



NON-MAJOR COMPREHENSIVE PLAN APPROVAL  
PERMIT APPLICATION - TRANSMITTAL NO. X266786  
(REVISED SEPTEMBER 2016)

Algonquin Gas Transmission, LLC > Weymouth Compressor Station  
Atlantic Bridge Project

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### 1.1. INTRODUCTION

Algonquin Gas Transmission, LLC (Algonquin) is proposing to increase the pipeline size and compressor station horsepower between a receipt point on Algonquin's system at Mahwah in Bergen County, New Jersey and various delivery points on the Algonquin and Maritimes & Northeast Pipeline, LLC (Maritimes) system, including at Beverly, Massachusetts, for further transportation and deliveries on the Maritimes system. Collectively, this project is referred to as the Atlantic Bridge (AB) Project.

The AB Project will require the addition of horsepower at two existing compressor stations in Connecticut and one new compressor station in Massachusetts. The new compressor station will be located in Weymouth, Norfolk County, Massachusetts (the Weymouth Compressor Station), on a parcel Algonquin has agreed to acquire from Calpine Fore River Energy Center, LLC. The Weymouth Compressor Station will be located adjacent to an existing metering and regulating station (the Weymouth M&R Station). This application accordingly seeks a non-major comprehensive air plan (Non-Major CPA) approval for the combination of the proposed Weymouth Compressor Station and the existing Weymouth M&R Station (hereinafter referred to as the "Site").

On October 22, 2015, Algonquin and Maritimes filed an Abbreviated Application for Certificates of Public Convenience and Necessity and for Related Authorizations with the Federal Energy Regulatory Commission (FERC) for the AB Project. On May 2, 2016, the FERC issued its Environmental Assessment (EA) of the project. Algonquin anticipates receiving its Certificate from the FERC in the fall of 2016.

Algonquin is proposing to install the following emission sources at the Weymouth Compressor Station:

- A new Solar Taurus 60-7802 natural gas-fired turbine-driven compressor unit;
- A new Waukesha VGF24GL natural gas-fired emergency generator;
- A new natural gas-fired turbine compressor fuel gas heater;
- Five new natural gas-fired catalytic space heaters;
- A new remote reservoir parts washer;
- New separator vessels and storage tanks; and
- Sources of fugitive emission (piping components, gas releases and truck loading).

The Weymouth Compressor Station will be constructed approximately 100 meters from the existing Weymouth M&R Station.

The emission units at the existing Weymouth M&R Station include the following:

- One Hanover natural gas-fired heater;
- One NATCO natural gas-fired heater;
- Three Lochinvar natural gas-fired boilers; and
- Sources of fugitive emissions (piping components and gas releases).

Algonquin proposes that MassDEP regard the combined operations at the Site as a single facility for air plan approval permitting purposes.

The combined potential emissions from the proposed Weymouth Compressor Station and the Weymouth M&R Station are below the MassDEP Title V permitting thresholds.

## 1.2. BENEFITS OF THE AB PROJECT

The AB Project will provide New England with a unique opportunity to secure a cost-effective, domestically produced, environmentally friendly source of energy to support its current demand, as well as its future growth, for clean burning natural gas. The AB Project is an infrastructure investment that expands the pipeline capacity of the existing Algonquin system, which will allow abundant regional natural gas supplies to flow reliably into New England. The AB Project will provide up to 132,705 decatherms per day (Dth/d), designed to meet the requirements of customers throughout New England.

In addition to reliability and cost benefits, the increased availability of natural gas to the region provides environmental benefits by increasing the supply of a cleaner burning fuel alternative to other traditional fuels such as biomass, coal, and fuel oils. Further, Algonquin has minimized the environmental impacts of the AB Project by proposing to install an efficient, low-emitting Solar Taurus 60-7802 natural gas turbine-driven compressor unit at the Weymouth Compressor Station. The Taurus 60-7802 turbine is designed to minimize combustion emissions through the use of state-of-the-art SoLoNO<sub>x</sub><sup>™</sup> dry low emissions technology and an oxidation catalyst on the turbine. For this project, Solar has guaranteed nitrogen oxide (NO<sub>x</sub>) emissions for the new unit at 9 parts per million volumetric dry (ppmvd) at 15 percent oxygen (O<sub>2</sub>) during steady-state operation at 50-100 percent engine load for all ambient temperatures above zero degrees Fahrenheit (°F).

## 1.3. AIR PERMITTING SUMMARY

The new Solar Taurus 60-7802 natural gas-fired turbine and fugitive emissions from gas releases and piping components will require a Non-Major CPA per 310 CMR 7.02(5)(a)(1) and 310 CMR 7.02(5)(a)(2). The new turbine will be subject to 40 CFR 60 Subpart KKKK, New Source Performance Standards for Stationary Gas Turbines as well as the applicable state regulations as outlined in Section 4.5 of this report. The new emergency generator will be subject to 40 CFR 60, Subpart JJJJ, New Source Performance Standards for Stationary Spark-Ignition Internal Combustion Engines and 40 CFR 63, Subpart ZZZZ, and National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. In addition, the Weymouth Compressor Station will be subject to the leak detection and repair (LDAR) requirements of 40 CFR 60, Subpart OOOOa. A review of New Source Review (NSR) requirements for the Site indicates that it will not trigger Prevention of Significant Deterioration (PSD) permitting per 40 CFR 52.21,<sup>1</sup> nor will it trigger permitting requirements for nonattainment areas per 310 CMR Appendix A. Details of this NSR applicability review are provided in Section 4.2 of this report.

Algonquin's Non-Major CPA application for the new turbine also covers fugitive emissions from gas releases and piping components, as well as emissions from the Weymouth M&R station. The new emergency generator at the compressor station will be operated under the Environmental Results Program (ERP) Certification requirements of 310 CMR 7.26(42) and 310 CMR 70.00; the required certification will be submitted within 60 days of commencement of operation of the emergency engine.

The new and existing natural gas-fired heaters and existing boilers are exempt from permitting per 310 CMR 7.02(2)(b)(15), since they will fire natural gas and the rated heat input of each heater is less than 10 MMBtu/hr.

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<sup>1</sup> The Massachusetts Department of Environmental Protection (MassDEP) is delegated authority to implement the federal PSD program at 40 CFR 52.21.

The new parts washer, new separator vessels and storage tanks, and fugitive emissions from truck loading are exempt from permitting per 310 CMR 7.02(2)(b)(7) because potential emissions from these individual sources are less than one ton per year (tpy) for any air pollutant. These sources are therefore not identified as emission units in the application. The emissions from their operation, however, are included as part of the overall limits set for the Site.

## 1.4. APPLICATION OVERVIEW

As required by the plan approval application, Algonquin is submitting the following information and attachments with this application:

- Section 2 – Project Overview
- Section 3 – Project Emissions Quantification
- Section 4 – Regulatory Applicability
- Section 5 – Best Available Control Technology Analysis
- Section 6 – Dispersion Modeling Analysis
- Section 7 – Noise Analysis
- Attachment A – Transmittal Form
- Attachment B – BWP AQ 02 Non-Major CPA Forms - CPA-FUEL, CPA-PROCESS
- Attachment C – Supplemental Forms - BWP AQ BACT Forms, BWP AQ Sound
- Attachment D – Figures - Site Plan, Process Flow Diagram
- Attachment E – Best Available Control Technology Analysis
- Attachment F – Noise Survey Report
- Attachment G – Detailed Emission Calculations and Manufacturer Specifications

The application transmittal form (transmittal number X266786) and plan approval application fee of \$2,370.00 made payable to “Massachusetts Department of Environmental Protection” was submitted in October 2015.

## 2. PROJECT OVERVIEW

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### 2.1. SITE DESCRIPTION

The existing Algonquin pipeline transports residential quality natural gas. The gas must be compressed along the pipeline to ensure efficient transportation and delivery to customers at serviceable pressures. The proposed location of the Weymouth Compressor Station is located approximately 100 meters northeast of the existing Weymouth M&R Station.

### 2.2. PROPOSED PROJECT DESCRIPTION

As part of the AB Project, Algonquin is proposing to install the following equipment at the Weymouth Compressor Station:

- A new Solar Taurus 60-7802 7,700 horsepower (HP) natural gas-fired turbine-driven compressor unit;<sup>2</sup>
- A new Waukesha VGF24GL 585 brake horsepower (bhp) natural gas-fired emergency generator;
- A new 0.23 MMBtu/hr heat input natural gas-fired turbine compressor fuel gas heater;
- Five new 0.076 MMBtu/hr heat input natural gas-fired catalytic space heaters;
- A new remote reservoir parts washer; and
- Three new separator vessels, one condensate storage tank, one lubricating oil storage tank, and one oily water storage tank.

In addition to the installed equipment, the Project will generate emissions from fugitive emission sources such as piping components, storage tank working and breathing losses, gas releases, and truck loading.

The new Solar Taurus 60-7802 turbine-driven compressor unit will be used for pipeline natural gas compression. The proposed new turbine will have a simple cycle design and will utilize an oxidation catalyst to control carbon monoxide (CO), volatile organic compounds (VOC), and organic hazardous air pollutant (HAP) emissions and will utilize dry low-NO<sub>x</sub> (DLN) combustion technology to reduce NO<sub>x</sub> emissions. The new turbine is subject to air permitting per 310 CMR 7.02(5)(a)(1) and 310 CMR 7.02(5)(a)(2).

The emission sources at the existing Weymouth M&R Station include the following:

- One Hanover 9.5 MMBtu/hr heat input natural gas-fired heater;
- One NATCO 6.8 MMBtu/hr heat input natural gas-fired heater;
- Three Lochinvar 1.8 MMBtu/hr heat input natural gas-fired boilers;
- Miscellaneous support equipment; and
- Sources of fugitive emissions (piping components and gas releases).

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<sup>2</sup> All turbine horsepower ratings are provided at ISO (International Organization of Standardization) conditions, all engine horsepower ratings are manufacturers' rated output per National Electric Manufacturers Association (NEMA) standards, and all heat inputs are provided at higher heating value (HHV).

## 2.3. PLAN APPROVAL EXEMPT EMISSION SOURCES

The following emission sources at the Site do not require air plan approvals and, therefore, are not identified as proposed emission units in the application. The potential emissions from their operation are however included as part of the proposed potential emissions for the Site and in the modeling.

The new Waukesha emergency generator set has a four-stroke, lean-burn, natural gas-fired stationary reciprocating internal combustion engine. The proposed emergency generator will be installed to meet site-wide emergency electrical demands as a result of the AB Project and will be operated only during normal testing and maintenance, and emergency situations. The engine will meet the definition of “emergency engine” per 310 CMR 7.00 Definitions and will be operated under the ERP Certification requirements of 310 CMR 7.26(42) and 310 CMR 70.00. Further, the engine will meet the definition of “emergency stationary internal combustion engine” per 40 CFR 60.4248, will comply with the requirements for operating emergency engines in 40 CFR 60.4243(d), and meet the requirements of 40 CFR 63 Subpart ZZZZ by complying with the requirements of 40 CFR 60 Subpart JJJJ.

The new natural gas-fired fuel gas heater and five new natural gas-fired catalytic space heaters are exempt from permitting per 310 CMR 7.02(2)(b)(15), since the rated heat input of each heater is less than 10 MMBtu/hr. The heaters will comply with applicable state requirements. The existing natural gas-fired heaters and boilers at the Weymouth M&R Station have a rated heat input of less than 10 MMBtu/hr and are therefore exempt from permitting per 310 CMR 7.02(2)(b)(15).

The new parts washer will be a remote reservoir cold solvent cleaner for cleaning equipment parts used at the Site. Potential emissions from the parts washer are conservatively estimated based on a make-up solvent rate of 120 gallons per year and a VOC content of 100 percent by weight. Based on these conservative estimates, potential emissions from operation of the parts washer are less than one tpy for any pollutant. The parts washer is exempt from permitting per 310 CMR 7.03(8) and will be operated in accordance with the requirements of 310 CMR 7.18(8)(a).

The new separator vessels and storage tanks proposed to be installed at the Weymouth Compressor Station are exempt from permitting per 310 CMR 7.02(2)(b)(7) since individually the potential emissions from each of these units are less than one tpy for any pollutant.

The fugitive emissions from truck loading are exempt from permitting since potential emissions from this activity are less than one tpy for any air pollutant.

## 2.4. ANALYSIS OF THE USE OF ELECTRIC-MOTOR DRIVEN COMPRESSORS

Algonquin is including this additional information on the use of electric motors to drive the compressors as an alternative to using natural-gas turbines to drive the compressor units. There are a number of compelling process and business reasons why Algonquin selected natural gas-fired combustion turbines for the Project. As detailed in Resource Report 10 (RR10) that was submitted to the FERC in connection with the AB Project (Docket No. CP16-9-000), and evaluated in the EA that was issued by the FERC staff on May 2, 2016, Algonquin considered the feasibility of installing electric-driven compressor units for the AB Project at the Weymouth Compressor Station. In this consideration, Algonquin evaluated a broad scope of factors including proximity to existing electric power sources and whether to upgrade existing electric power sources and/or construct new transmission or service lines and ancillary substation facilities. Algonquin also evaluated the installed and operational costs, including a power company’s ability to obtain necessary approvals for the electric



transmission facilities prior to the planned in-service date, along with the noise and emission standards applicable to turbine driven compressor units.

The EA noted that the installation of an electric-driven compressor unit would require additional facilities to be constructed such as electric transmission lines and substations, as currently there is not enough electric transmission infrastructure in place to accommodate the additional power supply. The EA further noted that for each station, the construction and operation of electric-driven units would increase the environmental impacts of the Project including an increase in the amount of land disturbed and creating new permanent visual impacts.

The EA also noted the following about the unavailability of backup power for electric-driven compressor units:

*Back-up generators at gas-fired compressor stations provide the lighting, small motor loads, and the ability to power the 125 hp electric motor to start a gas turbine in the event the turbine is off line when utility power is lost. In contrast, electric-driven compressors are solely dependent on the electric grid for their power source. Emergency generators are not sized to be a primary back-up electrical source for large electric drive motors like the 7,700 hp units that would be installed at the Weymouth and Oxford Compressor Station sites.*

After evaluating these factors in relation to the proposed Weymouth Compressor Station, the EA concluded that use of electric-driven compressor units would not be preferable to or offer a significant environmental advantage over the proposed project facilities (See Section 3.3.2 of the EA). Consequently, electric-driven compressors were not selected in the alternatives analysis provided in RR10 of the Atlantic Bridge Project Certificate Application, has not been included in the BACT analysis included in this application, and is not considered further in this application.

### 3. PROJECT EMISSIONS QUANTIFICATION

This section provides detailed emission calculations for the new Weymouth Compressor Station (new turbine, emergency generator, heaters, parts washer, separator vessels, storage tanks and fugitive components) to be installed at the Site (heaters, boilers, and fugitive components). Attachment G provides the detailed emission calculations for the Site.

#### 3.1. TURBINE EMISSIONS

Potential emissions from the new compressor turbine unit at the proposed Weymouth Compressor Station are estimated for operation during normal steady-state operating conditions, operation during low temperature events, and operation during startup and shutdown events as described in the following sections.

##### 3.1.1. Turbine Normal Steady-State Operation Hourly Emissions

Table 3-1 provides a summary of the uncontrolled emission factors used for each pollutant during normal steady-state operation.

**Table 3-1: New Turbine Pre-Control Emission Factors – Normal Operations**

<b>Pollutant</b>	<b>Emission Factor <sup>1</sup></b>	<b>Source</b>
NO <sub>x</sub>	9 ppmvd at 15% O <sub>2</sub>	Vendor guaranteed emission rate
CO	25 ppmvd at 15% O <sub>2</sub>	Vendor guaranteed emission rate
VOC	25 ppmvd TOC at 15% O <sub>2</sub> 0.0021 lb/MMBtu (HHV) VOC	TOC: vendor guaranteed emission rate VOC: Table 3.1-2a of AP-42
CH <sub>4</sub>	25 ppmvd TOC at 15% O <sub>2</sub> 0.0086 lb/MMBtu (HHV) CH <sub>4</sub>	TOC: vendor guaranteed emission rate CH <sub>4</sub> : Table 3.1-2a of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	0.0066 lb/MMBtu (HHV)	Table 3.1-2a of AP-42
SO <sub>2</sub>	14.29 lb/MMscf (HHV)	Table 3.1-2a of AP-42 scaled to 5 gr/100 scf fuel sulfur content
CO <sub>2</sub>	53.06 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-1
N <sub>2</sub> O	0.0001 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-2
Total HAPs	25 ppmvd TOC at 15% O <sub>2</sub> Multiple HAP factors	TOC: vendor guaranteed emission rate HAPs: Table 3.1-3 of AP-42

<sup>1</sup> The emission factors provided in this table represent uncontrolled emissions at temperatures above 0 °F.

The Taurus 60-7802 turbine is designed to minimize combustion emissions through the use of state-of-the-art SoLoNO<sub>x</sub>™ dry low emissions technology. For this project, Solar has guaranteed NO<sub>x</sub> emissions for the new unit at 9 ppmvd at 15 percent O<sub>2</sub> during steady-state operation at 50-100 percent engine load for all ambient temperatures above 0 °F. The oxidation catalyst vendor has guaranteed a destruction and removal efficiency (DRE) of 95 percent for CO and 50 percent for VOC, resulting in the emission rate provided in this section and Attachment G.

In order to calculate hourly emissions during normal operation, the emission factors provided in the table above are converted to factors in pounds per million standard cubic feet (lb/MMscf) as described in subsequent sections.

### 3.1.1.1. Turbine Emission Factors - NO<sub>x</sub>, CO and TOC

NO<sub>x</sub>, CO, and Total Organic Compounds (TOC) emitted by the combustion turbine during normal operation are calculated based on the vendor-guaranteed emission rates provided in Table 3-1. Although TOC is not a criteria pollutant, it is used to derive the emission factors for VOC, methane (CH<sub>4</sub> – a greenhouse gas), and HAPs. The turbine vendor provides the emissions and operating data listed below at ambient temperatures of 0 °F, 20 °F, 40 °F, 60 °F, 80 °F and 100 °F:

- Fuel: Lower Heating Value (BTU/scf)
- Turbine Performance: Net Output Power (hp), Heat Input at LHV (MMBtu/hr), Heat Rate at LHV (BTU/hp-hr)
- Exhaust Parameters: Exhaust Temperature (°F), Water Fraction (percent), O<sub>2</sub> Content (percent, dry), Molecular Weight (lb/lb-mol), Flowrate (lb/hr and acfm)
- Guaranteed Emission Rates for NO<sub>x</sub>, CO and TOC (ppmvd at 15 percent O<sub>2</sub>)

Operating and emissions data at other ambient temperatures are estimated by fitting the vendor-provided data to a curve that best represents the data and interpolating/extrapolating to the desired temperatures. Since the effectiveness of the emissions control inherent in the turbine's combustor design (i.e. SoLoNO<sub>x</sub>) is only guaranteed at temperatures above 0 °F, the concentration values (parts per million) provided in Table 3-1 do not apply to sub-zero operating conditions. Further, the mass emission rates of NO<sub>x</sub>, CO, and TOC at a given load decrease with increasing ambient temperature conditions (i.e., fuel consumption at 100 percent load is highest at lower ambient temperatures). As such, short-term, maximum hourly emission rates are estimated based on operating and emissions data at 0.01 °F to provide the most conservative estimate. Annual emissions estimates are based on the annual average ambient conditions at the proposed site of the Weymouth Compressor Station. As such, for annual emissions estimates, the operating data (turbine performance and exhaust gas parameters) are interpolated to estimate emissions at the average annual ambient temperature at the Site.<sup>3</sup> The emission factor at a given ambient temperature is calculated as illustrated in Equation 3-1 through Equation 3-3:

**Equation 3-1:**  $NO_x, CO, TOC \text{ EF (ppmw)} = ppmvd, 15\% O_2 \times nonwater\% \times \frac{20.9 - (vol\% O_2, dry \times 100)}{5.9} = ppmw$

**Equation 3-2:**  $NO_x, CO, TOC \text{ hourly emissions } \left(\frac{lb}{hr}\right) @ T = \frac{ppmw}{1,000,000} \times \left(\frac{lb \text{ exhaust}}{hr}\right)_T \times \frac{\frac{lb \text{ pollutant}}{lb \text{ mol}}}{\left(\frac{lb \text{ exhaust}}{lb \text{ mol}}\right)_T} = \left(\frac{lb \text{ pollutant}}{hr}\right)_T$

**Equation 3-3:**  $NO_x, CO, TOC \text{ EF @ } T = \left(\frac{lb}{hr}\right)_T \times \frac{1,000,000 \frac{scf}{MMscf}}{\left[\frac{scf \text{ fuel}}{hr}\right]_T} = \left(\frac{lb}{MMscf}\right)_T$

Where:  $T = \text{ambient temperature}^4$

<sup>3</sup> A weighted daily average ambient temperature is used in estimating emissions for the Weymouth Compressor Station and is based on meteorological information in U.S. EPA's TANKS 4.09d database. To determine ambient temperatures, the three meteorological stations in closest proximity to the station were reviewed, and the station with the lowest ambient temperatures was conservatively selected.

<sup>4</sup> Maximum hourly emissions are estimated at T = 0.01°F.

### 3.1.1.2. Turbine Emission Factors - VOC, CH<sub>4</sub>, and HAPs

VOC, CH<sub>4</sub>, and HAPs emitted by the combustion turbine are calculated using the vendor-guaranteed TOC emission rate and AP-42 emission factors, as VOC, CH<sub>4</sub>, and HAPs are constituents of TOC. The TOC emission factor in terms of lb/MMscf at a given ambient temperature is calculated as outlined above in Section 3.1.1.1.

Standard emission factors for VOC, CH<sub>4</sub>, HAPs, and TOC from stationary gas turbines are provided in Chapter 3.1 of EPA's Compilation of Air Pollutant Emission Factors (AP-42). Table 3.1-2a of AP-42 (version dated April 2000) provides emission factors of 0.0023 lb VOC per MMBtu, 0.0086 lb CH<sub>4</sub> per MMBtu, and 0.011 lb TOC per MMBtu from natural gas-fired turbines. Table 3.1-3 of AP-42 (version dated April 2000) provides emission factors for HAPs emitted from natural gas-fired turbines. These HAPs include:

- 1,3-Butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Ethylbenzene
- Formaldehyde
- Naphthalene
- Polycyclic aromatic hydrocarbons (PAH)
- Propylene oxide
- Toluene
- Xylenes

A total HAP emission factor is calculated as the sum of all individual HAP emission factors.

Ratios of VOC, CH<sub>4</sub>, and HAPs to TOC from the AP-42 factors are applied to the TOC factor derived from vendor information to obtain emission factors for VOC, CH<sub>4</sub>, and HAPs. For normal operation, the uncontrolled VOC, CH<sub>4</sub>, and HAP factors are derived as follows:

$$\text{Equation 3-4: } VOC, CH_4, HAP \text{ EF} = \frac{lb \text{ TOC}}{MMscf} \times \frac{\left( \frac{lb \text{ pollutant}}{MMBtu} \times 1,020 \frac{MMBtu}{MMscf} \right)}{\left( 0.011 \frac{lb \text{ TOC}}{MMBtu} \times 1,020 \frac{MMBtu}{MMscf} \right)} = \frac{lb}{MMscf}$$

### 3.1.1.3. Turbine Emission Factors - PM<sub>10</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub>

As indicated in Equation 3-5, particulate matter less than 10 microns in diameter (PM<sub>10</sub>), particulate matter less than 2.5 microns in diameter (PM<sub>2.5</sub>), and sulfur dioxide (SO<sub>2</sub>) emitted by the combustion turbine during normal operation are calculated based on the emission factors listed in Table 3.1-2a of AP-42 (version dated April 2000) for stationary gas turbines. The SO<sub>2</sub> emission factor is calculated using AP-42 based on a fuel sulfur content of 5 grains per 100 scf. It is conservatively assumed that all particulate emitted from natural gas combustion is less than 2.5 microns in diameter, so the emission rates for PM<sub>10</sub> and PM<sub>2.5</sub> are assumed equal to the total PM emission rate. The AP-42 emission factors are converted to lb/MMscf as follows:

$$\text{Equation 3-5: } PM_{10}, PM_{2.5} \text{ or } SO_2 \text{ EF} = \frac{lb}{MMBtu} \times 1,020 \frac{MMBtu}{MMscf} = \frac{lb}{MMscf}$$

#### 3.1.1.4. Turbine Emission Factors - CO<sub>2</sub>, N<sub>2</sub>O and CO<sub>2</sub>e

Emission factors for carbon dioxide (CO<sub>2</sub>) and nitrous oxides (N<sub>2</sub>O) emitted by the combustion of natural gas are calculated based on the HHV and the emission factors provided for pipeline natural gas combustion in 40 CFR 98, Subpart C, Tables C-1 and C-2, as follows:

**Equation 3-6:** 
$$CO_2 EF = 53.06 \frac{kg}{MMBtu} \times 2.2046 \frac{lb}{kg} \times 1,028 \frac{Btu}{scf} = 120,161 \frac{lb CO_2}{MMscf}$$

**Equation 3-7:** 
$$N_2O EF = 0.0001 \frac{kg}{MMBtu} \times 2.2046 \frac{lb}{kg} \times 1,028 \frac{Btu}{scf} = 0.23 \frac{lb N_2O}{MMscf}$$

Total greenhouse gas (GHG) emissions in terms of CO<sub>2</sub> equivalents (CO<sub>2</sub>e) are equal to the sum of all individual GHGs emitted by the turbine, accounting for the respective global warming potential of each GHG. The global warming potentials (GWPs) used to calculate CO<sub>2</sub>e emissions for each pollutant emitted by the Project are contained in Table 3-2.

**Table 3-2: Applicable Global Warming Potentials**

Pollutant <sup>1</sup>	GWP <sup>2</sup>
CO <sub>2</sub>	1
CH <sub>4</sub>	25
N <sub>2</sub> O	298

<sup>1</sup> Only those GHGs for which quantifiable emissions increases are expected due to this project are listed.

<sup>2</sup> GWPs are based on a 100-year time horizon, as identified in Table A-1 to 40 CFR Part 98, Subpart A as amended on November 29, 2013 to incorporate revised GWPs as published in the Intergovernmental Panel on Climate Change (IPCC) 4<sup>th</sup> Assessment Report (AR4).

As such, the CO<sub>2</sub>e factor is derived as follows:

**Equation 3-8:** 
$$CO_2e EF = \left( \frac{lb CO_2}{MMscf} \times 1 GWP \right) + \left( \frac{lb CH_4}{MMscf} \times 25 GWP \right) + \left( \frac{lb N_2O}{MMscf} \times 298 GWP \right) = \frac{lb CO_2}{MMscf}$$

#### 3.1.2. Turbine Low Temperature Operation Hourly Emissions

At low ambient temperatures (i.e., temperatures below 0 °F), lb/hr emissions of NO<sub>x</sub>, CO, and VOC increase. Low temperature hourly emissions were estimated using the vendor estimated emission rates at sub-zero temperatures (provided in Table 3-3), and following the calculation methodology outlined in the previous section for normal steady-state operation.

