converted using manufacturer fuel data
(6) Assume PMF=PMF-10=PMF-2.5
(7) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(8) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

<u>Table N-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources</u>
SHP Mockingbird Hill Compressor Station - West Virginia

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-Mockingbird		**2**	**1**	**1**
Pollutant	**HAP?**	**Solar Titan 130 Turbine**	**Boiler < 100 MMBtu**	**1000 KW Caterpillar Egen**
1,1,2,2-Tetrachloroethane	Yes			0.024
1,1,2-Trichloroethane	Yes			0.019
1,1-Dichloroethane	Yes			0.014
1,2,3-Trimethylbenzene	No			0.013
1,2,4-Trimethylbenzene	No			0.040
1,2-Dichloroethane	Yes			0.015
1,2-Dichloropropane	Yes			0.016
1,3,5-Trimethylbenzene	No			0.006
1,3-Butadiene	Yes			0.295
1,3-Dichloropropene	Yes			0.016
2,2,4-Trimethylpentane	Yes			0.305
2-Methylnaphthalene	No		0.001	0.008
3-Methylchloranthrene	No		0.000	
7,12-Dimethylbenz(a)anthracene	No		0.001	
Acenaphthene	No		0.000	0.000
Acenaphthylene	No		0.000	0.001
Acetaldehyde	Yes			2.796
Acrolein	Yes			2.803
Anthracene	No		0.000	0.000
Benz(a)anthracene	No		0.000	0.000
Benzene	Yes		0.130	0.699
Benzo(a)pyrene	No		0.000	0.000
Benzo(b)fluoranthene	No		0.000	0.000
Benzo(e)pyrene	No			0.000
Benzo(g,h,i)perylene	No		0.000	0.000
Benzo(k)fluoranthene	No		0.000	0.000
Biphenyl	Yes			0.001
Butane	No		129.854	1.711
Butyr/Isobutyraldehyde	No			0.157
Carbon Tetrachloride	Yes			0.022
Chlorobenzene	Yes			0.016
Chloroethane	Yes			
Chloroform	Yes			0.017
Chrysene	No		0.000	0.000
Cyclohexane	No			0.111
Cyclopentane	No			0.034
Dibenzo(a,h)anthracene	No		0.000	
Dichlorobenzene	Yes		0.074	
Ethane	No		191.689	25.544
Ethylbenzene	Yes			0.039
Ethylene Dibromide	Yes			0.026
Fluoranthene	No		0.000	0.000
Fluorene	No		0.000	0.001
Formaldehyde	Yes	1816.631	4.638	19.888
Hexane (or n-Hexane)	Yes		111.304	0.160
Indeno(1,2,3-c,d)pyrene	No		0.000	0.000
Isobutane	No			1.351
Methanol	Yes			0.894
Methylcyclohexane	No			0.122
Methylene Chloride	Yes			0.053
n-Nonane	No			0.011
n-Octane	No			0.027
Naphthalene	Yes		0.038	0.035
PAH	Yes			0.048
Pentane (or n-Pentane)	No		160.772	0.551
Perylene	No			0.000
Phenanthrene	No		0.001	0.001
Phenol	Yes			0.015
Propane	No		98.936	10.340
Propylene Oxide	Yes			
Pyrene	No		0.000	0.000
Styrene	Yes			0.020
Tetrachloroethane	No			
Toluene	Yes		0.210	0.347

Table N-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - West Virginia

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-Mockingbird		**2**	**1**	**1**
Pollutant	**HAP?**	**Solar Titan 130 Turbine**	**Boiler < 100 MMBtu**	**1000 KW Caterpillar Egen**
Vinyl Chloride	Yes			0.009
Xylene	Yes			0.097
Arsenic	Yes		0.012	
Barium	No		0.272	
Beryllium	Yes		0.001	
Cadmium	Yes		0.068	
Chromium	Yes		0.087	
Cobalt	Yes		0.005	
Copper	No		0.053	
Manganese	Yes		0.023	
Mercury	Yes		0.016	
Molybdenum	No		0.068	
Nickel	Yes		0.130	
Selenium	Yes		0.001	
Vanadium	No		0.142	
Zinc	No		1.793	
Lead	Yes		0.031	
Total HAPs		1923.863		
Total HAP/unit (lb/yr)		**1924**	**117**	**28.7**
Total HAP/unit (TPY)		**0.962**	**0.0584**	**0.0143**

Hazardous Air Pollutant

(1) Emissions above are on a per unit basis
(2) Calculations for the Caterpillar emergency generator assume 100 hours of operation; all other calculations assume 8,760 hours of operation
(3) Heat rates for Solar Turbines taken from Solar Datasheets
(4) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table N-6 Combustion Source HAP Emission Factors
SHP Mockingbird Hill Compressor Station - West Virginia

Pollutant	HAP?	Emission Factors		
		Solar Titan 130 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
1,1,2,2-Tetrachloroethane	Yes			1.7E-07
1,1,2-Trichloroethane	Yes			1.3E-07
1,1-Dichloroethane	Yes			9.9E-08
1,2,3-Trimethylbenzene	No			9.0E-08
1,2,4-Trimethylbenzene	No			2.8E-07
1,2-Dichloroethane	Yes			1.1E-07
1,2-Dichloropropane	Yes			1.1E-07
1,3,5-Trimethylbenzene	No			4.6E-08
1,3-Butadiene	Yes			2.1E-06
1,3-Dichloropropene	Yes			1.1E-07
2,2,4-Trimethylpentane	Yes			2.2E-06
2-Methylnaphthalene	No		2.4E-05	5.4E-08
3-Methylchloranthrene	No		1.8E-06	
7,12-Dimethylbenz(a)anthracene	No		1.6E-05	
Acenaphthene	No		1.8E-06	3.4E-09
Acenaphthylene	No		1.8E-06	8.1E-09
Acetaldehyde	Yes			2.0E-05
Acrolein	Yes			2.0E-05
Anthracene	No		2.4E-06	1.8E-09
Benz(a)anthracene	No		1.8E-06	8.5E-10
Benzene	Yes		2.1E-03	4.9E-06
Benzo(a)pyrene	No		1.2E-06	1.4E-11
Benzo(b)fluoranthene	No		1.8E-06	2.2E-11
Benzo(e)pyrene	No			6.0E-11
Benzo(g,h,i)perylene	No		1.2E-06	6.3E-11
Benzo(k)fluoranthene	No		1.8E-06	1.1E-11
Biphenyl	Yes			1.0E-08
Butane	No		2.1E+00	1.2E-05
Butyr/Isobutyraldehyde	No			1.1E-06
Carbon Tetrachloride	Yes			1.5E-07
Chlorobenzene	Yes			1.1E-07
Chloroethane	Yes			
Chloroform	Yes			1.2E-07
Chrysene	No		1.8E-06	1.7E-09
Cyclohexane	No			7.8E-07
Cyclopentane	No			2.4E-07
Dibenzo(a,h)anthracene	No		1.2E-06	
Dichlorobenzene	Yes		1.2E-03	
Ethane	No		3.1E+00	1.8E-04
Ethylbenzene	Yes			2.7E-07
Ethylene Dibromide	Yes			1.9E-07
Fluoranthene	No		3.0E-06	9.2E-10
Fluorene	No		2.8E-06	4.3E-09
Formaldehyde	Yes	2.9E-03	7.5E-02	1.4E-04
Hexane (or n-Hexane)	Yes		1.8E+00	1.1E-06
Indeno(1,2,3-c,d)pyrene	No		1.8E-06	2.5E-11
Isobutane	No			9.5E-06
Methanol	Yes			6.3E-06
Methylcyclohexane	No			8.6E-07
Methylene Chloride	Yes			3.7E-07

Table N-6 Combustion Source HAP Emission Factors
SHP Mockingbird Hill Compressor Station - West Virginia

Pollutant	HAP?	Emission Factors		
		Solar Titan 130 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
n-Nonane	No			7.8E-08
n-Octane	No			1.9E-07
Naphthalene	Yes		6.1E-04	2.5E-07
PAH	Yes			3.4E-07
Pentane (or n-Pentane)	No		2.6E+00	3.9E-06
Perylene	No			1.3E-11
Phenanthrene	No		1.7E-05	9.0E-09
Phenol	Yes			1.1E-07
Propane	No		1.6E+00	7.3E-05
Propylene Oxide	Yes			
Pyrene	No		5.0E-06	1.5E-09
Styrene	Yes			1.4E-07
Tetrachloroethane	No			
Toluene	Yes		3.4E-03	2.5E-06
Vinyl Chloride+A32	Yes			6.3E-08
Xylene	Yes			6.8E-07
Arsenic	Yes		2.0E-04	
Barium	No		4.4E-03	
Beryllium	Yes		1.2E-05	
Cadmium	Yes		1.1E-03	
Chromium	Yes		1.4E-03	
Cobalt	Yes		8.4E-05	
Copper	No		8.5E-04	
Manganese	Yes		3.8E-04	
Mercury	Yes		2.6E-04	
Molybdenum	No		1.1E-03	
Nickel	Yes		2.1E-03	
Selenium	Yes		2.4E-05	
Vanadium	No		2.3E-03	
Zinc	No		2.9E-02	
Lead	Yes		5.0E-04	
Total Haps		3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for 2 SLB natural gas engines and Caterpillar natural gas emergency generators
(4) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators c
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL

Table N-7 Potential Emissions From Fugitive Leaks
SHP Mockingbird Hill Compressor Station - West Virginia

Fugitive Emissions (FUG)

Source Designation:

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr		CH_4 Weight Fraction[1]	Fug Emission Rate tpy	
Solar Turbine	Gas	2.67E-02		0.934	250	

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	782	3.52	15.4	0.026	0.404	0.0271	0.418	0.895	13.8	1.48E-03	2.28E-02
Compressors	Gas	5.71E+01	2	114	500	0.026	13.12	0.0271	13.6	0.895	448	1.48E-03	7.41E-01
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	1	2.00E-04	8.76E-04	0.026	2.30E-05	0.0271	2.38E-05	0.895	7.84E-04	1.48E-03	1.30E-06
Flanges	Gas	3.90E-04	437	0.170	0.746	0.026	0.020	0.0271	0.020	0.895	0.668	1.48E-03	1.10E-03
Open-ended lines	Gas	2.00E-03		0.000	0.000	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
			Total	118	517	-	13.5	-	14.0	-	462	-	7.64E-01

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.

Sample Calculations:
Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count
Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table N-8a Tank Emissions
SHP Mockingbird Hill Compressor Station - West Virginia

Source Designation:	TK-1, TK-2

Tank Parameters

Source	Type of Tank	Contents	Capacity (gal)	Throughput gal/yr	Tank Diam. ft	Tank Length ft	Paint Color	Paint Condition
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	1,000	5,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	5.14E-07	2.25E-06	1.48E-06	6.50E-06	2.00E-06	8.75E-06

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.

Table N-8b Pipeline to Truck Liquid Loading Rack Emissions
SHP Mockingbird Hill Compressor Station - West Virginia

Source Designation:	LR-1

Chemical Parameters

Chemical	Vapor Mol. Weight [1] (lb/lb-mol)	Avg. Vapor Pressure [1] (psia)	Avg. Temperature [2] (deg. R)	Saturation Factor [3]	Throughput [4] Mgal/yr
Pipeline Liquids	43.86	7.70	520	0.6	12.50

References:
1. Vapor molecular weight and vapor pressure based on E&P output for Pipeline Liquids Storage Tank TK-1.
2. Based on average ambient temperature data for the area.
3. Saturation Factor based on "Submerged loading: dedicated normal service" in Table 5.2-1 of AP-42, Ch. 5.2.

Total Potential Emissions

Source	Total Loading Losses[1]		Pump Capacity [2]	Max Hourly Losses
	Average	Annual		
	(lbs/Mgal)	(tpy)	(gal/min)	lb/hr
Pipeline Liquids Truck Loading	4.86	0.03	90	26.2

References:
1. AP-42, Ch. 5.2, Equation 1 (Loading Loss = 12.46 x (Saturation Factor x TVP x Molecular Weight) / Temp.)
2. Assumed pump rate.

Speciated Potential Emissions

Source	Contents	VOC Weight Fraction[1] (%)	HAP Weight Fraction[1] (%)	Total VOC Emissions		Total HAP Emissions	
				lb/hr	tpy	lb/hr	tpy
Pipeline Liquids Truck Loading	Pipeline Liquids	20%	0.002%	5.25	0.006	4.98E-04	5.77E-07

References:
1. VOC and HAP weight fractions are based on 118-PF-04 tank emissions speciation.

Table N-9 Project Potential Emissions
SHP Mockingbird Hill Compressor Station - West Virginia

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	CT-01	26.8	27.8	1.43	2.58	4.36	4.36	4.36	10.8	90,196	7.40	2.27	91,059	0.962
Solar Titan 130 Turbine	CT-02	26.8	27.8	1.43	2.58	4.36	4.36	4.36	10.8	90,196	7.40	2.27	91,059	0.962
Caterpillar G3516 Egen	EG-01	0.312	0.295	0.0375	0.0003	0.0214	0.0214	0.0214	0.006	77.9	0.290	0	85.1	0.0584
Boiler	WH-01	1.55	2.60	0.170	0.0186	0.0587	0.0587	0.0587	0.176	3,710	0.0711	0.0680	3,732	0.0143
Fugitive Leaks - Blowdowns	FUG-01	-	-	12.9	-	-	-	-	-	13.4	442		11,060	0.731
Fugitive Leaks - Piping	FUG-02	-	-	13.5	-	-	-	-	-	14.0	462	-	11,567	0.764
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-
Truck Loading Track	LR-01	-	-	0.006	-	-	-	-	-	-	-	-	-	5.77E-07
Total (tons/yr)		**55.5**	**58.6**	**29.9**	**5.17**	**8.81**	**8.81**	**8.81**	**21.8**	**184,208**	**919**	**4.62**	**208,563**	**3.49**

```
******************************************************************************************
*     Project Setup Information                                                          *
******************************************************************************************
Project File             : M:\Projects\D\Dominion\Atlantic Coastal Pipeline and Supply Header
Pipeline\Draft Rule 13 - APC1\Emission Calcs\TK-1 - Produced Fluids Tank.ept
Flowsheet Selection      : Oil Tank with Separator
Calculation Method       : AP42
Control Efficiency       : 100.0%
Known Separator Stream   : Low Pressure Gas
Entering Air Composition : No

Date                     : 2015.07.13


******************************************************************************************
*     Data Input                                                                         *
******************************************************************************************

Separator Pressure       : 552.00[psig]
Separator Temperature    : 77.00[F]
Molar GOR                : 0.0500
Ambient Pressure         : 14.70[psia]
Ambient Temperature      : 70.00[F]
C10+ SG                  : 0.8990
C10+ MW                  : 166.00

-- Low Pressure Gas ----------------------------------------------------------------------
   No.    Component          mol %
   1      H2S               0.0000
   2      O2                0.0000
   3      CO2               1.0410
   4      N2                0.9940
   5      C1               94.2060
   6      C2                2.9230
   7      C3                0.5460
   8      i-C4              0.0790
   9      n-C4              0.0840
   10     i-C5              0.0240
   11     n-C5              0.0220
   12     C6                0.0320
   13     C7+               0.0490
   14     Benzene           0.0000
   15     Toluene           0.0000
   16     E-Benzene         0.0000
   17     Xylenes           0.0000
   18     n-C6              0.0000
   19     224Trimethylp     0.0000
```

```
   C7+ Molar Ratio: C7  :     C8  :     C9  :     C10+
                    1.0000    1.0000    1.0000    1.0000

-- Sales Oil -------------------------------------------------------------------------------
Production Rate            : 0.8[bbl/day]
Days of Annual Operation   : 365 [days/year]
API Gravity                : 46.0
Reid Vapor Pressure        : 7.70[psia]
Bulk Temperature           : 80.00[F]

-- Tank and Shell Data ---------------------------------------------------------------------
Diameter                   : 5.08[ft]
Shell Height               : 11.90[ft]
Cone Roof Slope            : 0.06
Average Liquid Height      : 2.50[ft]
Vent Pressure Range        : 0.06[psi]
Solar Absorbance           : 0.54

-- Meteorological Data ---------------------------------------------------------------------
```



```
City                       : Charleston, WV
Ambient Pressure           : 14.70[psia]
Ambient Temperature        : 70.00[F]
Min Ambient Temperature    : 44.00[F]
Max Ambient Temperature    : 65.50[F]
Total Solar Insolation     : 1123.00[Btu/ft^2*day]


******************************************************************************************
*     Calculation Results                                                                *
******************************************************************************************

-- Emission Summary ------------------------------------------------------------------------
Item                Uncontrolled   Uncontrolled
                    [ton/yr]       [lb/hr]
Total HAPs          0.010          0.002
Total HC            0.425          0.097
VOCs, C2+           0.383          0.087
VOCs, C3+           0.350          0.080

Uncontrolled Recovery Info.
       Vapor        21.2300 x1E-3  [MSCFD]
       HC Vapor     19.9800 x1E-3  [MSCFD]
       GOR          26.05          [SCF/bbl]

-- Emission Composition --------------------------------------------------------------------
No  Component       Uncontrolled   Uncontrolled
```

		[ton/yr]	[lb/hr]
1	H2S	0.002	0.000
2	O2	0.000	0.000
3	CO2	0.022	0.005
4	N2	0.001	0.000
5	C1	0.043	0.010
6	C2	0.032	0.007
7	C3	0.083	0.019
8	i-C4	0.033	0.008
9	n-C4	0.102	0.023
10	i-C5	0.039	0.009
11	n-C5	0.047	0.011
12	C6	0.015	0.003
13	C7	0.014	0.003
14	C8	0.006	0.001
15	C9	0.001	0.000
16	C10+	0.000	0.000
17	Benzene	0.001	0.000
18	Toluene	0.000	0.000
19	E-Benzene	0.000	0.000
20	Xylenes	0.000	0.000
21	n-C6	0.010	0.002
22	224Trimethylp	0.000	0.000
	Total	0.451	0.103

-- Stream Data --

No.	Component	MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S	34.80	0.0508	0.0349	0.0030	0.6834	0.1835	0.5755
2	O2	32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2	44.01	0.2437	0.0907	0.0000	6.3467	0.0001	4.9770
4	N2	28.01	0.0102	0.0005	0.0000	0.3990	0.0001	0.3129
5	C1	16.04	0.9543	0.1475	0.0000	33.1362	0.0001	25.9849
6	C2	30.07	0.6701	0.3531	0.0000	13.3133	0.0001	10.4401
7	C3	44.10	2.1827	1.7648	0.4600	18.8508	16.8782	18.4251
8	i-C4	58.12	1.1269	1.0450	0.6191	4.3934	9.6293	5.5234
9	n-C4	58.12	4.6091	4.4100	3.1320	12.5490	33.6645	17.1061
10	i-C5	72.15	3.1066	3.0997	2.8099	3.3810	11.9899	5.2389
11	n-C5	72.15	5.0558	5.0823	4.8107	4.0000	14.9972	6.3734
12	C6	86.16	4.1726	4.2520	4.3657	1.0044	4.1822	1.6902
13	C7	100.20	10.3655	10.6043	11.1500	0.8388	3.6780	1.4516
14	C8	114.23	10.8426	11.1074	11.7774	0.2806	1.2761	0.4954
15	C9	128.28	5.5127	5.6497	6.0063	0.0497	0.2328	0.0892
16	C10+	166.00	45.9695	47.1217	50.1681	0.0099	0.0486	0.0182
17	Benzene	78.11	0.5685	0.5808	0.6057	0.0778	0.3297	0.1322
18	Toluene	92.13	0.2132	0.2183	0.2311	0.0082	0.0362	0.0142
19	E-Benzene	106.17	0.0711	0.0729	0.0774	0.0009	0.0041	0.0016

20	Xylenes	106.17	0.6802	0.6971	0.7408	0.0075	0.0344	0.0133
21	n-C6	86.18	3.5939	3.6672	3.7955	0.6694	2.8351	1.1368
22	224Trimethylp	114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW		123.89	126.03	129.50	38.64	63.78	44.07
	Stream Mole Ratio		1.0000	0.9755	0.9688	0.0245	0.0067	0.0312
	Heating Value	[BTU/SCF]				2044.13	3547.91	2368.67
	Gas Gravity	[Gas/Air]				1.33	2.20	1.52
	Bubble Pt. @ 100F	[psia]	56.28	19.66	6.19			
	RVP @ 100F	[psia]	126.75	78.89	38.81			
	Spec. Gravity @ 100F		0.800	0.803	0.810			