**Table 3-3: New Turbine Emission Factors – Low Temperature Operation**

<b>Pollutant</b>	<b>Emission Factor (0 °F ≥ Temp ≥ - 20 °F)</b>	<b>Emission Factor (Temp ≤ - 20 °F)</b>	<b>Source</b>
NO <sub>x</sub>	42 ppmvd at 15% O <sub>2</sub>	120 ppmvd at 15% O <sub>2</sub>	Vendor provided emission rate
CO	100 ppmvd at 15% O <sub>2</sub>	150 ppmvd at 15% O <sub>2</sub>	Vendor provided emission rate
TOC	50 ppmvd at 15% O <sub>2</sub>	75 ppmvd at 15% O <sub>2</sub>	Vendor provided emission rate

The same emission rates that are used for normal operation for PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, CO<sub>2</sub>, and N<sub>2</sub>O are used for low temperature operation. However, it should be noted that the maximum hourly fuel consumption increases during low temperature operation, so hourly emissions during low temperature operation are higher than hourly emissions during normal operation, even for those pollutants for which the emissions on a lb/MMscf basis are not impacted by low temperature operation.

### **3.1.3. Turbine Startup and Shutdown Operation Hourly Emissions**

Emissions during startups and shutdowns are calculated based on vendor-specified transient operation profiles which are used to determine the maximum pound of pollutant per startup or shutdown event as described in further detail in the following sections.

#### **3.1.3.1. Turbine Startup Operation**

The startup process for the turbine is estimated to take approximately nine minutes from the initiation of startup to normal operation (startup sequence ends at approximately 50 percent load for most Solar turbines). This includes three minutes of ignition-idle operation and six minutes of loading/thermal stabilization operation.

Table 3-4 provides a summary of the emission factors used for each pollutant during the ignition-idle and loading/thermal stabilization phases of each startup event. It is assumed that the oxidation catalyst will not yet have a measurable destruction or removal efficiency (DRE) during startup, as it is designed to meet control specifications only during normal operation.

**Table 3-4: New Turbine Emission Factors – Startup Operation**

<b>Pollutant</b>	<b>Ignition-Idle Phase Emission Factor from Source <sup>1</sup></b>	<b>Loading/Thermal Stabilization Phase Emission Factor from Source <sup>1</sup></b>	<b>Source</b>
NO <sub>x</sub>	50 ppmvd at 15% O <sub>2</sub>	60 ppmvd at 15% O <sub>2</sub>	Vendor specified emission rate
CO	10,000 ppmvd at 15% O <sub>2</sub>	9,000 ppmvd at 15% O <sub>2</sub>	Vendor specified emission rate
VOC	1,000 ppmvd TOC at 15% O <sub>2</sub> 0.0021 lb/MMBtu (HHV) VOC	900 ppmvd TOC at 15% O <sub>2</sub> 0.0021 lb/MMBtu (HHV) VOC	TOC: vendor specified emission rate VOC: Table 3.1-2a of AP-42
CH <sub>4</sub>	1,000 ppmvd TOC at 15% O <sub>2</sub> 0.0086 lb/MMBtu (HHV) CH <sub>4</sub>	900 ppmvd TOC at 15% O <sub>2</sub> 0.0086 lb/MMBtu (HHV) CH <sub>4</sub>	TOC: vendor specified emission rate CH <sub>4</sub> : Table 3.1-2a of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	Same as normal operation		
SO <sub>2</sub>	Same as normal operation		
CO <sub>2</sub>	Same as normal operation		
N <sub>2</sub> O	Same as normal operation		
Total HAPs	1,000 ppmvd TOC at 15% O <sub>2</sub> Multiple HAP factors	900 ppmvd TOC at 15% O <sub>2</sub> Multiple HAP factors	TOC: vendor specified emission rate HAPs: Table 3.1-3 of AP-42

<sup>1</sup> The emission factors provided in this table represent uncontrolled emissions. The new turbine will be equipped with an oxidation catalyst, however it is assumed that the catalyst is not fully operational during startups.

All pollutants emitted by the combustion turbine during startup events are calculated based on the same methodology that is used to calculate emissions during normal operation. However, rather than calculate lb/MMscf emission factors, pounds per startup event (lb/event) are calculated for each pollutant based on the fuel consumed during the three-minute ignition-idle phase and during the six-minute loading/thermal stabilization phase as follows:

$$\text{Equation 3-9: } EF_x \text{ during SU event} = \frac{\text{lb Pollutant} \times}{\text{MMBtu}} \times 1,020 \frac{\text{MMBtu}}{\text{MMscf}} \times \frac{\text{scf fuel}}{\text{event}} \times \frac{\text{MMscf}}{1,000,000 \text{ scf}} = \frac{\text{lb Pollutant} \times}{\text{event}}$$

### 3.1.3.2. Turbine Shutdown Operation

The shutdown process for the turbine is estimated to take approximately 3.5 minutes from normal operation to shut down for a Taurus 60-7802. The shutdown event consists of loading/thermal stabilization operation.

Table 3-5 provides a summary of the pre-control emission factors used for each pollutant during each shutdown event. It is assumed that the oxidation catalyst will be operational during shutdown. The calculation for shutdowns is identical to that for startups as shown in Equation 3-9 above, except that the oxidation catalyst DRE is accounted for in calculating potential emissions.



**Table 3-5: New Turbine Pre-Control Emission Factors – Shutdown Operation**

<b>Pollutant</b>	<b>Loading/Thermal Stabilization Phase Emission Factor from Source <sup>1</sup></b>	<b>Source</b>
NO <sub>x</sub>	60 ppmvd at 15% O <sub>2</sub>	Vendor specified emission rate
CO	9,000 ppmvd at 15% O <sub>2</sub>	Vendor specified emission rate
VOC	900 ppmvd TOC at 15% O <sub>2</sub> 0.0021 lb/MMBtu (HHV) VOC	TOC: vendor specified emission rate VOC: Table 3.1-2a of AP-42
CH <sub>4</sub>	900 ppmvd TOC at 15% O <sub>2</sub> 0.0086 lb/MMBtu (HHV) CH <sub>4</sub>	TOC: vendor specified emission rate CH <sub>4</sub> : Table 3.1-2a of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	Same as normal operation	
SO <sub>2</sub>	Same as normal operation	
CO <sub>2</sub>	Same as normal operation	
N <sub>2</sub> O	Same as normal operation	
Total HAPs	900 ppmvd TOC at 15% O <sub>2</sub> Multiple HAP factors	TOC: vendor specified emission rate HAPs: Table 3.1-3 of AP-42

<sup>1</sup> The emission factors provided in this table represent uncontrolled emissions. The new turbine will be equipped with an oxidation catalyst, but the control from the catalyst is not accounted for in the factors above.

#### 3.1.4. Turbine Annual Potential Emissions

The emission factors described in the previous sections are multiplied by the following activity data to estimate annual potential emissions:

- **Normal Steady State Operation:** Annual fuel consumption as estimated from vendor-provided turbine parameters at the annual average ambient temperature for the proposed site of the Weymouth Compressor Station. Annual potential to emit (PTE) estimates assume 100 percent utilization (8,760 hours per year). CO, VOC, and HAP PTE estimates take the control efficiency of the proposed oxidation catalyst into account. Further, since an oxidation catalyst provides more complete conversion of CO to CO<sub>2</sub> (also a regulated pollutant), the controlled portion of the CO emissions is added back to the CO<sub>2</sub> emissions rate.
- **Low Temperature Operation:** Fuel consumption during low temperature operation as estimated by extrapolating vendor-provided turbine parameters to an ambient temperature of -20 °F. It is conservatively assumed that low temperature operation between -20 °F and 0 °F will account for a total of 12 hours per year. Due to the fact that the meteorological data indicates that there are expected to be no hours at -20 °F or below, it is assumed that low temperature operation less than or equal to -20 °F will account for a total of zero hours per year.<sup>5</sup>
- **Startup/Shutdown Operations:** The number of startup and shutdown events is conservatively estimated at 416 startup events and 416 shutdown events per year for the turbine. No credit for control by the oxidation catalyst is accounted for in the estimation of startup emissions. However, it is assumed that the oxidation catalyst will be operational during shutdown.

For some pollutants, emission rates from the combustion turbine are higher during normal steady-state operation than they are during low temperature operation or startup and shutdown. However, for other

<sup>5</sup> The 12 hours per year of low temperature operation is conservatively determined based on data extracted from USDOE-NREL's National Solar Radiation Database 1991-2010. The number of low temperature hours is determined based on data from the three stations in closest proximity to the station. Low temperature hours as well as distance to station are considered in determining the number of low temperature hours at the station for emission calculation purposes.

pollutants, emission rates may be higher during low temperature operation or startup and shutdown than during normal operation. As such, maximum annual emissions for the turbine are the maximum of potential combinations of normal, startup, shutdown, and low temperature operation as summarized in Equations 3-10 through 3-13 below.

**Equation 3-10:** 
$$\text{Normal} \frac{\text{ton}}{\text{yr}} = \text{Average} \frac{\text{lb}}{\text{hr}} \times \frac{8,760 \text{ hr}}{\text{yr}} \times \frac{\text{ton}}{2,000 \text{ lb}}$$

**Equation 3-11:** 
$$\text{Normal with Startup (SU) and Shutdown (SD)} \left( \frac{\text{ton}}{\text{yr}} \right) = \text{startup} \frac{\text{ton}}{\text{yr}} + \text{shutdown} \frac{\text{ton}}{\text{yr}} + \left( \text{normal} \frac{\text{ton}}{\text{yr}} \times \left( 1 - \frac{\text{startup hrs} + \text{shutdown hrs}}{8760} \right) \right)$$

**Equation 3-12:** 
$$\text{Normal with Low Temp (LT)} \left( \frac{\text{ton}}{\text{yr}} \right) = \text{low temp} \frac{\text{ton}}{\text{yr}} + \left( \text{normal} \frac{\text{ton}}{\text{yr}} \times \left( 1 - \frac{\text{low temp hrs}}{8760} \right) \right)$$

**Equation 3-13:** 
$$\text{Normal with SU, SD, and Low Temp (LT)} \left( \frac{\text{ton}}{\text{yr}} \right) = \text{startup} \frac{\text{ton}}{\text{yr}} + \text{shutdown} \frac{\text{ton}}{\text{yr}} + \text{low temp} \frac{\text{ton}}{\text{yr}} + \left( \text{normal} \frac{\text{ton}}{\text{yr}} \times \left( 1 - \frac{\text{startup hrs} + \text{shutdown hrs} + \text{low temp hrs}}{8760} \right) \right)$$

**Equation 3-14:** 
$$\text{Annual PTE} \left( \frac{\text{ton}}{\text{yr}} \right)_{\text{Pollutant } i} = \text{MAX} \left[ \text{Normal} \left( \frac{\text{ton}}{\text{yr}} \right), \text{Normal with SU, SD} \left( \frac{\text{ton}}{\text{yr}} \right), \text{Normal with LT} \left( \frac{\text{ton}}{\text{yr}} \right), \text{Normal with SU, SD, LT} \left( \frac{\text{ton}}{\text{yr}} \right) \right]_i$$

### 3.1.5. Short-Term Emission Limits

Algonquin requests short-term emission limits for the new Solar Taurus 60-7802 natural gas-fired turbine operation for the following alternate operating scenarios: (1) startup and shutdown; (2) low temperature conditions between 0 °F and -20 °F; and (3) low temperature conditions below -20 °F. As such, the short term emission rates for the new turbine operation for such alternate operating scenarios are provided below in Tables 3-6 through 3-8. Please note that the emission rates for the new turbine operating under normal conditions are provided in the CPA-FUEL Form.

- Pollutant emissions for the turbine operating at ambient temperatures between -20°F and 0°F are presented in Table 3-6 below. The emission rates are based on vendor full load operating data at an ambient temperature of -20°F; vendor guarantee for NO<sub>x</sub>, CO, and TOC emissions; AP-42; and use of an oxidation catalyst as described in Section 3.1.2.

**Table 3-6: Turbine Operating Emission Rates for Ambient Temperatures between -20°F and 0°F <sup>6</sup>**

<b>Pollutant</b>	<b>Low Ambient Temperature Emissions (lb/hr)</b>
PM	0.49
PM <sub>10</sub>	0.49
PM <sub>2.5</sub>	0.49
SO <sub>2</sub>	1.05
NO <sub>x</sub>	11.36
VOC <sup>7</sup>	0.52
CO	0.82

- Pollutant emissions for the turbine operating at temperatures below -20°F are presented in Table 3-7. The emission rates are based on vendor full load operating data at an ambient temperature of -20°F; vendor guarantee for NO<sub>x</sub>, CO, and TOC emissions; AP-42; and use of an oxidation catalyst as described in Section 3.1.2.

**Table 3-7: Turbine Operating Emission Rates for Ambient Temperatures below -20°F <sup>7</sup>**

<b>Pollutant</b>	<b>Extreme Low Ambient Temperature Emissions (lb/hr)</b>
PM	0.49
PM <sub>10</sub>	0.49
PM <sub>2.5</sub>	0.49
SO <sub>2</sub>	1.05
NO <sub>x</sub>	32.46
VOC	0.77
CO	1.24

- Pollutant emissions for turbine operation during startup and shutdown scenarios are presented in Table 3-8. The emission rates are based on vendor guarantee for NO<sub>x</sub>, CO, and TOC at an ambient temperature of 0.01°F; AP-42; and use of an oxidation catalyst only for shutdown emissions as described in Section 3.1.3. No control is assumed for the oxidation catalyst during startup as the catalyst will not reach its effective operating temperature until the end of the startup period.

<sup>6</sup> The emission rates can also be found in Table B-1Aj in Attachment G to this report.

<sup>7</sup> VOC emission rate is based on vendor guaranteed TOC emissions, and AP-42 emission factors. Ratios of VOC to TOC from the AP-42 factors are applied to the TOC factor derived from vendor information to obtain emission factors for VOC as described in Section 3.1.1.

**Table 3-8: Turbine Emission Rates for Startup and Shutdown <sup>8</sup>**

<b>Pollutant</b>	<b>Startup Emissions (lb/event)</b>	<b>Shutdown Emissions (lb/event)</b>
NO <sub>x</sub>	0.80	0.38
CO	77.24	1.74 <sup>9</sup>
VOC	0.97	0.22

### 3.1.6. Proposed Compliance Demonstration

As indicated in Table 3-1, the maximum emission rate for the new turbine during normal operation will be 9 ppmvd of NO<sub>x</sub> at 15 percent O<sub>2</sub> on a 3-hour average. Since this is a new technology and the resulting NO<sub>x</sub> emissions are dependent on site-specific factors, Algonquin and Solar are requesting an extended shakedown period to fully evaluate and tune the new turbine installation to achieve the very low NO<sub>x</sub> BACT emission rate. Based on information from the vendor, Algonquin expects a 6-month shakedown period before the 9 ppmvd technology will be installed and fully operational on the turbine.

Algonquin proposes to demonstrate compliance with the 9 ppmvd NO<sub>x</sub> limit for the new turbine via initial and subsequent emissions testing according to the requirements of 40 CFR Part 60 Subpart KKKK, as detailed in Section 4.3.1 below. Algonquin also proposes to continuously monitor natural gas flow to the new turbine to ensure compliance with the annual potential NO<sub>x</sub> emission rate shown in Table 3-13 on a rolling 12-month basis. Prior to the initial compliance demonstration (i.e., during the shakedown period), Algonquin will conservatively estimate emissions from the new turbine based on an emission factor of 15 ppmvd NO<sub>x</sub>.

## 3.2. EMERGENCY GENERATOR EMISSIONS

Algonquin is proposing to install a new Waukesha 585 bhp, four stroke lean burn natural gas-fired emergency generator. The emergency generator will be limited to 300 hours/year by the ERP Certification requirements of 310 CMR 7.26(42) and 310 CMR 70.00. Table 3-9 provides information on the emission factors used to calculate emissions from the emergency generator.

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<sup>8</sup> Please note that the estimated potential hourly emission rates for startup and shutdown are included in the detailed emissions calculations for the Site in Attachment G to this report. The pounds per event (lb/event) emission rates for startup and shutdown (without the use of oxidation catalyst) are provided in Table B-1Af and Table B-1Ag respectively in Attachment G to this report.

<sup>9</sup> The shutdown emission limit takes into account an oxidation catalyst control efficiency of 95 percent for CO and 50 percent for VOC.

**Table 3-9: Waukesha Emergency Generator Emission Factors**

<b>Pollutant</b>	<b>Emission Factor from Source</b>	<b>Source</b>
NO <sub>x</sub>	2.0 g/bhp-hr	Vendor data.
CO	1.3 g/bhp-hr	Vendor data.
VOC	0.43 g/bhp-hr	Vendor Data Table 3.2-2 of AP-42
CH <sub>4</sub>	4.5 g/bhp-hr	Vendor data Table 3.2-2 of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	0.00999 lb/MMBtu (HHV)	Table 3.2-2 of AP-42
SO <sub>2</sub>	14.29 lb/MMscf	Table 3.2-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content
CO <sub>2</sub>	53.06 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-1
N <sub>2</sub> O	0.0001 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-2
Total HAPs	Multiple HAP factors	Vendor Data Table 3.2-2 of AP-42

In order to calculate hourly emissions, the emission factors provided in Table 3-9 are converted to factors in lb/MMscf. These converted factors are multiplied by the generator's hourly fuel consumption in scf/hr to obtain hourly emissions. The following sections summarize the methods used to obtain lb/MMscf emission factors for each pollutant emitted from the new emergency generator.

### 3.2.1. Emergency Generator Emission Factors - NO<sub>x</sub>, CO, and VOC

NO<sub>x</sub>, CO, and VOC emitted by the emergency generator are calculated based on vendor guaranteed emission factors.

A VOC factor inclusive of formaldehyde is calculated using the relative emissions of formaldehyde and VOC provided in Table 3.2-2 of AP-42 (version dated July 2000). A VOC factor is calculated based on a scaling of the as the sum of the factors for all trace organic compounds listed in Table 3.2-2 which are VOCs. Formaldehyde emissions are proportional to VOC emissions, because formaldehyde is a constituent of VOC. The VOC factor is adjusted to account for formaldehyde as follows:

**Equation 3-15:** 
$$EF_{VOC} = \left[ \frac{EF_{FormaldehydeVendor}}{EF_{FormaldehydeAP42}} \right] \times (EF_{VOCAP42}) = lb/mmcf$$

Vendor-specified power output and fuel consumption for the engine are used to convert the g/bhp-hr factors. NO<sub>x</sub>, CO, and VOC factors are derived as follows:

**Equation 3-16:** 
$$NO_x, CO, VOC EF = \frac{g}{bhp-hr} \times \frac{lb}{453.6 g} \times hp \times \frac{hr}{scf fuel} \times \frac{1,000,000 scf}{MMscf} = \frac{lb}{MMscf}$$

### 3.2.2. Emergency Generator Emission Factors - CH<sub>4</sub> and HAPs

CH<sub>4</sub> and HAP emissions are calculated using the VOC emission rate and AP-42 emission factors. Standard emission factors for VOC, CH<sub>4</sub>, and HAPs from natural gas-fired engines are provided in Chapter 3.2 of AP-42. Table 3.2-2 (version dated July 2000) provides emission factors for VOC, CH<sub>4</sub>, and HAPs from four-stroke, lean-burn, natural gas-fired engines.

Using the same ratio method used to calculate CH<sub>4</sub> and HAPs emitted from the turbine (detailed in Section 3.1.1.2), CH<sub>4</sub> and HAPs emitted from engines are scaled based on the VOC emission rate from NSPS Subpart JJJJ.

### 3.2.3. Emergency Generator Emission Factors - PM<sub>10</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub>

PM<sub>10</sub> and PM<sub>2.5</sub> emitted by the emergency generator are calculated based on the emission factors listed in Table 3.2-2 of AP-42 (version dated July 2000) for natural gas-fired engines. PM<sub>10</sub> and PM<sub>2.5</sub> emission factors are calculated as the sum of the filterable and condensable PM emission factors. The SO<sub>2</sub> emission factor from Table 3.2-2 of AP-42 is scaled from a fuel sulfur content of 2,000 grains per MMscf to a fuel sulfur content of 5 grains per 100 scf.

### 3.2.4. Emergency Generator Emission Factors - CO<sub>2</sub>, N<sub>2</sub>O, and CO<sub>2e</sub>

CO<sub>2</sub> and N<sub>2</sub>O emitted by the emergency generator are calculated based on the emission factors listed in 40 CFR 98, Subpart C, Tables C-1 and C-2. Equation 3-6 and Equation 3-7 show how factors in lb/MMscf are derived for these pollutants. GHGs emitted from the engine include CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. CO<sub>2e</sub> emissions are calculated using the GWPs provided in Table 3-2.

## 3.3. NATURAL GAS HEATER EMISSIONS

Algonquin is proposing to install a new natural gas-fired fuel gas heater with a heat input of 0.23 MMBtu/hr at the Weymouth Compressor Station. In addition, there are two existing natural gas-fired heaters at the Weymouth M&R Station. Table 3-10 provides information on the emission factors used to calculate emissions from the new and existing heaters.

**Table 3-10: Process Heater Emission Factors <sup>1</sup>**

Pollutant	Emission Factor from Source	Source
NO <sub>x</sub>	80 ppmvd at 3% O <sub>2</sub>	Vendor specified emission rate
CO	200 ppmvd at 3% O <sub>2</sub>	Vendor specified emission rate
TOC	140 ppmvd at 3% O <sub>2</sub>	Vendor specified emission rate
VOC	140 ppmvd TOC at 3% O <sub>2</sub> 8.18 lb/MMscf	TOC: vendor specified emission rate Table 1.4-3 of AP-42
CH <sub>4</sub>	140 ppmvd TOC at 3% O <sub>2</sub> 2.30 lb/MMscf	TOC: vendor specified emission rate Table 1.4-2 of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	7.60 lb/MMscf	Table 1.4-2 of AP-42
SO <sub>2</sub>	14.29 lb/MMscf	Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content
CO <sub>2</sub>	53.06kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-1
N <sub>2</sub> O	0.0001 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-2
Total HAPs	Multiple HAP factors	Table 1.4-3 of AP-42

<sup>1</sup> New heaters at compressor station and existing heaters at M&R station.

### 3.3.1. Process Heater Emission Factors - NO<sub>x</sub>, CO, and TOC

**Equation 3-17:** 
$$NO_x, CO, TOC\ EF = ppmvd, 3\% O_2 \times \frac{lb/MMBtu}{ppmvd, 3\% O_2} \times 1,020 \frac{MMBtu}{MMscf} = \frac{lb}{MMscf}$$

*Where: 1 ppmvd, 3% O<sub>2</sub> = 829 NO<sub>2</sub> lb/MMbtu,  
= 1,360 CO lb/MMbtu and  
= 2380 TOC (as CH<sub>4</sub>) lb/MMbtu*

VOC, CH<sub>4</sub>, and HAP emissions are calculated using the vendor-specified TOC emission rate and AP-42 emission factors. Standard emission factors for TOC, VOC, CH<sub>4</sub>, and HAPs from natural gas-fired heaters are provided in Chapter 1.4 of AP-42. Table 1.4-2 (version dated July 1998) provides a CH<sub>4</sub> emission factor for natural gas-fired external combustion sources. The TOC and VOC factors used in the calculations differ slightly from the factors provided in Table 1.4-2. TOC and VOC factors are calculated as the sum of the factors for all speciated organic compounds listed in Table 1.4-3 which are TOCs and VOCs, respectively. Table 1.4-3 of AP-42 (version dated July 2000) provides emission factors for the HAPs emitted from natural gas-fired external combustion units.

### 3.3.3. Heater Emission Factors - PM<sub>10</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub>

### 3.3.4. Heater Emission Factors - CO<sub>2</sub>, N<sub>2</sub>O, and CO<sub>2</sub>e

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pollutants. GHGs emitted from the heater include CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. CO<sub>2</sub>e emissions are calculated using the GWPs provided in Table 3-2.

### 3.4. CATALYTIC SPACE HEATER EMISSIONS

Algonquin is proposing to install five new natural gas-fired catalytic space heaters with a heat input of 0.072 MMBtu/hr each at the Weymouth Compressor Station. Table 3-11 provides information on the emission factors used to calculate emissions from the five catalytic space heaters.

**Table 3-11: Catalytic Space Heater Emission Factors**

<b>Pollutant</b>	<b>Emission Factor from Source</b>	<b>Source</b>
NO <sub>x</sub>	94 lb/MMscf	Table 1.4-1 of AP-42
CO	40 lb/MMscf	Table 1.4-1 of AP-42
TOC	Multiple factors for speciated TOC compounds	Table 1.4-3 of AP-42
VOC	Multiple factors for speciated VOC compounds	Table 1.4-3 of AP-42
CH <sub>4</sub>	2.30 lb/MMscf	Table 1.4-2 of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	7.60 lb/MMscf	Table 1.4-2 of AP-42
SO <sub>2</sub>	14.29 lb/MMscf	Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content
CO <sub>2</sub>	53.06 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-1
N <sub>2</sub> O	0.0001 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-2
Total HAPs	Multiple HAP factors	Table 1.4-3 of AP-42

The emission factors provided in Table 3-11 are first converted to factors in lb/MMscf and then multiplied by the space heater's hourly fuel consumption in standard cubic feet per hour (scf/hr) to obtain hourly emissions. Fuel consumption is calculated from the heat output of the space heater assuming a thermal efficiency of 80 percent and a natural gas heating value of 1,020 Btu/scf. Annual potential emissions are calculated based on the average hourly fuel consumption rate and 8,760 hours per year. Maximum hourly potential emissions are calculated based on maximum hourly fuel consumption, assuming an overload capability of 105 percent. The following sections summarize the methods used to obtain lb/MMscf emission factors for each pollutant emitted from the new space heaters.

#### 3.4.1. Space Heater Emission Factors - NO<sub>x</sub> and CO

NO<sub>x</sub> and CO emitted by the space heaters are calculated based on emission factors provided directly in Table 1.4-1 of AP-42 (version dated July 1998) for residential furnaces with heat input ratings of less than 0.3 MMBtu/hr with no control.

#### 3.4.2. Space Heater Emission Factors - TOC, VOC, and HAPs

TOC, VOC, and HAP emissions are calculated using the AP-42 emission factors. Standard emission factors for TOC and VOC from natural gas-fired external combustion sources are provided in Chapter 1.4 of AP-42. The TOC and VOC factors used in the calculations differ slightly from the factors provided in Table 1.4-2. TOC and VOC

factors are calculated as the sum of the factors for all speciated organic compounds listed in Table 1.4-3 which are TOCs and VOCs, respectively.<sup>10</sup> Table 1.4-3 of AP-42 (version dated July 1998) provides emission factors for the HAPs emitted from natural gas-fired external combustion units.

### 3.4.3. Space Heater Emission Factors - PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, and CH<sub>4</sub>

PM<sub>10</sub> and PM<sub>2.5</sub> emitted by the space heaters are calculated based on the emission factors listed in Table 1.4-2 of AP-42 (version dated July 1998) for natural gas-fired external combustion sources. The total PM emission factor of 7.6 lb/MMscf, which includes filterable and condensable particulate, is used. It is assumed that all particulate emitted from natural gas combustion is less than 2.5 microns in diameters, so the emission rates for PM<sub>10</sub> and PM<sub>2.5</sub> are assumed equal to the total PM emission rate. The SO<sub>2</sub> emission factor of 0.6 lb/MMscf from Table 1.4-2 of AP-42 is scaled from a fuel sulfur content of 2,000 grains per MMscf to a fuel sulfur content of 5 grains per 100 scf. The CH<sub>4</sub> emission factor of 2.3 lb/MMscf is used directly from Table 1.4-2 of AP-42.

### 3.4.4. Space Heater Emission Factors - CO<sub>2</sub>, N<sub>2</sub>O, and CO<sub>2</sub>e

CO<sub>2</sub> and N<sub>2</sub>O emitted by the space heaters are calculated based on the emission factors listed in 40 CFR 98, Subpart C, Tables C-1 and C-2. Equation 3-6 and Equation 3-7 show how factors in lb/MMscf are derived for these pollutants. GHGs emitted from the heater include CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. CO<sub>2</sub>e emissions are calculated using the GWPs provided in Table 3-2.