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	TK-2
City:	
State:	West Virginia
Company:	
Type of Tank:	Horizontal Tank
Description:	Used Oil Aboveground Storage Tank
Tank Dimensions	
Shell Length (ft):	10.00
Diameter (ft):	4.12
Volume (gallons):	1,000.00
Turnovers:	5.00
Net Throughput(gal/yr):	5,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Charleston, West Virginia (Avg Atmospheric Pressure = 14.25 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TK-2 - Horizontal Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Used Oil	All	61.57	52.97	70.18	57.22	0.0001	0.0001	0.0001	380.0000			200.00	

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TK-2 - Horizontal Tank

Annual Emission Calcaulations	
Standing Losses (lb):	0.0130
Vapor Space Volume (cu ft):	84.9150
Vapor Density (lb/cu ft):	0.0000
Vapor Space Expansion Factor:	0.0618
Vented Vapor Saturation Factor:	1.0000
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	84.9150
Tank Diameter (ft):	4.1200
Effective Diameter (ft):	7.2446
Vapor Space Outage (ft):	2.0600
Tank Shell Length (ft):	10.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0000
Vapor Molecular Weight (lb/lb-mole):	380.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0001
Daily Avg. Liquid Surface Temp. (deg. R):	521.2427
Daily Average Ambient Temp. (deg. F):	54.9833
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	516.8933
Tank Paint Solar Absorptance (Shell):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,250.5726
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0618
Daily Vapor Temperature Range (deg. R):	34.4127
Daily Vapor Pressure Range (psia):	0.0000
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0001
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0001
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0001
Daily Avg. Liquid Surface Temp. (deg R):	521.2427
Daily Min. Liquid Surface Temp. (deg R):	512.6395
Daily Max. Liquid Surface Temp. (deg R):	529.8458
Daily Ambient Temp. Range (deg. R):	21.5333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	1.0000
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0001
Vapor Space Outage (ft):	2.0600
Working Losses (lb):	0.0045
Vapor Molecular Weight (lb/lb-mole):	380.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0001
Annual Net Throughput (gal/yr.):	5,000.0000
Annual Turnovers:	5.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	4.1200
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.0175

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TK-2 - Horizontal Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Used Oil	0.00	0.01	0.02

Solar Turbines Emissions Estimates

Titan 130-20502S

Assumptions: pipeline natural gas, sea level, 4"/4" inlet/outlet losses, nominal performance

50% load

Temp, F	HP	fuel flow, mmbtu/hr LHV	Thermal Eff, %	NOx (ppm)	NOx (lb/hr)	CO (ppm)	CO (lb/hr)	UHC (ppm)	UHC (lb/hr)	VOC (ppm)	VOC (lb/hr)	CO2 lb/hr	PM10/2.5 lb/mmbtu	PM10/2.5 lb/hr	Exhaust Temp (F)	Exhaust Flow (lb/hr)
0	10883	90.71	30.53	9	3.2	25	5.5	25	3.2	2.5	0.3	11896	0.02	2.0	704	334,570
59	10005	105.64	24.10	9	3.8	25	6.4	25	3.7	2.5	0.4	13738	0.02	2.3	992	312,106
100	8135	96.16	21.52	9	3.4	25	5.7	25	3.3	2.5	0.3	12273	0.02	2.1	1051	272535

75% load

Temp, F	HP	fuel flow, mmbtu/hr LHV	Thermal Eff, %	NOx (ppm)	NOx (lb/hr)	CO (ppm)	CO (lb/hr)	UHC (ppm)	UHC (lb/hr)	VOC (ppm)	VOC (lb/hr)	CO2 lb/hr	PM10/2.5 lb/mmbtu	PM10/2.5 lb/hr	Exhaust Temp (F)	Exhaust Flow (lb/hr)
0	16324	137.74	30.15	9	5.0	25	8.4	25	4.8	2.5	0.5	18019	0.02	3.0	899	412,957
59	15007	124.31	30.72	9	4.4	25	7.5	25	4.3	2.5	0.4	16161	0.02	2.7	955	357,451
100	12202	109.82	28.27	9	3.8	25	6.5	25	3.7	2.5	0.4	14013	0.02	2.4	1019	303557

100% load

Temp, F	HP	fuel flow, mmbtu/hr LHV	Thermal Eff, %	NOx (ppm)	NOx (lb/hr)	CO (ppm)	CO (lb/hr)	UHC (ppm)	UHC (lb/hr)	VOC (ppm)	VOC (lb/hr)	CO2 lb/hr	PM10/2.5 lb/mmbtu	PM10/2.5 lb/hr	Exhaust Temp (F)	Exhaust Flow (lb/hr)
0	21765	157.33	35.20	9	5.7	25	9.6	25	5.5	2.5	0.6	20565	0.02	3.5	900	437,973
59	20010	142.45	35.74	9	5.1	25	8.6	25	4.9	2.5	0.5	18511	0.02	3.1	944	392,270
100	16269	125.42	33.01	9	4.4	25	7.5	25	4.3	2.5	0.4	16001	0.02	2.8	994	339519

SoLoNOx Products: Emissions in Non-SoLoNOx Modes

Leslie Witherspoon
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PURPOSE

Solar's gas turbine dry low NOx emissions combustion systems, known as *SoLoNOx*™, have been developed to provide the lowest emissions possible during normal operating conditions. In order to optimize the performance of the turbine, the combustion and fuel systems are designed to reduce NOx, CO and unburned hydrocarbons (UHC) without penalizing stability or transient capabilities. At very low load and cold temperature extremes, the *SoLoNOx* system must be controlled differently in order to assure stable operation. The required adjustments to the turbine controls at these conditions cause emissions to increase.

The purpose of this Product Information Letter is to provide emissions estimates, and in some cases warrantable emissions for NOx, CO and UHC, at off-design conditions.

Historically, regulatory agencies have not required a specific emissions level to be met at low load or cold ambient operating conditions, but have asked what emissions levels are expected. The expected values are necessary to appropriately estimate emissions for annual emissions inventory purposes and for New Source Review applicability determinations and permitting.

COLD AMBIENT EMISSIONS ESTIMATES

Solar's standard temperature range warranty for gas turbines with *SoLoNOx* combustion is ≥ 0°F (–20°C). The *Titan*™ 250 is an exception, with a lower standard warranty at ≥ –20°F (–29°C). At ambient temperatures below 0°F, many of Solar's turbine engine models are controlled to increase pilot fuel to improve flame stability and emissions are higher. Without the increase in pilot fuel at temperatures below 0°F the engines may exhibit combustor rumble, as operation may be near the lean stability limit.

If a cold ambient emissions warranty is requested, a new production turbine configured with the latest combustion hardware is required. For most models this refers to the inclusion of Cold Ambient Fuel Control Logic.

Emissions warranties are not offered for ambient temperatures below –20°F (–29°C). In addition, cold ambient emissions warranties cannot be offered for the *Centaur*® 40 turbine.

Table 1 provides expected and warrantable (upon Solar's documented approval) emissions levels for Solar's *SoLoNOx* combustion turbines. All emissions levels are in ppm at 15% O_2. Refer to Product Information Letter 205 for *Mercury*™ 50 turbine emissions estimates.

For information on the availability and approvals for cold ambient temperature emissions warranties, please contact Solar's sales representatives.

Table 2 summarizes "expected" emissions levels for ambient temperatures below 0°F (–20°C) for Solar's *SoLoNOx* turbines that do not have current production hardware or for new production hardware that is not equipped with the cold ambient fuel control logic. The emissions levels are extrapolated from San Diego factory tests and may vary at extreme temperatures and as a result of variations in other parameters, such as fuel composition, fuel quality, etc.

For more conservative NOx emissions estimate for new equipment, customers can refer to the New Source Performance Standard (NSPS) 40CFR60, subpart KKKK, where the allowable NOx emissions level for ambient temperatures < 0°F (–20°F) is 150 ppm NOx at 15% O_2. For pre-February 18, 2005, *SoLoNOx* combustion turbines subject to 40CFR60 subpart GG, a conservative estimate is the appropriate subpart GG emissions level. Subpart GG levels range from 150 to 214 ppm NOx at 15% O_2 depending on the turbine model.

Table 3 summarizes emissions levels for ambient temperatures below –20°F (–29°C) for the *Titan* 250.

Table 1. Warrantable Emissions Between 0°F and –20°F (–20° to –29°C) for New Production

Turbine Model	Fuel System	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Centaur 50	Gas Only	Gas	50 to 100% load	42	100	50
	Dual Fuel	Gas	50 to 100% load	72	100	50
Taurus™ 60	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Taurus 65	Gas Only	Gas	50 to 100% load	42	100	50
Taurus 70	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Mars® 90	Gas Only	Gas	50 to 100% load	42	100	50
Mars 100	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Titan 130	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Titan 250	Gas Only	Gas	40 to 100% load	25	50	25
	Gas Only	Gas	40 to 100% load	15	25	25
Centaur 50	Dual Fuel	Liquid	65 to 100% load	120	150	75
Taurus 60	Dual Fuel	Liquid	65 to 100% load	120	150	75
Taurus 70	Dual Fuel	Liquid	65 to 100% load	120	150	75
Mars 100	Dual Fuel	Liquid	65 to 100% load	120	150	75
Titan 130	Dual Fuel	Liquid	65 to 100% load	120	150	75

Table 2. Expected Emissions below 0°F (–20°C) for SoLoNOx Combustion Turbines

Turbine Model	Fuel System	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Centaur 40	Gas Only or Dual Fuel	Gas	80 to 100% load	120	150	50
Centaur 50	Gas Only	Gas	50 to 100% load	120	150	50
	Dual Fuel	Gas	50 to 100% load	120	150	50
Taurus 60	Gas Only or Dual Fuel	Gas	50 to 100% load	120	150	50
Taurus 65	Gas Only	Gas	50 to 100% load	120	150	50
Taurus 70	Gas Only or Dual Fuel	Gas	50 to 100% load	120	150	50
Mars 90	Gas Only	Gas	80 to 100% load	120	150	50
Mars 100	Gas Only or Dual Fuel	Gas	50 to 100% load	120	150	50
Titan 130	Gas Only or Dual Fuel	Gas	50 to 100% load	120	150	50
Centaur 40	Dual Fuel	Liquid	80 to 100% load	120	150	75
Centaur 50	Dual Fuel	Liquid	65 to 100% load	120	150	75
Taurus 60	Dual Fuel	Liquid	65 to 100% load	120	150	75
Taurus 70	Dual Fuel	Liquid	65 to 100% load	120	150	75
Mars 100	Dual Fuel	Liquid	65 to 100% load	120	150	75
Titan 130	Dual Fuel	Liquid	65 to 100% load	120	150	75

Table 3. Expected Emissions below –20°F (–29°C) for the Titan 250 SoLoNOx Combustion Turbine

Turbine Model	Fuel System	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Titan 250	Gas Only	Gas	40 to 100% load	70	150	50

COLD AMBIENT PERMITTING STRATEGY

There are several permitting options to consider when permitting in cold ambient climates. Customers can use a tiered permitting approach or choose to permit a single emission rate over all temperatures. Historically, most construction and operating permits were silent on the ambient temperature boundaries for *SoLoNOx* operation.

Some customers have used a tiered permitting strategy. For purposes of compliance and annual emissions inventories, a digital thermometer is installed to record ambient temperature. The amount of time is recorded that the ambient temperature falls below 0°F. The amount of time below 0°F is then used with the emissions estimates shown in Tables 1 and 2 to estimate “actual” emissions during sub-zero operation.

A conservative alternative to using the NOx values in Tables 1, 2 and 3 is to reference 40CFR60 subpart KKKK, which allows 150 ppm NOx at 15% O_2 for sub-zero operation.

For customers who wish to permit at a single emission rate over all ambient temperatures, inlet air heating can be used to raise the engine inlet air temperature (T_1) above 0°F. With inlet air heating to keep T_1 above 0°F, standard emission warranty levels may be offered.

Inlet air heating technology options include an electric resistance heater, an inlet air to exhaust heat exchanger and a glycol heat exchanger.

If an emissions warranty is desired and ambient temperatures are commonly below –20°F (–29°C), inlet air heating can be used to raise the turbine inlet temperature (T_1) to at least –20°F. In such cases, the values shown in Table 1 can be warranted for new production.

EMISSIONS ESTIMATES IN NON-SOLONOX MODE (LOW LOAD)

At operating loads < 50% (<40% load for the *Titan* 250) on natural gas fuel and < 65% (< 80% load for *Centaur* 40) on liquid fuels, *SoLoNOx* engines are controlled to increase stability and transient response capability. The control steps that are required affect emissions in two ways: 1) pilot fuel flow is increased, increasing NOx emissions, and 2) airflow through the combustor is increased, increasing CO emissions. Note that the load levels are approximate. Engine controls are triggered either by power output for single-shaft engines or gas producer speed for two-shaft engines.

A conservative method for estimating emissions of NOx at low loads is to use the applicable NSPS: 40CFR60 subpart GG or KKKK. For projects that commence construction after February 18, 2005, subpart KKKK is the applicable NSPS and contains a NOx level of 150 ppm @ 15% O_2 for operating loads less than 75%.

Table 4 provides estimates of NOx, CO, and UHC emissions when operating in non-SoLoNOx mode for natural gas or liquid fuel. The estimated emissions can be assumed to vary linearly as load is decreased from just below 50% load for natural gas (or 65% load for liquid fuel) to idle.

The estimates in Table 4 apply for any product for gas only or dual fuel systems using pipeline quality natural gas. Refer to Product Information Letter 205 for *Mercury* 50 emissions estimates.

Table 4. Estimated Emissions in non-SoLoNOx Mode

Ambient	Fuel System	Engine Load	NOx, ppm	CO, ppm	UHC, ppm
***Centaur* 40/50, *Taurus* 60/65/70, *Mars* 90/100, *Titan* 130**					
≥ –20°F (–29°C)	Natural Gas	Less than 50%	70	8,000	800
		Idle	50	10,000	1,000
< –20°F (–29°C)	Natural Gas	Less than 50%	120	8,000	800
		Idle	120	10,000	1,000
***Titan* 250**					
≥ –20°F (–29°C)	Natural Gas	Less than 40%	50	25	20
		Idle	50	2,000	200
< –20°F (–29°C)	Natural Gas	Less than 40%	70	150	50
		Idle	70	2,000	200
***Centaur* 50, *Taurus* 60/70, *Mars* 100, *Titan* 130**					
≥ –20°F (–29°C)	Liquid	Less than 65%	120	1,000	100
		Idle	120	10,000	3,000
< –20°F (–29°C)	Liquid	Less than 65%	120	1,000	150
		Idle	120	10,000	3,000
***Centaur* 40**					
≥ –20°F (–29°C)	Liquid	Less than 80%	120	1,000	100
		Idle	120	10,000	3,000
< –20°F (–29°C)	Liquid	Less than 80%	120	1,000	150
		Idle	120	10,000	3,000

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Volatile Organic Compound, Sulfur Dioxide, and Formaldehyde Emission Estimates

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PURPOSE

This Product Information Letter summarizes methods that are available to estimate emissions of volatile organic compounds (VOC), sulfur dioxide (SO_2), and formaldehyde from gas turbines. Emissions estimates of these pollutants are often necessary during the air permitting process.

INTRODUCTION

In absence of site-specific or representative source test data, Solar refers customers to a United States Environmental Protection Agency (EPA) document titled “AP-42” or other appropriate EPA reference documents. AP-42 is a collection of emission factors for different emission sources. The emission factors found in AP-42 provide a generally accepted way of estimating emissions when more representative data are not available. The most recent version of AP-42 (dated April 2000) can be found at:

http://www.epa.gov/ttn/chief/ap42/ch03/index.html

Solar does not typically warranty the emission rates for VOC, SO_2 or formaldehyde.

Volatile Organic Compounds

Many permitting agencies require gas turbine users to estimate emissions of VOC, a subpart of the unburned hydrocarbon (UHC) emissions, during the air permitting process. Volatile organic compounds, non-methane hydrocarbons (NMHC), and reactive organic gases (ROG) are some of the many ways of referring to the non-methane (and non-ethane) portion of an “unburned hydrocarbon” emission estimate.

For natural gas fuel, Solar’s customers use 10-20% of the UHC emission rate to represent VOC emissions. The estimate of 10-20% is based on a ratio of total non-methane hydrocarbons to total organic compounds. The use of 10-20% provides a conservative estimate of VOC emissions. The balance of the UHC is assumed to be primarily methane.

For liquid fuel, it is appropriate to estimate that 100% of the UHC emission estimate is VOC.

Sulfur Dioxide

Sulfur dioxide emissions are produced by conversion of sulfur in the fuel to SO_2. Since Solar does not control the amount of sulfur in the fuel, we are unable to predict SO_2 emissions without a site fuel composition analysis. Customers generally estimate SO_2 emissions with a mass balance calculation by assuming that any sulfur in the fuel will convert to SO_2. For reference, the typical mass balance equation is shown below.

Variables: wt % of sulfur in fuel
Btu/lb fuel (LHV*)
MMBtu/hr fuel flow (LHV)

$$\frac{\text{lb } SO_2}{\text{hr}} = \left(\frac{\text{wt\% Sulfur}}{100}\right)\left(\frac{\text{lb fuel}}{\text{Btu}}\right)\left(\frac{10^6 \text{ Btu}}{\text{MMBtu}}\right)\left(\frac{\text{MMBtu fuel}}{\text{hr}}\right)\left(\frac{\text{MW } SO_2}{\text{MW Sulfur}}\right)$$

As an alternative to the mass balance calculation, EPA’s AP-42 document can be used. AP-42 (Table 3.1-2a, April 2000) suggests emission factors of 0.0034 lb/MMBtu for gas fuel (HHV*) and 0.033 lb/MMBtu for liquid fuel (HHV).

*LHV = Lower Heating Value; HHV = Higher Heating Value

Formaldehyde

In gas turbines, formaldehyde emissions are a result of incomplete combustion. Formaldehyde in the exhaust stream is unstable and very difficult to measure. In addition to turbine characteristics including combustor design, size, maintenance history, and load profile, the formaldehyde emission level is also affected by:

- Ambient temperature
- Humidity
- Atmospheric pressure
- Fuel quality
- Formaldehyde concentration in the ambient air
- Test method measurement variability
- Operational factors

The emission factor data in Table 1 is an excerpt from an EPA memo: "Revised HAP Emission Factors for Stationary Combustion Turbines, 8/22/03." The memo presents hazardous air pollutant (HAP) emission factor data in several categories including: mean, median, maximum, and minimum. The emission factors in the memo are a compilation of the HAP data EPA collected during the Maximum Achievable Control Technology (MACT) standard development process. The emission factor documentation shows there is a high degree of variability in formaldehyde emissions from gas turbines, depending on the manufacturer, rating size of equipment, combustor design, and testing events. To estimate formaldehyde emissions from gas turbines, users should use the emission factor(s) that best represent the gas turbines actual / planned operating profile. Refer to the memo for alternative emission factors.

Table 1. EPA's Total HAP and Formaldehyde Emission Factors for <50 MW Lean-Premix Gas Turbines burning Natural Gas

(Source: Revised HAP Emission Factors for Stationary Combustion Turbines, OAR-2002-0060, IV-B-09, 8/22/03)

Pollutant	Engine Load	95% Upper Confidence of Mean, lb/MMBtu HHV	95% Upper Confidence of Data, lb/MMBtu HHV	Memo Reference
Total HAP	> 90%	0.00144	0.00258	Table 19
Total HAP	All	0.00160	0.00305	Table 16
Formaldehyde	> 90%	0.00127	0.00241	Table 19
Formaldehyde	All	0.00143	0.00288	Table 16

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Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products

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Solar Turbines Incorporated

PURPOSE

The purpose of this Product Information Letter (PIL) is to provide emission estimates for start-up and shutdown events for *Solar*® gas turbines with *SoLoNOx*™ dry low emissions combustion systems. The commissioning process is also discussed.

INTRODUCTION

The information presented in this document is representative for both generator set (GS) and compressor set/mechanical drive (CS/MD) combustion turbine applications. Operation of duct burners and/or any add-on control equipment is not accounted for in the emissions estimates. Emissions related to the start-up, shutdown, and commissioning of combustion turbines will not be guaranteed or warranted.

Combustion turbine start-up occurs in one of three modes: cold, warm, or hot. On large, utility size, combustion turbines, the start-up time varies by the "mode". The start-up duration for a hot, warm, or cold *Solar* turbine is less than 10 minutes in simple-cycle and most combined heat and power applications.

Heat recovery steam generator (HRSG) steam pressure is usually 250 psig or less. At 250 psig or less, thermal stress within the HRSG is minimized and, therefore, firing ramp-up is not limited. However, some combined heat and power plant applications will desire or dictate longer start-up times, therefore emissions assuming a 60-minute start are also estimated.

A typical shutdown for a *Solar* turbine is <10 minutes. Emissions estimates for an elongated shutdown, 30-minutes, are also included.

Start-up and shutdown emissions estimates for the *Mercury*™ 50 engine are found in PIL 205.

For start-up and shutdown emissions estimates for conventional combustion turbines, landfill gas, digester gas, or other alternative fuel applications, contact Solar's Environmental Programs Department.

START-UP SEQUENCE

The start-up sequence, or getting to *SoLoNOx* combustion mode, takes three steps:

1. Purge-crank
2. Ignition and acceleration to idle
3. Loading / thermal stabilization

During the "purge-crank" step, rotation of the turbine shaft is accomplished with a starter motor to remove any residual fuel gas in the engine flow path and exhaust. During "ignition and acceleration to idle," fuel is introduced into the combustor and ignited in a diffusion flame mode and the engine rotor is accelerated to idle speed.

The third step consists of applying up to 50% load[1] while allowing the combustion flame to transition and stabilize. Once 50% load is achieved, the turbine transitions to *SoLoNOx* combustion mode and the engine control system begins to hold the combustion primary zone temperature and limit pilot fuel to achieve the targeted nitrogen oxides (NOx), carbon monoxide (CO), and unburned hydrocarbons (UHC) emission levels.

Steps 2 and 3 are short-term transient conditions making up less than 10 minutes.

SHUTDOWN PROCESS

Normal, planned cool down/shutdown duration varies by engine model. The *Centaur*® 40, *Centaur* 50, *Taurus*™ 60, and *Taurus* 65 engines take about 5 minutes. The *Taurus* 70, *Mars*® 90 and 100, *Titan*™ 130 and *Titan* 250 engines take about 10 minutes. Typically, once the shutdown process starts, the emissions will remain in *SoLoNOx* mode for approximately 90 seconds and move into a transitional mode for the balance of the estimated shutdown time (assuming the unit was operating at full-load).

START-UP AND SHUTDOWN EMISSIONS ESTIMATES

Tables 1 through 5 summarize the estimated pounds of emissions per start-up and shutdown event for each product. Emissions estimates are presented for both GS and CS/MD applications on both natural gas and liquid fuel (diesel #2). The emissions estimates are calculated using empirical exhaust characteristics.

COMMISSIONING EMISSIONS

Commissioning generally takes place over a two-week period. Static testing, where no combustion occurs, usually requires one week and no emissions are expected. Dynamic testing, where combustion will occur, will see the engine start and shutdown a number of times and a variety of loads will be placed on the system. It is impossible to predict how long the turbine will run and in what combustion / emissions mode it will be running. The dynamic testing period is generally followed by one to two days of "tune-up" during which the turbine is running at various loads, most likely within low emissions mode (warranted emissions range).

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San Diego, CA 92123-5398

[1] 40% load for the *Titan* 250 engine on natural gas. 65% load for all engines on liquid fuel (except 80% load for the *Centaur* 40).

Table 1. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set Applications
10 Minute Start-up and 10 Minute Shutdown
Natural Gas Fuel

Data will NOT be warranted under any circumstances

	Centaur 40 4701S				Centaur 50 6201S				Taurus 60 7901S				Taurus 65 8401S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	0.6	58.1	3.3	359	0.8	75.0	4.3	454	0.8	78.5	4.5	482	0.9	85.8	4.9	523
Total Emissions per Shutdown (lbs)	0.3	25.5	1.5	160	0.4	31.1	1.8	194	0.4	34.7	2.0	217	0.4	38.2	2.2	237

	Taurus 70 10801S				Mars 90 13002S GSC				Mars 100 16002S GSC				Titan 130 20501S				Titan 250 30002S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	1.1	103.9	5.9	634	1.4	129.0	7.4	868	1.6	151.2	8.6	952	2.1	195.6	11.2	1,194	2.5	22.7	1.5	1,925
Total Emissions per Shutdown (lbs)	1.3	110.7	6.3	689	1.7	147.9	8.4	912	1.9	166.8	9.5	1,026	2.4	210.0	12.0	1,303	3.0	19.9	1.5	1,993

Assumes ISO conditions: 59F, 60% RH, sea level, no losses

Assumes unit is operating at full load prior to shutdown.

Assumes natural gas fuel; ES 9-98 compliant.

Table 2. ***Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set Applications***
60 Minute Start-up and 30 Minute Shutdown
Natural Gas Fuel

Data will NOT be warranted under any circumstances

	Centaur 40 4701S				Centaur 50 6201S				Taurus 60 7901S				Taurus 65 8401S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	4.1	219.4	13.0	3,420	5.0	272.4	16.1	4,219	5.7	299.8	17.8	4,780	6.1	326.5	19.3	5,074
Total Emissions per Shutdown (lbs)	1.8	121.1	7.1	1,442	2.3	163.3	9.5	1,834	2.5	163.5	9.6	1,994	2.6	177.2	10.4	2,119

	Taurus 70 10801S				Mars 90 13002S				Mars 100 16002S				Titan 130 20501S				Titan 250 30002S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	7.6	410.3	24.2	6,164	10.5	570.8	33.7	8,641	11.3	583.5	34.6	9,691	13.8	740.4	43.8	11,495	14.6	75.5	7.3	16,253
Total Emissions per Shutdown (lbs)	3.3	223.0	13.0	2,588	4.3	277.0	16.2	3,685	4.8	308.1	18.0	4,056	6.0	405.3	23.7	4,826	6.2	52.6	4.1	7,222

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at full load prior to shutdown.

Assumes natural gas fuel; ES 9-98 compliant.

Table 3. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx CS/MD Applications

10 Minute Start-up and 10 Minute Shutdown

Natural Gas Fuel

Data will NOT be warranted under any circumstances

	Centaur 40 4702S				Centaur 50 6102S				Taurus 60 7802S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	0.7	64.4	3.7	392	0.8	69.1	4.0	469	0.7	64.3	3.7	410
Total Emissions per Shutdown (lbs)	0.3	30.2	1.7	181	0.4	35.4	2.0	217	0.4	33.0	1.9	204

	Taurus 70 10302S				Mars 90 13002S CSMD				Mars 100 16002S CSMD				Titan 130 20502S				Titan 250 30002S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	0.8	73.1	4.2	519	1.2	109.3	6.2	805	1.4	123.5	7.1	829	1.9	176.9	10.1	1,161	2.6	26.2	1.7	1,794
Total Emissions per Shutdown (lbs)	1.1	93.4	5.3	575	1.5	132.6	7.6	817	1.7	149.2	8.5	920	2.4	207.6	11.9	1,272	2.9	19.1	1.4	1,918

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at full load prior to shutdown.

Assumes natural gas fuel; ES 9-98 compliant.

Table 4. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set
10 Minute Start-up and 10 Minute Shutdown
Liquid Fuel (Diesel #2)

Data will NOT be warranted under any circumstances

	Centaur 40 4701S				Centaur 50 6201S				Taurus 60 7901S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	1.3	44.5	7.4	473	1.7	59.0	9.8	601	1.7	59.8	9.9	636
Total Emissions per Shutdown (lbs)	0.6	17.3	2.8	211	0.7	21.2	3.4	256	0.8	23.5	3.8	286

	Taurus 70 10801S				Mars 100 16002S GSC				Titan 130 20501S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	2.3	78.5	13.0	823	3.4	114.1	18.8	1,239	4.3	147.5	24.4	1,547
Total Emissions per Shutdown (lbs)	2.5	73.6	12.0	889	3.8	111.4	18.1	1,331	4.7	139.1	22.6	1,677

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at full load prior to shutdown.

Assumes #2 Diesel fuel; ES 9-98 compliant.

Table 5. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set
60 Minute Start-up and 30 Minute Shutdown
Liquid Fuel (Diesel #2)

Data will NOT be warranted under any circumstances

	Centaur 40 4701S				Centaur 50 6201S				Taurus 60 7901S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	11.7	194.7	30.9	4,255	15.2	271.9	43.3	5,302	14.7	282.6	45.0	5,962
Total Emissions per Shutdown (lbs)	4.4	84.7	13.6	1,816	6.7	164.3	27.0	2,334	6.3	159.0	26.0	2,515

	Taurus 70 10801S				Mars 100 16002S				Titan 130 20501S			
	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	18.4	360.3	57.4	7,375	29.1	552.0	87.7	11,685	34.4	677.0	108.0	13,731
Total Emissions per Shutdown (lbs)	8.0	207.8	34.1	3,156	12.3	302.6	49.4	4,970	15.0	388.5	63.7	5,876

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.
Assumes unit is operating at full load prior to shutdown.
Assumes #2 Diesel fuel; ES 9-98 compliant.

CO CATALYST DESIGN DATASHEET

ENQUIRY DETAILS	
Enquiry Number	32237
Revision	0
Date of Revision	26-May-2015
Project Name	Supply Header Project
Project Location	Mockingbird Hill
Application	Simple Cycle
Number of Systems	17

PROCESS DATA														
Design Case			Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
Customer Design Case			Centaur 40	Centaur 40	Centaur 50L	Centaur 50L	Taurus 60	Taurus 60	Taurus 70	Taurus 70	Mars 100	Mars 100	Titan 130	Titan 130
Percent Load		Percent	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Fuel Case			NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Exhaust Gas Mass Flowrate, Wet		lb/h	164994.0	127403.0	161184.0	127484.0	186880.0	151704.0	247255.0	179824.0	367228.0	289445.0	437956.0	341226.0
Exhaust Gas Volumetric Flowrate, Wet		ACFM	87269	73508	91761	80971	107807	96052	139492	112383	207193	177388	254955	215260
Exhaust Gas Temperature		degrees F	779.0	873.0	871.0	1004.0	888.0	999.0	858.0	980.0	859.0	953.0	900.0	993.0
Exhaust Gas Composition														
Component	*MW*													
O2	31.999	vol% (wet)	15.78	15.29	14.80	14.08	14.50	13.93	14.39	13.88	14.73	14.23	14.40	13.69
H2O	18.015	vol% (wet)	4.67	8.15	5.55	9.21	5.81	9.34	5.91	9.39	5.61	9.08	5.90	9.55
N2	28.013	vol% (wet)	76.23	73.41	75.88	73.01	75.78	72.96	75.74	72.93	75.85	73.06	75.75	72.88
CO2	44.010	vol% (wet)	2.41	2.27	2.86	2.83	3.00	2.90	3.05	2.93	2.90	2.76	3.04	3.01
Ar	39.948	vol% (wet)	0.91	0.88	0.91	0.87	0.91	0.87	0.91	0.87	0.91	0.87	0.91	0.87
			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Emissions from the Source	@ %O2	15												
Reference applicable for ppmvd and mg/Nm3 (dry)														
CO		ppmvd	50.00	50.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
CO		lb/h	5.67	4.19	3.31	2.63	4.02	3.20	5.42	3.83	7.62	5.81	9.58	7.49
Nox as NO2		ppmvd	25.00	25.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Nox as NO2		lb/h	4.66	3.44	1.95	1.55	2.38	1.89	3.20	2.26	4.51	3.44	5.66	4.43
SO2		ppmvd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO2		lb/h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO3		ppmvd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO3		lb/h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Particulates		kg/h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trace Elements		mg/Nm3 (dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VOC		ppmvd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amount of Nox as NO2		Percent	50	50	50	50	50	50	50	50	50	50	50	50
CO Reduction		Percent	90.00	90.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Performance Warranties	@ %O2	15												
Reference applicable for ppmvd and mg/Nm3 (dry)														
CO		ppmvd	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
CO		lb/h	0.57	0.42	0.66	0.53	0.80	0.64	1.08	0.77	1.52	1.16	1.92	1.50
VOC		ppmvd	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA
SO2 to SO3 Conversion*		Percent	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA
NO to NO2 Conversion*		Percent	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA
VOC Reduction*		Percent	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA
Pressure Drop across the catalyst*		inH2O	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA	VTA

** VTA = Vendor to Advise*

SITE/AMBIENT CONDITIONS		
Ambient Temperature	100	degrees F
Ambient Pressure	407	inH2O
Site Elevation	1500	ft
Gauge Duct Pressure	20.00	inH2O
Relative Humidity	60	Percent

G3516

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1800	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	11:1	APPLICATION:	Genset
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	STANDBY
AFTERCOOLER WATER INLET (°F):	130	FUEL:	Nat Gas
JACKET WATER OUTLET (°F):	210	FUEL SYSTEM:	LPG IMPCO
ASPIRATION:	TA		WITH AIR FUEL RATIO CONTROL
COOLING SYSTEM:	JW+OC, AC	FUEL PRESSURE RANGE(psig):	1.5-5.0
CONTROL SYSTEM:	EIS	FUEL METHANE NUMBER:	85
EXHAUST MANIFOLD:	ASWC	FUEL LHV (Btu/scf):	905
COMBUSTION:	Low Emission	ALTITUDE CAPABILITY AT 77°F INLET AIR TEMP. (ft):	3501
NOx EMISSION LEVEL (g/bhp-hr NOx):	2.0	POWER FACTOR:	0.8
		VOLTAGE(V):	240-480

RATING		NOTES	LOAD	100%	75%	50%
GENSET POWER	(WITHOUT FAN)	(1)(2)	ekW	1000	750	500
GENSET POWER		(1)(2)	kVA	1250	937	625
ENGINE POWER	(WITHOUT FAN)	(2)	bhp	1416	1059	707
GENERATOR EFFICIENCY		(1)	%	94.7	95.0	94.8
GENSET EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(3)	%	31.7	30.5	28.1
THERMAL EFFICIENCY		(4)	%	52.4	54.7	58.6
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(5)	%	84.1	85.2	86.7
ENGINE DATA						
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(6)	Btu/ekW-hr	10917	11314	12254
GENSET FUEL CONSUMPTION	(NOMINAL)	(6)	Btu/ekW-hr	11128	11533	12492
ENGINE FUEL CONSUMPTION	(NOMINAL)	(6)	Btu/bhp-hr	7859	8170	8831
AIR FLOW (77°F, 14.7 psia)	(WET)	(7) (8)	ft3/min	2988	2240	1522
AIR FLOW	(WET)	(7) (8)	lb/hr	13248	9934	6747
FUEL FLOW (60ºF, 14.7 psia)			scfm	205	159	115
COMPRESSOR OUT PRESSURE			in Hg(abs)	70.1	60.4	47.0
COMPRESSOR OUT TEMPERATURE			°F	309	269	201
AFTERCOOLER AIR OUT TEMPERATURE			°F	134	131	131
INLET MAN. PRESSURE		(9)	in Hg(abs)	62.6	48.5	34.9
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(10)	°F	138	135	134
TIMING		(11)	°BTDC	18	18	18
EXHAUST TEMPERATURE - ENGINE OUTLET		(12)	°F	876	873	879
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(13) (8)	ft3/min	8086	6062	4155
EXHAUST GAS MASS FLOW	(WET)	(13) (8)	lb/hr	13810	10371	7063
EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)		(14)(15)	g/bhp-hr	2.00	2.00	2.00
CO		(14)(16)	g/bhp-hr	1.89	1.90	1.95
THC (mol. wt. of 15.84)		(14)(16)	g/bhp-hr	2.36	2.47	2.82
NMHC (mol. wt. of 15.84)		(14)(16)	g/bhp-hr	0.35	0.37	0.42
NMNEHC (VOCs) (mol. wt. of 15.84)		(14)(16)(17)	g/bhp-hr	0.24	0.25	0.28
HCHO (Formaldehyde)		(14)(16)	g/bhp-hr	0.28	0.28	0.28
CO2		(14)(16)	g/bhp-hr	499	507	525
EXHAUST OXYGEN		(14)(18)	% DRY	7.5	7.2	6.9
LAMBDA		(14)(18)		1.49	1.43	1.35
ENERGY BALANCE DATA						
LHV INPUT		(19)	Btu/min	185475	144166	104103
HEAT REJECTION TO JACKET WATER (JW)		(20)(27)	Btu/min	49148	41900	34467
HEAT REJECTION TO ATMOSPHERE		(21)	Btu/min	6831	5682	4553
HEAT REJECTION TO LUBE OIL (OC)		(22)(27)	Btu/min	8040	6854	5638
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(23)(24)	Btu/min	51104	38351	26562
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(23)	Btu/min	39125	29274	20234
HEAT REJECTION TO AFTERCOOLER (AC)		(25)(28)	Btu/min	9329	5510	1919
PUMP POWER		(26)	Btu/min	971	971	971

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77°F, 29.60 in Hg barometric pressure.) No overload permitted at rating shown. Consult the altitude deration factor chart for applications that exceed the rated altitude or temperature.

Emission levels are at engine exhaust flange prior to any after treatment. Values are based on engine operating at steady state conditions, adjusted to the specified NOx level at 100% load. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than ± 3.

For notes information consult page three.

FUEL USAGE GUIDE

CAT METHANE NUMBER	30	35	40	45	50	55	60	65	70	75	80	85
SET POINT TIMING	-	-	-	-	-	-	-	-	15	16	17	18
DERATION FACTOR	0	0	0	0	0	0	0	0	1	1	1	1

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1	1	0.99	0.96	0.92	0.89	0.85	0.82	0.79	0.76	0.73	0.70	0.67
120	1	1	1	0.97	0.94	0.90	0.87	0.83	0.80	0.77	0.74	0.71	0.68
110	1	1	1	0.99	0.95	0.92	0.88	0.85	0.81	0.78	0.75	0.72	0.69
100	1	1	1	1	0.97	0.93	0.90	0.86	0.83	0.80	0.76	0.73	0.70
90	1	1	1	1	0.99	0.95	0.91	0.88	0.84	0.81	0.78	0.75	0.72
80	1	1	1	1	1	0.97	0.93	0.89	0.86	0.83	0.79	0.76	0.73
70	1	1	1	1	1	0.99	0.95	0.91	0.88	0.84	0.81	0.78	0.74
60	1	1	1	1	1	1	0.97	0.93	0.89	0.86	0.82	0.79	0.76
50	1	1	1	1	1	1	0.99	0.95	0.91	0.87	0.84	0.81	0.77

ALTITUDE (FEET ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.40	1.46	1.54	1.61	1.68	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
120	1.32	1.38	1.45	1.52	1.59	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
110	1.23	1.30	1.37	1.44	1.51	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
100	1.15	1.22	1.29	1.35	1.42	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
90	1.07	1.14	1.20	1.27	1.34	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
80	1	1.06	1.12	1.19	1.25	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
70	1	1	1.04	1.10	1.17	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19
60	1	1	1	1.02	1.08	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
50	1	1	1	1	1	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02

ALTITUDE (FEET ABOVE SEA LEVEL)

FUEL USAGE GUIDE:
This table shows the derate factor and full load set point timing required for a given fuel. Note that deration and set point timing reduction may be required as the methane number decreases. Methane number is a scale to measure detonation characteristics of various fuels. The methane number of a fuel is determined by using the Caterpillar methane number calculation program.

ALTITUDE DERATION FACTORS:
This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site.

ACTUAL ENGINE RATING:
To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/Temperature deration factors and RPC (reference the Caterpillar Methane Program) establish air system limitations. RPC comes into play when the Altitude/Temperature deration is less than 1.0 (100%). Under this condition, add the two factors together. When the site conditions do not require an Altitude/ Temperature derate (factor is 1.0), it is assumed the turbocharger has sufficient capability to overcome the low fuel relative power, and RPC is ignored. To determine the actual power available, take the lowest rating between 1) and 2).
1) Fuel Usage Guide Deration
2) 1-((1-Altitude/Temperature Deration) + (1-RPC))

AFTERCOOLER HEAT REJECTION FACTORS(ACHRF):
To maintain a constant air inlet manifold temperature, as the inlet air temperature goes up, so must the heat rejection. As altitude increases, the turbocharger must work harder to overcome the lower atmospheric pressure. This increases the amount of heat that must be removed from the inlet air by the aftercooler. Use the aftercooler heat rejection factor (ACHRF) to adjust for inlet air temp and altitude conditions. See note 28 for application of this factor in calculating the heat exchanger sizing criteria. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

NOTES:
1. Generator efficiencies, power factor, and voltage are based on standard generator. [Genset Power (ekW) is calculated as: Engine Power (bkW) x Generator Efficiency], [Genset Power (kVA) is calculated as: Engine Power (bkW) x Generator Efficiency / Power Factor]
2. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
3. ISO 3046/1 Genset efficiency tolerance is (+)0, (-)5% of full load % efficiency value based on a 1.0 power factor.
4. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, and exhaust to 248ºF with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
5. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
6. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% of full load data. Nominal genset and engine fuel consumption tolerance is ± 3.0% of full load data.
7. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
8. Inlet and Exhaust Restrictions must not exceed A&I limits based on full load flow rates from the standard technical data sheet.
9. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
11. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
12. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
13. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
14. Emissions data is at engine exhaust flange prior to any after treatment.
15. NOx tolerances are ± 18% of specified value.
16. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "Not to Exceed" levels. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
17. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
18. Exhaust Oxygen tolerance is ± 0.5; Lambda tolerance is ± 0.05. Lambda and Exhaust Oxygen level are the result of adjusting the engine to operate at the specified NOx level.
19. LHV rate tolerance is ± 3.0%.
20. Heat rejection to jacket water value displayed includes heat to jacket water alone. Value is based on treated water. Tolerance is ± 10% of full load data.
21. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
22. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
23. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
24. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
25. Heat rejection to aftercooler based on treated water. Tolerance is ±5% of full load data.
26. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
27. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2). Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.
28. Total Aftercooler Circuit heat rejection is calculated as: AC x ACHRF x 1.05. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.