## 3.5. NATURAL GAS-FIRED BOILERS

There are three Lochinvar boilers rated at 1.8 MMBtu/hr heat input capacity at the Weymouth M&R Station. Table 3-12 provides information on the emission factors used to calculate emissions from the three existing boilers.

**Table 3-12: Boiler Emission Factors**

Pollutant	Emission Factor from Source	Source
NO <sub>x</sub>	30 ppmvd at 3% O <sub>2</sub>	Vendor specified emission rate
CO	84 lb/MMscf	Table 1.4-1 of AP-42
TOC	Multiple factors for speciated TOC compounds	Table 1.4-3 of AP-42
VOC	Multiple factors for speciated VOC compounds	Table 1.4-3 of AP-42
CH <sub>4</sub>	2.30 lb/MMscf	Table 1.4-2 of AP-42
PM <sub>10</sub> /PM <sub>2.5</sub>	7.60 lb/MMscf	Table 1.4-2 of AP-42
SO <sub>2</sub>	14.29 lb/MMscf	Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content
CO <sub>2</sub>	53.06 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-1
N <sub>2</sub> O	0.0001 kg/MMBtu (HHV)	40 CFR 98, Subpart C, Table C-2
Total HAPs	Multiple HAP factors	Table 1.4-3 of AP-42

<sup>10</sup> For TOC, VOC, CH<sub>4</sub>, and CO<sub>2</sub>, the most conservative approach in either AP-42 or 40 CFR Part 98 (if applicable) was used to calculate potential emissions.

The emission factors provided in Table 3-12 are first converted to factors in lb/MMscf and then multiplied by the boiler's hourly fuel consumption in standard cubic feet per hour (scf/hr) to obtain hourly emissions. Fuel consumption is calculated from the heat output of the boiler assuming a thermal efficiency of 84 percent and a natural gas heating value of 1,020 Btu/scf. Annual potential emissions are calculated based on the average hourly fuel consumption rate and 8,760 hours per year. Maximum hourly potential emissions are calculated based on maximum hourly fuel consumption, assuming an overload capability of 105 percent. The following sections summarize the methods used to obtain lb/MMscf emission factors for each pollutant emitted from the existing boilers at the M&R Station.

### 3.5.1. Boiler Emission Factors - NO<sub>x</sub> and CO

NO<sub>x</sub> emissions from the boilers are based on vendor-specified emission rates and vendor-specified fuel consumption for the heaters as calculated in Equation 3-17 above. The CO emitted by the boilers is calculated based on emission factors provided directly in Table 1.4-1 of AP-42 (version dated July 1998) for small boilers with heat input ratings of less than 100 MMBtu/hr.

### 3.5.2. Boiler Emission Factors - Other Pollutants

Emissions for rest of the pollutants, including TOC, VOC, HAPs, PM<sub>10</sub> and PM<sub>2.5</sub>, SO<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>O, and CO<sub>2</sub>e, are calculated as specified in Section in 3.4 for space heaters.

## 3.6. PARTS WASHER EMISSIONS

Algonquin is proposing to install a new remote reservoir parts washer. Potential emissions from the parts washer are calculated based on the physical and chemical properties of a worst-case representative solvent used in the parts washer and the maximum throughput of the parts washer. In order to conservatively calculate potential emissions, it is assumed that all volatile organic compounds in the solvent are emitted to the atmosphere and that the VOC content is 100 percent. The maximum throughput of the parts washer will be 120 gallons of solvent per year, based on past experience and the addition of a safety factor. A worst-case specific gravity is assumed based on typical solvents used at other Algonquin sites.

Potential VOC emissions from the parts washer are calculated as follows:

**Equation 3-18:** 
$$VOC = 120 \frac{\text{gal solvent}}{\text{year}} \times (0.82 \times 8.34 \frac{\text{lb}}{\text{gal}}) \times 1 \frac{\text{lb VOC}}{\text{lb solvent}} = 0.4103 \frac{\text{tons VOC}}{\text{yr}}$$

## 3.7. STORAGE TANKS

Although natural gas in pipelines is considered a dry gas, it is not uncommon for a certain amount of water and hydrocarbons to condense out of the gas stream while in transit. Removing the condensate is a necessary activity to ensure that the natural gas in the pipeline is as pure as possible. Compressor stations typically have equipment to remove liquids from the natural gas in order to protect equipment (e.g., scrubbers, separators, filters, traps, drains, and drip pots). Separator vessels are designed with baffles and demister pads to ensure removal of any liquid entrained in the natural gas prior to atmospheric release. Any liquid that is separated in the vessels is stabilized and then transferred to the condensate storage tank via the pipeline liquids system. Stabilization of condensate is a process utilizing controlled flashing (the partial vapor that occurs when a saturated liquid stream undergoes a reduction in pressure by passing through a throttling valve or other throttling device) to allow it to be stored in atmospheric vessels. At the Weymouth Compressor Station, flashing

losses will occur at the separator vessels and include VOCs, GHGs, and HAPs. Total flashing losses are calculated based on a flash gas rate and a representative flash gas density. The flash gas rate is calculated based on a liquids input rate and a flash factor.<sup>11</sup> Emissions of individual VOCs, GHGs, and HAPs are calculated from total flashing losses using a representative pipeline liquids composition. Stabilized condensate has no flashing losses, but has negligible emissions due to breathing and working losses.

Working and breathing losses occur at all tanks at the Weymouth Compressor Station, including separator vessels, the condensate storage tank, the lubricating oil storage tank, and the oily water storage tank. Working and breathing losses include VOCs, GHGs, and HAPs and are calculated with the U.S. EPA's TANKS 4.09d program using maximum potential throughputs for each tank.

### 3.8. FUGITIVE EMISSIONS

Fugitive emissions from piping components, gas releases, and truck loading occur or will occur at the Site. The methodologies used to calculate potential fugitive emissions are described in the following sections.

#### 3.8.1. Fugitive Emissions from Piping Components

As part of the AB Project, Algonquin is implementing an enhanced LDAR program for pipeline liquids at the Site. This enhanced LDAR program will be in addition to the LDAR program required under 40 CFR Part 60, Subpart OOOOa that is discussed in Section 4.3.3 below. In estimating fugitive emissions for the Site, the enhanced LDAR program to be implemented is taken into consideration when calculating emissions for the piping components in pipeline liquids service (i.e., potential emissions for these components take into account an aspect of control due to the enhanced LDAR monitoring).

More specifically, potential emissions from piping components are calculated as follows:

- > Piping components in natural gas service, pipeline liquids service, and in light or heavy liquid service (based on liquid vapor pressure) use emission factors from EPA's *Protocol for Equipment Leak Emission Estimates* (EPA 453/R-95-017), Table 2-4.
- > Piping components in pipeline liquids service use emission factors from EPA 453/R-95-017 with the appropriate Texas Commission on Environmental Quality (TCEQ) 28RCT LDAR control efficiencies (CE) applied.<sup>12</sup>
- > Since an emission factor is not provided for leaks from pump seals in heavy liquid service in Table 2-4, the average SOCM I without ethylene emission factor for pumps in heavy liquid service from Table 2-1 is used to estimate emissions.

The uncontrolled annual emissions are conservatively calculated assuming that the components are in continuous gas, pipeline liquids, or light or heavy liquid service as follows:

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<sup>11</sup> The liquids input rate is determined based on operator experience with the incorporation of a safety factor, and the flash factor in standard cubic foot per barrel (scf/bbl) was determined in a laboratory analysis of a gas sample taken from Atlanta, Texas.

<sup>12</sup> TCEQ – Control Efficiencies for TCEQ Leak Detection and Repair Programs, Revised 07/11, [https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/control\\_eff.doc](https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/control_eff.doc)

**Equation 3-19:**

Total Emissions from Components in Gas, Pipeline Liquids, or Light or Heavy Liquid Service

$$= \# \text{ of components} \times \frac{\frac{kg}{hr}}{\text{component}} \times \frac{8,760 \text{ hrs}}{yr} \times \frac{1,000 \text{ g}}{kg} \times \frac{lb}{453.6 \text{ g}} \times \frac{1 \text{ ton}}{2,000 \text{ lb}} = \frac{\text{tons}}{yr}$$

The controlled annual emissions are also conservatively calculated assuming that the components are in continuous pipeline liquids service as follows:

**Equation 3-20:**

Total Emissions from Components in Pipeline Liquids Service

$$= \# \text{ of components} \times \frac{\frac{kg}{hr}}{\text{component}} \times (1 - CE) \times \frac{8,760 \text{ hrs}}{yr} \times \frac{1,000 \text{ g}}{kg} \times \frac{lb}{453.6 \text{ g}} \times \frac{1 \text{ ton}}{2,000 \text{ lb}} \\ = \frac{\text{tons}}{yr}$$

The emission factors utilized include emissions reductions associated with an LDAR monitoring program. Emissions of individual VOCs, GHGs, and HAPs are calculated by multiplying the total fugitive gas emissions from piping components in gas, pipeline liquids, and light or heavy liquid service by the weight percent of each pollutant in gas, pipeline liquids, and oil. Gas, pipeline liquids, and oil compositions are engineering estimates based on available worst case data to be conservative.<sup>13</sup>

### 3.8.2. Fugitive Emissions from Gas Releases

Gas releases occur with both pipeline operation and station operation. Gas releases refer to the intentional and unintentional venting of gas for maintenance, routine operations such as startup and shutdown, or during emergency conditions. The proposed Project will result in fugitive emissions from gas releases. The potential volume of gas emitted was estimated in standard cubic feet per year based on the design data for other compressor stations. Additional details on gas release volume estimation are provided in Attachment G to this application. Emissions of individual VOCs, GHGs, and HAPs are calculated by multiplying the total fugitive gas emissions from gas releases by the weight percent of each pollutant in the natural gas compressed at the Site.<sup>13</sup>

### 3.8.3. Fugitive Emissions from Truck Loading

Emissions occur during the loading of volatile organic liquids into tanker trucks and include VOCs, GHGs, and HAPs. Total loading losses are calculated based on calculation methods for submerged filling provided in AP-42 Section 5.2 (version dated January 1995). Emissions of individual VOCs, GHGs, and HAPs are calculated from total loading losses using representative pipeline liquids and lubricating oil compositions.

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<sup>13</sup> Natural gas composition is based on a composite average of 62 samples collected during an extended gas analysis from sites along the Algonquin and Maritimes system in New Jersey, New York, Connecticut, Rhode Island and Maine between 2011 and 2015.

### 3.9. TOTAL PROJECT EMISSIONS

Tables 3-13 through 3-16 present total potential emissions from all emission sources to be installed as a part of the AB Project at the Weymouth Compressor Station and the existing emission sources at the Weymouth M&R Station. Detailed emission calculations can be found in Attachment G of this application report.

**Table 3-13: Potential Emissions from Combustion Units at the Site**

Pollutant	Taurus 60-7802 (tpy)	Waukesha Emergency Generator (tpy)	Sivalls Fuel Gas Process Heater (tpy)	Five Bruest Catalytic Space Heaters (tpy per unit) <sup>1</sup>	Existing Hanover Heater (tpy)	Existing NATCO Heater (tpy)	Existing Three Lochinvar Boilers (tpy per unit) <sup>1</sup>	Project Combustion Emissions (tpy)
	Attachment G Table							
	B-1Aj	C-1A	D-1D	D-1E	D-1A	D-1B	D-1C	
NO <sub>x</sub>	9.96	0.39	0.10	0.03	4.03	2.88	0.29	17.68
CO	16.77	0.25	0.15	0.012	6.13	4.38	0.65	28.34
VOC	1.26	0.08	0.04	0.0025	1.48	1.06	0.06	3.98
PM <sub>10</sub> /PM <sub>2.5</sub>	1.99	0.007	0.01	0.002	0.31	0.22	0.06	2.60
SO <sub>2</sub>	4.23	0.01	0.014	0.004	0.58	0.42	0.11	5.37
CO <sub>2</sub> e	35,800	103	119	37	4,921	3,515	929	45,424
Total HAPs	0.28	0.05	0.008	0.0006	0.34	0.24	0.015	0.93

<sup>1</sup> To obtain total emissions multiply indicated value by total number of units.



**Table 3-14: Potential Fugitive Emissions from the Site**

Pollutant	Truck Loading Fugitive Emissions (tpy)	Piping Component Fugitive Emissions (tpy) <sup>3</sup>	Gas Release Fugitive Emissions (tpy) <sup>3</sup>	Total Project Fugitive Emissions (tpy)
	Attachment G Table			
	F-1H, F-1I, F-1J	H-1Ba	G-1B	
NO <sub>x</sub>	--	--	--	--
CO	--	--	--	--
VOC	0.01	2.38	18.93	21.32
PM <sub>10</sub> /PM <sub>2.5</sub>	--	--	--	--
SO <sub>2</sub>	--	--	--	--
CO <sub>2</sub> e	1	753	13,103	13,857
Total HAPs	0.0007	0.18	1.09	1.27

**Table 3-15: Potential Emissions from Parts Washer, Separator Vessels, and Storage Tanks at the Site**

Pollutant	Parts Washer (tpy)	Separator Vessel SV-V01S (tpy)	Separator Vessel SV-V01C (tpy)	Separator Vessel SV-V02 (tpy)	Separator Vessel V4SD (tpy)	Condensate Storage Tank V5 (tpy)	Lubricating Oil Storage Tank OIL1 (tpy)	Oily Water Storage Tank OW1 (tpy)	Total Emissions from Parts Washer, Separator Vessels and Storage Tanks (tpy)
	Attachment G Table								
	I-1	F-1A	F-1B	F-1C, E-1A	F-1D	F-1E	F-1F	F-1G	
NO <sub>x</sub>	--	--	--	--	--	--	--	--	--
CO	--	--	--	--	--	--	--	--	--
VOC	0.41	0.131	0.131	0.705	0.013	0.291	0.002	0.001	1.68
PM <sub>10</sub> /PM <sub>2.5</sub>	--	--	--	--	--	--	--	--	--
SO <sub>2</sub>	--	--	--	--	--	--	--	--	--
CO <sub>2</sub> e	--	7	7	22	1	16	--	--	53
Total HAPs	--	0.008	0.008	0.043	0.001	0.018	--	--	0.08

**Table 3-16: Total Potential Emissions from the Site**

<b>Pollutant (tpy)</b>	<b>Combustion Sources (tpy)</b>	<b>Fugitive Sources (tpy)</b>	<b>Parts Washer, Separator Vessels, and Tanks (tpy)</b>	<b>Total Project Emissions (tpy)</b>
NO <sub>x</sub>	17.68	--	--	17.68
CO	28.34	--	--	28.34
VOC	3.98	21.32	1.70	26.98
PM <sub>10</sub> /PM <sub>2.5</sub>	2.60	--	--	2.60
SO <sub>2</sub>	5.37	--	--	5.37
CO <sub>2e</sub>	45,424	13,857	53	59,334
Total HAPs	0.93	1.27	0.08	2.28

## 4. REGULATORY APPLICABILITY

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This section of the application report addresses the conformity of the Site to the applicable permitting programs and air quality regulations.

### 4.1. TITLE V AND STATE PERMITTING REQUIREMENTS

310 CMR 7.02 provides the applicability criteria for MassDEP's state air permitting program. New or modified emission units meeting these criteria must obtain a plan approval prior to construction or operation of a new source. The new Solar Taurus 60-7802 natural gas-fired turbine will require a Non-Major CPA per 310 CMR 7.02(5)(a)2a as it is fired by natural gas and has a heat input rating greater than 40,000,000 Btu/hr. In addition, the combined fugitive emissions from the piping components and gas releases from the Site require permitting per 310 CMR 7.02(5)(a)(1) and hence are included in the Non-Major CPA application.

The new Waukesha emergency generator will meet the definition of "emergency engine" per 310 CMR 7.00 Definitions and will be operated under the ERP Certification requirements of 310 CMR 7.26(42) and 310 CMR 70.00. As such, it is not included in the attached Non-Major CPA application.

The new heaters at the Weymouth Compressor Station and the existing heaters and boilers at the Weymouth M&R Station are exempt from permitting per 310 CMR 7.02(2)(b)15, since the heat input of each heater is less than 10 MMBtu/hr. Potential emissions from the parts washer, separator vessels and storage tanks are less than one tpy for any pollutant and the units are exempt from permitting per 310 CMR 7.02(2)(b)7.

Therefore, the new emergency generator, the new fuel gas heater, the new space heaters, the new parts washer and the new separator vessels and storage tanks, and existing heaters and boilers at the Weymouth M&R Station are not addressed in the attached plan approval application forms. However, emissions from the new units are accounted for in the NSR applicability analysis provided in Section 4.2.

The following sections outline the state-specific requirements for 310 CMR 7.02(5) Non-Major CPA applications.

#### 4.1.1. State Best Available Control Technology Applicability

Per 310 CMR 7.02(5) and MassDEP guidance,<sup>14</sup> a Non-Major Plan Approval application requires a Top-Down Best Available Control Technology (BACT) analysis for any new or modified emission units. Based on the MassDEP request during the initial pre-application meeting, a greenhouse gas BACT analysis is also provided with this application. The detailed BACT analysis is provided in Section 5 of this report.

#### 4.1.2. Dispersion Modeling Requirements

Per a request from MassDEP, an ambient air quality impact analysis is provided with this application. Air dispersion modeling is relied upon to demonstrate that the Project complies with the applicable National Ambient Air Quality Standards (NAAQS). Additionally, the MassDEP requested an air dispersion modeling analysis for toxic pollutants. The detailed dispersion modeling analysis is provided as a separate report titled "Air Dispersion Modeling Report" along with application package.

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<sup>14</sup> <http://www.mass.gov/eea/docs/dep/air/approvals/aq/aqpaguid.pdf>

## 4.2. NEW SOURCE REVIEW

The federal NSR program is comprised of two distinct pre-construction permitting programs: 1) PSD (for attainment areas/pollutants); and 2) Nonattainment New Source Review (NNSR) (for nonattainment areas/pollutants). For any new stationary source such as the Weymouth Compressor Station, these permitting programs are required to be evaluated. The applicability determination for new stationary sources involves first determining if the proposed changes/new PTE are subject to PSD and/or NNSR permitting requirements.

### 4.2.1. Major NSR Permitting Programs

PSD permitting may apply to facilities located in areas designated as in attainment with the National Ambient Air Quality Standards (NAAQS). Projects that are either new major stationary sources or modifications to existing major sources resulting in a significant emissions increase AND a significant net emissions increase of an attainment pollutant are subject to the PSD permitting program. The MassDEP is delegated authority to implement the federal PSD program at 40 CFR 52.21.

NNSR permitting may apply to facilities located in areas that are designated as not in attainment with the NAAQS for a specific criteria pollutant. Projects that are either new major stationary sources or modifications to existing major sources resulting in a significant net emissions increase of a nonattainment pollutant are regulated under the NNSR program in Massachusetts. MassDEP's NNSR permitting program is established in 310 CMR Appendix A.

### 4.2.2. NAAQS Attainment Status

The Weymouth Compressor Station will be a new compressor station located in Norfolk County, Massachusetts which is in serious nonattainment for ozone and in attainment for all other pollutants per 310 CMR 7.00 Definitions and 40 CFR 81.322, Subpart C – Section 107.

### 4.2.3. Major Source Status under NSR and Title V

In accordance with 40 CFR 52.21 and 310 CMR Appendix A, determination of whether NNSR/PSD applies to a project is a two-step process. The first step in completing a PSD/NNSR applicability analysis is to determine if a project is currently considered a major stationary source. The second step requires the determination of whether the proposed changes/project causes a significant emissions increase AND a significant net emissions increase, which involves the quantification of the change in emissions resulting from the project itself plus any other contemporaneous changes in emissions (i.e. increases or decreases in actual emissions) that have occurred at the facility. Projects that do not trigger NSR major source status (i.e. the first step of the process) do not trigger NNSR/PSD and are exempt from the second step of the process.

According to 40 CFR 52.21(b)(1)(i)(b), the major source threshold for PSD review is 250 tpy for any regulated NSR pollutant.

For nonattainment pollutants, MassDEP defines a major stationary source in 310 CMR Appendix A which establishes the major source threshold at 100 tpy for any regulated NSR pollutant except for VOC and NO<sub>x</sub>, which have a lower threshold of 50 tpy each in a serious ozone nonattainment area.

Per 310 CMR Appendix C, the Title V source threshold is 100 tpy for any air pollutant. Additionally, the Title V source threshold for greenhouse gases is 100,000 tpy CO<sub>2e</sub> and 100 tons per year of greenhouse gases on a mass basis. The PTE from the Weymouth Compressor Station for greenhouse gases is below 100,000 tpy CO<sub>2e</sub> and hence it is not subject to the Title V program. Note that per 40 CFR 52.21(b)(1)(i)(c) and 310 CMR Attachment C,

fugitive emissions from a stationary source shall not be included in determining a facility's PSD and Title V major stationary source status unless the facility type is listed in the 28 defined source categories. Natural gas transmission facilities are not included in the list of 28 source categories. As such, fugitive emissions are not included in the PSD and Title V major source evaluation for the Site.

In summary, the NSR major stationary source thresholds for the Site are the following:

- > For ozone precursors: NO<sub>x</sub> – 50 tpy and VOC – 50 tpy (NNSR/Title V)
- > For greenhouse gases: carbon dioxide equivalent (CO<sub>2</sub>e) – 100,000 tpy (Title V) <sup>15</sup>
- > All other NSR regulated pollutants: 250 tpy (PSD)
- > All other NSR regulated pollutants: 100 tpy (Title V)

Since the Weymouth Compressor Station is a new compressor station, the PTE from the Project (excluding fugitive emissions) will be compared to the above mentioned NSR major stationary source thresholds. The PTE (excluding fugitive emissions) from the Site as provided in Table 3-16 is well below the PSD/NNSR as well as the Title V thresholds, as such the facility does not trigger NSR major source status and is only required to prepare a Non-Major CPA application.

### 4.3. NEW SOURCE PERFORMANCE STANDARDS (NSPS)

This section summarizes the applicability of NSPS regulations codified in 40 CFR Part 60 to the new turbine.

#### 4.3.1. 40 CFR Part 60, Subpart KKKK – Standards of Performance for Stationary Gas Turbines (After February 18, 2005)

##### Applicability

Pursuant to 40 CFR 60.4305(a), the Solar Taurus 60-7802 gas turbine is subject to requirements of 40 CFR 60 Subpart KKKK, because its heat input at peak load will be greater than or equal to 10 MMBtu/hr (HHV) and Algonquin will have commenced the construction of the turbine after February 18, 2005.

##### Emission Limits

Pursuant to 40 CFR 60.4320(a) and Table 1 to Subpart KKKK of Part 60 – Nitrogen Oxide Emission Limits for New Stationary Combustion Turbines, the Solar Taurus 60-7802 gas turbine, which will have an HHV heat input of between 50 and 850 MMBtu/hr, will comply with a NO<sub>x</sub> emission standard of 25 ppmvd at 15 percent O<sub>2</sub> as indicated by the vendor guarantee listed in Table 3-1. Subpart KKKK also includes a NO<sub>x</sub> limit of 150 ppmvd at 15 percent O<sub>2</sub> or 8.7 pounds per megawatt-hour (lb/MWh) for turbine operation at temperatures less than 0 °F and turbine operation at loads less than 75 percent of peak load which the new turbine will meet.

The new Solar Taurus 60-7802 turbine will comply with an SO<sub>2</sub> emission standard of 0.9 lb/MW-hr gross output and will not burn any fuel that has the potential to emit in excess of 0.060 lb/MMBtu SO<sub>2</sub> heat input, pursuant to 40 CFR 60.4330(a)(1) and (2), respectively.

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<sup>15</sup> In accordance with the June 13, 2014 ruling of the United States Supreme Court, the EPA no longer requires stationary sources to obtain PSD and Title V permits solely due to GHG/ CO<sub>2</sub>e emissions.

### General Compliance Requirements

Pursuant to 40 CFR 60.4333(a), the new Taurus 60-7802, its air pollution control equipment, and its monitoring equipment will be maintained in a manner that is consistent with good air pollution control practices for minimizing emissions. This requirement applies at all times including during startup, shutdown, and malfunction.

### NO<sub>x</sub> Monitoring

Pursuant to 40 CFR 60.4340(a), since the new Taurus 60-7802 will not use water or steam injection to control NO<sub>x</sub> emissions, Algonquin will perform annual performance tests in accordance with 40 CFR 60.4400 to demonstrate continuous compliance. If the NO<sub>x</sub> emission result from the performance test is less than or equal to 75 percent of the NO<sub>x</sub> emission limit for the turbine ( $\leq 18.75$  ppmvd at 15 percent O<sub>2</sub> or  $\leq 0.9$  lb/MW-hr), Algonquin may reduce the frequency of subsequent performance tests to once every 2 years (no more than 26 calendar months following the previous performance test).<sup>16</sup> If the results of any subsequent performance test exceed 75 percent of the NO<sub>x</sub> emission limit, Algonquin will be required to resume annual performance testing.

Per 40 CFR 60.8(a), the initial NO<sub>x</sub> performance test for the new Taurus 60-7802 is required to be conducted within 60 days after achieving the maximum production rate (i.e. the turbine's maximum rated heat output), but no later than 180 days after initial startup.

### SO<sub>2</sub> Monitoring

Pursuant to 40 CFR 60.4365(a), in order to demonstrate continuous compliance with the applicable 0.0060 lb/MMBtu potential SO<sub>2</sub> emissions limit, Algonquin will utilize a current, valid purchase contract, tariff sheet or transportation contract for natural gas that will specify that the maximum total sulfur content of the natural gas used at the facility is less than 20 grains per 100 standard cubic feet (gr/scf).

### Reporting

Pursuant to 40 CFR 60.4375(b), since Algonquin will be conducting annual performance testing in accordance with 40 CFR 60.4340(a), a written report of the results of each performance test will be submitted to MassDEP and the U.S. EPA before the close of business on the 60th day following the completion of the performance test.

Per 40 CFR 60.7(a)(1), Algonquin will submit notification of the date construction of the new Taurus 60-7802 commenced. The submittal will be postmarked by no later than 30 days after the commencement of construction date. Per 40 CFR 60.7(a)(3), the submittal of the notification of the actual date of initial startup of the new Taurus 60-7802 will be postmarked by no later than 15 days after the initial startup date.

## **4.3.2. 40 CFR Part 60, Subpart GG - Standards of Performance for Stationary Gas Turbines**

Pursuant to 40 CFR 60.4305(b) under 40 CFR Part 60 Subpart KKKK, since the new turbine at the Weymouth Compressor Station is subject to 40 CFR 60 Subpart KKKK, it is exempt from 40 CFR 60 Subpart GG.

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<sup>16</sup> Table 1 to Subpart KKKK of Part 60—Nitrogen Oxide Emission Limits for New Stationary Combustion Turbines, New turbine firing natural gas, >50 MMBtu/h and  $\leq 850$  MMBtu/h, 25 ppmvd at 15 percent O<sub>2</sub> or 150 ng/J of useful output (1.2 lb/MWh).

#### **4.3.3. 40 CFR Part 60, Subpart OOOO - Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution**

On December 31, 2014, the U.S. EPA finalized amendments to the NSPS for Crude Oil and Natural Gas Production, Transmission, and Distribution (40 CFR 60, Subpart OOOO). Affected sources under Subpart OOOO include storage vessels in the oil and natural gas production segment, natural gas processing segment, or natural gas transmission and storage segment with VOC emissions exceeding six tpy as described in 40 CFR 60.5365(e) as well as equipment leaks at natural gas processing plants as described in 40 CFR 60.5365(f).