ENGINE POWER (bhp):	1416	COOLING SYSTEM:	JW+OC, AC
ENGINE SPEED (rpm):	1800	AFTERCOOLER WATER INLET (°F):	130
EXHAUST MANIFOLD:	ASWC	JACKET WATER OUTLET (°F):	210

Free Field Mechanical and Exhaust Noise

SOUND PRESSURE LEVEL (dB)											
Octave Band Center Frequency (OBCF)											
100% Load Data			**dB(A)**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
Mechanical Sound	Distance from the Engine (ft)	3.3	100	95	96.6	92.8	94	96.1	93.3	90.1	84.4
		23.0	90.4	85.4	87	83.2	84.4	86.5	83.7	80.5	74.8
		49.2	85.1	80.1	81.7	77.9	79.1	81.2	78.4	75.2	69.5
Exhaust Sound	Distance from the Engine (ft)	4.9	115.4	104.7	105.7	112.4	110.6	108.3	108.2	108	106.1
		23.0	102	92.4	95.4	100.2	96.7	95.4	94.7	94.6	91.8
		49.2	95.4	85.8	88.8	93.6	90	88.8	88.1	87.9	85.2

SOUND PARAMETER DEFINITION:

Data Variability Statement:

Sound data presented by Caterpillar has been measured in accordance with ISO 6798 in a Grade 3 test environment. Measurements made inaccordance with ISO 6798 will result in some amount of uncertainty. The uncertainties depend not only on the accuracies with which sound pressurelevels and measurement surface areas are determined, but also on the 'near-field error' which increases for smaller measurement distances and lowerfrequencies. The uncertainty for a Grade 3 test environment, that has a source that produces sounds that are uniformly distributed in frequency over thefrequency range of interest, is equal to 4 dB (A-weighted). This uncertainty is expressed as the largest value of the standard deviation.

GE Oil & Gas
Reciprocating Compression

Manufacturer's Expected Exhaust Emissions and Performance Data

Date: July 28, 2015
Prepared For: Dominion Hastings - LE maximum load emissions
Engine: DPC-2803 LE
Ajax, Fuel Injected, Spark Ignited, Naturally Aspirated, 2-stroke lean burn (2SLB)

Specified Conditions:

	Site Altitude (FASL)	:	788
	Site Fuel Composition	:	Itemized on Page 2
	Ambient Temp For Defining Maximum Load	:	100 Degrees F
	Average Ambient Temp For Defining Exhaust Emissions	:	100 Degrees F
	Bore x Stroke (in)	:	15 x 16
	No. of Cylinders	:	3
	Site Rated Speed (RPM)	:	440
	Exhaust System	:	Premium Catalyst*
	Site Rated Load (BHP) (BHP available at engine)	:	542
	Site Rated Load (BMEP, psi)	:	57.5
NOx	g/bhp-hr	:	1.0
	ppmvd @ 15% O2	:	70
	lb/hr	:	1.19
	Tpy	:	5.2
CO	g/bhp-hr	:	2.0
	ppmvd @ 15% O2	:	230
	lb/hr	:	2.39
	Tpy	:	10.5
VOC	g/bhp-hr	:	0.7
	ppmvd @ 15% O2	:	51
	lb/hr	:	0.84
	Tpy	:	3.7
H2CO	g/bhp-hr	:	0.08
	ppmvd @ 15% O2	:	8
	lb/hr	:	0.10
	Tpy	:	0.40
	BSFC - Btu/Bhph	:	7914
	Exhaust Stack Inside Diameter - in	:	17.3
	Exhaust Stack Height - in	:	241.00
	Exhaust Gas Temp @ Stack - ºF	:	574
	Exh. Velocity @ Stack - ft /min	:	2756
	Exhaust Gas Flow @ Stack - acfm	:	4473
	Exhaust Gas Flow @ Stack - lb/min	:	171.9
	Exhaust Oxygen Concentration (vol%, dry)	:	14.5
	Exhaust Gas Moisture Content (% H2O)	:	6.7

Manufacturer's Expected Exhaust Emissions and Performance Data

Fuel Composition:

Compound	Formula	Mole %
Nitrogen	N2	0.2796
Carbon Dioxide	CO2	0.2476
Oxygen	O2	0.0000
Helium	He	0.0000
Hyd. Sulfide	H2S	0.0000
Methane	CH4	95.1116
Ethane	C2H6	3.9371
Propane	C3H8	0.3289
Iso – Butane	i-C4	0.0406
n - Butane	n-C4	0.0262
Iso - Pentane	i-C5H12	0.0063
n - Pentane	n-C5h12	0.0090
n-Hexane	C6H14	0.0130
n-Heptane	n-C7H16	0.0000
n-Octane	n-C8H18	0.0000
	Total Volume % =	100.00
	NBN =	1.81

The above emissions and performance data is contingent on:

1.) Using a GE supplied Oxidation Catalyst, when specified, and using Catalyst Friendly oil as specified Ajax instruction manual.

2.) Insulated exhaust pipes and Silencer insulated up to the Catalyst.

3.) No changes in the as quoted site conditions per specified site conditions and fuel composition above.

4.) GE Engine must be maintained in good working order per operating specifications outlined in GE engineering specification ES 4019.

5.) GE Engineering approved engine upgrades must meet Ajax specifications and installation guidelines.

6.) Engine operating parameters must be consistent with those specified in the Ajax instruction manual.

7.) Performance tests shall be conducted at 100% of the site rated load (+/-10%)

8.) Test data shall be taken from test ports located in the tailpipe of GE supplied exhaust silencer

9.) Emissions Test protocol shall follow:

- a.) NOx emissions: 40 CFR Part 60, Appendix A, Method 7e
- b.) CO emissions: 40 CFR Part 60, Appendix A, Method 10
- c.) VOC (NMNEHC) emissions: 40 CFR Part 60, Methods 25A and 18 or 40 CFR Part 60 Method 25A and 40 CFR Part 63 Method 320
- d.) HCHO emissions: 40 CFR Part 63, Appendix A, Method 320 or Method 328

10.) Remediation of reported non-conformance to be mutually agreed upon between GE and purchaser.

Manufacturer's Expected Exhaust Emissions and Performance Data

Definition of Terms

NOx = Nitrogen Oxide as NO2
CO = Carbon Monoxide
VOC = Non-methane, Non-ethane and Non-formaldehyde concentration reported as Propane
Note: VOC definition is according to 40 CFR 60 Subpart JJJJ (Spark Ignited NSPS)
H2CO = Formaldehyde
g/bhp-hr = Grams per brake horsepower-hour
ppmvd = Parts per million volume on a dry basis corrected to 15% oxygen
Tpy= Tons per year @ 8760 hrs per year & 1 Ton = 2000 lbs
FASL = Feet Above Sea Level
ACFM = Actual Cubic Feet Per Minute
BSFC = Brake Specific Fuel Consumption, Btu / Bhp-hr, based on LHV
BMEP = Brake Mean Effective Pressure, psi
NBN = Normal Butane Number

*Catalyst Performance is guaranteed for one year.

For additional information, please contact Application Engineering at (405) 670-4121
GE Oil & Gas - Reciprocating Compression, 2101 SE 18th Street Oklahoma City, OK USA

GE Oil & Gas
Reciprocating Compression

Manufacturer's Expected Exhaust Emissions and Performance Data

Date: July 28, 2015
Prepared For: Dominion Hastings - LE Max load emissions
Engine: DPC-2802 LE
Ajax, Fuel Injected, Spark Ignited, Naturally Aspirated, 2-stroke lean burn (2SLB)

Specified Conditions:

	Site Altitude (FASL)	:	788
	Site Fuel Composition	:	Itemized on Page 2
	Ambient Temp For Defining Maximum Load	:	100 Degrees F
	Average Ambient Temp For Defining Exhaust Emissions	:	100 Degrees F
	Bore x Stroke (in)	:	15 x 16
	No. of Cylinders	:	2
	Site Rated Speed (RPM)	:	440
	Exhaust System	:	Premium Catalyst*
	Site Rated Load (BHP) (BHP available at engine)	:	347
	Site Rated Load (BMEP, psi)	:	55.2
NOx	g/bhp-hr	:	1.0
	ppmvd @ 15% O2	:	69
	lb/hr	:	0.77
	Tpy	:	3.4
CO	g/bhp-hr	:	2.0
	ppmvd @ 15% O2	:	228
	lb/hr	:	1.53
	Tpy	:	6.7
VOC	g/bhp-hr	:	0.7
	ppmvd @ 15% O2	:	51
	lb/hr	:	0.54
	Tpy	:	2.4
H2CO	g/bhp-hr	:	0.08
	ppmvd @ 15% O2	:	8
	lb/hr	:	0.06
	Tpy	:	0.30
	BSFC - Btu/Bhph	:	7973
	Exhaust Stack Inside Diameter - in	:	13.3
	Exhaust Stack Height - in	:	260.00
	Exhaust Gas Temp @ Stack - ºF	:	577
	Exh. Velocity @ Stack - ft /min	:	2961
	Exhaust Gas Flow @ Stack - acfm	:	2836
	Exhaust Gas Flow @ Stack - lb/min	:	114.6
	Exhaust Oxygen Concentration (vol%, dry)	:	14.7
	Exhaust Gas Moisture Content (% H2O)	:	6.5

Manufacturer's Expected Exhaust Emissions and Performance Data

Fuel Composition:

Compound	Formula	Mole %
Nitrogen	N2	0.2796
Carbon Dioxide	CO2	0.2476
Oxygen	O2	0.0000
Helium	He	0.0000
Hyd. Sulfide	H2S	0.0000
Methane	CH4	95.1116
Ethane	C2H6	3.9371
Propane	C3H8	0.3289
Iso – Butane	i-C4	0.0406
n - Butane	n-C4	0.0262
Iso - Pentane	i-C5H12	0.0063
n - Pentane	n-C5h12	0.0090
n-Hexane	C6H14	0.0130
n-Heptane	n-C7H16	0.0000
n-Octane	n-C8H18	0.0000
	Total Volume % =	100.00
	NBN =	1.81

The above emissions and performance data is contingent on:

1.) Using a GE supplied Oxidation Catalyst, when specified, and using Catalyst Friendly oil as specified Ajax instruction manual.
2.) Insulated exhaust pipes and Silencer insulated up to the Catalyst.
3.) No changes in the as quoted site conditions per specified site conditions and fuel composition above.
4.) GE Engine must be maintained in good working order per operating specifications outlined in GE engineering specification ES 4019.
5.) GE Engineering approved engine upgrades must meet Ajax specifications and installation guidelines.
6.) Engine operating parameters must be consistent with those specified in the Ajax instruction manual.
7.) Performance tests shall be conducted at 100% of the site rated load (+/-10%)
8.) Test data shall be taken from test ports located in the tailpipe of GE supplied exhaust silencer
9.) Emissions Test protocol shall follow:
    a.) NOx emissions: 40 CFR Part 60, Appendix A, Method 7e
    b.) CO emissions: 40 CFR Part 60, Appendix A, Method 10
    c.) VOC (NMNEHC) emissions: 40 CFR Part 60, Methods 25A and 18 or 40 CFR Part 60 Method 25A and 40 CFR Part 63 Method 320
    d.) HCHO emissions: 40 CFR Part 63, Appendix A, Method 320 or Method 328
10.) Remediation of reported non-conformance to be mutually agreed upon between GE and purchaser.

Manufacturer's Expected Exhaust Emissions and Performance Data

Definition of Terms

NOx = Nitrogen Oxide as NO2
CO = Carbon Monoxide
VOC = Non-methane, Non-ethane and Non-formaldehyde concentration reported as Propane
Note: VOC definition is according to 40 CFR 60 Subpart JJJJ (Spark Ignited NSPS)
H2CO = Formaldehyde
g/bhp-hr= Grams per brake horsepower-hour
ppmvd = Parts per million volume on a dry basis corrected to 15% oxygen
Tpy= Tons per year @ 8760 hrs per year & 1 Ton = 2000 lbs
FASL = Feet Above Sea Level
ACFM = Actual Cubic Feet Per Minute
BSFC = Brake Specific Fuel Consumption, Btu / Bhp-hr, based on LHV
BMEP = Brake Mean Effective Pressure, psi
NBN = Normal Butane Number

*Catalyst Performance is guaranteed for one year.

For additional information, please contact Application Engineering at (405) 670-4121
GE Oil & Gas - Reciprocating Compression, 2101 SE 18th Street Oklahoma City, OK USA

Attachment O

Attachment O

Monitoring, Recordkeeping, Reporting, Testing Plans.

Dominion Transmission, Inc. will comply all of the monitoring, recordkeeping, reporting, and testing requirements established in the issued permit for Mockingbird Hill Station.

Attachment P

AIR QUALITY PERMIT NOTICE
Notice of Application

Notice is given that Dominion Transmission, Inc. has applied to the West Virginia Department of Environmental Protection, Division of Air Quality, for a General Permit for a compressor station operation located in Pine Grove, Wetzel County, West Virginia. The latitude and longitude coordinates are: 39.54814 and -80.66666.

The applicant estimates the maximum potential to discharge the following regulated air pollutants on a facility-wide basis will be:

Carbon Monoxide (CO) = 58.58 tpy
Nitrogen Oxides (NO_x) = 55.54 tpy
Particulate Matter ($PM_{Filterable}$) = 8.81 tpy
Particulate Matter ($PM_{Condensable}$) = 21.77 tpy
Particulate Matter ($PM_{2.5}$) = 8.81 tpy
Particulate Matter (PM_{10}) = 8.81 tpy
Sulfur Dioxide (SO_2) = 5.17 tpy
Formaldehyde (CH_2O) = 0.95 tpy
Volatile Organic Compounds (VOC) = 29.91 tpy
Benzene = 0.001 tpy
Toluene = 0.001 tpy
Ethylbenzene = <0.001 tpy
Xylene = <0.001 tpy
Hazardous Air Pollutants (HAPs) = 3.49 tpy
Carbon Dioxide Equivalents (CO_2e) = 208,563 tpy

Written comments will be received by the West Virginia Department of Environmental Protection, Division of Air Quality, 601 57th Street, SE, Charleston, WV 25304, for at least 30 calendar days from the date of publication of this notice.

Any questions regarding this permit application should be directed to the DAQ at (304) 926-0499, extension 1227, during normal business hours.

Dated this the 18th day of September, 2015.

By: Dominion Transmission, Inc.
Robert Bisha
Project Director Supply Header Project
500 Dominion Blvd.
Glen Allen, VA 23060

Attachment Q

Attachment Q
Business Confidential Claims

There is no confidential information associated with this permit application.

Attachment R

Attachment R
Authority Forms

Since this application is signed by the "Responsible Official", this section is not applicable.

Attachment S

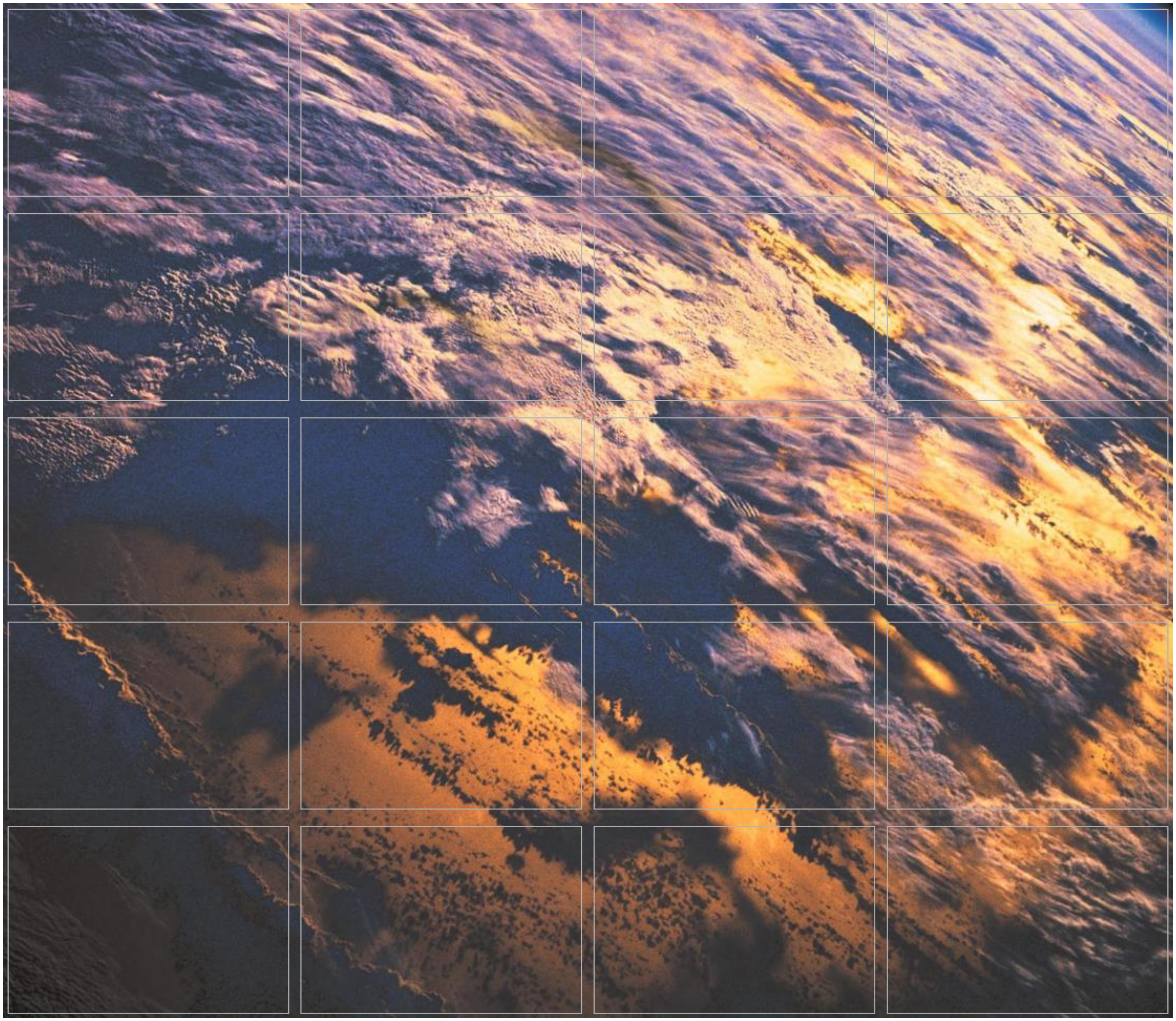
Attachment S

Title V Permit Revision Information

An Attachment S is not being provided with this permit application since the site does not currently possess a Title V Permit.

APPENDIX B

AIR MODELING RESULTS



Dominion Transmission, Inc.

Mockingbird Compressor Station
Air Quality Modeling Report

Wetzel County, West Virginia

September 2015

Environmental Resources Management
75 Valley Stream Parkway, Suite 200
Malvern, PA 19355
www.erm.com

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APPENDICES

1.0 INTRODUCTION

Dominion Transmission, Inc. (Dominion) submits this air quality modeling report to support an air quality permit application that is being submitted to WVDEP. The application is being submitted to authorize the development of an expansion of the existing Mockingbird Hill Compressor Station in Wetzel County, West Virginia. The proposed Mockingbird Hill Expansion is located at approximately 39° 33′ 8″ and 80° 39′ 46″. A general area map showing the proposed location of the facility, as well as the general layout of the existing and proposed facility is provided in Appendix A of this report. An air quality modeling protocol was submitted to WVDEP on July 2, 2015, followed by a revised protocol on September 1, 2015 (September 2015 protocol). The revised protocol described the assumptions and procedures that were utilized in the air quality modeling analysis presented in this report. The September 2015 protocol is included as Attachment 1 of this report.

1.1 PROJECT OVERVIEW

Dominion proposes to construct an expansion of the existing Mockingbird Hill Compressor Station located in Wetzel County, WV. This project will involve the installation of two new combustion turbines (CTs), each rated at 20,500 bhp each, that will power the natural gas compressing operation at the proposed facility, and auxiliary boiler, and an emergency generator.

1.2 OVERVIEW OF METHODOLOGY

Table 1-1 provides a summary of the attainment status of Wetzel County, West Virginia. The attainment status determines which regulatory programs new major sources or modifications to existing sources must address in the context of obtaining an air quality construction permit. Table 1-2 provides a summary of the regulatory program(s) that must be addressed for each regulated pollutant that will be emitted by the Project. Pollutants with emission levels that trigger Non-attainment New Source Review (NA-NSR) requirements are subject to additional control (Lowest Achievable Emission Rate, LAER) and emissions offset requirements but are not required to conduct air quality dispersion modeling. Pollutants from this Project do not trigger NA-NSR requirements. In attainment areas, pollutants that trigger the significant emission rate (SER) must address requirements of the Prevention of Significant Deterioration (PSD) program.

Table 1-1 Attainment Status of Wetzel County, West Virginia

Pollutant	Attainment Status of Wetzel County, West Virginia
SO_2 (annual)	Unclassifiable/Attainment
SO_2 (1-hr)	Unclassifiable/Attainment
CO	Unclassifiable/Attainment
Pb	Unclassifiable/Attainment
O_3 (1-hr)	Unclassifiable/Attainment
PM_{10}	Unclassifiable/Attainment
NO_2 (annual)	Unclassifiable/Attainment

Pollutant	Attainment Status of Wetzel County, West Virginia
NO_2 (1-hr)	Unclassifiable/Attainment
O_3 (8-hr)	Unclassifiable/Attainment
$PM_{2.5}$ (annual)	Unclassifiable/Attainment
$PM_{2.5}$ (24-hr)	Unclassifiable/Attainment

Table 1-2 Project-Related Significant Emissions Increases

Pollutant	Project Emissions (tons/yr)	PSD SER
PM_{10}	30.6	15
$PM_{2.5}$	30.6	10

Emissions from the proposed project exceed the PSD SERs for PM_{10} and $PM_{2.5}$, dispersion modeling was performed for PM_{10} and $PM_{2.5}$ to assess the ambient air impacts resulting from the Project emissions increases. A complete assessment of emissions increases for all criteria pollutants with respect to the PSD SERs is included in the air quality permit application submitted to WVDEP coincident with this modeling report. The modeling analyses presented in this report addresses compliance with the National Ambient Air Quality Standards (NAAQS) and PSD increments, as applicable. The modeling analyses described in this report conform to Appendix W of 40 CFR Part 51 (Guideline on Air Quality Models). The September 2015 protocol described the assumptions and procedures utilized in the air quality modeling analyses in detail. The September 2015 protocol is included as Attachment 1 of this report. The key elements of the modeling analyses are:

- Use of the latest version of AERMOD (version 15181);
- Use of input meteorological data from North Central West Virginia Airport (KCKB) from 2010 to 2014;
- Use of upper air data from Pittsburgh, PA;
- Application of the latest version of AERSURFACE as recommended in the USEPA AERMOD Implementation Guidance (USEPA 2009);
- Develop a comprehensive receptor grid designed to identify maximum modeled concentrations;
- Conduct air quality modeling to determine the magnitude and location of ambient concentrations due to emissions from the Project;
- In accordance with PSD requirements, determine whether emissions from the Project that are subject to PSD will have an effect on growth, soils, vegetation, and visibility in the vicinity of the Project;
- Compare maximum predicted impacts to relevant Significant Impact Levels (SILs) and Significant Monitoring Concentrations (SMCs) to determine if additional modeling or monitoring is required.

2.0 PROJECT EMISSIONS AND SOURCE CHARACTERIZATION

The Mockingbird Hill Expansion Project will have an increase in emissions of PM_{10} and $PM_{2.5}$ that exceed the significant emission rates (SERs) for PSD applicability. The emissions increase of PM_{10} and $PM_{2.5}$ includes contemporaneous emissions increases from the existing Mockingbird Hill/Lewis Wetzel/Hastings Compressor Station complex. Table 2-1 presents the stack characteristics and emission rates on a source by source basis, including the project sources, contemporaneous sources, and existing sources.

Table 2-1 Emissions and Stack Parameters – Proposed Project Sources and Existing Sources

Source	Facility	Model ID	Stack Height (ft.)	Exit Diameter (ft.)	Exit Gas Velocity (ft./sec)	Exit Gas Flow Rate (acfm)	Exit Gas Temp. (°F)	$PM_{2.5}/PM_{10}$ (lb/hr)	$PM_{2.5}/PM_{10}$ (tpy)
Project Sources									
Solar Titan 130 Turbine	Mockingbird - New	TRB1	70	10.0	54.10	254,955	900	3.46	15.16
Solar Titan 130 Turbine	Mockingbird - New	TRB2	70	10.0	54.10	254,955	900	3.46	15.16
Boiler	Mockingbird - New	AUXB	28	0.7	247.35	5,232	838	0.05	0.23
Caterpillar G3516 Emergency Generator	Mockingbird - New	EGEN	8	0.5	61.12	720	840	0.01	0.03
Contemporaneous Sources									
Generac Model QT080 Natural Gas-Fired Emergency Generator (002-006)	Hastings	AUX6	5	0.5	61.12	720	840	0.0018	0.0054
CAT 3612 Compressor Engine	Lewis Wetzel	EN03	45	1.0	505.24	23,809	838	0.55	2.43
Cummins KTA19G Aux. Generator	Lewis Wetzel	AZ05	10	1.0	66.21	3,120	1286	0.09	0.38
Bryan Model RV 450W-FDG Boiler	Lewis Wetzel	BLR5	18	0.7	247.35	5,232	838	0.06	0.26
Existing Sources									
Solar Taruus 60 Turbine	Mockingbird	TB02	50	4.0	145.89	110,000	900	2.69	11.78
Capstone C60 Microturbines / Aux. Generator	Mockingbird	AXG2	12	0.7	247.35	5,232	725	0.03	0.13
Capstone C60 Microturbines / Aux. Generator	Mockingbird	AXG3	12	0.7	247.35	5,232	725	0.03	0.13
Capstone C60 Microturbines / Aux. Generator	Mockingbird	AXG4	12	0.7	247.35	5,232	725	0.03	0.13
Boiler	Mockingbird	BLR2	18	0.7	247.35	5,232	838	0.04	0.18
Recip. Engine - Copper GMXE-6	Hastings	EN01	25	1.4	45.67	4,473	574	0.01	0.04
Recip. Engine - Copper GMXE-6	Hastings	EN02	25	1.4	45.67	4,473	574	0.01	0.04
Dehydration Unit Flare	Hastings	DEHY	17	0.7	33.09	700	950	0.03	0.13
Heater; Natco 96x30	Hastings	HTR1	24	2.0	42.44	8,000	725	0.08	0.35

The primary project sources of emissions of $PM_{2.5}/PM_{10}$ are the two new proposed Solar Titan 130 turbines. The emissions and stack characteristics for these turbines presented in Table 2-1 represent the turbines operating at full load. Typical operation of the proposed turbines will be at full load. The worst case emissions profile for $PM_{2.5}/PM_{10}$ for these units on a 24-hr basis and annual basis will be 24 continuous hours of operation at full load for every day of the year. Accounting for scenarios involving partial loads or startup and shutdown operations during would not result in higher $PM_{2.5}/PM_{10}$ emissions during any 24-hr or annual operating period, compared to continuous operation at full load. While Solar does acknowledge the potential for higher NO_x, CO, and VOC during startup, shutdown and low-load conditions, the emission rate for $PM_{2.5}/PM_{10}$ does not change during these times. Therefore, the full load scenario is the only scenario that was accounted for in the air quality modeling analysis as this represents the worst case emissions scenario.

3.0 MODELING METHODOLOGY

As stated previously, the methodology and assumptions utilized in the air quality modeling analyses described in this report were included in the September 2015 protocol. This section is provided as part of this report for ease of reference. Detailed discussion referred to in this section is provided in their entirety in the September 2015 protocol in Attachment 1 of this report.

3.1 MODEL SELECTION AND APPLICATION

The latest version of USEPA's AERMOD model (version 14134) was used for predicting ambient impacts for each modeled pollutant. Regulatory default options were used in the analysis. The highest predicted impacts (H1H) were used as the design concentrations in the SIL analyses.

The design concentrations for the NAAQS and PSD increment modeling analyses followed the form of the NAAQS for each applicable pollutant and averaging period. For the PSD increment, the H2H values will be used for the 24-hr averaging period.

3.2 AMBIENT AIR QUALITY STANDARDS

Table 3-1 presents a summary of the air quality standards that were addressed for PM_{10} and $PM_{2.5}$. The SILs are presented, along with the SMCs, PSD increments, and NAAQS. If Project impacts are shown to be less than the SILs and SMCs, then no further analysis is required. If the SILs are exceeded, additional analysis will be necessary including the development of a background source inventory and background measured concentrations.

Table 3-1 Ambient Air Quality Standards

	Averaging Period	SIL	SMC	PSD Increment	NAAQS
PM_{10}	24 Hour	5	10	30	150
	Annual	1	-	17	-
$PM_{2.5}$	24 Hour	1.2	-	9	35
	Annual	0.3	-	4	12
NOTE: All concentrations are shown in micrograms/cubic meter ($\mu g/m^3$)					

The September 2015 protocol included a discussion of the $PM_{2.5}$ SILs. In January 2013, USEPA also remanded the Significant Impact Level (SIL) for $PM_{2.5}$. USEPA intends to revise the approach to how the SIL is implemented. In the interim, widely accepted practice for PSD permitting is to continue to use the $PM_{2.5}$ SILs as benchmarks to determine a project's de-minimis standing with respect to the $PM_{2.5}$ NAAQS, but also to ensure that a project's modeled impacts do not exceed the NAAQS (despite being less than the SIL) when added to an existing representative background value of $PM_{2.5}$. Dominion has used this practice as part of the air quality modeling analysis, specifically, that the project's modeled concentrations of directly emitted $PM_{2.5}$ are both less than the levels of the SIL, but also less than the NAAQS when added to a representative background $PM_{2.5}$ concentration, obtained from a representative $PM_{2.5}$ monitor in Marion County, WV (Monitor ID # 54-049-0006). A discussion of the representativeness of the Marion County $PM_{2.5}$ monitor data to the region of the Mockingbird Hill station was provided in the September 2015 protocol.

3.3 GEOGRAPHIC SETTING

3.3.1 Land Use Characteristics

The Mockingbird Hill station is located in a rural setting. Therefore, AERMOD was used in the default (rural) mode. Dominion has analyzed the land use classifications within an area defined by a 3 km radius from the approximate center of the site, and has determined that the land use within this area is less than 1% urban classification. This determination was used by analyzing the USGS NLCD 1992 data, where urban classifications were assumed to be category 21 (high intensity residential) and category 23 (commercial/industrial/ transportation). A graphical representation of this land use analysis is presented in Appendix B of this report.

3.3.2 Terrain

Terrain elevations and hill scale heights for each receptor were determined for use in this analysis. The latest version of USEPA's AERMAP program (version 11103) was used to determine the ground elevation and hill scale for each receptor, based on data obtained from the USGS National Elevation Database (NED) at a 10-m resolution.

3.4 RECEPTOR GRID

A comprehensive Cartesian receptor grid extending to approximately 20 kilometers (km) from the new Mockingbird Hill site was used in the air quality modeling analysis to assess maximum ground-level pollutant concentrations. The Cartesian receptor grid consists of the following receptor spacings:

- 50-meter spacing along the fence line and extending to 1.8 km from the facility;
- 100-meter spacing from 1.8 km to 2.5 km from the facility;
- 250-meter spacing from 2.5 km to 4 km from the facility;
- 500-meter spacing from 4 km to 10 km from the facility;
- 1000-meter spacing from 10 km to 20 km from the facility.

As noted previously, AERMAP was used to define ground elevations and hill scales for each receptor. Dominion analyzed isopleths of modeled concentrations due to the proposed project to determine if the proposed receptor grid adequately accounted for the worst case impacts. Dominion did not need to make any adjustments to the receptor grid proposed in the modeling protocol.

3.5 METEOROLOGICAL DATA FOR AIR QUALITY MODELING

Surface meteorological data from North Central West Virginia Airport (KCKB), along with upper air data from Pittsburgh, PA for the years 2010-2014 were used in this air quality modeling analysis. The AERMET (version 15181) meteorological processor and associated programs AERMINUTE and AERSURFACE were used to process the data for use as input into AERMOD. Section 3.7 of the September 2015 protocol contained a detailed description of the methodologies used in the AERMET processing, and a justification for the representativeness of the meteorological data to the area of the Mockingbird Hill Expansion Project. As described in the September 2015 protocol, the KCKB meteorological data were processed using surface roughness values for both the KCKB ASOS site as well as the Mockingbird Hill expansion site. Both sets of meteorological data were then used in the air quality modeling analyses in order to "bound" the modeling analysis by applying roughness values for both the site and the airport. This method is a reasonable measure to ensure that the most conservative model results are obtained when the comparison of surface roughness values for the airport and application site showed noted discrepancies, as described in the September 2015 protocol.

3.6 BUILDING WAKE EFFECTS

The USEPA's Building Profile Input Program (BPIP), Version 04274, was used to calculate downwash effects for the modeled emission sources. Building locations and heights relative to the modeled sources were determined as input into BPIP. A graphical representation of the building downwash analysis is presented in Appendix C of this report. The new combustion turbine stacks will not exceed the greater of the GEP formula height calculated by BPIP or 65 m (213 feet).

4.0 RESULTS OF AIR QUALITY MODELING ANALYSIS

Two criteria pollutants were modeled, specifically $PM_{2.5}$ and PM_{10}. Maximum ground level model design values were identified for the appropriate averaging periods and assessed against the SILs. The NAAQS and PSD increments were then evaluated as necessary.

As mentioned in Section 3.5, all of the model runs were conducted using two different scenarios: one run using meteorological data with the default approach of surface roughness derived from the 1-km radius surrounding the ASOS site at the KCKB airport, and another run using meteorological data with surface roughness derived from the 1-km radius surrounding the Project site. The results using both of these approaches are presented in the following sections of the report.

4.1 SIGNIFICANCE MODELING RESULTS

The first highest modeled concentration for each pollutant and averaging period was used to assess its significance. Tables 4-1 and 4-2 summarize the results of this analysis. 24-hour and annual $PM_{2.5}$ as well as 24-hour and annual PM_{10} were all modeled above their respective SIL values in the airport surface roughness runs, and therefore will require further assessment with cumulative impact modeling. Only 24-hour $PM_{2.5}$ and PM_{10} and annual $PM_{2.5}$ exceeded the SIL for the runs with site surface roughness. Plots of the modeled concentrations for the airport surface roughness runs are displayed in Figures 4-1 through 4-3.

In addition to comparison to the SILs, 24-hour PM_{10} was also compared to its SMC. Because the modeled concentration is less than the SMC limit of 10 $\mu g/m^3$, no preconstruction monitoring will be required for the Project.

Table 4-1 SIL Modeling Results – Airport Surface Roughness

Pollutant	Averaging Period	Class II SIL	Maximum Modeled Concentration
		$\mu g/m^3$	$\mu g/m^3$
$PM_{2.5}$	24-hour	1.2	7.13
	Annual	0.3	0.88
PM_{10}	24-hour	5	9.58
	Annual	1	1.02

Table 4-2 SIL Modeling Results – Site Surface Roughness

Pollutant	Averaging Period	Class II SIL	Maximum Modeled Concentration
		µg/m³	µg/m³
$PM_{2.5}$	24-hour	1.2	4.71
	Annual	0.3	0.84
PM_{10}	24-hour	5	5.53
	Annual	1	0.98