Since the potential VOC emissions from the new separator vessels and storage tanks will not exceed six tpy, the Project is not subject to the requirements of Subpart OOOO.

Per 40 CFR 60.5365(f)(2), equipment leaks from process units located at onshore natural gas processing plants are subject to the LDAR requirements established in Subpart OOOO. Because the Weymouth Compressor Station operates under North American Industry Classification System (NAICS) Code 486210 for the Pipeline Transportation of Natural Gas, the facility is not a natural gas processing plant and equipment leaks at the Weymouth Compressor Station are not subject to the requirements of Subpart OOOO pursuant to 40 CFR 60.5365(f)(2).

#### **4.3.4. 40 CFR Part 60, Subpart OOOOa - Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution**

40 CFR Part 60, Subpart OOOOa applies to sources that are constructed/modified after September 18, 2015, including centrifugal compressors, reciprocating compressors, pneumatic controllers, pneumatic pumps, storage vessels, equipment leaks and sweetening units within the crude oil and natural gas sector. In the natural gas transmission segment, Subpart OOOOa has standards for each of these affected facilities, except for pneumatic pumps and sweetening units.

Centrifugal compressors with wet seals constructed after September 18, 2015 are subject to the control, recordkeeping, and reporting requirements of Subpart OOOOa. Algonquin will not be installing any centrifugal compressors with wet seals as a part of the AB Project at the Weymouth Compressor Station. In addition, no reciprocating compressors are being installed as part of the Project. Therefore, the Weymouth Compressor Station will not be subject to the rod packing replacement or control requirements for compressors. Any new natural gas pneumatic controller installed will have a bleed rate less than or equal to six standard cubic feet per hour (scf/hour), as required by Subpart OOOOa. While any tanks being installed have the potential to be subject, the potential emissions from each of the tanks proposed at the Weymouth Compressor Station as part of the AB Project are well below the six tpy threshold. As such, the requirements of Subpart OOOOa do not apply to the tanks.

Subpart OOOOa has added LDAR requirements for new or modified compressor stations in the transmission segment. As such, the fugitive emissions components at the Weymouth Compressor Station will be subject to the LDAR requirements of Subpart OOOOa. Please note that compressor station is defined in Subpart OOOOa as:

“Compressor station means any permanent combination of one or more compressors that move natural gas at increased pressure through gathering or transmission pipelines, or into or out of storage. This includes, but is not limited to, gathering and boosting stations and transmission compressor stations. The combination of one or more compressors located at a well site, or located at an onshore natural gas processing plant, is not a compressor station for purposes of § 60.5397a.”



#### **4.3.5. 40 CFR Part 60, Subpart JJJJ - Standards of Performance for Stationary Spark Ignition Internal Combustion Engines**

40 CFR Part 60, Subpart JJJJ applies to owners and operators of new or existing stationary spark ignition internal combustion engines (SI ICE) rated at greater than 25 hp that commence construction, modification, or reconstruction after June 12, 2006. Since the new emergency stationary SI ICE proposed at the Weymouth Compressor Station is greater than 25 hp, the requirements of Subpart JJJJ will apply to the Project.

### **4.4. NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP)**

This section summarizes the applicability of National Emission Standards for Hazardous Air Pollutants (NESHAP) codified in 40 CFR Parts 61 and 63. Sources of HAPs are defined as major sources (if potential emissions exceed major source thresholds) or area sources (i.e., they are not major).

#### **4.4.1. 40 CFR Part 63, Subpart YYYY - National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines**

Subpart YYYY applies to major HAP sources. Per 40 CFR 63.6085, the new Solar Taurus 60-7802 gas turbine is not subject to requirements of 40 CFR 63 Subpart YYYY because the Site will be an area source of HAPs. An area source of HAPs is a source with potential HAP emissions are less than 10 tpy for any individual HAP and less than 25 tpy for the aggregate of all HAPs.

#### **4.4.2. 40 CFR Part 63, Subpart HHH - National Emission Standards for Hazardous Air Pollutants from Natural Gas Transmission and Storage Facilities**

Subpart HHH applies to major HAP sources. Per 40 CFR 63.1270(a), major sources of HAPs that engage in natural gas transmission and storage and that transport or store natural gas prior to entering the pipeline to a local distribution company or to a final end user (if there is no local distribution company) are subject to requirements of 40 CFR Part 63 Subpart HHH. Since the Site will be an area source of HAPs, the requirements of Subpart HHH do not apply.

#### **4.4.3. 40 CFR Part 63, Subpart DDDDD - National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters**

Subpart DDDDD applies to certain new and existing boilers and process heaters located at major HAP sources. Per 40 CFR 63.7485, since the Project will be an area source of HAPs, the new heaters at the Site will not be subject to the requirements of 40 CFR Part 63, Subpart DDDDD. Similarly, the existing heaters and boilers at the Weymouth M&R Station are not subject to Subpart DDDDD.

#### **4.4.4. 40 CFR Part 63, Subpart ZZZZ - National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines**

Subpart ZZZZ applies to certain stationary reciprocating internal combustion engines (RICE) located at major and area sources of HAPs. Per 40 CFR Part 63.6585, Subpart ZZZZ applies to existing, new, and reconstructed RICE depending on size, use. The AB Project includes the installation of one new emergency stationary RICE with a site rating greater than 500 hp at the Weymouth Compressor Station. New stationary RICE located at area sources of HAPs, such as the emergency engine proposed for the AB Project, must meet the requirements of Subpart ZZZZ by meeting the NSPS. As discussed above in Section 4.3.3, the new emergency engine proposed at



the Weymouth Compressor Station is subject to the NSPS at 40 CFR Part 60, Subpart JJJJ, therefore the requirements of Subpart ZZZZ will be met.

#### **4.4.5. 40 CFR Part 63, Subpart JJJJJJ - National Emission Standards for Hazardous Air Pollutants for Area Sources: Industrial, Commercial, and Institutional Boilers**

Process heaters are not covered under Subpart JJJJJ, therefore, the new gas-fired heaters to be installed as a part of the Project are not covered under this rule. Additionally, boilers which only burn gaseous fuel are not covered under the rule. The boilers at the existing Weymouth M&R Station burn natural gas exclusively, therefore Subpart JJJJJJ is not applicable to their operation.

### **4.5. ADDITIONAL APPLICABLE STATE REGULATIONS**

#### **4.5.1. 310 CMR 7.06 - Visible Emissions**

This regulation contains opacity and smoke standards:

- Opacity – Not to exceed 20 percent opacity for a period or aggregate period of time in excess of two minutes during any one hour provided that, at no time during the said two minutes shall the opacity exceed 40 percent.
- Smoke – Not equal to or greater than No. 1 of the Chart for a period, or aggregate period of time in excess of six minutes during any one hour, provided that at no time during the said six minutes shall the shade, density, or appearance be equal to or greater than No. 2 of the Chart.<sup>17</sup>

The new turbine at the Weymouth Compressor Station will comply with the opacity and smoke limits in this rule by firing only natural gas. The proposed emergency generator and heaters and existing heaters and boilers at the Weymouth M&R Station will also be subject to the rule and will comply by burning only natural gas.

#### **4.5.2. 310 CMR 7.09 - Dust, Odor, Construction, and Demolition**

This regulation prohibits emissions which create or contribute to dust or odors that constitute a nuisance. Algonquin will comply with this requirement during the construction and operation of the facility.

#### **4.5.3. 310 CMR 7.10 - Noise**

This regulation prohibits sounds that cause a nuisance, could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business. The Weymouth Compressor Station must demonstrate compliance to 310 CMR 7.10, which requires that there cannot be an increase over ambient sound levels of more than 10 decibels (A-weighted – db(A)) or produce a “pure tone” condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more. Based on an acoustical analysis conducted by Algonquin, the Weymouth Compressor Station will comply with the requirements of this rule.

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<sup>17</sup> Chart means the Ringelmann Scale for grading the density of smoke, as published by the United States Bureau of Mines.

#### **4.5.4. 310 CMR 7.18 - Volatile and Halogenated Organic Compounds**

The operation of cold solvent degreasing units (i.e., the proposed parts washer) are regulated under 310 CMR 7.18(8)(a). The requirements of this regulation include use of solvent that has a vapor pressure of less than 1 mm Hg at 20 °C, as well as other design and operation requirements. The new parts washer proposed at Weymouth Compressor Station will be subject to the requirements of 310 CMR 7.18(8)(a) for Cold Cleaning Degreasing.

#### **4.5.5. 310 CMR 7.19 - RACT for Sources of Nitrogen Oxides Emissions**

This regulation contains NO<sub>x</sub> Reasonably Available Control Technology (RACT) standards for combustion sources located at major stationary sources of NO<sub>x</sub> in the state (uncontrolled PTE greater than 50 tpy). The NO<sub>x</sub> PTE from the Site is below 50 tpy and therefore the facility is not subject to this requirement. This was also discussed and confirmed with MassDEP during the pre-application meeting.<sup>18</sup>

#### **4.5.6. 310 CMR 7.22 - Sulfur Dioxide Emissions Reductions for the Purpose of Reducing Acid Rain**

This rule limits the SO<sub>2</sub> emission rate to no greater than an annual calendar average of 1.2 pounds of SO<sub>2</sub> per MMBtu of fuel input from a fuel utilization facility with a capacity to burn fuel at a rate greater than or equal to 100 MMBtu/hr fuel input per hour. The new turbine at the Weymouth Compressor Station has fuel input less than 100 MMBtu/hr and is not subject to this requirement.

#### **4.5.7. 310 CMR 7.26 - Engines and Turbines**

This regulation applies to non-emergency engines with a rated power output equal to or greater than 50 kW and to turbines with a rated power output less than or equal to 10 MW that are constructed, substantially reconstructed, or altered on or after March 23, 2006. The Solar Taurus 60-7802 turbine proposed at the Weymouth Compressor Station is a non-emergency turbine with an output rating of 7,700 hp (5.74 MW). The 9 ppmvd NO<sub>x</sub> limit at 15 percent O<sub>2</sub> when converted to an equivalent emission rate equals 0.38 lb/MW-hr. The conversion is based on turbine performance values at an average ambient temperature of 46.65 °F. The emission limits set forth in the regulation are based on the use of selective catalytic reduction (SCR) as BACT. Based on the BACT review done for this project, SCR is not proposed for installation. Section 7.26(43)(a)2 allows units operated to compress natural gas at a pipeline compressor station to file a CPA application in accordance with the requirements of 310 CMR 7.02(5)(c) in lieu of complying with the requirements of 310 CMR 7.26(43). Algonquin has chosen to file this Non-Major CPA application in accordance with the requirements of 310 CMR 7.02(5)(c) in lieu of complying with the requirements of 310 CMR 7.26(43). Section 5.4, Turbine – NO<sub>x</sub> BACT, outlines the BACT analysis conducted for the Project and the proposed BACT emission limits. Therefore the industry performance standards included in 310 CMR 7.26(43) are not discussed further in this application.

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<sup>18</sup> Pre-application meeting with MassDEP (Tom Cushing, Pete Russell, Samrawit Dererie), Spectra (Reagan Mayces, Terry Doyle, Bill Welch, Owen McManus), TRC (Kate Brown) and Trinity Consultants (Wendy Merz) on March 10, 2015.

## 5. BACT ANALYSIS

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This section discusses the regulatory basis for BACT, the approach used in completing the BACT analyses, and the BACT analyses for the proposed turbine and fugitive emissions from piping components and gas releases. The MassDEP BACT forms and supporting documentation are included in Attachments C and E.

### 5.1. BACT DEFINITION

Per 310 CMR 7.02(5) and MassDEP guidance for a CPA application submittal, a Top-Down BACT or Top-Case BACT analysis is required for any new or modified emission units.<sup>19</sup> The MassDEP Top-Case BACT guidelines for simple cycle turbines (> 10 MW/hr) are based on electricity generation with SCR controls. This Top-Case BACT analysis is not directly applicable to the proposed natural gas combustion turbine at the Weymouth Compressor Station. Hence, a Top-Down BACT analysis is provided in this section.

BACT is defined in the MassDEP regulations [310 CMR 7.00 et seq.] As:

*“An emission limitation based on the maximum degree of reduction of any regulated air contaminant emitted from or which results from any regulated facility which the Department (MassDEP),<sup>20</sup> on a case-by-case basis taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems and techniques for control of each such contaminant. The best available control technology determination shall not allow emissions in excess of any emissions standard established under the New Source Performance Standards, National Emissions Standards for Hazardous Air Pollutants or under any other applicable section of 310 CMR 7.00, and may include a design feature, equipment specification, work practice, operating standard or combination thereof.*

A BACT analysis must also take into account energy, economic and environmental impacts, including secondary and cumulative impacts, and other costs.

To assist applicants and regulators with the case-by-case BACT process, in 1987 EPA issued a memorandum that implemented certain program initiatives to improve the effectiveness of the PSD program within the confines of existing regulations and state implementation plans. Among the initiatives was a “top-down” approach for determining BACT. In brief, the top-down process suggests that all available control technologies be ranked in descending order of control effectiveness. The most stringent or “top” control option is the default BACT emission limit unless the applicant demonstrates, and the permitting authority in its informed opinion agrees, that energy, environmental, and/or economic impacts justify the conclusion that the most stringent control option is not achievable in that case. Upon elimination of the most stringent control option based upon energy, environmental, and/or economic considerations, the next most stringent alternative is evaluated in the same manner. This process continues until a BACT is selected.

The five steps in a top-down BACT evaluation can be summarized as follows:

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<sup>19</sup> <http://www.mass.gov/eea/docs/dep/air/approvals/aq/aqpaguid.pdf>

<sup>20</sup> The term air contaminant and pollutant are used throughout the MassDEP BACT guidance document. Air contaminant is the term used in MassDEP regulations and is more inclusive than the term “pollutant” which is used by EPA in its regulations. Noise and other air contaminants that may result in a condition of air pollution (e.g. nuisance) are not regulated under the federal Clean Air Act, but are included in the Massachusetts NSR Program.

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

## 5.2. BACT REQUIREMENT

Per 310 CMR 7.02(5) for a CPA permit application submittal,<sup>21</sup> MassDEP requires a Top-Down BACT or Top-Case BACT analysis for any new or modified emission units. The pollutants subject to the BACT analysis include NO<sub>x</sub>, SO<sub>2</sub>, CO, PM (including PM<sub>10</sub> and PM<sub>2.5</sub>), and VOC from the new turbine. Also, since fugitive emissions from gas releases and piping components will be permitted as part of the AB Project, a BACT analysis is required for VOC from these sources at the Site.

Note that Algonquin is proposing to install dry low NO<sub>x</sub> combustion technology on the new turbine which will meet 9 ppmvd NO<sub>x</sub>. Algonquin and Solar Turbines believe that SoLoNO<sub>x</sub> is not an add-on control device, but rather it is a type of combustion chamber design that is integral to the design of the entire turbine, and that 9 ppmvd is the appropriate NO<sub>x</sub> BACT baseline for Solar Taurus 60-7802 turbine proposed at the Weymouth Compressor Station. In order to streamline the review of this permit, Algonquin is voluntarily providing a Top-Down BACT analysis for NO<sub>x</sub> emissions. As such, Algonquin is submitting the BACT analysis for NO<sub>x</sub>, CO, PM, SO<sub>2</sub>, and VOC from the new turbine and VOC from gas releases and piping components fugitive emissions.

Per MassDEP request, a GHG BACT analysis is also provided even though the CO<sub>2</sub>e emissions from the proposed facility do not exceed 100,000 tpy. The following GHG emission sources are part of the proposed project.

- Combustion Sources
  - Simple cycle natural gas-fired combustion turbine
  - Natural gas-fired heaters
  - Natural gas-fired Emergency Generator
- Process Sources:
  - Piping component leaks
  - Gas releases
- Ancillary Sources:
  - Separator Vessels
  - Condensate Storage Tank
  - Truck Loading
  - Parts Washer

The methodology used to estimate potential project emissions of GHG is described in Section 3 of this application report and detailed calculations are presented in Attachment G. Table 5-1 provides a summary of the project potential GHG emissions on both a mass and CO<sub>2</sub>e basis from each of the affected emission units at the Site.

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<sup>21</sup> <http://www.mass.gov/eea/docs/dep/air/approvals/aq/aqpaguid.pdf>

**Table 5-1: Summary of GHG Potential Emissions from the Site**

Emissions Unit Description	Project PTE				Percent of Total CO <sub>2</sub> e
	CO <sub>2</sub> (tpy)	CH <sub>4</sub> (tpy)	N <sub>2</sub> O (tpy)	CO <sub>2</sub> e (tpy)	
Solar Taurus 60 - 7,700 bhp	35,568	9.6	0.07	35,800	58.3%
0.23 MMBtu/hr NG fired fuel heater	118.9	0.01	0.0002	119	0.2%
Four 0.072 MMBtu/hr NG fired space heaters	148	0.0028	0.00028	149	0.2%
585 bhp Emergency Generator	82	3.63	0.0002	172	0.3%
Separator vessels and Storage Tanks	0.125	2.10	NA	53	0.1%
Truck Loading	0.0009	0.023	NA	1	0.0%
Piping Components Fugitive Emissions <sup>1</sup>	0.72	30.08	NA	753	1.2%
Gas Releases Fugitive Emissions <sup>1</sup>	12.46	524	NA	13,103	21.4%
M&R Station heaters and boilers	11,197	1	0.021	11,223	18.3%
<b>Total</b>				<b>61,372</b>	<b>100%</b>

<sup>1</sup> Site-wide emissions (includes proposed Weymouth Compressor Station and existing M&R Station).

As noted in Table 5-1, GHG emissions from the Project are predominantly driven by the compressor turbine. Therefore, the GHG BACT analysis included in subsequent sections is focused on GHG emissions from the new turbine.

### 5.3. BACT ASSESSMENT METHODOLOGY - TURBINE

The following sections provide detail on the assessment methodology utilized in preparing the BACT analysis for the proposed facility. As previously noted, the minimum emission limit to be considered in a BACT assessment must result in an emission rate less than or equal to any applicable NSPS or NESHAP emission rate for the source. The following NSPS or NESHAP emission limits will apply to proposed equipment and effectively set the minimum requirement for BACT for these units for certain pollutants:

- Simple Cycle Combustion Turbine
  - NO<sub>x</sub> limit of 25 ppmvdat 15 percent O<sub>2</sub>

#### 5.3.1. Identification of Potential Control Technologies

Potentially applicable emission control technologies were identified by researching the EPA control technology databases, technical literature, control equipment vendor information, state permitting authority files, and by using process knowledge and engineering experience. MassDEP provides guidance and lists Top-Case BACT determinations made by the agency. <sup>22</sup> Connecticut Department of Energy and Environmental Protection (CTDEEP) maintains a state database which list state specific BACT and Lowest Achievable Emission Rate (LAER) determinations made by the agency. The US EPA Reasonably Available Control Technology (RACT)/BACT/LAER Clearinghouse (RBLC), a database made available to the public through the EPA's Office of Air Quality Planning and Standards (OAQPS) Technology Transfer Network (TTN), lists technologies and corresponding emission limits that have been approved by regulatory agencies in permit actions. These technologies are grouped into categories by industry and can be referenced in determining what emissions levels were proposed for similar types of emissions units.

<sup>22</sup> <http://www.mass.gov/eea/docs/dep/air/approvals/bactcmb.pdf>

Trinity performed searches of the RBLC database, CTDEEP BACT Database and MassDEP BACT Guidance to identify the emission control technologies and emission levels that were determined by permitting authorities as BACT within the past ten years for emission sources comparable to the proposed sources. The following emission source categories were searched:

- Small Combustion Turbines (< 25 MW) – Simple Cycle (no waste heat recovery) – Natural Gas (RBLC Code 16.110)
- Large Combustion Turbines (> 25 MW) – Simple Cycle (no waste heat recovery) – Natural Gas (RBLC Code 15.110). As discussed below, per NSPS Subpart KKKK, only turbines with a heat input less than 850 MMBtu/hr were considered in the BACT analysis. Turbines larger than 850 MMBtu/hr have inherent design differences that can lead to inherently lower NO<sub>x</sub> emission levels.

Upon completion of the RBLC search, Trinity then reviewed relevant vendor information, pending permit applications, and issued permits not included in the RBLC. Attachment E presents a summary table of relevant BACT determinations for the units mentioned above.

### 5.3.2. Economic Feasibility Calculation Process

Economic analyses were performed to compare total costs (capital and annual) for potential control technologies. Capital costs include the initial cost of the components intrinsic to the complete control system. Annual operating costs include the financial requirements to operate the control system on an annual basis and include overhead, maintenance, outages, raw materials, and utilities.

Detailed cost analyses calculations are presented in Attachments C and E.

## 5.4. TURBINE - NO<sub>x</sub> BACT

In combustion turbines, NO<sub>x</sub> is typically formed by two fundamentally different mechanisms: fuel NO<sub>x</sub> and thermal NO<sub>x</sub>. Because the turbine will fire natural gas exclusively, thermal NO<sub>x</sub> is the primary NO<sub>x</sub> generating mechanism applicable to the proposed project.

“Fuel NO<sub>x</sub>” forms when the fuel bound nitrogen compounds are converted into nitrogen oxides. The amount of fuel bound nitrogen converted to fuel NO<sub>x</sub> depends largely upon the fuel type, nitrogen content of the fuel, air supply, and turbine design (including combustion temperature). The reaction between elemental nitrogen and oxygen to form nitrogen oxides happens very rapidly. Therefore, the primary mechanisms for reducing fuel NO<sub>x</sub> involve creating a minimum amount of excess oxygen available to react with the fuel bound nitrogen throughout the combustion process.<sup>23</sup>

NO<sub>x</sub> formed in the high-temperature, post-flame region of the combustion equipment is “thermal NO<sub>x</sub>.” Temperature is the most important factor, and at flame temperatures above 2,200 °F, thermal NO<sub>x</sub> formation increases exponentially.<sup>24</sup>

Nitrogen monoxide (NO) formation is inherent in all high temperature combustion processes. NO<sub>2</sub> can then be formed in a reaction between the NO and oxygen in the combustion gases. In stationary source combustion, little of the NO is converted to NO<sub>2</sub> before being emitted. However, the NO continues to oxidize in the atmosphere. For this reason, all NO<sub>x</sub> emissions from combustion stacks are usually reported as NO<sub>2</sub>.

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<sup>23</sup> Kraft, D.L. Bubbling Fluid Bed Boiler Emissions Firing Bark & Sludge. Barberton, OH: Babcock & Wilcox. September 1998. <http://www.babcock.com/library/pdf/BR-1661.pdf>.

<sup>24</sup> Ibid.



Also, in general, technology and emissions performance data, as reviewed for this BACT analysis, has been limited to those turbines within the size range of typical compressor turbines, and specifically those the size of the turbine required for the Project. US EPA has, in support of federal regulations such as the NSPS for combustion turbines (NSPS KKKK), reviewed the NO<sub>x</sub> emissions performance data for combustion turbines of all sizes and found differing performance data for turbines based on the size of the unit.<sup>25</sup> Here is a direct quotation from EPA documentation, found in 70 FR 8318 (2/18/05);

*We identified a distinct difference in the technologies and capabilities between small and large turbines,,,,, the smaller combustion chamber of small turbines provides inadequate space for the adequate mixing needed for very low NO<sub>x</sub> emission levels.*

The EPA finalized NSPS KKKK with a breakpoint in consideration of turbine sizes greater than 850 MMBtu/hr, between 50 MMBtu/hr and 850 MMBtu/hr, and less than 50 MMBtu/hr. Since the Project turbine is within the 50-850 MMBtu/hr size range, units greater than 850 MMBtu/hr were not considered for this analysis, since as identified by EPA there are inherent design differences in units at that size and above that can lead to inherently lower NO<sub>x</sub> emission levels.

Algonquin reviewed RBLC database entries for all natural gas-fired, simple cycle turbines less than 850 MMBtu/hr. The proposed turbine at Weymouth will utilize a simple cycle, which is common for turbines located at compressor stations. Compressor stations have no operational need for additional heat, steam, or electrical power output such as is provided from a combined cycle process which are more typically used in electric utility projects. Consistent with MassDEP guidance, the forms and tables provided in Attachment E focus on turbines of similar size to the proposed Taurus 60-7802. For RBLC database entries, Algonquin has provided detailed emission tables for all simple cycle turbines less than 25 MW.

#### 5.4.1. Step 1 - Identification of Potential Control Techniques

NO<sub>x</sub> reduction can be accomplished by two general methodologies: combustion control techniques and post-combustion control methods. Combustion control techniques incorporate fuel or air staging that affect the kinetics of NO<sub>x</sub> formation (reducing peak flame temperature) or introduce inerts (combustion products, for example) that limit initial NO<sub>x</sub> formation, or both. Several post-combustion NO<sub>x</sub> control technologies are potentially applicable to the proposed turbine. These technologies employ various strategies to chemically reduce NO<sub>x</sub> to elemental nitrogen (N<sub>2</sub>) with or without the use of a catalyst.

Attachment E provides a list of potential control technologies with application on simple cycle turbines. Using the RBLC search, as well as a review of technical literature, potentially applicable NO<sub>x</sub> control technologies for turbines were identified based on the principles of control technology and engineering experience for general combustion units.

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<sup>25</sup> <http://www.epa.gov/ttn/atw/nsps/turbine/turbnsps.html>

Combustion control options include:<sup>26</sup>

- Water or Steam Injection
- Dry Low-NO<sub>x</sub> (DLN) Combustion Technology (such as SoLoNO<sub>x</sub>)
- Good Combustion Practices (base case)

Post-combustion control options include:

- EM<sub>x</sub><sup>TM</sup>/SCONO<sub>x</sub><sup>TM</sup> Technology
- Selective Catalytic Reduction (SCR)
- Selective Non-Catalytic Reduction (SNCR)

Each control technology is described in detail below.

#### *5.4.1.1. Water or Steam Injection*

Water or steam injection operates by introducing water or steam into the flame area of the gas turbine combustor. The injected fluid provides a heat sink that absorbs some of the heat of combustion, thereby reducing the peak flame temperature and the formation of thermal NO<sub>x</sub>. The water injected into the turbine must be of high purity such that no dissolved solids are injected into the turbine. Dissolved solids in the water may damage the turbine due to erosion and/or the formation of deposits in the hot section of the turbine. Although water/steam injection acts to reduce NO<sub>x</sub> emissions, the lower average temperature within the combustor may produce higher levels of CO and hydrocarbons as a result of incomplete combustion. Additionally water/steam injection results in a decrease in combustion efficiency and increased maintenance requirements due to wear.

#### *5.4.1.2. Dry Low-NO<sub>x</sub> (DLN) Combustors*

The lean premix technology, also referred to as dry low-NO<sub>x</sub> combustion technology, is a pollution prevention technology that controls NO<sub>x</sub> emissions by reducing the conversion of atmospheric nitrogen to NO<sub>x</sub> in the turbine combustor. This is accomplished by reducing the combustor temperature using lean mixtures of air and/or fuel staging or by decreasing the residence time of the combustor. In lean combustion systems, excess air is introduced into the combustion zone to produce a significantly leaner fuel/air mixture than is required for complete combustion. This excess air reduces the overall flame temperature because a portion of the energy released from the fuel must be used to heat the excess air to the reaction temperature. Pre-mixing the fuel and air prior to introduction into the combustion zone provides a uniform fuel/air mixture and prevents localized high temperature regions within the combustor area. Since NO<sub>x</sub> formation rates are an exponential function of temperature, a considerable reduction in NO<sub>x</sub> can be achieved by the lean pre-mix system.