Figure 4-1 PM_{10} 24-hour SIL Concentrations

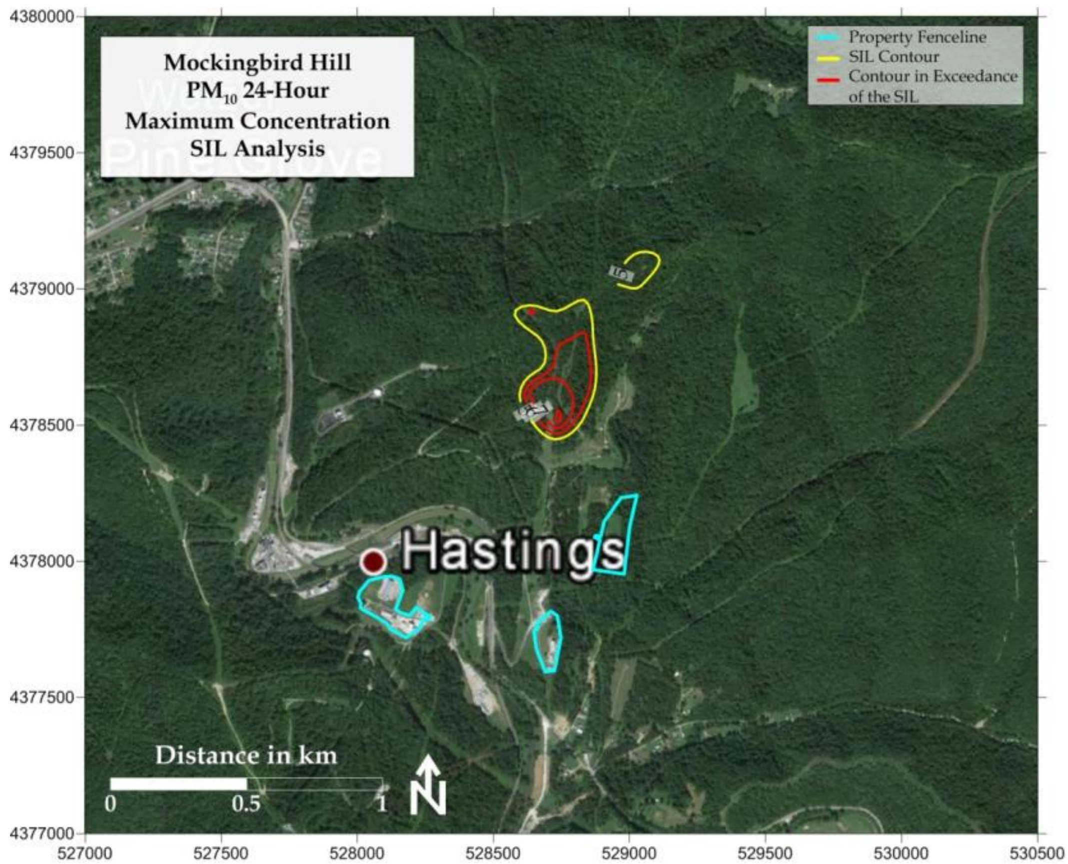


Figure 4-2 $PM_{2.5}$ 24-hour SIL Concentrations

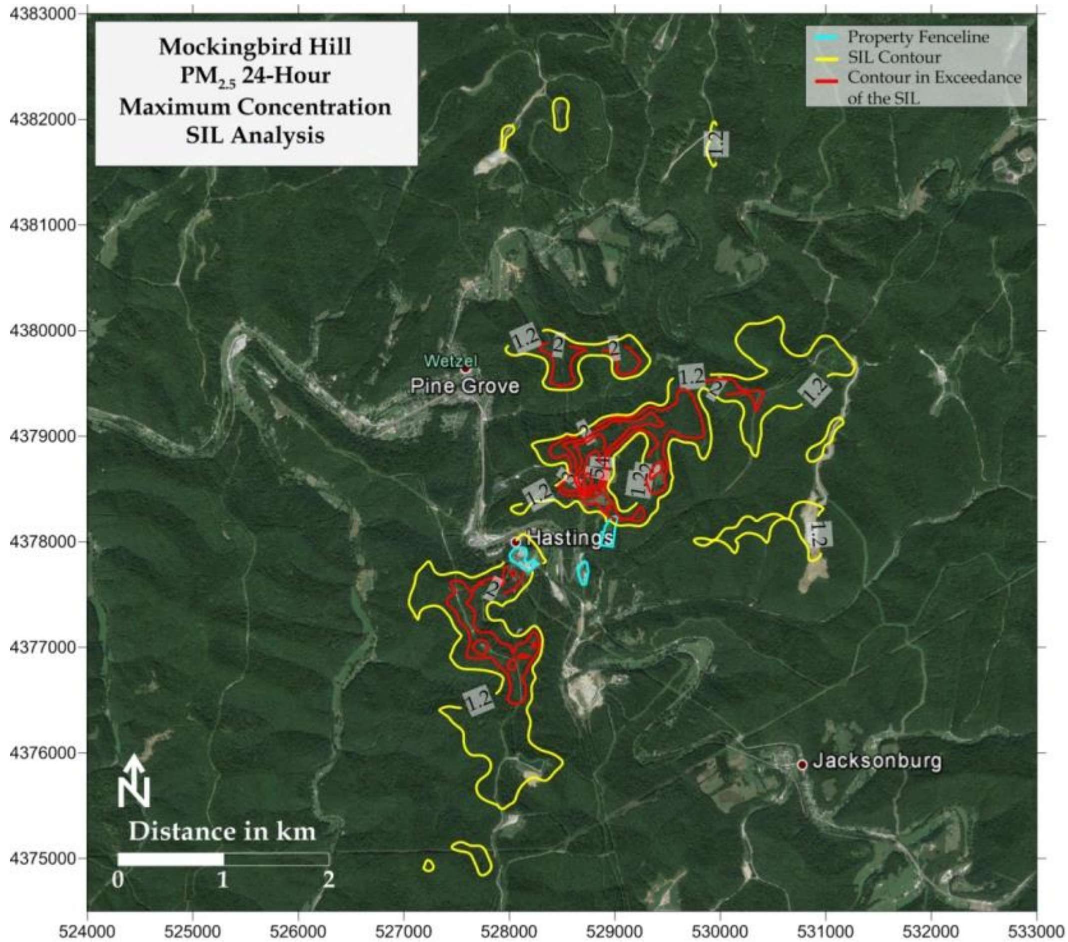
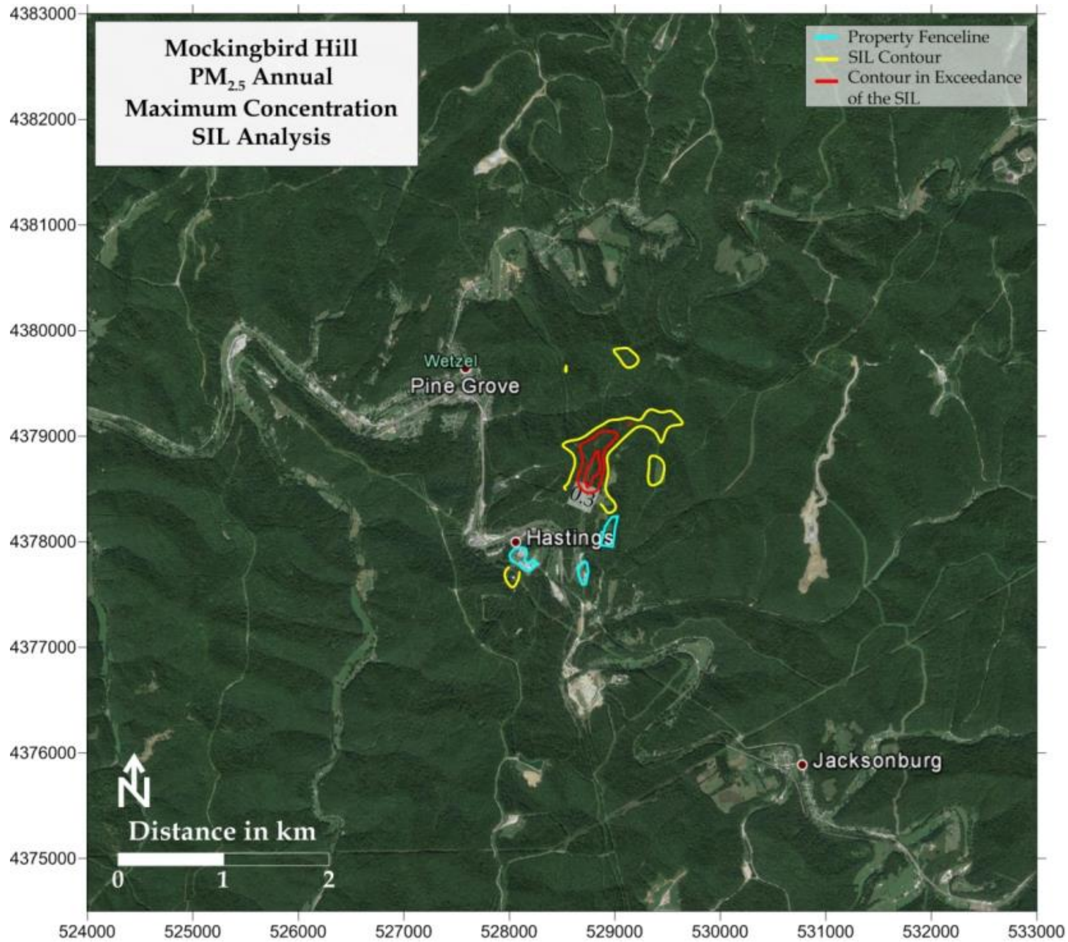


Figure 4-3 $PM_{2.5}$ Annual SIL Concentrations



4.2 CUMULATIVE MODELING INVENTORY

Regional major stationary sources (Title V source) within 20-km of the Mockingbird Hill Expansion Site were used to develop a cumulative modeling inventory for PM_{10}/$PM_{2.5}$. The following regional sources have been identified by Dominion for inclusion in the cumulative air quality modeling analysis. Distances noted are from the proposed Mockingbird Hill Expansion Site:

- Dominion Hasting Extraction Plant (Separate Title V from Hastings/Lewis Wetzel/Mockingbird Hill Compressor Station) – 1.27 km
- Equitrans Logansport #49 Compressor Station – 9.8 km
- Columbia Gas Smithfield Compressor Station – 13.4 km
- Wetzel County Sanitary Landfill – 17.5 km

Stack parameters and emission rates for these sources are summarized in Appendix D of this report.

4.3 NAAQS AND PSD INCREMENT MODELING RESULTS

For the cumulative modeling analysis, background concentrations were determined for 24-hour and annual $PM_{2.5}$ and 24-hour PM_{10}. These background values are provided in Table 4-3 below, and were chosen based on their proximity and representativeness with respect to the Project location. A more thorough description of the monitor selection was provided in the September 2015 protocol.

Table 4-3 Background Concentrations

Pollutant	Averaging Period	Monitor ID	Location Name	Monitor County, State	Distance to Site (km)	Background Value (μg/m³)	Design Value Basis
$PM_{2.5}$	24-hour	54-049-0006	Fairmont, WV	Marion County, WV	46	19	2014 Design Value
$PM_{2.5}$	Annual	54-049-0006	Fairmont, WV	Marion County, WV	46	9.7	2014 Design Value
PM_{10}	24-hour	39-081-0001	Brilliant, OH	Jefferson County, OH	80	42	3-yr Average of 2nd Highest (2012-2014)

Project sources were modeled along with existing, contemporaneous, and offsite $PM_{2.5}$ and PM_{10} emissions sources. The entire receptor grid was included in the cumulative analysis as a conservative measure, rather than including only the significant receptors determined from the SIL analysis. The design value of the modeling results were combined with the appropriate background value and then compared to their respective NAAQS. The results of this analysis are provided in Tables 4-4 and 4-5 below.

Table 4-4 NAAQS Modeling Results – Airport Surface Roughness

Pollutant	Averaging Period	Model Design Value	Background Concentration	Total Concentration	NAAQS	Maximum Dominion Contribution to any NAAQS Exceedance
		μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
$PM_{2.5}$	24-hour	7.8	19.0	26.8	35	N/A
	Annual	3.0	9.7	12.7	12	0.065
PM_{10}	24-hour	83.5	42	125.5	150	N/A

Table 4-5 NAAQS Modeling Results – Site Surface Roughness

Pollutant	Averaging Period	Model Design Value	Background Concentration	Total Concentration	NAAQS	Maximum Dominion Contribution to any NAAQS Exceedance
		μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
$PM_{2.5}$	24-hour	4.9	19.0	23.9	35	N/A
	Annual	1.8	9.7	11.5	12	N/A
PM_{10}	24-hour	47.8	42	89.8	150	N/A

The results for annual $PM_{2.5}$ using the default meteorological data show an exceedance of the annual NAAQS. However, this exceedance is located at only one receptor approximately 18 km from the site. This receptor is located directly over one of the offsite modeled locations, the Wetzel County Sanitary Landfill, and was included in the cumulative analysis despite the fact that it did not exceed the SIL when modeling the project only contributions. The Project's contribution from the new, existing and contemporaneous sources to the NAAQS exceedance is below the SIL of 0.3. It can therefore be concluded that the Project does not significantly contribute to this modeled exceedance of the annual $PM_{2.5}$ NAAQS.

The modeled contributions of the Project, new and contemporaneous sources in this instance, were also used in the increment analysis. The results of the increment analysis are shown below in Tables 4-6 and 4-7. All of the modeled concentrations are below the allowable increment for the Project.

Table 4-6 Increment Modeling Results – Airport Surface Roughness

Pollutant	Averaging Period	Model Design Value	Allowable Increment	Maximum Dominion Contribution to any Increment Exceedance
		μg/m³	μg/m³	μg/m³
$PM_{2.5}$	24-hour*	8.20	9	N/A
	Annual	1.02	4	N/A
PM_{10}	24-hour*	8.20	30	N/A
	Annual	1.02	17	N/A

* Highest 2nd Highest

Table 4-7 Increment Modeling Results – Site Surface Roughness

Pollutant	Averaging Period	Model Design Value	Allowable Increment	Maximum Dominion Contribution to any Increment Exceedance
		μg/m³	μg/m³	μg/m³
$PM_{2.5}$	24-hour*	4.69	9	N/A

Pollutant	Averaging Period	Model Design Value	Allowable Increment	Maximum Dominion Contribution to any Increment Exceedance
		µg/m³	µg/m³	µg/m³
	Annual	0.98	4	N/A
PM_{10}	24-hour*	4.69	30	N/A
	Annual	0.98	17	N/A

* Highest 2nd Highest

4.4 CLASS I ANALYSIS

The proposed Project is located within 300 km of four (4) federally protected Class I areas. All of these Class I areas are located generally to the east and southeast of the Project. A Q/D analysis, provided in Table 4-8, demonstrates that the ratios are below the FLM screening level of 10, therefore no AQRV analysis is required.

Table 4-8 Q/D Analysis

	Q (TPY)	D (km)	Q/D
Otter Creek Wilderness	90.87	102	0.89
Dolly Sods Wilderness		124	0.73
Shenandoah National Park		214	0.42
James River Face Wilderness		240	0.38

Q represents the PTE from the Mockingbord Hill Expansion Sources: 55.1 tpy NO_X, 5.17 tpy SO_2, 30.6 tpy $PM_{2.5}$

Dominion evaluated the project related increase of PM_{10} and $PM_{2.5}$ against the Class I SILs by applying the AERMOD dispersion model to a ring of receptors defined by a 50-km radius surrounding the Project site. The elevations for these receptors were determined by AERMAP for the receptor locations recommended by the National Park Service for the closest Class I area, Otter Creek. After the elevations for each Class I area receptor were determined with AERMAP, the maximum and minimum elevations were identified (and associated hill scale heights) for all Otter Creek receptors. These maximum and minimum elevations and associated hill scales were used as the elevation and hill scale for each receptor in the 50-km ring. Since both the maximum and minimum elevations were used, 720 total Class I receptors were modeled. The results of the Class I analysis are provided below in Table 4-9.

Table 4-9 Class I Modeling Results

Pollutant	Averaging Period	Class I SIL	Maximum Modeled Concentration
		μg/m³	μg/m³
$PM_{2.5}$	24-hour	0.07	0.018
	Annual	0.06	0.0014
PM_{10}	24-hour	0.3	0.018
	Annual	0.2	0.0014

The maximum modeled concentrations at the 50-km receptors are below the Class I SILs for PM_{10} and $PM_{2.5}$. These results prove that the project would also have maximum potential impacts that would be less than the SILs at the more distant Class I areas. Because the modeled concentrations are below the SILs, the project will have an insignificant impact to any Class I area.

4.5 ADDITIONAL IMPACTS ON GROWTH SOILS, VEGETATION, AND VISIBILITY

PSD requirements include an evaluation of the effects of growth due to a project, and an evaluation of the effects of the project emissions on soils, vegetation, and visibility.

The impact of the Mockingbird Hill Expansion Project on growth is not expected to be significant. The Project is expected to create approximately eight full time positions once the facility is constructed and operational. There will be no need for additional infrastructure (upgraded roads, housing developments, etc.) to account for these new positions. Therefore, no significant air quality or other environmental impacts are expected due to net population growth associated with this project.

Dominion notes that the result of the SILs and NAAQS analysis presented above demonstrate that the Project will not have a significant impact on air quality in the region. Therefore, the Project's impact on soils, vegetation, and visibility will be minimal. It should also be noted that the Project will comply with the applicable West Virginia visible emissions regulations, which will ensure that emissions from the proposed Project do not have adverse effects on local visibility. An analysis of potential project related visibility impacts for selected Class II areas in the vicinity of the proposed Project is included in Appendix E of this report.

4.6 CONCLUSIONS

The results of the air quality modeling analysis demonstrate that the proposed Mockingbird Hill Expansion Project and existing Dominion sources do not significantly contribute to any modeled exceedance of the PM_{10} and $PM_{2.5}$ NAAQS and PSD increments. For the sole modeled exceedance of the annual $PM_{2.5}$ NAAQS, the contribution due to Dominion sources is well under the annual $PM_{2.5}$ SIL. Dominion notes that the violating receptor is within the area source created to define the Wetzel County Landfill, and the landfill's emissions drive the modeled concentration that exceeds the annual NAAQS when added to a background annual monitored value of $PM_{2.5}$. Dominion believes that the landfill source could likely treat this receptor location as exclusive from ambient air, and therefore this modeled concentration should not be considered an actual modeled violation of the $PM_{2.5}$ annual NAAQS. However, since this receptor location cannot be considered exclusive of ambient air due to control by Dominion, it is included in this analysis for completeness purposes.

All relevant electronic modeling files are contained on CD-ROM in Appendix F of this report. The following summarizes the contents of the CD-ROM:

- AERMOD input and output files for all SIL and NAAQS analyses
- AERMAP input and output
- AERMET input and output, including all raw meteorological data
    - AERSURFACE input and output, including data sources used to derive moisture assumptions
    - Customized surface roughness calculation spreadsheet
- Relevant Title V permits and/or applications used to develop the cumulative NO_X inventory, including materials for regional sources excluded from the analysis
- BPIP input and output

5.0 REFERENCES

U.S. Environmental Protection Agency. (USEPA 2011) USEPA memo entitled "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard", USEPA, Office of Air Quality Planning and Standards, Raleigh, NC. March 1, 2011.

U.S. Environmental Protection Agency. (USEPA 2009) AERMOD Implementation Guide, AERMOD Implementation Workgroup. March 19, 2009.

U.S. Environmental Protection Agency. (USEPA 2013) AERSURFACE User's Guide, Office of Air Quality Planning and Standards, Raleigh, NC. January 2008, Revised 01/16/2013.

U.S. Environmental Protection Agency. (USEPA 2014) Guidance for $PM_{2.5}$ Permit Modeling, Memo from Stephen D. Page to Regional Air Division Directors, Office of Air Quality Planning and Standards, Raleigh, NC. May 20, 2014.

West Virginia Department of Environmental Protection. (WVDEP 2005) 2005 Air Quality Annual Report

West Virginia Department of Environmental Protection. (WVDEP 2008) 2008 Air Quality Annual Report

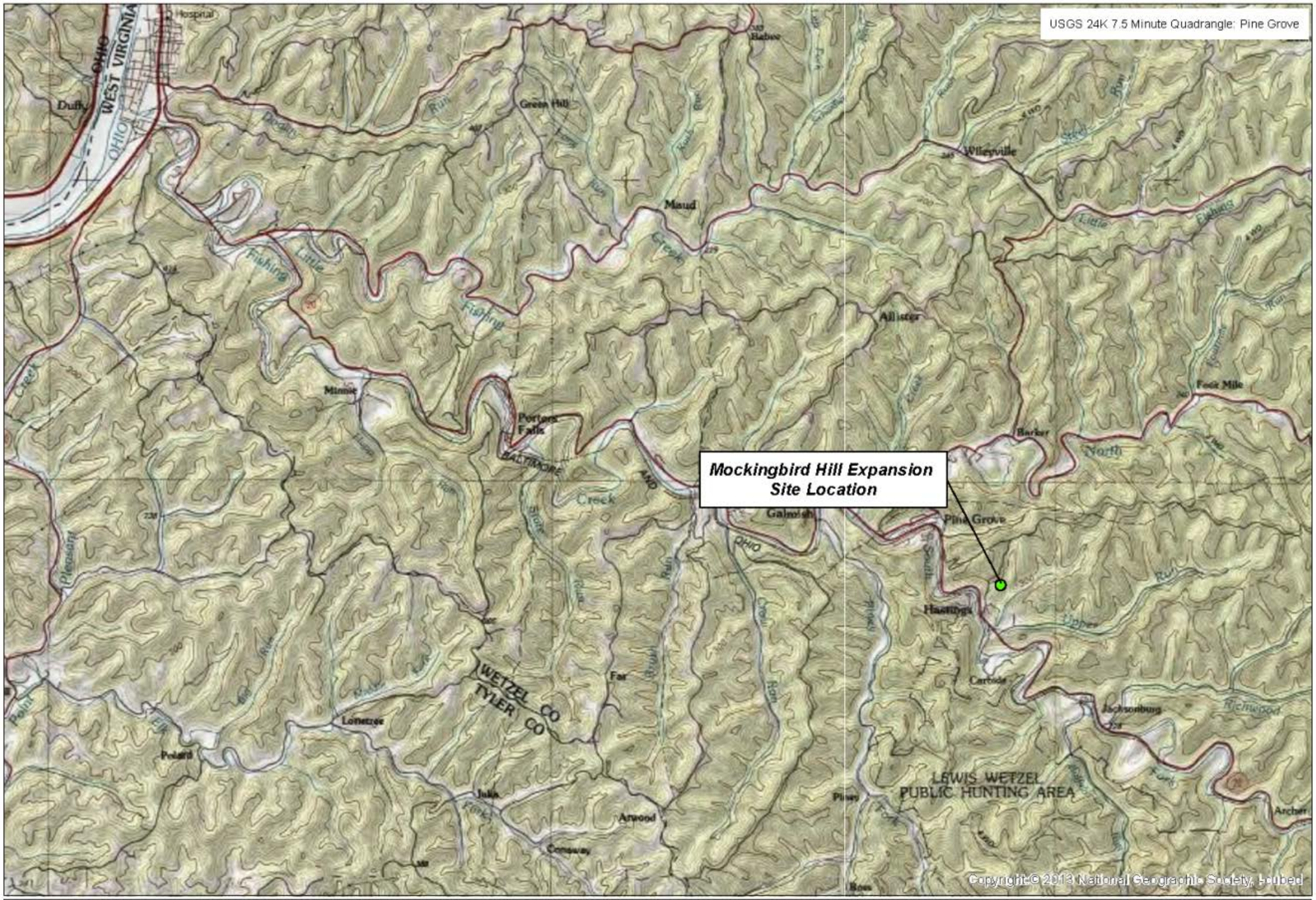
West Virginia Department of Environmental Protection. (WVDEP 2012) Resignation Request and Maintenance Plan for the West Virginia portion of the Wheeling, WV-OH 1997 $PM_{2.5}$ Nonattainment Area, March 2012

Environ International Corporation. (ENVIRON 2008) Technical Support Document for the Association for Southeastern integrated planning (ASIP) Emissions and Air Quality Modeling to Support $PM_{2.5}$ and 8-Hour ozone State Implementation Plans, March 24 2008

West Virginia Department of Environmental Protection. (WVDEP2009) Resignation Request and Maintenance Plan for the West Virginia portion of the Wheeling, WV-OH 1997 $PM_{2.5}$ Nonattainment Area – Appendix B, November 2009