SoLoNO<sub>x</sub> is a type of dry low NO<sub>x</sub> combustion technology from Solar Turbines, a turbine manufacturer. Alternative turbine manufacturers could provide additional types of combustion technology that would be classified as BACT. However, as Algonquin has identified a turbine manufactured by Solar Turbines as part of this project, the available control technology from Solar Turbines was evaluated. Throughout this report, SoLoNO<sub>x</sub> and dry low NO<sub>x</sub> combustion technology may be used interchangeably when referring to the combustion turbine.

The dry low NO<sub>x</sub> combustion technology typically do not require additional power or heat rate compared to that of units with conventional combustors. Depending on the manufacturer and product, different levels of

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<sup>26</sup> An additional combustion control technology potentially identified was XONON which was offered by Catalytica Energy Systems. Catalytica merged with NZ Legacy in 2007 to form Renergy Holdings Inc. In November 2007, Renergy sold its SCR catalyst and management services business (SCR-Tech, LLC). Based on research, neither SCR-Tech LLC or for any company currently makes XONON. As such, it is not considered available for this BACT analysis.



efficiencies can be achieved. Specifically, for Solar Turbines, the manufacturer of the proposed Taurus 60-7802 combustion turbine, a dry low emission combustor (or SoLoNO<sub>x</sub>), can reach approximately 9 – 15 ppmvd NO<sub>x</sub>.

The proposed turbine will receive a 9 ppmvd NO<sub>x</sub> vendor guarantee from Solar. This guarantee is possible due to improvements and refinements of several of the technologies implemented in 15 ppmvd NO<sub>x</sub> capable turbines such as the Augmented Backside Cooled (ABC) combustor liner, parallel fuel valves, fuels system upgrades, closed loop pilot, and injector improvements. Specifically to reach 9 ppm, the control algorithm is changed to operate directly off calculated primary zone temperature allowing for more precise burner temperature control with varying ambient conditions across the load range which results in tighter control of emissions. Primary zone temperature control requires the addition of several different new measurements in the engine which are not standard for the 15 ppmvd configuration. These modifications allow for a lower vendor guarantee. Note, that the items listed above go beyond the simple replacement of dry low NO<sub>x</sub> burners to a more efficient model. Instead, the improvements are inherent in the design of the turbine's combustion chamber itself.

#### 5.4.1.3. Good Combustion Practices

Good combustion practices are those, in the absence of control technology, which allow the equipment to operate as efficiently as possible. The operating parameters most likely to affect NO<sub>x</sub> emissions include ambient temperature, fuel characteristics, and air-to-fuel ratios.

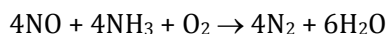
#### 5.4.1.4. EM<sub>x</sub>/SCONO<sub>x</sub>

EM<sub>x</sub> (the second-generation of the SCONO<sub>x</sub> NO<sub>x</sub> Absorber Technology) utilizes a coated oxidation catalyst to remove both NO<sub>x</sub> and CO without a reagent, such as ammonia (NH<sub>3</sub>). Hydrogen (H<sub>2</sub>) is used as the basis for the proprietary catalyst regeneration process. The SCONO<sub>x</sub> system consists of a platinum-based catalyst coated with potassium carbonate to oxidize NO<sub>x</sub> and CO (to CO<sub>2</sub>). The catalyst is installed in the flue gas with a temperature range between 300 °F to 700 °F. The SCONO<sub>x</sub> catalyst is susceptible to fouling by sulfur if the sulfur content of the fuel is high. This then requires the SCONO<sub>x</sub> catalyst to be re-coated every six months to one year, with the frequency depending on the sulfur content of the fuel.<sup>27</sup>

Estimates of control efficiency for a SCONO<sub>x</sub> system vary depending on the pollutant controlled. California Energy Commission reports a control efficiency of 78 percent for NO<sub>x</sub> reductions up to 2.0 ppm, and even higher NO<sub>x</sub> reductions up to 1 ppmvd for some designs.<sup>28</sup>

#### 5.4.1.5. Selective Catalytic Reduction

SCR is a post-combustion gas treatment process in which NH<sub>3</sub> is injected into the exhaust gas upstream of a catalyst bed. On the catalyst surface, NH<sub>3</sub> and NO react to form diatomic nitrogen and water vapor. The overall chemical reaction can be expressed as:



When operated within the optimum temperature range, the reaction can result in removal efficiencies between 70 and 90 percent.<sup>29</sup> SCR units have the ability to function effectively under fluctuating temperature conditions although fluctuation in exhaust gas temperature reduces removal efficiency slightly by disturbing the NH<sub>3</sub>/NO<sub>x</sub>

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<sup>27</sup> BACT Analysis for JEA-Greenland Energy Center Units 1 and 2, Combined Cycle Combustion Turbines. Prepared by Black & Veatch (September 2008).

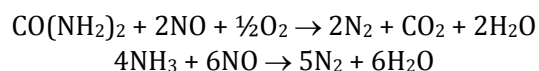
<sup>28</sup> California Energy Commission, Evaluation of Best Available Control Technology, Appendix 8.1E, Page 8.1E-7.

<sup>29</sup> U.S. EPA, Office of Air Quality Planning and Standards. *OAQPS Control Cost Manual Section 4-2 Chapter 2*, 6th edition. EPA 452/B-02-001. Research Triangle Park, NC. January 2002.

molar ratio. SCR can be used to reduce NO<sub>x</sub> emissions from combustion of natural gas and light oils (e.g., distillate). Combustion of heavier oils can produce high levels of particulate, which may foul the catalyst surface, reducing the NO<sub>x</sub> removal efficiency.

#### 5.4.1.6. Selective Non-Catalytic Reduction (SNCR)

SNCR is a post-combustion NO<sub>x</sub> control technology based on the reaction of urea or NH<sub>3</sub> with NO<sub>x</sub>. In the SNCR chemical reaction, urea [CO(NH<sub>2</sub>)<sub>2</sub>] or NH<sub>3</sub> is injected into the combustion gas path to reduce the NO<sub>x</sub> to nitrogen and water. The overall reaction schemes for both urea and NH<sub>3</sub> systems can be expressed as follows:



Typical removal efficiencies for SNCR range from 40 to 60 percent.<sup>30</sup> An important consideration for implementing SNCR is the operating temperature range. The optimum temperature range is approximately 1,600 to 2,000 °F.<sup>31</sup> Operation at temperatures below this range results in ammonia slip. Operation above this range results in oxidation of NH<sub>3</sub>, forming additional NO<sub>x</sub>.

### 5.4.2. Step 2 - Elimination of Technically Infeasible Control Options

After the identification of potential control options, the second step in the BACT assessment is to eliminate technically infeasible options. A control option is eliminated from consideration if there are process-specific conditions that would prohibit the implementation of the control or if the highest control efficiency of the option would result in an emission level that is higher than any applicable regulatory limits.

Each of the following identified technologies were determined to be technically infeasible for the proposed Taurus 60-7802 turbine.

#### 5.4.2.1. EM<sub>x</sub><sup>TM</sup>/SCONO<sub>x</sub><sup>TM</sup> Technology Feasibility

The EM<sub>x</sub><sup>TM</sup>/SCONO<sub>x</sub><sup>TM</sup> catalyst system is designed to operate effectively at temperatures ranging from 300 to 700 °F. The Solar Taurus 60-7802 turbine proposed for installation will be a simple-cycle system, with an exhaust temperature of approximately 950 °F. EM<sub>x</sub><sup>TM</sup>/SCONO<sub>x</sub><sup>TM</sup> applications on turbines with outlet temperatures this high have not been identified. Consequently, it is concluded that EM<sub>x</sub><sup>TM</sup>/SCONO<sub>x</sub><sup>TM</sup> is not technically feasible for control of NO<sub>x</sub> emissions from the proposed turbine.

#### 5.4.2.2. SNCR Feasibility

The temperature range required for effective operation of this technology is above the peak exhaust temperature for the Solar Taurus 60-7802 turbine. In addition, a review of EPA's RBL database and EPA's National Combustion Turbine Spreadsheet shows that SNCR has never been demonstrated on a turbine of this size. Therefore, SNCR is not technically feasible for control of NO<sub>x</sub> emissions from the proposed turbine.

#### 5.4.2.3. Water or Steam Injection Feasibility

Water or steam injection is a NO<sub>x</sub> reduction technology that could be installed in the combustion turbine. It is determined to be technically feasible for the combustion turbine itself, and is included in the following BACT

<sup>30</sup> U.S. EPA, Office of Air Quality Planning and Standards. *OAQPS Control Cost Manual Section 4-2 Chapter 1*, 6th edition. EPA 452/B-02-001. Research Triangle Park, NC. January 2002.

<sup>31</sup> U.S. EPA, Clean Air Technology Center. *Oxides of nitrogen (NO<sub>x</sub>), Why and How They Are Controlled*. Research Triangle Park, North Carolina. p. 18, EPA-456/F-99-006R, November 1999.

steps. Note, water or steam injection is not an add-on control technology that could be installed downstream of the combustion turbine, meaning this is not a viable option for addition to the turbine stacks. However, it is important to note that reductions of NO<sub>x</sub> in the combustion turbine due to water or steam injection would reduce NO<sub>x</sub> emissions origination from the turbine.

5.4.2.4. *Dry Low NO<sub>x</sub> Combustion Technology*

Dry low NO<sub>x</sub> combustion technology is a NO<sub>x</sub> control technology that would be integral to the combustion turbine. It is determined to be technically feasible for the combustion turbine itself. Note, dry low NO<sub>x</sub> combustion technology is not an add-on control device that could be installed downstream of the combustion turbine, meaning this option is not a viable option for addition to the turbine stacks. However, it is important to note that reductions of NO<sub>x</sub> in the combustion turbine due to the dry low NO<sub>x</sub> combustion technology would reduce NO<sub>x</sub> emissions origination from the turbine.

5.4.2.5. *SCR Feasibility*

SCR is a technically feasible, add-on control technology which can be installed on a turbine’s stack. As such, it is considered technically feasible to install SCR as a post-combustion control device for the turbine.

5.4.2.6. *Good Combustion Practices Feasibility*

Good combustion practices allow equipment to operate as efficiently as possible to maintain optimal emission release conditions from the unit. This is considered technically feasible for the control of NO<sub>x</sub> emissions from the turbine.

5.4.3. **Step 3 - Rank of Remaining Control Technologies**

The remaining control technologies are DLN combustion technology, SCR, water injection, and good combustion practices, which offer the control efficiencies identified in Table 5-2.

**Table 5-2: Remaining NO<sub>x</sub> Control Technologies**

<b>Rank</b>	<b>Control Technology</b>	<b>Potential NO<sub>x</sub> Emissions (ppm) or Control Efficiency (%)</b>
1	SCR	70% to 90%
2	Dry Low NO <sub>x</sub> Combustion Technology (SoLoNO <sub>x</sub> )	5 to 25 ppm
3	Water Injection	20 to 42 ppm (water)
4	Good Combustion Practices	Base Case

5.4.4. **Step 4 - Evaluation of Most Stringent Controls**

The fourth of the five steps in the Top-Down BACT assessment procedure is to evaluate the most effective control and document the results. This step has been performed for each remaining control technology on the basis of economic, energy, and environmental considerations, and is described in the following sections. In this step, once an option is selected no further (i.e., lower ranking) options are assessed.

An economic analysis was conducted to determine the cost of installing an SCR past the combustion chamber on the turbine. The analysis was conducted using procedures and guidelines in U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002, Section 4.2, Chapter 2. The installation of an SCR on the

turbine will cost approximately \$41,541 per ton of NO<sub>x</sub> removed, which is considerably higher than the MassDEP range of \$11,000-\$13,000. As such, SCR technology is considered economically infeasible for the proposed simple-cycled combustion turbine. Attachment E contains the detailed cost analysis for the SCR. Attachment E also includes copies of the cost calculations and SCR vendor quote.

The proposed combustion turbine will be subject to NSPS Subpart KKKK, as previously discussed. NSPS Subpart KKKK provides a NO<sub>x</sub> limit of 25 ppmvd at 15 percent O<sub>2</sub> for combustion turbines burning natural gas. Therefore, NSPS Subpart KKKK sets the floor of allowable NO<sub>x</sub> BACT limits. Possible control technologies with NO<sub>x</sub> capabilities higher than the BACT floor are no longer viable for this project, and are not evaluated further.

Therefore, DLN combustion technology, water/steam injection, and good combustion practices are the remaining control technologies for the Solar Taurus 60-7802 turbine. DLN combustion technology is the next ranked available control technology.

#### 5.4.5. Step 5 - Selection of BACT

The next ranked NO<sub>x</sub> control technology available for the combustion turbine is dry low NO<sub>x</sub> combustion technology, such as SoLoNO<sub>x</sub>. As a pollution prevention control method, operating SoLoNO<sub>x</sub> in the turbine would decrease NO<sub>x</sub> emissions downstream of the turbine(s), including from the turbine exhaust stack.

Research within available literature, EPA rulemaking, recently issued permits, and BACT determinations was conducted in order to determine an acceptable NO<sub>x</sub> BACT limitation for the compressor turbine at the Weymouth Compressor Station. The majority of units reported in the various EPA resources including the RBLC database for gas-fired simple cycle combustion turbines pertain to electrical generating turbines. Electric generating turbines, without SCR have reported significantly lower emission limits than those for compressor turbines. These sources with lower emission limits (i.e., 9 ppmvd NO<sub>x</sub>) were found to be primarily electrical generating units, with significantly larger turbines and overall power output. These units were found to be primarily those units with a heat input capacity above 850 MMBtu/hr. As noted above, those units should not be considered based on EPA's review of the emissions performance capabilities of combustion turbines through development of NSPS KKKK.

In the review of BACT determinations, NO<sub>x</sub> emission limits below 9 ppmvd were found to be generally associated with SCR control technology. As discussed in the previous section, SCR was found to not be cost effective for the Project at the Weymouth Compressor Station. Since this control technology has been eliminated from feasibility, the low values that are achieved via control using an SCR are not addressed further in this BACT analysis. Further scrutiny was given to those simple cycle combustion units which research found to be achieving less than 9 ppmvd NO<sub>x</sub> at 15percent O<sub>2</sub>, without the use of SCR. Based on BACT determinations, only one candidate site was found;

- MGM Mirage, with a permitted NO<sub>x</sub> value of 5 ppmvd NO<sub>x</sub> at 15 percent O<sub>2</sub>

The unit listed above is Solar Mercury series natural gas turbine. Solar Mercury Turbines are smaller sized units than the Solar Taurus 60-7802 turbine proposed to be installed for the AB Project. Solar's Mercury turbines can achieve lower NO<sub>x</sub> emissions by using a recuperator in the combustion turbine. This allows the turbine to provide more power at lower combustion temperatures (reducing thermal NO<sub>x</sub> formation). Larger sized turbines such as the Solar Taurus 60-7802 generate a greater amount of waste heat and are not capable of achieving the low combustion temperatures which result in NO<sub>x</sub> emissions in the 5 ppmvd range. In addition, the Mercury unit was permitted in warmer climates (i.e., Nevada). Solar's NO<sub>x</sub> emission guarantee ends at a minimum temperature of 0 °F. At ambient temperatures lower than 0 °F, NO<sub>x</sub> emissions are calculated based on

the low temperature operating scenario outlined in Section 3.1.2. Because the Mercury unit has a smaller size and different design basis, this unit is not considered to be a valid point of comparison for this BACT analysis.

Completing an economic feasibility review of SoLoNO<sub>x</sub> technology is not needed as it has been determined to be BACT for other natural gas combustion turbines. Therefore, Algonquin proposes that SoLoNO<sub>x</sub> is BACT for the combustion turbine. Algonquin is proposing a two-stage limit for NO<sub>x</sub> from the new turbine. The final BACT emission rate for the turbine will be 9 ppmvd at 15 percent O<sub>2</sub> of NO<sub>x</sub>. Algonquin will be the first customer of Solar's to receive a 9 ppmvd NO<sub>x</sub> vendor guarantee for a Solar Taurus 60-7802 turbine. Other Taurus 60-7802 units have been guaranteed at 15 ppmvd NO<sub>x</sub> (at 15 percent O<sub>2</sub>). Because this is a new design and the resulting NO<sub>x</sub> emissions are dependent on site-specific factors, Algonquin and Solar are requesting an extended shakedown period to fully evaluate and tune the new turbine installation to achieve the very low NO<sub>x</sub> BACT emission rate. Based on information from the vendor, Algonquin expects a 6-month shakedown period before the 9 ppmvd technology will be installed and fully operational on the turbine. In this interim time period, Algonquin will meet a NO<sub>x</sub> BACT emission limit of 15 ppmv at 15 percent O<sub>2</sub> during normal operation. The 15 ppmv NO<sub>x</sub> limit is consistent with the BACT limits for many existing simple cycle turbines using Solar DLN technology.

Compliance with the 9 ppmvd limit will be performed through stack testing with EPA Method 7/7E. This limit corresponds to an annual NO<sub>x</sub> limit of 9.96 tpy from the turbine.

## 5.5. TURBINE - CO AND VOC BACT

### 5.5.1. Step 1 - Identification of Potential Control Techniques

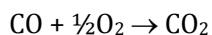
In combustion turbines, CO and VOCs are generated as a result of incomplete combustion. Attachment C provides a list of potential CO and VOC control technologies with application on simple cycle turbines. Detailed tables of BACT determinations from the MassDEP Guidelines, CTDEEP BACT Database and RBLC database are also provided in Attachment E. Candidate control options identified from the BACT database searches, permit review, and the literature review include those classified as pollution reduction techniques. CO and VOC reduction options include:

- Oxidation Catalyst
- Good Combustion Practices

#### 5.5.1.1. Oxidation Catalyst

The rate of formation of CO and VOC during natural gas combustion depends primarily on the efficiency of combustion. The formation of CO occurs in small, localized areas around the burner where oxygen levels cannot support the complete oxidation of hydrocarbons to CO<sub>2</sub>. VOC is emitted when some of the fuel remains unburned or is only partially burned during the combustion process. With natural gas, some organics are carried over as unreacted, trace constituents of the gas, while others may be pyrolysis products of the heavier hydrocarbon constituents. Good combustion practices include providing sufficient excess air (i.e. O<sub>2</sub>) for complete combustion and/or staged combustion to complete combustion of CO and VOC, thereby ensuring proper air-to-fuel ratios.

CO emissions resulting from natural gas combustion can be decreased via an oxidation catalyst control system. The oxidation is carried out by the following overall reaction:



This reaction is promoted by several noble metal-enriched catalysts at high temperatures. Under optimum operating temperatures, this technology can generally achieve between 70 and 95 percent reduction efficiency for CO emissions.<sup>32</sup> An oxidation catalyst designed to control CO would provide a side benefit of also controlling VOC emissions.

Oxidation efficiency also depends on exhaust flow rate and composition. Residence time required for oxidation to take place at the active sites of the catalyst may not be achieved if exhaust flow rates exceed design specifications. Also, sulfur and other compounds may foul the catalyst, leading to decreased efficiency.

Catalyst fouling occurs slowly under normal operating conditions and is accelerated by even moderate sulfur concentrations in the exhaust gas. The catalyst may be chemically washed to restore its effectiveness, but eventually irreversible degradation occurs. The catalyst replacement timeframe varies depending on type and operating conditions.

#### 5.5.1.2. Good Combustion Practices

Ensuring that the temperature and oxygen availability are adequate for complete combustion minimizes CO and VOC formation. This technique includes continued operation of the turbine at the appropriate oxygen range and temperature.

### 5.5.2. Step 2 - Elimination of Technically Infeasible Control Options

The oxidation catalyst and good combustion controls are both technically feasible options for the control of CO and VOC emissions from the Solar Taurus 60-7802 turbine.

### 5.5.3. Step 3 - Rank of Remaining Control Technologies

The third of the five steps in the top-down BACT assessment procedure is to rank technically feasible control technologies by control effectiveness. The remaining control technologies are presented in Table 4-3.

**Table 5-3: Remaining CO and VOC Control Technologies**

Rank	Control Technology	Potential CO Control Efficiency (%)	Potential VOC Control Efficiency (%)
1	Oxidation Catalyst	70-95	50
2	Good Combustion Controls	Base Case	Base Case

### 5.5.4. Step 4 - Evaluation of Most Stringent Controls

The potentially feasible technologies are discussed further in this section.

#### 5.5.4.1. Oxidation Catalyst

Environmental impacts and costs associated with the operation of an oxidation catalyst to remove CO and VOC emissions include increased downtime required for catalyst washing and hazardous material handling concerns during catalyst disposal. Masking or poisoning of the catalyst occurs when materials deposit on the catalyst surface and either cover the active areas (mask) or chemically react with the active areas and reduce the

<sup>32</sup> Control efficiency range is based on data provided by gas turbine manufacturers.



catalyst's reduction capacity (poison). Masking agents include sulfur, calcium, fine silica particles, and hydrocarbons. Poisoning agents include phosphorus, lead, and chlorides. These masking and poisoning agents are found in the fuel and/or lubricating oils. The effects of masking can be reversed by cleaning the catalyst (except for fine silica particles that cannot be dislodged from the porous catalyst surface). The effects of poisoning are permanent and cannot be reversed.

There is also potential energy penalties associated with the use of an oxidation catalyst. Installation of a catalyst system will increase the pressure drop experienced by the turbine exhaust flow. The increased pressure drop in the exhaust of a gas turbine will impact both the heat rate and power output. There will be a fuel penalty cost to compensate for the increased heat rate as a result of the increased exhaust backpressure. In addition, implementing oxidation catalyst control may result in a reduction in turbine power output caused by the increased backpressure on the turbine.

#### 5.5.5. Step 5 - Selection of BACT

Completing an economic feasibility review of this technology is not needed as oxidation catalyst is the first ranked control option and has been determined to be BACT for other natural gas combustion turbines. Therefore, Algonquin proposes that installation of an oxidation catalyst is BACT for CO and VOC emissions from the combustion turbine. Algonquin proposes an annual CO emission limit of 16.77 tpy and an annual VOC emission limit of 1.26 tpy for the Solar Taurus 60-7802 turbine. The annual CO and VOC limits include startup, shutdown and low temperature operation. Note that the oxidation catalyst is not expected to be operational during the turbine's startup periods.

### 5.6. TURBINE - PM AND SO<sub>2</sub> BACT

Natural gas-fired turbines, such as the Solar Taurus 60-7802 proposed at the Weymouth Compressor Station, emit a relatively small amount of PM, of which the formation depends on sulfur, nitrogen and ash amounts in fuel. The emission of sulfur compounds, mainly SO<sub>2</sub>, is very low too and is directly related to the sulfur content of the fuel.

#### 5.6.1. Step 1 - Identification of Potential Control Techniques

Based on the BACT determinations from the MassDEP Guidelines, the CTDEEP BACT database, the RBLC database and recent permit applications for natural gas compressor stations, the following two control technologies has been identified as BACT for the control of PM and SO<sub>2</sub> emissions from simple cycle turbines. The detailed tables of BACT determinations are provided in Attachment E.

- Clean fuel selection
- Good combustion and operating practices

##### 5.6.1.1. Clean Fuel Selection

Combustion of natural gas generates low PM and SO<sub>2</sub> emissions in comparison to other fuels due to the low ash and sulfur contents. The fuel for firing the combustion turbine at the Weymouth Compressor Station is pipeline quality natural gas.

##### 5.6.1.2. Good combustion and operating practices

As previously discussed in Section 5.4.1, good combustion/operating practices imply that the unit is operated within parameters that, without significant control technology, allow the equipment to operate as efficiently as possible. A properly operated combustion unit will minimize the formation of PM and SO<sub>2</sub> emissions. Proper

design of the combustion units concerns features such as the fuel and combustion air delivery system and the shape and size of the combustion chamber. Good operating practices typically consist of controlling parameters such as fuel feed rates and air/fuel ratios. Natural gas-fired turbines typically operate in a lean pre-mix mode to ensure an effective staging of air/fuel ratios in the turbine to maximize fuel efficiency and minimize incomplete combustion. Furthermore, the proposed Solar Taurus 60-7802 turbine is sufficiently automated to ensure optimal fuel combustion and efficient operation leaving virtually no need for operator tuning of these aspects of operation.

#### **5.6.2. Step 2 - Elimination of Technically Infeasible Control Options**

The use of clean fuel (i.e. natural gas) and good combustion and operating practices are both technically feasible options for the control of PM and SO<sub>2</sub> emissions from the proposed Solar Taurus 60-7802 turbine at the Weymouth Compressor Station.

#### **5.6.3. Step 3 - Rank of Remaining Control Technologies**

Both of the technically feasible options, use of natural gas and good combustion practices, represent the base case for the operation of Weymouth Compressor Station.

#### **5.6.4. Step 4 - Evaluation of Most Stringent Controls**

There are no associated environmental impacts with the use of natural gas as fuel and good combustion practices. An economic analysis is not required since the top ranking control technologies are selected as BACT for the control of PM and SO<sub>2</sub> emissions from the proposed project.

#### **5.6.5. Step 5 - Selection of BACT**

The use of pipeline quality natural gas and good combustion and operating practices are proposed the BACT for the new Solar Taurus 60-7802 turbine at the Weymouth Compressor Station. Algonquin proposes an annual PM<sub>10</sub>/PM<sub>2.5</sub> emission limit of 1.99 tpy and an annual SO<sub>2</sub> emission limit of 4.23 tpy for the new Solar Taurus 60-7802 turbine at the Weymouth Compressor Station. The annual PM and SO<sub>2</sub> limits include startup, shutdown and low temperature operation.

### **5.7. TURBINE - GHG BACT**

As previously discussed, Algonquin is proposing to install a new Solar Taurus 60-7802 gas turbine as the compressor driver at the proposed Weymouth Compressor Station as part of the AB Project. The combustion of natural gas in this turbine produces GHG emissions consisting of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. More than 99 percent of these combustion-related GHG emissions are in the form of CO<sub>2</sub> on a mass basis, since each carbon atom combusted in the fuel stream essentially results in one molecule of CO<sub>2</sub> emissions.<sup>33</sup> CH<sub>4</sub> and N<sub>2</sub>O emissions are byproducts of the combustion reactions and are formed in much lower quantities. Even when scaling CH<sub>4</sub> and N<sub>2</sub>O by their relative GWPs, these constituents combined contribute less than one percent of the total GHG emissions (on a CO<sub>2</sub>e basis) resulting from the combustion of natural gas and process gas. The proposed project design requires the use of natural gas as fuel for the new turbine-driven compressor as it can be locally sourced and other fuels are not readily available at the location and/or are more carbon intensive than natural gas. The proposed project does not rely on alternative or backup fuels.

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<sup>33</sup> Although small fractions of fuel carbon convert to combustion byproducts such as CO, or are unreacted CH<sub>4</sub>, the majority of carbon combusted in the fuel stream is converted to CO<sub>2</sub>. Consequently, standard emission factors for CO<sub>2</sub> are developed by assuming that the fuel carbon completely oxidizes to CO<sub>2</sub> (i.e., oxidation factor = 1.00).



A simple cycle turbine was selected as it is the most energy efficient mode of compressing natural gas that is feasible at the proposed site location. The use of a combined cycle process is infeasible for the following reasons:

- Combined cycle processes recover heat from the exhaust of the combustion turbines to produce steam as a product, and/or to drive a steam turbine generator to produce electricity. The Weymouth Compressor Station does not have any process needs or capacity for the amount of additional steam or power that would be generated in a combined cycle process.
- The compression demand at a transmission compressor station such as the proposed Weymouth Compressor Station is not stable and may fluctuate significantly. Combined cycle combustion turbines are most effective at steady, predictable loads. Further, they take time to bring on-line as the heat recovery loop must be heat saturated before power can be derived. As such, simple cycle combustion turbine is necessary for the design of this project to accommodate the rapid deployment and frequent load changes inherent in transmission compressor station operations.

In comparison to other similar compressor turbines, the Solar Taurus 60-7802 is a state-of-the-art industrial turbine that offers equivalent or better energy efficiency than other models of similar size operated in a simple cycle. With a heat rate of 7,841 Btu/hp-hr for a Taurus 60-7802 (vendor-specified performance based on the lower heating value of natural gas and 0 °F ambient temperature), the selected turbine is a highly efficient model. GHG control technologies available specifically for this type of source are reviewed further under the five step, top-down BACT analysis that follows.

#### 5.7.1. Step 1 – Identify All Control Technologies

GHG BACT is a relatively new requirement, therefore along with typical BACT resources, the following guidance documents were also utilized for identifying and understanding potential control technologies.

- PSD and Title V Permitting Guidance For Greenhouse Gases (hereafter referred to as General GHG Permitting Guidance);<sup>34</sup>
- Air Permitting Streamlining Techniques and Approaches for Greenhouse Gases: A Report to the U.S. Environmental Protection Agency from the Clean Air Act Advisory Committee; Permits, New Source Reviews and Toxics Subcommittee GHG Permit Streamlining Workgroup; Final Report;<sup>35</sup> and
- Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boilers.<sup>36</sup>

A search of the MassDEP BACT Guidance document, CTDEEP BACT database and RBLC database was performed in August 2015 to identify the emission control technologies and emission levels that were determined to be BACT by permitting authorities for emission sources comparable to the proposed facility. The following categories were searched:

- Commercial/Institutional-Size Boilers/Furnaces (< 100 MMBtu/hr) – Gaseous Fuels & Gaseous Fuel Mixtures (RBLC Code 13.000)

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<sup>34</sup> U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: March 2011). <http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf>

<sup>35</sup> <http://www.epa.gov/nsr/ghgdocs/20120914CAAACPermitStreamlining.pdf> (September 2012).

<sup>36</sup> U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: October 2010). <http://www.epa.gov/nsr/ghgdocs/iciboilers.pdf>.

- Commercial/Institutional-Size Boilers/Furnaces (< 100 MMBtu/hr) – Natural Gas (includes propane and liquefied petroleum gas) (RBL Code 13.310)
- Large Combustion Turbines (> 25 MW) – Simple Cycle (no waste heat recovery) (RBL Code 15.100)
- Large Combustion Turbines (> 25 MW) – Simple Cycle (no waste heat recovery) – Natural Gas (includes propane & liquefied petroleum gas) (RBL Code 15.110)
- Large Internal Combustion Engines (> 500 hp) – Natural Gas (includes propane & liquefied petroleum gas) (RBL Code 17.130)

Upon completion of this search, Trinity then reviewed relevant vendor information, pending permit applications, and issued permits not included in the RBL.

The U.S. EPA’s “top-down” BACT analysis procedure also recommends the consideration of inherently lower emitting processes as available control options under Step 1. For GHG BACT analyses, low-carbon intensity fuel selection is the primary control option that can be considered a lower emitting process. As a natural gas pipeline compressor station, Algonquin proposes the use of pipeline quality natural gas only for the new turbine. Table C-1 of 40 CFR Part 98 shows CO<sub>2</sub> emissions per unit heat input (lb/MMBtu) for a wide variety of industrial fuel types. Only landfill and other biomass gases (captured methane) and coke oven gas are shown as having lower CO<sub>2</sub> emissions per unit heat input than natural gas. Neither biogas nor coke oven gas is available commercially for the Weymouth Compressor Station. These fuels are commonly produced for consumption at the source where they are manufactured. Thus, it is not feasible to use these fuels at the station and they are not considered further in this analysis. In addition, Table C-2 of 40 CFR Part 98 shows that natural gas has one of the lowest emission factors for other important GHGs including CH<sub>4</sub> and N<sub>2</sub>O. For this reason, Algonquin is proposing to use the available fuel type (i.e. natural gas with the lowest carbon intensity) in the new turbine at the Weymouth Compressor Station.

It should be noted that the U.S. EPA’s GHG BACT requirements suggests that carbon capture and sequestration (CCS) be evaluated as an available control for projects with large amounts of potential CO<sub>2</sub>e emissions (i.e., where CO<sub>2</sub>e emissions levels are in the order of 1,000,000 tpy CO<sub>2</sub>e), or for industrial facilities with high-purity CO<sub>2</sub> streams. The proposed project’s emissions are well below the recommended threshold, and the turbine exhaust cannot be considered a high-purity CO<sub>2</sub> stream (turbine exhaust has a high flowrate and relatively low CO<sub>2</sub> concentration). Per U.S. EPA’s guidance, CCS is not feasible for projects of smaller profiles such as the proposed Project.<sup>37</sup> Further, Algonquin was unable to identify a facility similar to the Weymouth Compressor Station where CCS technology has been successfully installed and implemented. However, as technology is currently evolving with respect to CCS, it has been included as a potentially technically feasible control technology in this analysis.

The following potential GHG emission control strategies for the proposed Taurus 60-7802 gas turbine were considered as part of this BACT analysis (Table 5-3):

- CCS
- Optimum Turbine Efficiency;
- Fuel Selection; and
- Good Combustion/Operating Practices.

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<sup>37</sup> PSD and Title V permitting Guidance for Greenhouse Gases. March 2011, pages 32-33. Also, see Report of the Interagency Task Force on Carbon Capture and Storage, page 50.

**Table 5-4: Potential CO<sub>2</sub> Control Strategies for Combustion Turbines**

<b>Control Strategy</b>	<b>Description</b>
Carbon Capture and Storage (CCS)	System that captures CO <sub>2</sub> in the turbine exhaust and transfers it to permanent storage
Optimum Turbine Efficiency	Selection of turbine with high efficiency ratings
Fuel Selection	Combustion of low carbon intensity fuel
Good Combustion/Operating Practices	Adherence to good combustion practices

## 5.7.2. Step 2 – Eliminate Technically Infeasible Options

### 5.7.2.1. Carbon Capture and Sequestration

An effective CCS system would require three elements:

- Separation technology for the CO<sub>2</sub> exhaust stream (i.e., “carbon capture” technology),
- Transportation of CO<sub>2</sub> to a storage site, and
- A viable location for long-term storage of CO<sub>2</sub>.

These three elements work in series. To execute a CCS program as BACT, all three elements must be ‘available’.

#### CO<sub>2</sub> Capture

CCS would involve post-combustion capture of the CO<sub>2</sub> from the combustion turbine and sequestration of the CO<sub>2</sub> in some fashion. Carbon capture is an established process in some industry sectors, although not in the natural gas transmission sector (i.e., for compressor stations). In theory, carbon capture could be accomplished with low pressure scrubbing of CO<sub>2</sub> from the exhaust stream with either solvents (e.g., amines and ammonia), solid sorbents, or membranes. However, only solvents have been used to-date on a commercial (slip stream) scale, and solid sorbents and membranes are only in the R&D phase.

In terms of post combustion CCS for power plants, the following projects have taken place on slip streams at coal-fired power plants:<sup>38, 39</sup>

1. *First Energy R.E. Burger* (Dec. 2008-Dec. 2010): First Energy conducted a CO<sub>2</sub> capture pilot test using Powerspan’s ECO<sub>2</sub>® technology on a 1 MWe slipstream from the outlet of the R.E. Burger Station (near Shadyside, Ohio) demonstration-scale 50 MW ECO unit (Powerspan’s multipollutant control system). The ECO<sub>2</sub>® CO<sub>2</sub> capture system uses a proprietary ammonia-based solvent in a thermal swing absorption (TSA) process to remove CO<sub>2</sub> from the flue gas. An independent review of the pilot test indicated that “technology is ready for scale-up for use in commercial scale (200 MW or larger) generating plants.” To date, this technology has not been scaled up to any known commercial scale operations.<sup>40</sup>
2. *AES Warrior Run* (2000-Present) and *Shady Point* (1991-Present): AES captures 66,000 - 110,000 tpy CO<sub>2</sub> using the ABB/Lummus monoethanolamine (MEA) solvent-based system from a small slipstream of the 180-320 MWe coal-fired circulating fluidized bed (CFB) power plants at its stations in Cumberland, Maryland

<sup>38</sup> CCS Task Force Report, <http://www.epa.gov/climatechange/Downloads/ccs/CCS-Task-Force-Report-2010.pdf>, p. 31

<sup>39</sup> International Energy Agency GHG Research & Development Program, RD&D Database: CO<sub>2</sub> Capture Commercial Projects, <http://www.ieaghg.org/index.php?/RDD-Database.html>

<sup>40</sup> Powerspan, FirstEnergy ECO<sub>2</sub>® Pilot Facility, <http://powerspan.com/projects/firstenergy-eco2-pilot-facility/>; <http://powerspan.com/technology/eco2-co2-capture/independent-review-of-eco2/>.

and Panama, Oklahoma. The CO<sub>2</sub> is not stored, but rather is used in the food processing industry and related processes.

3. *IMC Chemicals (formerly Searles Valley Minerals) (1978-Present)*: IMC Chemicals captures 270,000 tpy CO<sub>2</sub> from the flue gas of two 52-56 MW industrial coal boilers using amine scrubbing technology at its soda ash production plant in Trona, California. The captured CO<sub>2</sub> is used for the carbonation of brine from Searles Lake, and the brine is subsequently used in the soda ash production process.<sup>41</sup>
4. *WE Energy Pleasant Prairie (June 2008-Oct. 2009)*: WE Energy captured 15,000 tpy CO<sub>2</sub> using Alstom's chilled ammonia process from a 5 MWe slipstream of the 1,210 MW coal-fired power plant at its Pleasant Prairie station in Pleasant Prairie, Wisconsin. The literature does not suggest the CO<sub>2</sub> was permanently sequestered in any geologic formation or by any other means.<sup>42</sup>

These projects have demonstrated the technical feasibility of small-scale CO<sub>2</sub> capture on a slipstream of a coal fired power plant's emissions using various solvent based scrubbing processes. In addition to the coal fired power projects deploying CO<sub>2</sub> capture at a small scale, Florida Power & Light (FPL) conducted CO<sub>2</sub> capture to produce 320-350 tpd CO<sub>2</sub> using the Fluor Econamine FG<sup>SM</sup> scrubber system on 15 percent of the flue gas from its 320 MWe 2 × 1 natural gas cycle unit in Bellingham, Massachusetts from 1991 to 2005. Due to increases in natural gas prices in 2004-2005, FPL changed from a base/intermediate load plant to a peaking plant, which made the continued operation of the capture plant uneconomical. The captured CO<sub>2</sub> was compressed and stored on site for sale to two nearby major food processing plants.<sup>43, 44</sup> Although this project indicates small-scale CO<sub>2</sub> capture is technically feasible for natural gas combined cycle combustion turbine flue gas, it does not support the availability of full-scale CO<sub>2</sub> capture from simple-cycle combustion turbines.

The projects identified do not propose post combustion capture of CO<sub>2</sub> from a simple cycle turbine to be used in a peaking role. Although the compressor station turbine will not function in a "peaking role" as units would for a power facility, the potential fluctuation in their operation would make implementation of post combustion capture difficult. Moreover, the projects identified are for post combustion capture on pulverized coal (PC) plants or a natural gas combined cycle combustion turbine (in one case) using a slip stream versus the full exhaust stream. Also, the exhaust from a PC plant would have a significantly higher concentration of CO<sub>2</sub> in the slipstream as compared to a more dilute stream from the combustion of natural gas (approximately 13-15 percent for a coal fired system versus 3-4 percent for a natural gas-fired system).<sup>45</sup>

In addition, prior to sending the CO<sub>2</sub> stream to the appropriate sequestration site, it is necessary to compress the CO<sub>2</sub> from near atmospheric pressure to pipeline pressure (around 2,000 psia). The compression of the CO<sub>2</sub> would require a large auxiliary power load, resulting in additional fuel (and CO<sub>2</sub> emissions) to generate the same amount of power.<sup>46</sup>

While carbon capture technology may be technologically available on a small-scale, it has not been demonstrated in practice for full-scale natural gas compressor stations. CCS is, therefore, not commercially

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<sup>41</sup> Electrical Power Research Institute, CO<sub>2</sub> Capture and Storage Newsletter, "Visit to the Trona plant MEA CO<sub>2</sub> Removal System in Trona, California, in September 2006", Issue #2 December 2006, <http://mydocs.epri.com/docs/public/00000000001014698.pdf>.

<sup>42</sup> MIT Carbon Capture & Sequestration Technologies, AEP Alstom Mountaineer Fact Sheet: Carbon Dioxide Capture and Storage Project, November 23, 2011, [http://sequestration.mit.edu/tools/projects/pleasant\\_prairie.html](http://sequestration.mit.edu/tools/projects/pleasant_prairie.html).

<sup>43</sup> International Energy Agency GHG Research & Development Program, RD&D Database: Florida Light and Power Bellingham CO<sub>2</sub> Capture Commercial Project, <http://www.ieaghg.org/index.php?/RDD-Database.html>.

<sup>44</sup> Reddy, Satish, et. al., Fluor's Econamine FG Plus<sup>SM</sup> Technology for CO<sub>2</sub> Capture at Coal-fired Power Plants, Power Plant Air Pollutant Control "Mega" Symposium, August 25-28, 2008, Baltimore, Maryland, <http://web.mit.edu/mitei/docs/reports/reddy-johnson-gilmartin.pdf>.

<sup>45</sup> CCS Task Force Report, August 2010, p. 29.

<sup>46</sup> CCS Task Force Report, August 2010, p. 30.

available as BACT at present for the turbine given the limited deployment of only slipstream/demonstration applications of CCS.

### CO<sub>2</sub> Transport

In addition to the challenges presented for CO<sub>2</sub> capture, Since the Weymouth Compressor Station is not located near a geologic formation that would be appropriate for carbon sequestration, transportation of the CO<sub>2</sub> would be required. Accordingly, Algonquin is including a discussion on the feasibility of transporting the CO<sub>2</sub> captured from the exhaust of the turbine to an appropriate sequestration site. Algonquin would need to either transport the captured CO<sub>2</sub> to an existing CO<sub>2</sub> pipeline or transport the CO<sub>2</sub> to a site with recognized potential for storage (e.g., an enhanced oil recovery [EOR] site).

In its effort to identify best approaches to safely and permanently store CO<sub>2</sub>, the U.S. Department of Energy (DOE) tasked seven Regional Carbon Sequestration Partnerships (RCSPs) for locating such areas in their respective regions.<sup>47</sup> The state of Massachusetts does not lie within the geographical extent of any of these RCSPs. However, the Midwest Regional Carbon Sequestration Partnership (MRCSP) is the closest RCSP covering the states of New York and New Jersey. For the analysis of available CO<sub>2</sub> transport options for the AB Project at the Weymouth Compressor Station, locations in MRCSP region were considered.

The Worldwide Carbon Capture and Storage Database (WCCUS) provides a map of potential storage locations.<sup>48</sup> All of the potential sites within the surrounding area (MRCSP region) are still in the development phase, which is likely to continue until after 2018 or did not pass validation and, as such, future phases were cancelled.<sup>49</sup> In reality, the closest active injection sites, which are still in development phase, are located in the Upper Peninsula of Michigan (Otsego County) and in Central Illinois, both of which are over 1,000 miles from the station. Of these two sites, the Michigan site appears to be further along in the development process and possibly open to receiving CO<sub>2</sub> from outside sources in the future.

Another potential site is the Triassic Newark Basin of New York and New Jersey. Currently field studies are in process to characterize the Newark Basin for its's CO<sub>2</sub> storage potential.<sup>50</sup> In addition, the New York State Geological Survey (NYSGS) has identified three potential sequestration sites in the state's oil and gas fields.<sup>51</sup> Projects are underway to assess evaluate the feasibility of using these site for sequestration. While the locations in New York are not active injection sites, for the purposes of this analysis, the closest potential location in New York was selected to use in the analysis.

Refer to Figure 5-1 below for a map illustrating the location of the closest potential CO<sub>2</sub> sequestration site.<sup>52</sup>

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<sup>47</sup> Regional Carbon Sequestration Partnership (RCSP) Initiative. Accessed on Aug 14, 2015.  
<http://www.netl.doe.gov/research/coal/carbon-storage/carbon-storage-infrastructure/rcsp>.

<sup>48</sup> <http://www.natcarbviewer.com/>

<sup>49</sup> Information on the wetlands reclamation projects being considered for soil carbon sequestration is located at:  
<http://216.109.210.162/TerrestrialDemonstrationWetlandAndMarshland.aspx>.

<sup>50</sup> Information on the results of the Triassic Newark Basin field project is located at:  
<http://www.netl.doe.gov/publications/factsheets/project/FE0002352.pdf>

<sup>51</sup> <http://www.nysm.nysed.gov/nysgs/research/carbon/ny.html>

<sup>52</sup> This map is taken directly from: <http://www.natcarbviewer.com/>



**Figure 5-1: CO<sub>2</sub> Potential Injection Location**



The green marker indicates the location of the Triassic Newark Basin Study.

There are no known CO<sub>2</sub> pipelines near the station or within the region.<sup>53,54</sup> It is considered technically feasible to construct a CO<sub>2</sub> pipeline to either of these sequestration sites for the purposes of this analysis.

### CO<sub>2</sub> Storage

The process of injecting CO<sub>2</sub> into subsurface formations for long-term sequestration is referred to as geologic CO<sub>2</sub> storage. CO<sub>2</sub> can be stored underground in oil/gas fields, unmineable coal seams, and saline formation. In practice, CO<sub>2</sub> is currently injected into the ground for enhanced oil and gas recovery. Per the CCS Task Force Report, approximately 50 million metric tons (tonnes) of CO<sub>2</sub> per year are injected during enhanced oil and gas recovery operations.

Within the MRCSP region, alternatives to subsurface injection have been considered but have yet to prove feasible.<sup>55</sup> Examples include marshlands reclamation projects in New Jersey and Maryland.

Internationally, there are three large scale projects that are currently in operation worldwide as follows:<sup>56</sup>

1. The Sleipner Project (1996 – current): One million tonnes of CO<sub>2</sub> per year is separated from produced natural gas in Norway and is injected into Utsira Sand (high permeability, high porosity sandstone) 1,100 meters below the sea surface.

<sup>53</sup> [http://www.majorpipe.com/?page\\_id=1057](http://www.majorpipe.com/?page_id=1057)

<sup>54</sup> <http://www.globalccsinstitute.com/publications/global-status-ccs-2012/online/48641>

<sup>55</sup> Midwest Regional Carbon Sequestration Partnership (MRCSP) maintains a website at <http://216.109.210.162/>

<sup>56</sup> CCS Task Force Report, Pages C-1 and C-2.

2. The Weyburn Project (2000 – 2011): 1.8 million tonnes of CO<sub>2</sub> per year is injected into 29 horizontal and vertical wells into two adjacent carbonate layers in Saskatchewan, Canada near the North Dakota border. The CO<sub>2</sub> originates from a nearby synfuel plant.<sup>57</sup>
3. The Snohvit Project (2010 – current): The Project is expected to inject 0.7 million tonnes CO<sub>2</sub> per year from natural gas production operations near the Barents Sea. The injection well reaches 2,600 meters beneath the seabed in the Tubasen sandstone formation.
4. The In Salah Project (2004 – current): The Project injects 1.2 million tonnes of CO<sub>2</sub> annually produced from natural gas into 1,800 meter deep muddy sandstone (low porosity, low permeability).

For the purposes of this analysis, it is assumed that CO<sub>2</sub> storage is a technically feasible option for Algonquin to employ for CO<sub>2</sub> emissions from the new combustion turbine at the Weymouth Compressor Station.

Based on the assumptions previously stated that CCS is technically feasible, Algonquin has provided a cost effectiveness assessment for simple cycle turbine in Section 5.7.4.

#### 5.7.2.2. Optimum Turbine Efficiency

The affected unit for this project is as follows, with information per the specifications provided by Solar.

- A new 7,700 hp Solar Taurus 60-7802 natural gas-fired turbine-driven compressor unit.

As previously stated, the Solar Taurus 60-7802 is a state-of-the-art industrial turbine that offers equivalent or better energy efficiency than other models of similar size, operated in a simple cycle. With a heat rate of 7,841 Btu/hp-hr (vendor-specified performance based on the lower heating value of natural gas and 0 °F ambient temperature), the selected turbine is a highly efficient model. The Solar Taurus 60-7802 is a simple cycle design. As previously discussed, a combined cycle turbine is not appropriate for the proposed project.

#### 5.7.2.3. Fuel Selection

The fuel for firing the combustion turbine is natural gas only. As discussed in Section 5.7.1, natural gas has the lowest carbon intensity of any available fuel for such unit and its use is technically feasible for this project.

#### 5.7.2.4. Good Combustion/Operating Practices

Good combustion/operating practices are a potential control option for optimizing the fuel efficiency of the combustion turbine. Natural gas-fired combustion turbines typically operate in a lean pre-mix mode to ensure an effective staging of air/fuel ratios in the turbine to maximize fuel efficiency and minimize incomplete combustion. Furthermore, the proposed turbine is sufficiently automated to ensure optimal fuel combustion and efficient operation leaving virtually no need for operator tuning of these aspects of operation.

### 5.7.3. Step 3 – Rank Remaining Control Options by Effectiveness

The following control options remain and are ranked by their effectiveness in reducing CO<sub>2</sub> emissions from the turbine. Details of these technologies are provided in Step 1.

- CCS, 90 percent<sup>58</sup>

<sup>57</sup> Petroleum Technology Research Centre, [http://www.ptrc.ca/weyburn\\_overview.php](http://www.ptrc.ca/weyburn_overview.php)

<sup>58</sup> Capture efficiency of 90% is assumed by NETL in its costing document, *Estimating Carbon Dioxide Transport and Storage Costs*, Page 9. <http://netldev.netl.doe.gov/research/energy-analysis/publications/details?pub=d9585d27-1433-463a-87d1-9d791b62cf72>.

- Use of high efficiency turbines, fueled by natural gas and employing good combustion/operating practices (Base Case).

In terms of comparing relative heat rates and efficiencies, similar models and sizes of industrial simple cycle gas turbines suitable for use in natural gas compression from leading manufacturers are ranked by efficiency in Table 5-4 below.

**Table 5-5: Comparison of Turbine Heat Rates and Efficiencies**

Manufacturer	Model	Output (hp)	Heat Rate (Btu/hp-hr) <sup>59</sup>	Efficiency
Solar <sup>60</sup>	Taurus 60	7,700	7,840	32.4%
General Electric <sup>61</sup>	NovaLT5-2	7,509	8,304	31.5%
Siemens <sup>62</sup>	SGT-100	7,640	7,738	32.9%

As shown, the Solar Taurus 60-7802 turbine is one of the most efficient models of generally available mechanical drive turbines in the needed HP range presented. The Solar model also has the advantage of a lower vendor-guaranteed NO<sub>x</sub> emission rate than the other models shown.

#### 5.7.4. Step 4 – Evaluation of Most Stringent Controls

The energy, environmental, and economic impacts analysis under Step 4 of a GHG BACT assessment presents a unique challenge with respect to the evaluation of CO<sub>2</sub> and CH<sub>4</sub> emissions. The technologies that are most frequently used to control emissions of CH<sub>4</sub> in hydrocarbon-rich streams (e.g., flares and thermal oxidizers) actually convert CH<sub>4</sub> emissions to CO<sub>2</sub> emissions. Consequently, the reduction of one GHG (i.e., CH<sub>4</sub>) results in a proportional increase in emissions of another GHG (i.e., CO<sub>2</sub>).

As the most stringent control option available, CCS would be considered BACT, barring the consideration of its energy, environmental, and/or economic impacts. However, for the reasons outlined in this section, this option should not be relied upon as BACT and the next most stringent alternative evaluated.

Notwithstanding the information above, Algonquin has opted to include a cost feasibility assessment for use of CCS to support the argument that while CCS could be considered to be technically feasible, it is not a viable option for this project. The costs associated with CCS can be broken down into the same three categories that the CCS process is divided: CO<sub>2</sub> capture, CO<sub>2</sub> transport, and CO<sub>2</sub> storage.

##### 5.7.4.1. Carbon Capture Costs

Carbon capture costs have been estimated using published articles and government resources in the absence of cost data or specific technology details for the capture of CO<sub>2</sub> from commercial applications. Capture and compression costs vary widely depending on what type of combustion equipment and process is used at the

<sup>59</sup> As reported by the manufacturers at ISO conditions, for shaft output, and based on LHV of natural gas.

<sup>60</sup> Solar Turbines, Taurus 60 Gas Turbine Compressor Set, General Specifications, <https://mysolar.cat.com/cda/layout?m=41425&x=7>

<sup>61</sup> GE Energy Gas Turbine Data Sheet – Mechanical Drive, [https://www.geoilandgas.com/sites/geog.dev.local/files/ge\\_novalt5\\_brochure.pdf](https://www.geoilandgas.com/sites/geog.dev.local/files/ge_novalt5_brochure.pdf)

<sup>62</sup> SGT-100 Industrial Gas Turbine – Mechanical Drive, Specifications Sheet, [http://www.energy.siemens.com/hq/pool/hq/power-generation/gas-turbines/downloads/Industrial%20Gas%20Turbines/Industrial\\_Gas\\_Turbines\\_EN\\_new.pdf](http://www.energy.siemens.com/hq/pool/hq/power-generation/gas-turbines/downloads/Industrial%20Gas%20Turbines/Industrial_Gas_Turbines_EN_new.pdf)



facility. Of the plant configurations for which cost factors are provided in the CCS Task Force Report, the factor for a new natural gas combined cycle facility, while not the same process, is taken to be the most pertinent with respect to the Weymouth Compressor Station. Capture and compression costs typically use either a “CO<sub>2</sub>-captured” or a “CO<sub>2</sub>-avoided” basis. The CO<sub>2</sub>-captured basis accounts for all CO<sub>2</sub> that is removed from the process as a result of the installation and use of a control technology, without including any losses during transport and storage or emissions from the control technology itself. A CO<sub>2</sub>-avoided basis takes into account the CO<sub>2</sub> losses during transport and storage as well as CO<sub>2</sub> emissions from equipment associated with the implementation of the CCS system. It is more appropriate to use the CO<sub>2</sub>-captured monetary estimates because the BACT analysis is based on emissions from a single source (e.g., the direct emissions from the simple cycle combustion turbine) and does not account for secondary emissions (e.g., the GHG emissions generated from the act of compressing the CO<sub>2</sub> to pipeline pressures). As such, the cost factor which uses a CO<sub>2</sub>-captured basis is selected for use in this analysis. It should also be noted that for this analysis, the factors which appear in the CCS Task Force Report have been converted from a metric tons basis to a short tons basis and scaled from December 2009 dollars to August 2015 (current) dollars using appropriate price indices.<sup>63</sup> A ten year lifespan is used for the capital calculations because the acidic nature of CO<sub>2</sub> will deteriorate the equipment at a more aggressive rate.

#### 5.7.4.2. Carbon Transport Costs

The cost of pipeline installation and operation are obtained from the National Energy Technology Laboratory (NETL)’s Document *Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs DOE/NETL-2010/1447*. Per this document, the pipeline costs include pipeline installation costs, other related capital costs, and operation and maintenance (O&M) costs.