Proposed Facility Location

Appendix A

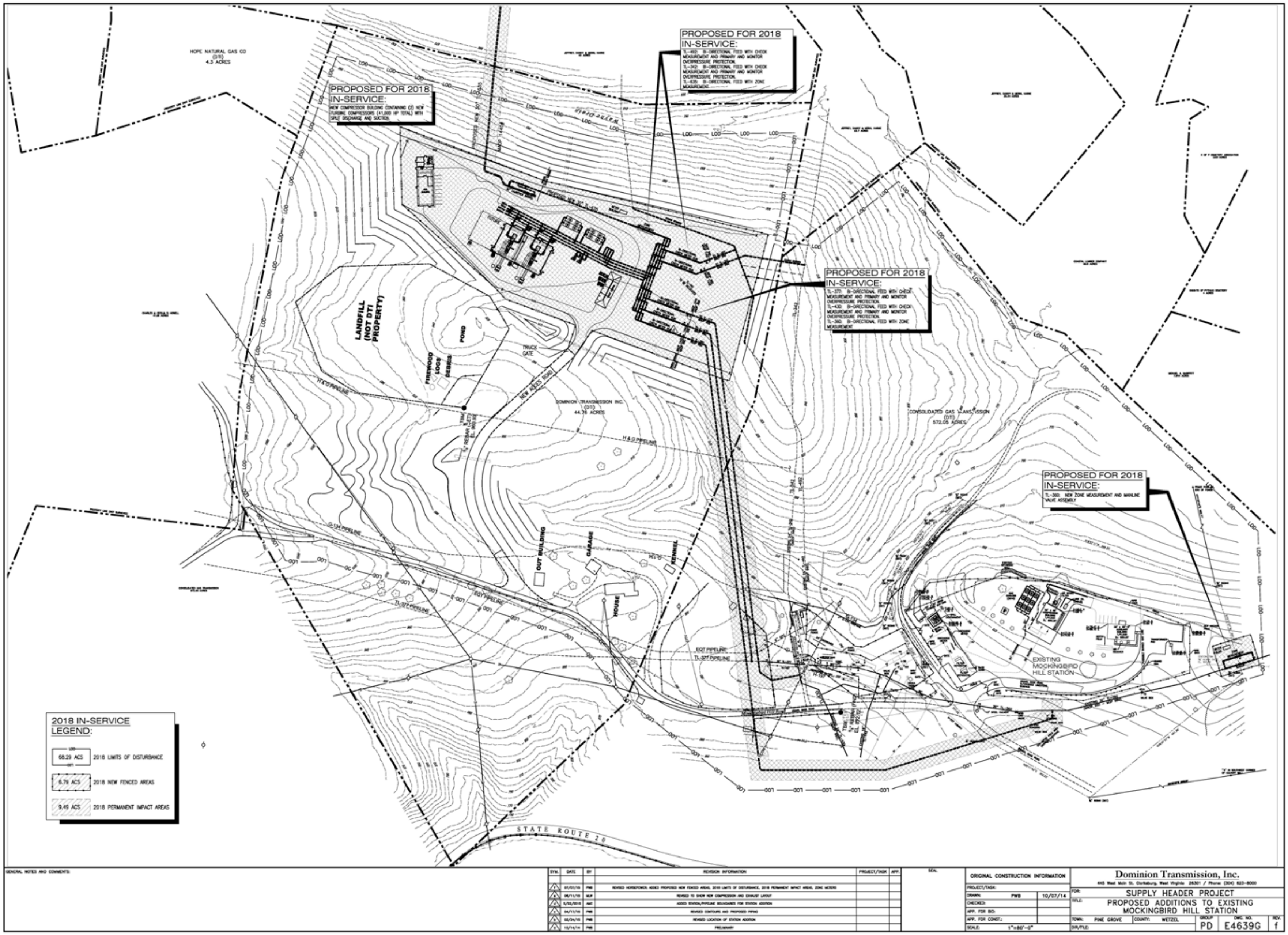


Environmental Resources Management, Inc.
Philadelphia Office
484-913-0300
April 15, 2015

N
W E
S

Scale in Miles
0 0.5 1 2 3
Miles

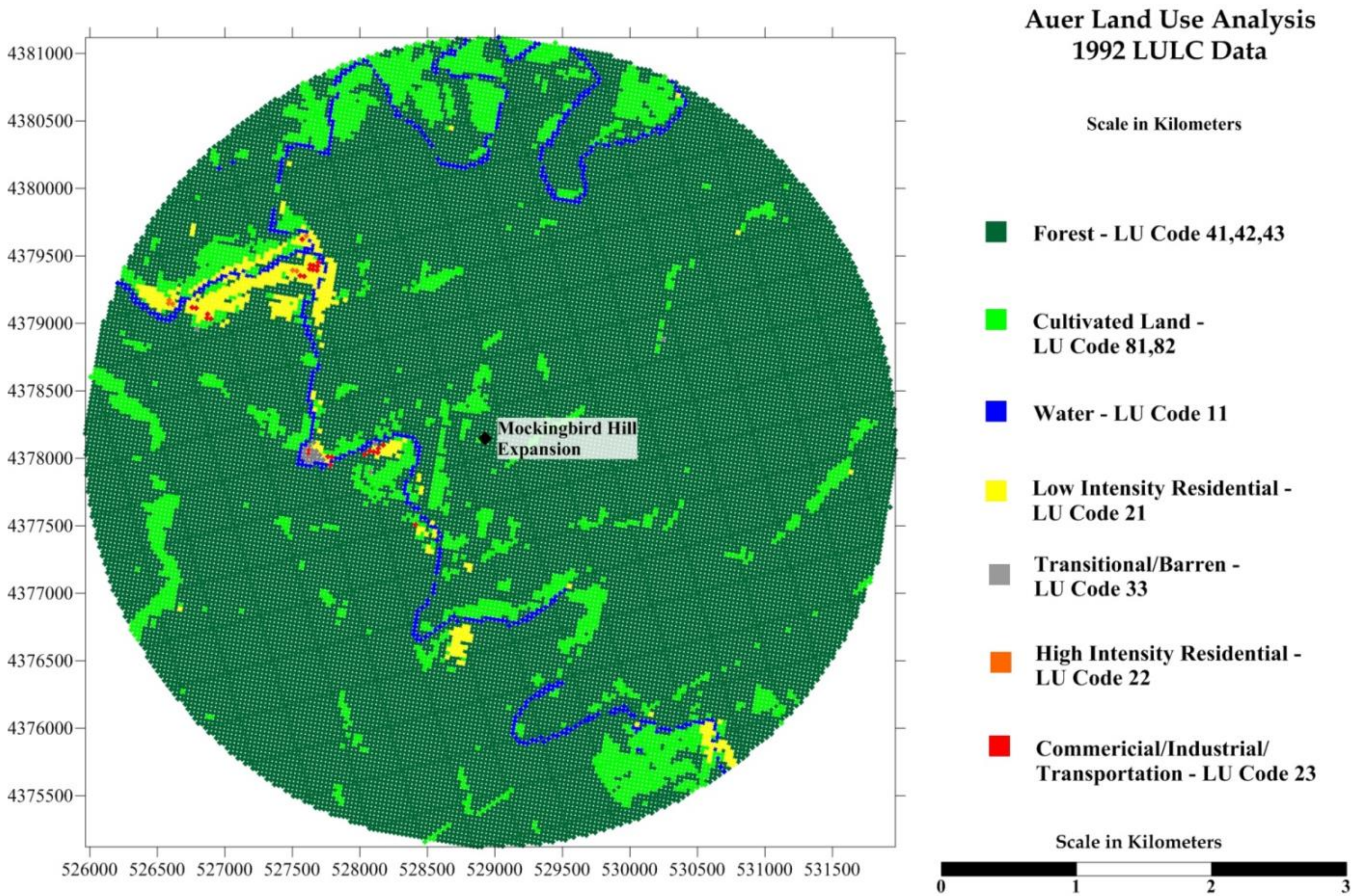
FIGURE A-1
Facility Location
Dominion Transmission, Inc.
Wetzel County, West Virginia



PROPOSED FOR 2018 IN-SERVICE:
NEW COMPRESSOR BUILDING CONTAINING (2) NEW TURBINE COMPRESSORS (41,000 HP TOTAL) WITH SPLIT DISCHARGE AND SUCTION.
PROPOSED FOR 2018 IN-SERVICE:
TL-492: BI-DIRECTIONAL FEED WITH CHECK MEASUREMENT AND PRIMARY AND MONITOR OVERPRESSURE PROTECTION.
TL-342: BI-DIRECTIONAL FEED WITH CHECK MEASUREMENT AND PRIMARY AND MONITOR OVERPRESSURE PROTECTION.
TL-635: BI-DIRECTIONAL FEED WITH ZONE MEASUREMENT.
PROPOSED FOR 2018 IN-SERVICE:
TL-377: BI-DIRECTIONAL FEED WITH CHECK MEASUREMENT AND PRIMARY AND MONITOR OVERPRESSURE PROTECTION.
TL-430: BI-DIRECTIONAL FEED WITH CHECK MEASUREMENT AND PRIMARY AND MONITOR OVERPRESSURE PROTECTION.
TL-360: BI-DIRECTIONAL FEED WITH ZONE MEASUREMENT
PROPOSED FOR 2018 IN-SERVICE:
TL-360: NEW ZONE MEASUREMENT AND MAINLINE VALVE ASSEMBLY
HOPE NATURAL GAS CO (DTI) 4.3 ACRES
LANDFILL (NOT DTI PROPERTY)
FIREWOOD
LOGS
DEBRIS
POND
TRUCK GATE
NEW ACCESS ROAD
DOMINION TRANSMISSION INC. (DTI) 44.76 ACRES
H&G PIPELINE
CONSOLIDATED GAS TRANSMISSION (DTI) 572.05 ACRES
OUT BUILDING
GARAGE
KENNEL
HOUSE
EQT PIPELINE
TL-377 PIPELINE
EXISTING MOCKINGBIRD HILL STATION
STATE ROUTE 20
2018 IN-SERVICE LEGEND:
68.29 ACS 2018 LIMITS OF DISTURBANCE
5.79 ACS 2018 NEW FENCED AREAS
9.49 ACS 2018 PERMANENT IMPACT AREAS
GENERAL NOTES AND COMMENTS:
REVISION INFORMATION
REVISED HORSEPOWER, ADDED PROPOSED NEW FENCED AREAS, 2018 LIMITS OF DISTURBANCE, 2018 PERMANENT IMPACT AREAS, ZONE METERS
REVISED TO SHOW NEW COMPRESSION AND EXHAUST LAYOUT
ADDED STATION/PIPELINE BOUNDARIES FOR STATION ADDITION
REVISED CONTOURS AND PROPOSED PIPING
REVISED LOCATION OF STATION ADDITION
PRELIMINARY
ORIGINAL CONSTRUCTION INFORMATION
DRAWN: PWB 10/07/14
SCALE: 1"=80'-0"
Dominion Transmission, Inc.
445 West Main St. Clarksburg, West Virginia 26301 / Phone: (304) 623-8000
FOR: SUPPLY HEADER PROJECT
TITLE: PROPOSED ADDITIONS TO EXISTING MOCKINGBIRD HILL STATION
TOWN: PINE GROVE
COUNTY: WETZEL
GROUP: PD
DWG. NO. E4639G
REV. f

Land Use Classifications Surrounding the Project Site

Appendix B


Auer Land Use Analysis
1992 LULC Data
Scale in Kilometers
Forest - LU Code 41,42,43
Cultivated Land - LU Code 81,82
Water - LU Code 11
Low Intensity Residential - LU Code 21
Transitional/Barren - LU Code 33
High Intensity Residential - LU Code 22
Commericial/Industrial/ Transportation - LU Code 23
Mockingbird Hill Expansion
4381000
4380500
4380000
4379500
4379000
4378500
4378000
4377500
4377000
4376500
4376000
4375500
526000 526500 527000 527500 528000 528500 529000 529500 530000 530500 531000 531500
Scale in Kilometers
0 1 2 3

Building Downwash Analysis

Appendix C

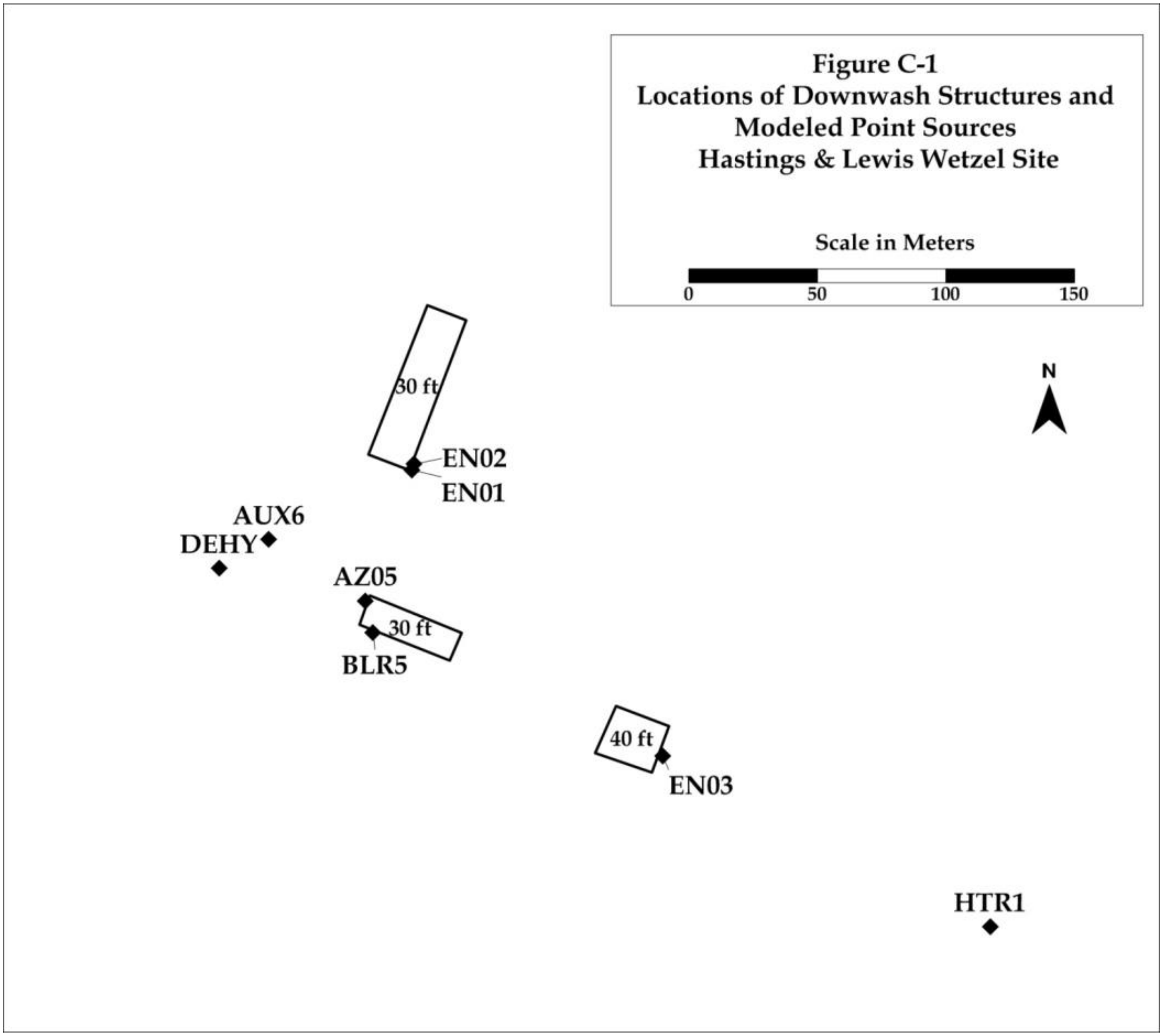
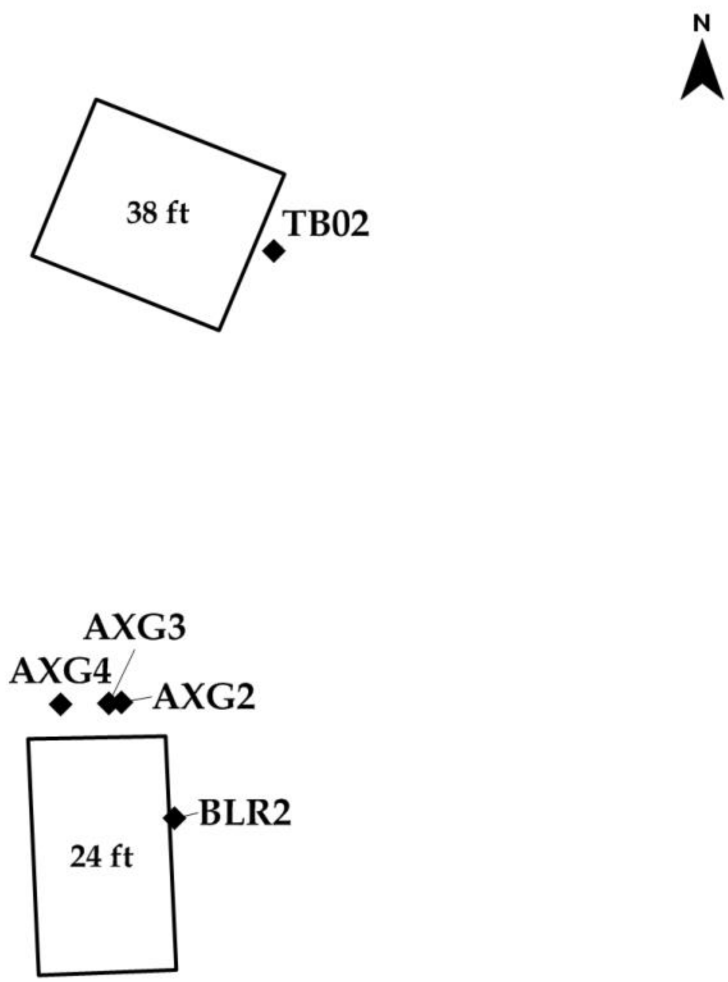


Figure C-1
Locations of Downwash Structures and
Modeled Point Sources
Hastings & Lewis Wetzel Site
Scale in Meters
0
50
100
150
N
30 ft
EN02
EN01
AUX6
DEHY
AZ05
30 ft
BLR5
40 ft
EN03
HTR1

Figure C-2
Locations of Downwash Structures and Modeled Point Sources
Existing Mockingbird Hill Site

Scale in Meters

0 10 20 30



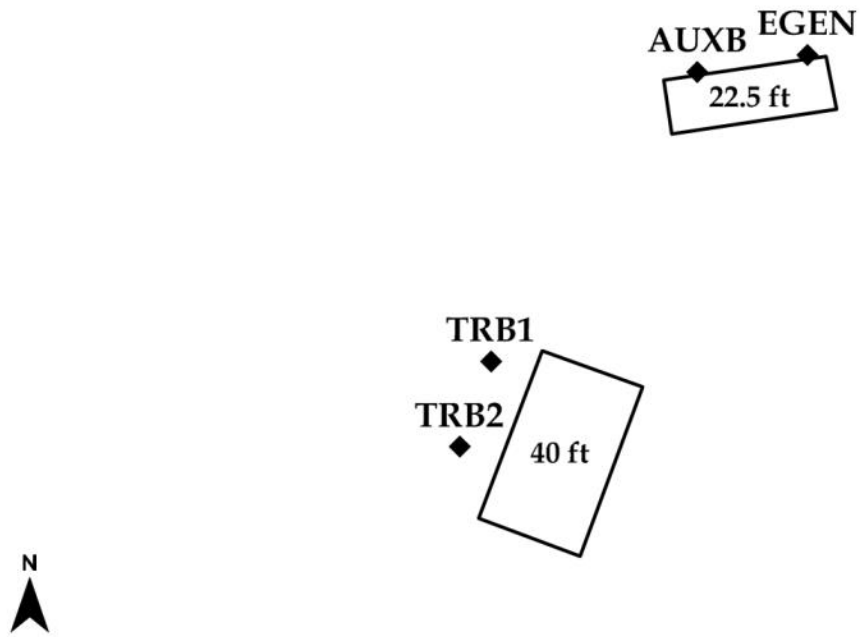
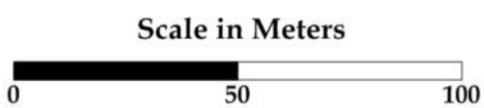


Figure C-3
Locations of Downwash Structures and Modeled Point Sources
Proposed Mockingbird Hill Site