As noted in Section 5.7.2, the closest carbon sequestration site, which is still in the experimental phase, is the Newark Basin. It is located approximately 180 miles from the Weymouth Compressor Station. For cost estimation purposes, a pipeline length of 180 miles is assumed for a CO<sub>2</sub> transfer pipeline straight from the Project site location to the carbon sequestration site. The required diameter for the pipeline was estimated using the publication by MIT titled “Carbon Management GIS: CO<sub>2</sub> Pipeline Transport Cost Estimation”.<sup>64</sup> It was estimated that a four-inch diameter pipeline would be appropriate for this transport need.

#### 5.7.4.3. Geological Storage Costs

The NETL’s *Estimating Carbon Dioxide Transport and Storage Costs* document contains the average saline formation depths and capacities. As previously indicated in the transportation section, the storage location included in this analysis is a gas or oil reservoir, which may have different dimensions than a saline formation. However, due to the small impact on overall calculations and the small amount of CO<sub>2</sub> being sequestered, this is considered to be a reasonable estimate. Based on the published information, the average storage site depth is 1,236 meters and each injection well is able to accommodate an average of 10,320 tpd. The Weymouth Compressor Station would be sequestering 97 tpd, and therefore would only require one injection well. It should be noted that differences in formation properties could have a significant effect on the project design, such as limiting the throughput to a well, thereby increasing the number of wells needed and increasing storage costs. However, due to the uncertainty of the effect of the differences in the storage formations, the storage costs estimated in the NETL guidance are used in this analysis in order to not overestimate costs.

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<sup>63</sup> Price indices are obtained from the Producer Price Index published by the U.S. Bureau of Labor Statistics. PPI values obtained from historic tables. Accessed online 08/18/2015 at <http://www.bls.gov/>

<sup>64</sup> Carbon Capture and Sequestration Technologies Program Massachusetts Institute of Technology. Carbon Management GIS: CO<sub>2</sub> Pipeline Transport Cost Estimation. October 2006, Updated in June 2009.

#### 5.7.4.4. Overall Cost of Carbon Capture and Sequestration

The estimated total cost for the capture of CO<sub>2</sub> emissions from the turbine, the cost to transport the CO<sub>2</sub> from the turbine to an appropriate storage facility, and the cost to sequester the resulting supercritical fluid is estimated to be \$709 per ton of CO<sub>2</sub> captured. Considering the quantity of CO<sub>2</sub> generated, this figure represents an unreasonable cost for GHG control that Algonquin believes is not cost effective.<sup>65</sup>

In addition to the direct costs included in the previous section, the energy and environmental impacts would not be insignificant. The flue gas stream from the turbine stacks is significantly lower in CO<sub>2</sub> concentration than exhaust streams from the projects discussed above that have been used for demonstrating capture of CO<sub>2</sub> for sequestration. As such, additional processing of the exhaust gas would be required in order to implement CCS for the AB Project. These steps include separation (removal of other pollutants from the waste gases), capture, and compression of CO<sub>2</sub> at both the Weymouth Compressor Station and at the wellhead, transfer of the CO<sub>2</sub> stream and sequestration of the CO<sub>2</sub> stream. These processes require additional equipment to reduce the exhaust temperature, compress the gas, and transport the gas via pipeline. These units would require additional electricity and generate additional air emissions, of both criteria pollutants and GHG pollutants.

Algonquin also anticipates significant additional costs to inquire about and secure a carbon storage site that is within a reasonable distance and that will accept the CO<sub>2</sub> stream. Based on the research conducted for this analysis, it will likely be difficult to find an available storage location. Algonquin would also incur significant cost to obtain rights and permitting for an additional pipeline to handle the CO<sub>2</sub> transport to the wellhead.

For multiple reasons, including the uncertainty of locating a carbon storage site, the undue burden of applying a technology that has yet to be proven for gas turbines, and the excessive cost to implement this technology, CCS is eliminated from further review.

Use of high efficiency turbine, fueled by natural gas and employing good combustion/operating practices are the remaining control technologies and represent the base case.

#### 5.7.5. Step 5 - Selection of BACT

Establishing an appropriate averaging period for the BACT limit is a key consideration under the BACT process. Localized GHG emissions are not known to cause adverse public health or environmental impacts. Rather, EPA has determined that GHG emissions are anticipated to contribute to long-term environmental consequences on a global scale. Accordingly, EPA's Climate Change Workgroup has characterized the category of regulated GHGs as a "global pollutant." Since localized short-term health and environmental effects from GHG emissions are not recognized, Algonquin proposes only annual GHG BACT limits. The resulting BACT standard is a proposed annual emissions limitation of 35,800 tons CO<sub>2</sub>e/year/turbine for the new turbine. The annual CO<sub>2</sub>e limit includes startup, shutdown and low temperature operation. Because the tpy CO<sub>2</sub>e emission rate from the turbine is lower during startup and shutdown than during normal operation, Algonquin proposes that the requested BACT limit applies at all times. Because cold weather operation of the turbine may result in instantaneous lb

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<sup>65</sup> For comparison, U.S. EPA evaluated a PSD application from ETC Texas Pipeline, Ltd, submitted March 15, 2012, for a gas processing plant in Ganado, TX. In its application, ETC Texas Pipeline evaluated the cost of an 8-inch diameter, 120-mile CO<sub>2</sub> pipeline using the same document from NETL. ETC found the control cost per ton associated with CO<sub>2</sub> transport to be \$80.80 per ton of CO<sub>2</sub>. On May 24, 2012, U.S. EPA issued a final permit that did not require CCS for this facility. Calpine Corporation also submitted a GHG PSD application to U.S. EPA for a gas-fired power station at the Deer Park Energy Center on September 1, 2011. Calpine estimated the costs of post-combustion CCS at the facility to be between \$44.11 and \$103.42 per ton of CO<sub>2</sub>, using scalable cost estimation methods for gas-fired power stations. In its statement of basis for its draft permit issued August 2, 2012, U.S. EPA stated that CCS at this facility would be "financially prohibitive due to the overall cost of GHG control strategies."

CO<sub>2</sub>e/hr emission rates higher than the proposed annual average limit and conversely lower in warm weather operation, the requested BACT limit is only appropriate on a 12-month rolling average basis. For compliance purposes, CO<sub>2</sub>e emissions are calculated using the global warming potentials listed under 40 CFR part 98, Table A-1, as Algonquin will be required to use these global warming potentials in calculating annual GHG emissions for submittal under 40 CFR Part 98(a)(2).

Through the proposed BACT limit, Algonquin limits the maximum fuel consumption and CO<sub>2</sub> emissions, effectively requiring efficient operation at the design heat rate, when operating at 100 percent load (as inefficient turbine operation would require additional fuel consumption which is undesirable from an operator's perspective). Algonquin will operate turbine under an Operations and Maintenance (O&M) Plan to ensure that the units are operated in accordance with recommended good combustion practices such that optimum efficiency is maintained. Furthermore, the proposed unit contains modern process control technology that continually seeks optimum efficiency from the turbine.

## 5.8. FUGITIVE EMISSIONS FROM PIPING COMPONENTS - VOC BACT

The following section presents the Top-Down BACT analysis for VOC emissions from new piping components that will be installed at the Site. Piping components that produce fugitive emissions include: valves, pressure relief valves, pump seals, compressor seals, and sampling connections.

### 5.8.1. Step 1 – Identification of Potential Control Technologies

In determining whether a technology is available for controlling VOC fugitive emissions from piping components, available permits, permit applications, industry guidance, MassDEP BACT guidelines and EPA's RBLC database were consulted. Based on these resources, the following available control technologies were identified:<sup>66</sup>

- "Leakless technology" piping components instead of traditional components;
- Leak detection and repair (LDAR) program; and
- Audio/visual/olfactory (AVO) monitoring program.

It should be noted that the only fugitive VOC control technology identified by the RBLC database is the use of an LDAR program. However, there are no natural gas transmission compressor stations listed in the RBLC at the time of submittal of this application.

### 5.8.2. Step 2 – Elimination of Infeasible Options

#### 5.8.2.1. Leakless Technology

Leakless technology valves are available and currently in use, primarily where highly toxic or otherwise hazardous materials are used. These technologies are generally considered cost prohibitive except for specialized service. Some leakless technologies, such as bellow valves, if they fail, cannot be repaired without a unit shutdown that often generates additional emissions. Further, it is not accurate to assume that "leakless" components do not leak over the lifetime of the component or that their use would result in zero emissions. In the September 27, 2013 response to Sierra Club's comment letter on draft permit PSD-TX-102982-GHG, ExxonMobil stated that, "For example, the valve packing configurations noted by the BAAQMD permits for refineries noted by the Sierra Club, such as bellow sealed valves and live loaded packed valves do leak. Bellow

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<sup>66</sup> <https://archive.epa.gov/region6/6pd/air/pd-r/ghg/web/pdf/exxonmobil-baytown-response092713.pdf>

seals can fail, live load packing wears and leaks, etc.”<sup>66</sup> In addition, high process temperatures can cause degradation of leakless components, such as bellow valves, which can reduce the useful life of the component. Recognizing that leakless technologies have not been universally adopted as LAER or BACT, even for toxic or extremely hazardous services, it is reasonable to state that these technologies are impractical for control of the low levels of VOC emissions generated from piping components at the Site and will not be considered further in this analysis.

#### 5.8.2.2. LDAR

LDAR programs using instrument or imaging-based detection of leaks are well-established for the control of VOC emissions. BACT determinations related to control of VOC emissions rely on technical feasibility, economic reasonableness, reduction of potential environmental impacts, and regulatory requirements for these programs. As such, LDAR technology based on EPA Method 21 or optical gas imaging (OGI) is considered technically feasible for this project.

#### 5.8.2.3. AVO Methods

Leaking fugitive components can be identified through audio, visual, or olfactory (AVO) methods. The natural gas that passes through the Site is odorized and therefore natural gas leaks from components are expected to have discernible odor to some extent, making them detectable by olfactory means. A large leak can be also detected by sound (audio) and sight. The visual detection can be a direct viewing of leaking gases, or a secondary indicator such as condensation around a leaking source due to cooling of the expanding gas as it leaves the leak interface. As such, AVO methods (including audio or visual) are considered technically feasible for this project.

### 5.8.3. Step 3 – Rank of Remaining Control Technologies

The following list provides a ranking of the remaining control technologies based on their approximate control efficiencies:

- LDAR Programs – 40 – 97 percent efficient depending on the component type<sup>67,68</sup>
- AVO Methods – control efficiency unknown for natural gas service

Audio/visual/olfactory means of identifying leaks owes its effectiveness to the frequency of observation opportunities. Those opportunities arise as operating technicians make rounds, inspecting equipment during those routine tours of the operating areas. The Weymouth Compressor Station is classified as an unmanned site. While someone may be present at the site during the daytime work shift, there are periods during which no one will be at the site. Further, AVO is typically used for inorganic/odorous and low vapor pressure compounds such as chlorine, ammonia, hydrogen sulfide, and hydrogen cyanide. This method cannot generally identify

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<sup>67</sup> Per Technical Support Document for NSPS 0000, this is based on emission reductions at refineries that were obtained for various components from EPA’s recently collected data for the Uniform Standards. In the Technical Support Document, EPA states that this data represents the most up-to-date information that is available for equipment leaks from the oil and gas sector. The reductions do not include uncontrolled piping components less than two inches in diameter. The NSPS 0000 technical support document references a Memorandum from Cindy Hancy, RTI to Jodi Howard, EPA, Analysis of Emission Reduction Techniques for Equipment Leaks, December 21, 2011, EPA-HQ-OAR-2002-0037-0180 as the basis for these reductions.

<sup>68</sup> Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Background Technical Support Document for the Final New Source Performance Standards 40 CFR Part 60, Subpart 0000a, EPA-HQ-OAR-2010-0505-7631, May 2016, p. 41 estimates the overall reduction efficiency from Subpart 0000a to be 80 percent based on quarterly monitoring.

leaks at as low a leak rate as instrumented readings or imaging can identify and therefore it is generally used to supplement an LDAR monitoring program. As such, its effectiveness as a stand-alone control technology is relatively low for the Site and therefore is ranked below LDAR programs.

#### **5.8.4. Step 4 – Evaluation of Most Stringent Controls**

Environmental impacts associated with the implementation of LDAR are minimal. Completing an economic feasibility of this technology is not needed as this is the first ranked control options and Algonquin proposes to implement it at the Site.

#### **5.8.5. Step 5 – Selection of BACT**

Algonquin proposes to comply with the Subpart 0000a requirements for components in natural gas service, as applicable, at the Site. In addition, as detailed in Section 3.8.1 Algonquin will utilize an enhanced LDAR program for the piping components in pipeline liquids service at the Site. Algonquin proposes an annual VOC emission limit of 2.38 tpy for the piping components fugitive emissions. The VOC emission limit is based on the use of control efficiencies for Texas Commission on Environmental Quality (TCEQ) LDAR program 28 RCT for the piping components in pipeline liquids service at the Site.

### **5.9. EMISSIONS FROM GAS RELEASES - VOC BACT**

Gas releases refers to the intentional and unintentional venting of gas for maintenance, routine operations such as startup and shutdown, or during emergency conditions. Algonquin estimates that the natural gas that is released during these events contains less than 10 percent VOC by weight. Potential emissions from gas releases at the Site are based on conservative assumptions that over-predict emissions from these sources. Actual emissions from gas releases are expected to be significantly lower.

#### **5.9.1. Step 1. Identification of Control Technologies**

Based on RBLC search results and recent permit applications for natural gas compressor stations, there are no documented available technologies to reduce emissions of VOC from gas release events at natural gas compression stations.

A possible measure to reduce blowdown gases is to inject the gases into a low pressure main or a fuel gas system (i.e., drawing the pressure down). In-line and/or portable compressors may also be used to lower gas line pressure before maintenance in order to reduce emissions. This measure is known as “pipeline pump-down”.

#### **5.9.2. Step 2. Eliminate Technically Infeasible Controls**

Drawing the pressure down using a fuel gas system is considered infeasible for the proposed compressor station. Pressure draw-downs are not achievable without the use of equipment such as low pressure laterals or microturbines, such as those that might be present at an electric utility. Any addition of the types of equipment that would need to be present in order to draw down the pressure to reduce gas releases would change the fundamental design of the AB Project at the Site.

#### **5.9.3. Step 3. Ranking of Technically Feasible Controls**

At this single-turbine compressor station, good operating practices, along with ESD preventative measures are the only feasible control options for reducing emissions from gas release events.

#### **5.9.4. Step 4. Evaluation of Most Stringent Controls**

The environmental impacts related with the implementation of good engineering practices, along with ESD preventative measures, are minimal. Completing an economic feasibility of this technology is not needed as this is the only technically feasible control option and Algonquin proposes to implement it at the Site.

#### **5.9.5. Step 5. Selection of BACT**

Algonquin will maintain good operating practices, along with ESD preventative measures, as BACT for gas release events.

## 6. DISPERSION MODELING ANALYSIS

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The detailed dispersion modeling analysis is submitted as a separate report, titled “Air Dispersion Modeling Report” along with this application package.



## 7. NOISE SURVEY

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The noise survey report is included as Attachment F to this application package.

## ATTACHMENT A: TRANSMITTAL FORM

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Enter your transmittal number

X266786

Transmittal Number

Your unique Transmittal Number can be accessed online: <http://mass.gov/dep/service/online/trasmfrm.shtml>

**Massachusetts Department of Environmental Protection**

## Transmittal Form for Permit Application and Payment

1. Please type or print. A separate Transmittal Form must be completed for each permit application.

2. Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

3. Three copies of this form will be needed.

**Copy 1 - the original** must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

4. Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

MassDEP  
P.O. Box 4062  
Boston, MA  
02211

**\* Note:**  
For BWSC Permits, enter the LSP.

### A. Permit Information

BWP AQ 02

Non-Major CPA-FUEL and Non-Major CPA-Process

1. Permit Code: 7 or 8 character code from permit instructions

2. Name of Permit Category

Installation of a new natural gas compressor station.

3. Type of Project or Activity

### B. Applicant Information – Firm or Individual

Algonquin Gas Transmission, LLC

1. Name of Firm - Or, if party needing this approval is an individual enter name below:

2. Last Name of Individual

3. First Name of Individual

4. MI

P.O. Box 1642

5. Street Address

Houston

TX

77251

713-627-5400

4790

6. City/Town

7. State

8. Zip Code

9. Telephone #

10. Ext. #

Reagan M. Mayces

RMMayces@spectraenergy.com

11. Contact Person

12. e-mail address (optional)

### C. Facility, Site or Individual Requiring Approval

Weymouth Compressor Station

1. Name of Facility, Site Or Individual

50 Bridge Street

2. Street Address

Weymouth

MA

02191

3. City/Town

4. State

5. Zip Code

6. Telephone #

7. Ext. #

8. DEP Facility Number (if Known)

9. Federal I.D. Number (if Known)

10. BWSC Tracking # (if

### D. Application Prepared by (if different from Section B)\*

Trinity Consultants

1. Name of Firm Or Individual

225 Cedar Hill Street, Suite 200

2. Address

Marlborough

MA

01752

508-630-2130

3. City/Town

4. State

5. Zip Code

6. Telephone #

7. Ext. #

Kristine Davies

8. Contact Person

9. LSP Number (BWSC Permits only)

### E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☐ yes ☒ no  
If yes, enter the project's EOE file number - assigned when an Environmental Notification Form is submitted to the MEPA unit:

EOEA File Number

### F. Amount Due

#### Special Provisions:

1. ☐ Fee Exempt (city, town or municipal housing authority)(state agency if fee is \$100 or less).  
*There are no fee exemptions for BWSC permits, regardless of applicant status.*
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

DEP Use Only

Permit No:

Rec'd Date:

Reviewer:

627145

Check Number

\$2,370.00

Dollar Amount

09/14/2015

Date

## ATTACHMENT B: BWP AQ 02 NON-MAJOR CPA FORMS

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BWP AQ 02 Non-Major CPA-FUEL  
BWP AQ 02 Non-Major CPA-PROCESS



# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

## CPA-FUEL (BWP AQ 02 Non-Major, BWP AQ 03 Major)

### Comprehensive Plan Application for Fuel Utilization Emission Unit(s)

X266786

Transmittal Number

Facility ID (if known)

Use this form for:

- Boilers firing Natural Gas and having a heat input capacity of 40,000,000 British Thermal Units per hour (Btu/hr) or more.
- Boilers firing Ultra Low Sulfur Distillate Fuel Oil and having a heat input capacity of 30,000,000 Btu/hr or more.
- Emergency turbines with a rated power output of more than 1 Megawatt (MW) and/or in lieu of complying with 310 CMR 7.26(43) for engines or turbines as described at 310 CMR (43)2 and 3.
- Other Fuel Utilization Units as specified at 310 CMR 7.02(5)(a)2. See the instructions for a complete list.

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



**Type of Application:** ☒ BWP AQ 02 Non-Major CPA ☐ BWP AQ 03 Major CPA

### A. Facility Information

Weymouth Compressor Station

1. Facility Name

50 Bridge Street

2. Street Address

Weymouth

3. City

MA

4. State

02191

5. ZIP Code

6. MassDEP Account # / FMF Facility # (if Known)

4922

8. Standard Industrial Classification (SIC) Code

7. Facility AQ # / SEIS ID # (if Known)

486210

9. North American Industry Classification System (NAICS) Code

10. Are you proposing a new facility?

☒ Yes ☐ No - If Yes, skip to Section B.

11. List ALL existing Air Quality Plan Approvals, Emission Cap Notifications, and 310 CMR 7.26 Compliance Certifications and associated facility-wide emission caps, if any, for this facility in the table below. If you hold a Final Operating Permit for this facility, you may leave this table blank.

Table 1			
Approval Number(s)/ 25% or 50% Rule/ 310 CMR 7.26 Certification	Transmittal Number(s) (if Applicable)	Air Contaminant (e.g. CO, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , VOC, HAP, PM or Other [Specify])*	Existing Facility-Wide Emission Cap(s) Per Consecutive 12-Month Time Period (Tons)
N/A			

\*CO = carbon monoxide, CO<sub>2</sub> = carbon dioxide, NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, VOC = volatile organic compound, HAP = hazardous air pollutant, PM = particulate matter, specify if "Other"



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**CPA-FUEL** (BWP AQ 02 Non-Major, BWP AQ 03 Major)  
Comprehensive Plan Application for Fuel Utilization Emission Unit(s)

X266786

Transmittal Number

Facility ID (if known)

**A. Facility Information** (continued)

12. Will this proposed project result in an increase in any facility-wide emission cap(s)?

☐ Yes ☒ No

If Yes, describe:

**B. Equipment Description**

Note that per 310 CMR 7.02, MassDEP can issue a Plan Approval only for proposed Emission Unit(s) with air contaminant emissions that are representative of Best Available Control Technology (BACT). See Section D: Best Available Control Technology (BACT) Emissions and the MassDEP BACT Guidance.

1. Is this proposed project modifying previously approved equipment?

☐ Yes ☒ No

If Yes, list pertinent Plan Approval(s):

2. Is this proposed project replacing previously approved equipment?

☐ Yes ☒ No

If Yes, list pertinent Plan Approval(s):

3. Provide a description of the proposed project, including relevant parameters (including but not limited to operating temperature and pressure) and associated air pollution controls, if any:

The proposed project includes the installation of one (1) Solar Taurus 60 natural gas turbine compressor unit (7,700 hp), a Waukesha VGF24GL natural gas fired emergency generator (585 hp), a fuel gas process heater (0.23 MMBtu/hr heat input), five fuel gas space heaters (0.072 MMBtu/hr heat input) a parts washer, new separator vessels and storage tanks and a gas cooler for the station. The new compressor turbine will be equipped with Solar's SoLoNOx technology to control emissions of NOx, CO and other air pollutants. Additionally, this application is including the operation of the existing metering and regulation (M&R) station as part of the facility.

**Netting & Offsets**

4. Is netting being used to avoid 310 CMR 7.00: Appendix A?

☐ Yes\* ☒ No

\*If Yes, attach a description of contemporaneous increases and decreases in applicable potential (or allowable) nonattainment pollutant emissions over a period of the most recent five (5) calendar years, including the year that the proposed project will commence operating. For each emission unit, this description must include: a description of the emission unit, the year it commenced operation or was removed from service, any associated MassDEP-issued Plan Approval(s), and its potential (or allowable) nonattainment pollutant emissions. In any case, a proposed project cannot "net out" of the requirement to submit a plan application and comply with Best Available Control Technology (BACT) pursuant to 310 CMR 7.02.

5. Is the proposed project subject to 310 CMR 7.00: Appendix A Nonattainment Review?

☐ Yes\* ☒ No – Skip to 6

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**CPA-FUEL** (BWP AQ 02 Non-Major, BWP AQ 03 Major)**Comprehensive Plan Application for Fuel Utilization Emission Unit(s)**

X266786

Transmittal Number

Facility ID (if known)

**B. Equipment Description** (continued)

**Note:** Complete this table if you answered Yes to Question 5. Otherwise, skip to Question 6.

Table 2					
Source of Emission Reduction Credits (ERCs) or Emission Offsets	Transmittal No. of Plan Approval Verifying Generation of ERCs, if Any	Air Contaminant	Actual Baseline Emissions (Tons per Consecutive 12-Month Time Period) <sup>1</sup>	New Potential Emissions <sup>2</sup> (Tons per Consecutive 12-Month Time Period After Control)	ERC <sup>3</sup> or Emission Offsets, Including Offset Ratio & Required ERC Set Aside (Tons per Consecutive 12-Month Time Period)
N/A					

<sup>1</sup> Actual Baseline Emissions means the average actual emissions for the source of emission credits or offsets in the previous two years (310 CMR 7.00: Appendix A).

<sup>2</sup> New Potential Emissions means the potential emissions for the source of emission credits or offsets after project completion (310 CMR 7.00: Appendix A).

<sup>3</sup> Emission Reduction Credit (ERC) means the difference between Actual Baseline and New Potential Emissions, including an offset ratio of 1.26:1 (310 CMR 7.00: Appendix B(3)).

6. Complete the table below to summarize the details of the proposed project.

**Note:** For additional information, see the instructions for a link to the MassDEP BACT Guidance.

Table 3				
Facility-Assigned Identifying Number for Proposed Equipment (Emission Unit No.)	Description of Proposed Equipment Including Manufacturer & Model Number or Equivalent (e.g. Acme Boiler, Model No. AB500)	Manufacturer's Maximum Heat Input Rating in Btu/hr	Proposed Primary Fuel	Proposed Back-Up Fuel (if Any)
EU1 <input checked="" type="checkbox"/> New <input type="checkbox"/> Modified	Solar Taurus 60-7802 natural gas turbine*	74,910,000*	Natural Gas	N/A
<input type="checkbox"/> New <input type="checkbox"/> Modified				
<input type="checkbox"/> New <input type="checkbox"/> Modified				
<input type="checkbox"/> New <input type="checkbox"/> Modified				



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**B. Equipment Description** (continued)

7. Complete the table below to summarize the burner details if the proposed project includes boiler(s).

**Table 4**

Emission Unit No.	Burner Manufacturer & Model Number or Equivalent (e.g. Acme Burner, Model No. AB300)	Manufacturer's Maximum Firing Rate (Gallons per Hour or Cubic Feet per Hour)	Type of Burner (e.g. Ultra Low NOx Burner)	Is Emission Unit Equipped with Flue Gas Recirculation?
N/A				<input type="checkbox"/> Yes <input type="checkbox"/> No
				<input type="checkbox"/> Yes <input type="checkbox"/> No
				<input type="checkbox"/> Yes <input type="checkbox"/> No
				<input type="checkbox"/> Yes <input type="checkbox"/> No

**Note:** For additional information, see the instructions for a link to the MassDEP BACT Guidance.

8. Complete the table below if the proposed project includes turbine(s).

**Table 5**

Emission Unit No.	Maximum Firing Rate (Gallons per Hour or Cubic Feet per Hour)	Maximum Output Rating (Megawatts [MW] or Kilowatts [kW]; Indicate Unit of Measure)
EU1	73,444 scfh*	6.46 MW*

\* Maximum heat input rating, maximum firing rate, and maximum output rating for EU1 is for low temperature conditions. See Table B-1Ah in Attachment G

**Continue to Next Page ►****B. Equipment Description** (continued)

9. Are you proposing an Air Pollution Control Device (PCD)?

☒ Yes\* ☐ No

\*If Yes, complete the table below to summarize the details of each PCD being proposed.

**Note:** If you are proposing one or more

**Table 6a**



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Air Pollution Control Devices (PCDs), you must also submit the applicable Supplemental Form(s). See Page 6 for additional information.

Description of Proposed PCD	Emission Unit No(s). Served by PCD	Air Contaminant(s) Controlled	Overall Control (Percent by Weight)
The proposed turbine is equipped with SoLoNO <sub>x</sub> to control emissions  <input checked="" type="checkbox"/> New  <input type="checkbox"/> Existing	EU1	VOC	
		CO	
		PM <sup>1</sup>	
		NO <sub>x</sub>	N/A <sup>1</sup>
		NH <sub>3</sub>	
		Other:	

<sup>1</sup> PM includes particulate matter having a diameter of 10 microns or less (PM<sub>10</sub>) and particulate matter having a diameter of 2.5 microns or less (PM<sub>2.5</sub>).

**Note:** If you are proposing more than two Air Pollution Control Devices (PCDs), complete additional copies of these tables.