Cumulative Modeling Inventory

Appendix D

Plant Name	Stack Description	Model ID	Source Type	UTME (m)	UTMN (m)	Elevation (m)	Stack Height (ft)	Stack Diameter (ft)	Exit Velocity (ft/sec)	Gas Temp (°F)	PM Limit	PM Limit Units	PM Specification	Capacity	Capacity Units	Modeled PM (lb/hr)	Modeled PM (g/s)	Comments/Reference
Dominion Hastings Extraction	Boiler1	BOILR1	POINT	527672.17	4377989.9	218.93	20	1	529.53	400	0.19	lb/hr	PM/PM10/PM2.5	25.1	MMBtu/hr	0.19	0.02394	Permit application, Attachment E
	Boiler2	BOILR2	POINT	527676.32	4377983.38	218.82	20	1	353.35	400	0.13	lb/hr	PM/PM10/PM2.5	16.75	MMBtu/hr	0.13	0.01638	Permit application, Attachment E
	Heater3	HEATR3	POINT	527694	4377971.35	218.37	100	2	369.12	400	0.53	lb/hr	PM	70	MMBtu/hr	0.53	0.06678	permit, page 22
Wetzel County Sanitary Landfill	Area	WETZEL	AREAPOLY	512278.6	4383599.4	334	3.28	-	-	-	1.278	tpy	PM2.5	450700	m^2	6.47E-07	8.157E-08	lb/hr-m^2, Emissions from Attachment E of permit application
											8.52	tpy	PM10	450700	m^2	4.32E-06	5.438E-07	lb/hr-m^2, Emissions from Attachment E of permit application
Equitrans Logansport Compressor	Compressor Engine1	LOGAN1	POINT	538042.5	4378256.3	432.9	25	1.5	9.28	925	0.33	lb/hr	PM/PM10/PM2.5	800	HP	0.33	0.04158	Permit application, Attachment E
	Compressor Engine2	LOGAN2	POINT	538042.5	4378256.3	432.9	25	1.5	9.28	925	0.33	lb/hr	PM/PM10/PM2.5	800	HP	0.33	0.04158	Permit application, Attachment E
	Generator1	LOGAN3	POINT	538042.5	4378256.3	432.9	30	1	4.4	1035	0.04	lb/hr	PM/PM10/PM2.5	265	HP	0.04	0.00504	Permit application, Attachment E
	Generator2	LOGAN4	POINT	538042.5	4378256.3	432.9	30	1	4.4	1035	0.04	lb/hr	PM/PM10/PM2.5	265	HP	0.04	0.00504	Permit application, Attachment E
	Heating Boiler	LOGAN5	POINT	538042.5	4378256.3	432.9	15	0.33	10.07	500	0.019	lb/hr	PM/PM10/PM2.5	2.5	MMBtu/hr	0.019	0.002394	Permit application, Attachment E
	Indirect Line Heater	LOGAN6	POINT	538042.5	4378256.3	432.9	15	0.33	10.07	500	0.011	lb/hr	PM/PM10/PM2.5	1.5	MMBtu/hr	0.011	0.001386	Permit application, Attachment E
	Hot Water Heater	LOGAN7	POINT	538042.5	4378256.3	432.9	4	0.1	10.2	500	0.008	lb/hr	PM/PM10/PM2.5	1	MMBtu/hr	0.008	0.001008	Permit application, Attachment E
	Dehy Boiler	LOGAN8	POINT	538042.5	4378256.3	432.9	15	0.33	10.2	500	0.005	lb/hr	PM/PM10/PM2.5	0.7	MMBtu/hr	0.005	0.00063	Permit application, Attachment E
Columbia Gas Smithfield Compressor	Heating Boiler1	SMITH1	POINT	539754.8	4370190.96	271.3	30	2.5	9.58	350	0.0065	lb/hr	PM10	3.4	MMBtu/hr	0.0065	0.000819	Permit application, PTE Report
	Engine1	SMITH2	POINT	539754.8	4370190.96	271.3	30	1	212.27	750	0.0012	lb/hr	PM10	1500	HP	0.0012	0.0001512	Permit application, PTE Report
	Engine2	SMITH3	POINT	539754.8	4370190.96	271.3	30	1	212.27	750	0.0012	lb/hr	PM10	1500	HP	0.0012	0.0001512	Permit application, PTE Report
	EGEN2	SMITH4	POINT	539754.8	4370190.96	271.3	20	0.5	113.85	1000	0.025	lb/hr	PM10	250	HP	0.025	0.00315	Permit application, PTE Report
	Heater1	SMITH5	POINT	539754.8	4370190.96	271.3	10	0.5	17.59	350	0.0005	lb/hr	PM10	0.25	MMBtu/hr	0.0005	0.000063	Permit application, PTE Report
	Engine5	SMITH6	POINT	539754.8	4370190.96	271.3	57	2.5	241.04	826	0.15	lb/hr	PM10	6736	HP	0.15	0.0189	Permit application, PTE Report
	Heater2	SMITH7	POINT	539754.8	4370190.96	271.3	20	0.82	12.8	350	0.001	lb/hr	PM10	0.5	MMBtu/hr	0.001	0.000126	Permit application, PTE Report
	EGEN3	SMITH8	POINT	539754.8	4370190.96	271.3	20	0.66	150.03	844	-	-	-	530	HP	0.053	0.006678	Emission rate scaled from EGEN2 based on capacity (HP)
	Warehouse Heater3	SMITH9	POINT	539754.8	4370190.96	271.3	28	1.67	15.58	350	-	-	-	0.3	MMBtu/hr	0.0006	0.0000756	Emission rate scaled from Heater2 based on capacity (MMBtu/hr)

Class II Visibility Analysis

Appendix E

Class II Visibility Impairment Analysis

Dominion has conducted a screening modeling analysis to estimate worst case visibility impacts for an observer located 5 km away from the Mockingbird Hill Expansion site. The intent of this analysis is to demonstrate worst case screening impacts in the vicinity of the Project to satisfy the requirement of additional impacts to visibility under the PSD regulations.

A stack plume visibility screening analysis was performed based upon the procedures described in USEPA's Workbook for Plume Visual Impact Screening and Analysis.[1] The screening procedure involves calculation of plume perceptibility (ΔE) and contrast (C) with the USEPA VISCREEN (Version 1.01, dated 13190) model, emissions of NO_x and PM/PM_{10}, worst-case meteorological dispersion conditions, and other default parameters as inputs. The screening procedure determines the light scattering impacts of particulates, including sulfates and nitrates, with a mean diameter of two micrometers (µm) and a standard deviation of two (2) µm. The VISCREEN model evaluates both plume perceptibility and contrast against two backgrounds, sky and terrain.

The VISCREEN model provides three (3) levels of analysis, the first two (2) of which are screening approaches. The Level-1 VISCREEN analysis was selected for the Project. The Level-1 VISCREEN assessment uses a series of default criteria values to assess the visible impacts. If the source passes the criteria defined for a Level-1 VISCREEN assessment ($\Delta E<2.0$ and $Cp<0.05$), potential for visibility impairment is not expected to be significant and no further analysis is necessary. If a source fails the Level-1 criteria, more refined assumptions would be necessary. The analysis was performed assuming that all emitted particulate from the stacks would be PM_{10}. The emissions of primary NO_2, soot, and SO_4 were set equal to the Level-1 VISCREEN default of 0.00 grams per second (g/s). The emission rates and other VISCREEN input assumptions are summarized in Table D-1.

Table D-1 – VISCREEN Model Input Data

Parameter	Value Used in VISCREEN
Mockingbird Hill Expansion Project Emission Rates (Total Project Emissions, g/sec) • Total NO_x as NO_2 • Primary NO_2 • PM_{10} • Soot (elemental C) • Primary SO_4	 • 55.1 • 0.0 • 30.6 • 0.0 • 0.0
Background visual range (km)	20
Source-observer distance (km)	5.0
Minimum source distance (km)	5.0
Maximum source distance	7.0

The VISCREEN Level-1 model results are summarized in Table D-2. The calculated plume perceptibility and contrast parameters were determined to be below the VISCREEN default criteria for a visibility screening analysis for all screening criteria.

[1] USEPA, Workbook for Plume Visual Impact Screening and Analysis (Revised), EPA-454/R-92-023, 1992.

Table D-2 – VISCREEN Level-1 Analysis Results[a]

Background	Theta[b] (degrees)	Azimuth[c] (degrees)	Distance (km)	Alpha[d] (degrees)	Perceptibility (ΔE)[e]		Contrast (C)[f]	
					Criteria	Plume	Criteria	Plume
Inside Surrounding Area								
Sky	10	144	7	25	2.00	1.209	0.05	0.008
Sky	140	144	7	25	2.00	0.393	0.05	-0.007
Terrain	10	84	5	84	2.24	1.660	0.05	0.012
Terrain	140	84	5	84	2.00	0.229	0.05	0.006

[a] Based on proposed Project emissions
[b] Theta is the vertical angle subtended by the plume
[c] Azimuth is the angle between the line connecting the source, observer and the line of sight
[d] Alpha is the angle between the line of sight and the plume centerline
[e] Plume perceptibility parameter (dimensionless)
[f] Visual contrast against background parameter (dimensionless)

Air Quality Modeling Files (CD-ROM)
Appendix F

September 2015 Air Quality Modeling Protocol

Attachment 1

APPENDIX C

BACT REVIEW SUPPORTING DETAILS

Small Combustion Turbine: **PM Controls**
RBLC Search for Small Combustion Turbines > 25 MW Simple Cycle Burning Natural Gas (Process Type 16.110)

State	Facility Name	Permit Date	Process Name	Throughput	Throughput Unit	Pollutant	Emission Limit 1	Updated Emission Limit	Emission Limit 1 Unit	Notes
ID	COMPRESSOR STATION NO. 4	2/19/2004	19500-HP GAS TURBINE	19500	HP	FPM10	0.007	0.022	LB/MMBTU	Converted from limit of 0.015 gr/dscf; filterable
MI	ANR PIPELINE CO./BRIDGMAN COMPRESSOR STATION	1/2/2002	COMBUSTION TURBINE, 15000 HP SOLAR MARS	13803	HP	FPM10	0.031	0.031	LB/MMBTU	
TX	UNION CARBIDE TEXAS CITY	10/1/2007	TURBINE AND WASTE HEAT BOILER FIRING	95.6	MMBtu/hr	FPM10	0.040	0.040	LB/MMBTU	
WA	FREDERICKSON PLANT	11/24/2003	(7) COMBUSTION TURBINES, NAT GAS	22	MW Each	FPM10	0.046	0.046	LB/MMBTU	
AK	NORTH COOK INLET UNIT	9/29/2003	TURBINE COMPRESSOR NO. 2	4700	HP	PM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	NORTH COOK INLET UNIT	9/29/2003	TURBINE COMPRESSOR NO. 4	6749	HP	PM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	NORTH COOK INLET UNIT	9/29/2003	TURBINE COMPRESSOR NO. 1	4700	HP	PM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	NORTH COOK INLET UNIT	9/29/2003	TURBINE COMPRESSOR NO. 3	6749	HP	PM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	MILNE POINT PRODUCTION FACILITY	9/29/2003	TURBINES (2), PU-0701 AND PU-0801	29500	HP EACH	PM	0.007	0.062	LB/MMBTU Each	Converted from 0.05 gr/dscf (AK law driven limit)
AK	KENAI REFINERY	1/5/2005	WELL FRACTIONATION UNIT TURBINES	6200	HP	PM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	KENAI NITROGEN OPERATIONS	1/30/2015	Five (5) Natural Gas Fired Combustion Turbines	37.6	MMBtu/hr	TPM10	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	KENAI NITROGEN OPERATIONS	1/30/2015	Five (5) Natural Gas Fired Combustion Turbines	37.6	MMBtu/hr	TPM2.5	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
AK	KENAI NITROGEN OPERATIONS	1/30/2015	Five (5) Natural Gas Fired Combustion Turbines	37.6	MMBtu/hr	TPM	0.007	0.062	LB/MMBTU	Converted from 0.05 gr/dscf (AK law driven limit)
OR	COMPRESSOR STATION 12	11/13/2003	GAS TURBINE A, SCENARIO #2	19200	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 12	11/13/2003	GAS TURBINE B, SCENARIO #2	14300	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 12	11/13/2003	GAS TURBINE C, SCENARIO #2	19500	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 12	11/13/2003	GAS TURBINE A, SCENARIO #1	19200	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 12	11/13/2003	GAS TURBINE C, SCENARIO #1	19500	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 10	9/29/2003	TURBINE A, SCENARIO 1	14100	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 10	9/29/2003	TURBINE A, SCENARIO #2	14100	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 10	9/29/2003	TURBINE B, SCENARIO #2	14300	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 10	9/29/2003	TURBINE C, SCENARIO #2	19500	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf
OR	COMPRESSOR STATION 10	9/29/2003	TURBINE C, SCENARIO #1	14000	HP	PM	0.014	0.124	LB/MMBTU	converted from 0.100 gr/dscf

Mockingbird Expansion Project

PSD Air Permit Application, GHG BACT Analysis

Cost Analysis - GHG Cost Effectiveness Summary for Carbon Capture and Sequestration

Combined Combustion Sources

Post-Combustion CO_2 Capture and Compression		
Base Capture System Capital[1]	$234.84/ton CO2 captured	$53,125,552
Capital Cost for 3 Booster Stations	See Compression Cost Table	$726,168
Annual O&M (fixed)[2]	$5.81/ton CO2 captured	$1,314,916
Annual O&M (variable)[2]	$2.71/ton CO2 captured	$612,474
Annual O&M for stations (fixed)[3]	See Compression Cost Table	$29,047
Total Capital costs for capture & compression	Capture and Compression System + Booster Stations	$53,851,720
Total Annual O&M costs	fixed + variable	$2,564,867
Incremental Utility Costs[2]		
CO2 Capture Units Steam Usage (10^3 lb)	3521.54 lb steam/ton CO2 captured	648,600
Amine System Power Usage (kWe)	47.59 kWe/ton CO2 captured	10,765,114
Compressor Power Usage (kWe)	See Compression Cost Sheet	814,972
CO2 Capture Steam Cost [4]	$4.16/MMBtu	$3,318,362
CO2 Capture Power Cost	0.0604 $/kWe	$699,437

Pipeline Cost Breakdown[6]		
L, Pipeline Length (miles)		218
D, Pipeline Diameter (inches)		15
Pipeline Costs		
Materials	$70,350 + $2.01 x L x (330.5 x D^2 + 686.7 x D + 26,960)	$51,707,237
Labor	$371,850 + $2.01 x L x (343.2 x D^2 + 2074 x D + 170,013)	$129,144,091
Miscellaneous	$147,250+ $1.55 x L x (8,417 x D + 7,234)	$47,771,466
Right of Way	$51,200 + $1.28 x L x (577 x D + 29,788)	$11,378,104
Other Capital		
CO_2 Surge Tank	Fixed	$1,311,593
Pipeline Control System	Fixed	$117,919
O&M		
Fixed O&M ($/year)	$8,454 x L	$1,945,543

Geologic Storage Costs[7]		
Number of Injection Wells		2
Well Depth (m)	Depth of formation[8]	1,825
Baseline CO_2 Captured (tons)	90% capture	184,181
CO_2 Generated for Capture & Compression (tons) [9]	117 lb CO2/MMBtu	46,711
CO_2 Captured including Amine Regeneration (tons)[10]	Baseline plus 90% CO_2 Generated for Capture & Compression	226,221
Capital		
Site Screening and Evaluation	Fixed	$5,355,300
Injection Wells	$272,048 x $e^{0.0008 \text{ x Well Depth}}$	$1,171,427
Injection Equipment	$106,269 x $(7,839/(280 \text{ x Number of Injection Wells}))^{0.5}$	$397,596
Liability Bond	Fixed	$5,000,000
Declining Capital Funds		
Pore Space Acquisition	$0.377/short ton CO2	$85,393
O&M		
Normal Annual Expenses	$13,072/Injection Well*365	$9,542,233
Consumables	$3,385/yr/ton CO_2/day	$2,097,881
Surface Maintenance	$26,534 x $(7,839/(280 \text{ x Number of Injection Wells}))^{0.5}$	$99,275
Subsurface Maintenance	$8.00/ft-depth/Injection Well	$95,819

Annualized Cost Estimate	
Economic Life, years	20
Interest Rate (%)	7
Capital Costs	$305,862,334
Annual O&M Costs	$20,363,418
Capital Recovery	$28,871,240
Total Annualized Cost	$49,234,658
CO_2 Controlled (tpy)	184,181
CO_2 Cost-Effectiveness ($/ton removed)	$267

[1] Adapted from the "*Cost and Performance Baseline For Fossil Energy Plants*", DOE/NETL-2010/1397 from Exhibit 5-14 (pg 474) and Exhibit 5-24 (pg 497). Total Overnight Cost (TOC) adjusted using the ENR Construction Cost Index to 2014 dollars. To find capital cost ($/tons CO_2 captured) the TOC of Case 14 less the TOC of Case 13 was divided by the tons of CO_2 captured to determine the added capital cost of a CSS.

[2] The total fixed and variable operating cost for Case 13 and 14 was adapted from the "*Cost and Performance Baseline For Fossil Energy Plants*", DOE/NETL-2010/1397. These values were located Exhibit 5-15 (pg. 475) and Exhibit 5-26 (pg. 498). The O&M prices were adjusted using the ENR Construction Cost Index from 2007 to 2014 dollars. To find the fixed O&M cost ($/tons captured) the cost of Case 14 less the cost of Case 13 was divided by the tons of CO_2 captured. Utility costs were estimated by scaling steam usage from Exhibit 5-17 (pg. 478) and auxiliary load from Exhibit 5-18 (pg. 479) based on CO2 captured.

[3] Compression System costs estimated based on "*Techno-Economic Models for Carbon Dioxide Compression, Transport, and Storage and Correlations for Estimating Carbon Dioxide Density and Viscosity*" by UC Davis Institute of Transportation Studies pages 1-8.

[4] Based on the methodology presented in DOE/GO-102000-1115, "Benchmark on the Fuel Cost of Steam Generation". Assumes combustion efficiency of 81.7%. Additionally, O&M and Capital Recovery costs for the incremental steam demand has been estimated as ~50% of fuel cost.

[5] Electric cost for West Virginia from US eia's "Electric Power Monthly with Data for April 2014".

[6] Pipeline cost estimates based on "*Carbon Dioxide Transport and Storage Costs in NETL Studies*", DOE/NETL-2013/1614 (March 2013). Costs adjusted using the ENR Construction Cost Index to 2014 dollars.

[7] Geologic Storage cost estimates based on "*Estimating Carbon Dioxide Transport and Storage Costs*" , DOE/NETL-2010/1447 (March 2010). Costs adjusted using the ENR Construction Cost Index to 2014 dollars.

[8] Average depth of targeted coal seams per SECARB's Central Appalachian Coal Seam Project "Summary of Field Test Site and Operations".

[9] Based on additional steam demand and the emission factor for NG combustion from 40 CFR 98, Table C-1 to Subpart C.

[10] Assumes that additional emissions generated by the capture system are controlled.

Compressor Power Calculations		
General Parameters		
R =	8.314	kJ/kmol-K
M =	44.01	kg/kmol
T in =	69	F
Tin =	293.56	K
ηis =	**0.75**	
CR =	2.15	per stage
Stage 1		
Zs1 =	0.995	
ks1 =	1.277	
Ws1 =	438.3908451	
Stage 2		
Zs2 =	0.985	
ks2 =	1.286	
Ws2 =	434.9195516	
Stage 3		
Zs3 =	0.97	
ks3 =	1.309	
Ws3 =	430.6024463	
Stage 4		
Zs4 =	0.935	
ks4 =	1.379	
Ws4 =	421.46033	
Stage 5		
Zs5 =	0.845	
ks5 =	1.704	
Ws5 =	402.4788621	
Total Compressor Power		
Ws 1-5 =	2,128	kW
N trains =	1	
Pump Power Calculation		
CO2 mass captured =	620	ton/day
CO2 mass captured (m) =	562	tonnes/day
Pinitial =	0.162	MPa
Pfinal	**15**	MPa
Pcut-off =	7.38	MPa
ρ =	**630**	kg/m^3
Nstages	5	
nρ =	**0.75**	
Wρ =	105	kW
Total Transport Power		
Pump + Compressor =	2,233	kW
	814,972	kWe

Initial Compression/Pumping Cost			
Capital Cost			
m train =		6.51	kg/s
Capital cost of compressor =	$	14,968,710	2014 $
Capital cost of pump =	$	242,056	2014 $
Total Capital	$	15,210,766	2014 $
O&M cost			
Annual O&M	$	608,430.64	2014 $
Electricity Cost			
price of electricity		0.0604	$/kWh
annual electricity	$	945,107	$/yr

Compressor Booster Stations (3 needed)			
Pump Power Calculation			
CO_2 mass captured =		620	ton/day
CO_2 mass captured (m) =		562	tonnes/day
Pinitial =		8.10	MPa
Pfinal		**15**	MPa
Pcut-off =		7.38	MPa
ρ =		**630**	kg/m^3
$n\rho$ =		**0.75**	
$W\rho$ =		105	kW
		38,306	kWe
Total Pumping Cost for Booster Stations			
Capital Cost			
Capital cost of pump 2005 =	$	186,493	2005 $
Total capital (1 station) =	$	242,056	2014 $
Total Capital (3 stations) =	$	726,168	2014 $
O&M cost			
Annual O&M (1 station)	$	9,682	2014 $
Annual O&M (3 stations)	$	29,047	2014 $
Electricity Cost			
price of electricity		0.0604	$/kWh
annual electricity	$	44,423	$/yr