Table 6b			
Description of Proposed PCD	Emission Unit No(s). Served by PCD	Air Contaminant(s) Controlled	Overall Control (Percent by Weight)
Oxidation Catalyst  <input checked="" type="checkbox"/> New  <input type="checkbox"/> Existing	EU1	VOC	50%
		CO	95%
		PM <sup>1</sup>	
		NO <sub>x</sub>	
		NH <sub>3</sub>	
		Other:	

**B. Equipment Description** (continued)

**Supplemental Forms Required**

If you are proposing one or more PCDs, you will also need to submit the applicable form(s) below.

<sup>1</sup> Algonquin and Solar Turbines believe that SoLoNO<sub>x</sub> is not an add-on control device, but rather it is a type of combustion chamber design that is integral to the design of the entire turbine, and that 9 ppm is the appropriate NO<sub>x</sub> BACT baseline for Solar Taurus 60-7802 turbine proposed at the Weymouth Compressor Station.



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If Your Project Includes:	You Must File Form(s):
Wet or Dry Scrubbers	BWP AQ Scrubber
Cyclone or Inertial Separators	BWP AQ Cyclone
Fabric Filter	BWP AQ Baghouse/Filter
Adsorbers	BWP AQ Adsorption Equipment
Afterburners or Oxidizers	BWP AQ Afterburner/Oxidizer
Electrostatic Precipitators	BWP AQ Electrostatic Precipitator
Selective Catalytic Reduction	BWP AQ Selective Catalytic Reduction
Sorbent/Reactant Injection	BWP AQ Sorbent/Reactant Injection

10. Is there any external noise generating equipment associated with the proposed project? ☒ Yes ☐ No – Skip to 12

11. Complete the table(s) below to summarize all associated noise suppression equipment, if any is being proposed, and attach a completed Form BWP AQ Sound to this application (unless MassDEP waives this requirement).

Table 7

Emission Unit No.	Type of Noise Suppression Equipment (e.g. Mufflers, Acoustical Enclosures)	Equipment Manufacturer	Equipment Model No.
EU1	Acoustical Enclosure (Building)	N/A	N/A
EU1	Turbine Exhaust Silencer	TBD	TBD
EU1	Air Intake Silencer	TBD	TBD

Note: TBD = To Be Determined

**B. Equipment Description** (continued)

12. Have you attached a completed Form BWP AQ Sound to this application? ☒ Yes ☐ No\*

\*If No, explain:

**Note:** The installation of some fuel burning equipment can cause off-site noise if proper precautions are not taken. For additional guidance, see MassDEP's Noise Pollution Policy Interpretation.



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13. Describe the potential for visible emissions from the proposed project and how they will be controlled:

No visible emissions from the proposed project will be expected due to the nature of operations and use of natural gas as fuel.

14. Describe the potential for odor impacts from the proposed project and how they will be controlled:

No odor impacts from the proposed project will be expected due to the nature of operations and use of natural gas as fuel.

### C. Stack Description

Complete the table below to summarize the details of the proposed project's stack configuration.

**Note:** Discharge must meet Good Air Pollution Control Engineering Practice. When designing stacks, special consideration must be given to nearby structures and terrain to prevent emissions downwash and adverse impacts upon sensitive receptors. Stack must be vertical, must not impede vertical exhaust gas flow, and must be a minimum of 10 feet above rooftop or fresh air intake, whichever is higher. For additional guidance, refer to the MassDEP "Stack" guidance.

Table 8						
Emission Unit No.	Stack Height Above Ground (Feet)	Stack Height Above Roof (Feet)	Stack Exit Diameter or Dimensions (Feet)	Exhaust Gas Exit Temperature Range (Degrees Fahrenheit)	Exhaust Gas Exit Velocity Range (Feet per Second)	Stack Liner Material
EU1	60	15	9.027	865-999	25-28	Steel

### D. Best Available Control Technology (BACT) Emissions

1. Complete the table(s) below to summarize the proposed project's BACT emissions.

**Note:** Complete a separate table for

Table 9A



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each proposed fuel to be used in each Emission Unit. For example, if one Emission Unit will be capable of burning two different fuels, you will need to complete two tables.

Emission Unit No. & Fuel Used	Air Contaminant	Uncontrolled Emissions (Pounds per Hour [lbs/hr], Pounds per 1 Million British Thermal Units [lb/MMBtu] or Parts per Million Dry Volume Corrected Basis [ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> ]) <sup>2</sup>	Proposed BACT Emissions (lbs/hr, lb/MMBtu or ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions Restrictions (Tons, if Any) <sup>3</sup>	Proposed Monthly Time Period Emissions Restrictions (Tons, if Any) <sup>5</sup>	Proposed Fuel Usage Limit(s) (if Any) <sup>5</sup>
Unit No. EU1  Fuel Used Natural Gas	PM <sup>1</sup>	0.48 lbs/hr	N/A	1.99	N/A	N/A
	PM <sub>2.5</sub>	0.48 lbs/hr	N/A	1.99	N/A	N/A
	PM <sub>10</sub>	0.48 lbs/hr	N/A	1.99	N/A	N/A
	NO <sub>x</sub> <sup>2</sup>	2.38 lbs/hr	9 ppmvd at 15% O <sub>2</sub> <sup>4</sup>	9.96	N/A	N/A
	CO	4.02 lbs/hr	0.20 lbs/hr	16.77	N/A	N/A
	VOC	0.50 lbs/hr	0.25 lbs/hr	1.26	N/A	N/A
	SO <sub>2</sub>	1.03 lbs/hr	N/A	4.23	N/A	N/A
	HAP <sup>3</sup>	0.17 lbs/hr	N/A	0.10	N/A	N/A
	Total HAPs <sup>3</sup>	0.25 lbs/hr	N/A	0.28	N/A	N/A
	CO <sub>2</sub> <sup>4</sup>	8,625 lbs/hr	N/A	35,568	N/A	N/A

<sup>1</sup>PM includes particulate matter having a diameter of 10 microns or less (PM<sub>10</sub>) and particulate matter having a diameter of 2.5 microns or less (PM<sub>2.5</sub>).

<sup>2</sup> NO<sub>x</sub> emissions from this proposed project need to be included for the purposes of NO<sub>x</sub> emissions tracking for 310 CMR 7.00: Appendix A, if applicable.

<sup>3</sup>Operating Permit facilities are required to track emissions of Hazardous Air Pollutants.

<sup>4</sup>Pounds of CO<sub>2</sub> per unit product (e.g. pounds CO<sub>2</sub> per megawatt, pounds CO<sub>2</sub> per 1,000 pounds of steam).

<sup>5</sup>Enter "N/A" if not requesting emissions restrictions and/or fuel usage limit.

<sup>2</sup> The uncontrolled emission rates are based on maximum hourly emission rates for normal operations after SoLoNO<sub>x</sub> but before oxidation catalyst. Algonquin and Solar Turbines believe that SoLoNO<sub>x</sub> is not an add-on control device, but rather it is a type of combustion chamber design that is integral to the design of the entire turbine. For emission rates during startup, shut down and low temperature operations, please refer to Attachment G.

<sup>3</sup> Values represent the proposed emissions (tpy) from the project after the implementation of an oxidation catalyst on the turbine.

<sup>4</sup> Equivalent to 0.38 lb/MW-hr, based on an average NO<sub>x</sub> emission rate 2.23 lb/hr at 46.65 °F and 5.85 MW. The data used for the conversion is provided in Attachment G.

<sup>5</sup> Formaldehyde emissions are presented for worst-case Individual HAP.

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**D. Best Available Control Technology (BACT) Emissions** (continued)

Table 9B						
Emission Unit No. & Fuel Used	Air Contaminant	Uncontrolled Emissions (Pounds per Hour [lbs/hr], Pounds per 1 Million British Thermal Units [lb/MMBtu] or Parts per Million Dry Volume Corrected Basis [ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> ])	Proposed BACT Emissions (lbs/hr, lb/MMBtu or ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions Restrictions (Tons, if Any) <sup>5</sup>	Proposed Monthly Time Period Emissions Restrictions (Tons, if Any) <sup>5</sup>	Proposed Fuel Usage Limit(s) (if Any) <sup>5</sup>
Unit No.  Fuel Used	PM					
	PM <sub>2.5</sub>					
	PM <sub>10</sub>					
	NO <sub>x</sub>					
	CO					
	VOC					
	SO <sub>2</sub>					
	HAP					
	Total HAPs					
	CO <sub>2</sub>					

**D. Best Available Control Technology (BACT) Emissions** (continued)

**Note:** If you are proposing more additional Emissions Units or fuels, complete additional copies of these tables.

Table 9C						
Emission Unit No. & Fuel Used	Air Contaminant	Uncontrolled Emissions (Pounds per Hour [lbs/hr], Pounds per 1 Million British Thermal Units [lb/MMBtu] or Parts per Million Dry Volume Corrected Basis [ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> ])	Proposed BACT Emissions (lbs/hr, lb/MMBtu or ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions Restrictions (Tons, if Any) <sup>5</sup>	Proposed Monthly Time Period Emissions Restrictions (Tons, if Any) <sup>5</sup>	Proposed Fuel Usage Limit(s) (if Any) <sup>5</sup>



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Unit No.	PM					
	PM <sub>2.5</sub>					
	PM <sub>10</sub>					
	NO <sub>x</sub>					
	CO					
	VOC					
	SO <sub>2</sub>					
	HAP					
	Total HAPs					
	CO <sub>2</sub>					

**Note:** Top-Case BACT is the emission rate identified via the MassDEP BACT Guidance or a pre-application meeting with MassDEP.

2. Are proposed BACT emission limits in the tables above Top-Case BACT as referenced in 310 CMR 7.02(8)(a)2.a?

☐ Yes ☒ No\*

\*If No, you must submit form BWP AQ BACT to demonstrate that this project meets BACT as provided in 310 CMR 7.02(8)(a)2 or 310 CMR 7.02(8)(a)2.c..

## E. Monitoring Procedures

Complete the table below to summarize the details of the proposed project's monitoring procedures.

Table 10			
Emission Unit No.	Type or Method of Monitoring (e.g. CEMS <sup>1</sup> , Fuel Flow)	Parameter/Emission Monitored	Frequency of Monitoring
EU1	Performance Test	NO <sub>x</sub> emission rate	Initial and Annual
EU1	Performance Test	CO emission rate	Initial
EU1	Purchase Contract	Sulfur Content of the natural gas used at the facility	N/A

<sup>1</sup> CEMS = Continuous Emissions Monitoring System

## F. Record Keeping Procedures

Complete the table below to summarize the details of the proposed project's record keeping procedures. Proposed record keeping procedures need to be able to demonstrate your compliance status with regard to all limitations/restrictions proposed herein. Record keeping may include, but is not limited to, hourly or daily logs, meter charts, time logs, fuel purchase receipts, CEMS records, etc.





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Table 11			
Emission Unit No.	Parameter/Emission (e.g. Temperature, Material Usage, Air Contaminant)	Record Keeping Procedures (e.g. Data Logger or Manual)	Frequency of Data Record (e.g. Hourly, Daily)
EU1	NOx and CO Emissions	Copy of compliance test reports	As conducted
EU1	Emissions	Calculation of emissions	Monthly and 12-month rolling

Examples of emissions calculations for record keeping purposes:

NOx:  $\{(0.085 \text{ pounds per } 1,000,000 \text{ British thermal units (MMBtu)}) \times (\text{X cubic feet}) \times (1,000 \text{ Btu per cubic foot}) + (0.10 \text{ pounds per MMBtu}) \times (\text{Y gallons of fuel oil}) \times (130,000 \text{ Btu per gallon})\} \times 1 \text{ ton per } 2000 \text{ pounds} = \text{NOx in tons per consecutive twelve month time period}$

CO:  $\{(0.035 \text{ pounds per MMBtu}) \times (\text{X cubic feet}) \times (1000 \text{ Btu per cubic foot}) + (0.035 \text{ pounds per MMBtu}) \times (\text{Y gallons of fuel oil}) \times (130,000 \text{ Btu per gallon})\} \times 1 \text{ ton per } 2000 \text{ pounds} = \text{CO in tons per consecutive twelve month time period}$

VOC:  $\{(0.035 \text{ pounds per MMBtu}) \times (\text{X cubic feet}) \times (1000 \text{ Btu per cubic foot}) + (0.035 \text{ pounds per MMBtu}) \times (\text{Y gallons of fuel oil}) \times (130,000 \text{ Btu per gallon})\} \times 1 \text{ ton per } 2000 \text{ pounds} = \text{VOC in tons per consecutive twelve month time period}$

SO<sub>2</sub>:  $\{(0.0015 \text{ lb per MMBtu}) \times (\text{Y gallons of fuel oil}) \times (130,000 \text{ Btu per gallon})\} \times 1 \text{ ton per } 2000 \text{ pounds} = \text{SO}_2 \text{ in tons per consecutive twelve month time period}$

Where: X = cubic feet of natural gas burned per consecutive twelve month time period

Y = gallons of ULSD oil burned per consecutive twelve month time period

## G. Additional Information Checklist

Attach a specific facility description and the following required additional information that MassDEP needs to process your application. Check the box next to each item to ensure that your application is complete.

- ☒ Plot Plan
- ☒ Combustion Equipment Manufacturer Specifications, Including but not Limited to Emissions Data
- ☐ Combustion Equipment Standard Operating Procedures
- ☐ Combustion Equipment Standard Maintenance Procedures, Including Cleaning Method & Frequency
- ☒ Calculations to Support This Plan Application
- ☒ Air pollution control device manufacturer specifications, if applicable
- ☐ Air pollution control device standard operating procedures, if applicable
- ☐ Air pollution control device standard maintenance procedures, if applicable
- ☒ BWP AQ BACT Form, if not proposing Top-Case BACT



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- ☒ Air quality dispersion modeling demonstration documenting that National Ambient Air Quality Standards (NAAQS) are not exceeded
- ☒ Process flow diagram for the proposed equipment and any PCD, if applicable, including relevant parameters (e.g. flow rate, pressure and temperature)

**Note:** Pursuant to 310 CMR 7.02(5)(c), MassDEP may request additional information.

## H. Other Regulatory Considerations

Indicate below whether the proposed project is subject to any additional regulatory requirements.

310 CMR 7.00: Appendix A Nonattainment Review, or is netting used to avoid review ☐ Yes ☒ No under 310 CMR 7.00 Appendix A or 40 CFR 52.21?

40 CFR 60: New Source Performance Standards (NSPS) ☒ Yes ☐ No

If Yes: Which subpart? **JJJJ, KKKK** Applicable emission limitation(s):

**NOx - 25 ppm @  
15% O2**

40 CFR 61: National Emission Standards for Hazardous Air Pollutants (NESHAPS) ☐ Yes ☒ No

If Yes: Which subpart? Applicable emission limitation(s):

**Continue to Next Page ►**

40 CFR 63: NESHAPS for Source Categories – Maximum Achievable (MACT) or Generally Available (GACT) Control Technology ☒ Yes ☐ No

If Yes: Which subpart? Applicable emission limitation(s):

301 CMR 11.00: Massachusetts Environmental Policy Act (MEPA)? ☐ Yes ☒ No

If Yes: EOE No.:

Other Applicable Requirements? ☐ Yes ☒ No

If Yes: Specify:

Facility-Wide Potential-to-Emit Hazardous Air Pollutants (HAPS): ☐ Major\* ☒ Non-Major

\*A Major source has a facility-wide potential-to-emit of 25 tons per year or more of the sum of all hazardous air pollutants or 10 tons per year or more of any individual hazardous air pollutant.



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**I. Professional Engineer's Stamp**

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

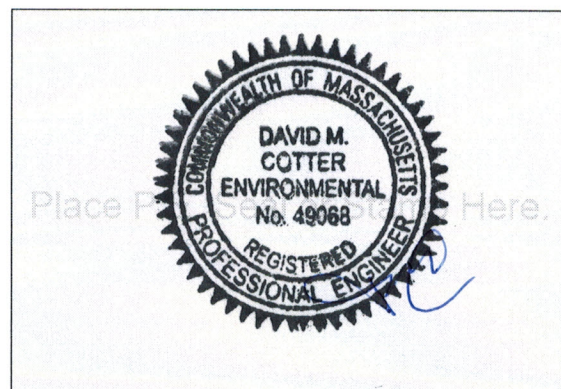
Trinity Consultants

Company

Date (MM/DD/YYYY)

49068

P.E. Number





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## J. Certification by Responsible Official

The signature below provides the affirmative demonstration pursuant to 310 CMR 7.02(5)(c)8 that any facility(ies) in Massachusetts, owned or operated by the proponent for this project (or by an entity controlling, controlled by or under common control with such proponent) that is subject to 310 CMR 7.00, et seq., is in compliance with, or on a MassDEP approved compliance schedule to meet, all provisions of 310 CMR 7.00, et seq., and any plan approval, order, notice of noncompliance or permit issued thereunder. This Form must be signed by a Responsible Official working at the location of the proposed new or modified facility. Even if an agent has been designated to fill out this Form, the Responsible Official must sign it. (Refer to the definition given in 310 CMR 7.00.)

I certify that I have personally examined the foregoing and am familiar with the information contained in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including possible fines and imprisonment.

Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

Responsible Official Signature

VP- Field Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

Date (MM/DD/YYYY)

09/08/2016





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### Comprehensive Plan Application for Fuel Utilization Emission Unit(s)

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#### K. Energy Efficiency Evaluation Survey

1. Do you know where your electricity and/or fuel and/or water and/or heat and/or compressed air is being used/consumed? ☒ Yes ☐ No
2. Has your facility had an energy audit performed by your utility supplier (or other) in the past two years?<sup>1</sup> ☐ Yes ☒ No (this is a new facility)
  - a. Did the audit include evaluations for heat loss, lighting load, cooling requirements and compressor usage? ☐ Yes ☐ No
  - b. Did the audit influence how this project is configured? ☐ Yes ☐ No
3. Does your facility have an energy management plan? ☐ Yes ☒ No
  - a. Have you identified and prioritized energy conservation opportunities? ☐ Yes ☒ No
  - b. Have you identified opportunities to improve operating and maintenance procedures by employing an energy management plan? ☐ Yes ☒ No
4. Has each emission unit proposed herein been evaluated for energy consumption including average and peak electrical use; efficiency of electric motors and suitability of alternative motors such as variable speed; added heat load and/or added cooling load as a result of the operation of the proposed process; added energy load due to building air exchange requirements as a result of exhausting heat or emissions to the ambient air; and/or use of compressors? ☐ Yes ☒ No
5. Has your facility considered alternative energy methods such as solar, geothermal or wind power as a means of supplementing all or some of the facility's energy demand? ☐ Yes ☒ No
6. Does your facility comply with Leadership in Energy & Environmental Design (LEED) Green Building Rating System design recommendations?<sup>2</sup> ☐ Yes ☒ No

<sup>1</sup>A facility wide energy audit would include an inspection of such things as lighting, air-conditioning, heating, compressors and other energy-demand equipment. It would also provide you with information on qualifying equipment rebates and incentive programs; analysis of your energy consumption patterns and written cost-savings recommendations and estimated cost savings for installing new, high-efficiency equipment.

<sup>2</sup>To understand the LEED Rating System, it is important to become familiar with its comprising facets. To be considered for LEED New Construction and Major Renovations, a building must meet specific prerequisites and additional credit areas within six categories:

- |                                |                           |                         |
|--------------------------------|---------------------------|-------------------------|
| • Sustainable Sites            | • Materials and Resources | • Water Efficiency      |
| • Indoor Environmental Quality | • Energy and Atmosphere   | • Innovation and Design |



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**CPA-PROCESS** (BWP AQ 02 Non-Major, BWP AQ 03 Major)

**Comprehensive Plan Application for Process Emission Unit(s)**

For Process Equipment Emitting 10 Tons or More of an Air Contaminant per  
Consecutive 12-Month Time Period.

Facility ID (if known)

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



**Type of Application:** ☒ BWP AQ 02 Non-Major CPA ☐ BWP AQ 03 Major CPA

**A. Facility Information**

Weymouth Compressor Station

1. Facility Name

50 Bridge Street

2. Street Address

Weymouth

3. City

MA

4. State

02191

5. ZIP Code

6. MassDEP Account # / FMF Facility # (if Known)

4922

8. Standard Industrial Classification (SIC) Code

7. Facility AQ # / SEIS ID # (if Known)

486210

9. North American Industry Classification System (NAICS) Code

10. Are you proposing a new facility?

☒ Yes ☐ No - If Yes, skip to Section B.

11. List ALL existing Air Quality Plan Approvals, Emission Cap Notifications, and 310 CMR 7.26 Compliance Certifications and associated facility-wide emission caps, if any, for this facility in the table below. If you hold a Final Operating Permit for this facility, you may leave this table blank.

Table 1			
Approval Number(s)/ 25% or 50% Rule/ 310 CMR 7.26 Certification	Transmittal Number(s) (if Applicable)	Air Contaminant (e.g. CO, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , VOC, HAP, PM or Other [Specify])*	Existing Facility-Wide Emission Cap(s) Per Consecutive 12-Month Time Period (Tons)
N/A			

\*CO = carbon monoxide, CO<sub>2</sub> = carbon dioxide, NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, specify if "Other"

12. Will this proposed process result in an increase in any facility-wide emission cap(s)?

☐ Yes\* ☒ No

\*If Yes, describe:



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**B. Equipment Description**

Note that per 310 CMR 7.02, MassDEP can issue a Plan Approval only for proposed Emission Unit(s) with air contaminant emissions that are representative of Best Available Control Technology (BACT). See Section D: Best Available Control Technology (BACT) Emissions and the MassDEP BACT Guidance. See the instructions for a link.

1. Is this proposed project modifying previously approved equipment? ☐ Yes ☒ No

If Yes, list pertinent Plan Approval(s):

2. Is this proposed project replacing previously approved equipment? ☐ Yes ☒ No

If Yes, list pertinent Plan Approval(s):

3. Provide a description of the proposed project, including relevant parameters (including but not limited to operating temperature and pressure) and associated air pollution controls, if any:

The proposed project includes the installation of one (1) Solar Taurus 60 natural gas turbine compressor unit (7,700 hp), a Waukesha VGF24GL natural gas fired emergency generator (585 hp), a fuel gas process heater (0.23 MMBtu/hr heat input), five fuel gas space heaters (0.072 MMBtu/hr heat input) a parts washer, new separator vessels and storage tanks and a gas cooler for the station. The new compressor turbine will be equipped with Solar's SoLoNOx technology to control emissions of NOx, CO and other air pollutants. Additionally, this application is including the operation of the existing metering and regulation (M&R) station as part of the facility.

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**Netting & Offsets**

4. Is netting being used to avoid 310 CMR 7.00: Appendix A? ☐ Yes\* ☒ No – Skip to 5

\*If Yes, attach a description of contemporaneous increases and decreases in applicable potential (or allowable) nonattainment pollutant emissions over a period of the most recent five (5) calendar years, including the year that the proposed project will commence operating. For each emission unit, this description must include: a description of the emission unit, the year it commenced operation or was removed from service, any associated MassDEP-issued Plan Approval(s), and its potential (or allowable) nonattainment pollutant emissions. In any case, a proposed project cannot "net out" of the requirement to submit a plan application and comply with Best Available Control Technology (BACT) pursuant to 310 CMR 7.02.

5. Is the proposed project subject to 310 CMR 7.00: Appendix A Nonattainment Review? ☐ Yes\* ☒ No – Skip to 6

\*If Yes, pursuant to 310 CMR 7.00: Appendix A(6), federally enforceable emission offsets, such as Emission Reduction Credits (ERCs), must be used for this part of the application. Complete Table 2 on the next page to summarize either the facility providing the federally enforceable emission offsets, or what is being shut down, curtailed or further controlled at this facility to obtain the required emission offsets. Emission offsets must be part of a federally enforceable Plan Approval to be used for offsetting emission increases in applicable nonattainment pollutants or their precursors.

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**B. Equipment Description** (continued)

**Note:** Complete this table if you answered Yes to Question 5. Otherwise, skip to Question 6.

Table 2					
Source of Emission Reduction Credits (ERCs) or Emissions Offsets	Transmittal No. of Plan Approval Verifying Generation of ERCs, if Any	Air Contaminant	Actual Baseline Emissions (Tons per Consecutive 12-Month Time Period) <sup>1</sup>	New Potential Emissions <sup>2</sup> (Tons per Consecutive 12-Month Time Period After Control)	ERC <sup>3</sup> or Emission Offsets, Including Offset Ratio & Required ERC Set Aside (Tons per Consecutive 12-Month Time Period)

<sup>1</sup> Actual Baseline Emissions means the average actual emissions for the source of emission credits or offsets in the previous two years (310 CMR 7.00: Appendix A: Emission Offsets and Nonattainment Review).

<sup>2</sup> New Potential Emissions means the potential emissions for the source of emission credits or offsets after project completion (310 CMR 7.00: Appendix A: Emission Offsets and Nonattainment Review).

<sup>3</sup> Emission Reduction Credit (ERC) means the difference between Actual Baseline and New Potential Emissions, including an offset ratio of 1.26:1 (310 CMR 7.00: Appendix B(3)).

6. Complete the table(s) below to summarize the details of each Emission Unit being proposed.

Table 3A			
Facility-Assigned Identifying Number for Equipment (Emission Unit No.)	Description of Equipment Including Manufacturer & Model Number or Equivalent (e.g. Acme Coating Line, Model No. AB12)	Air Contaminant(s) Emitted	Potential Emissions, <sup>1</sup> Uncontrolled (Tons per Consecutive 12-Month Time Period)
EU2 <input checked="" type="checkbox"/> New <input type="checkbox"/> Modified	Emissions from gas venting	PM <sup>2</sup>	N/A
		VOC	18.93
		CO <sub>2</sub>	12.46
		Total HAPs	1.09
		Worst Case Individual HAP <sup>1</sup>	0.82
		Other: CO <sub>2</sub> equivalent	13,103

<sup>1</sup> Potential emissions based on worst case raw material (e.g. coating) using maximum application rate and no air pollution control equipment. (See Section F. Record-Keeping Procedures.)

<sup>2</sup> PM includes particulate matter having a diameter of 10 microns or less (PM<sub>10</sub>) and particulate matter having a diameter of 2.5 microns or less (PM<sub>2.5</sub>).

<sup>1</sup> Hexane(n-) emissions are presented for worst-case Individual HAP



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Facility ID (if known)

<sup>3</sup> Calculate Worst Case Individual Hazardous Air Pollutant (HAP) potential emissions based on use of the raw material with the highest individual HAP content.

**B. Equipment Description** (continued)

Table 3B			
Facility-Assigned Identifying Number for Equipment (Emission Unit No.)	Description of Equipment Including Manufacturer & Model Number or Equivalent (e.g. Acme Coating Line, Model No. AB12)	Air Contaminant(s) Emitted	Potential Emissions, Uncontrolled (Tons per Consecutive 12-Month Time Period)
EU3 <input checked="" type="checkbox"/> New <input type="checkbox"/> Modified	Fugitive Emissions from piping components	PM	NA
		VOC	4.68
		CO <sub>2</sub>	0.72
		Total HAPs	0.52
		Worst Case Individual HAP <sup>2</sup>	0.22
		Other: CO <sub>2</sub> equivalent	753

**Note:** If you are proposing more than three Emission Units, complete additional copies of these tables.

Table 3C			
Facility-Assigned Identifying Number for Equipment (Emission Unit No.)	Description of Equipment Including Manufacturer & Model Number or Equivalent (e.g. Acme Coating Line, Model No. AB12)	Air Contaminant(s) Emitted	Potential Emissions, Uncontrolled (Tons per Consecutive 12-Month Time Period)
<input type="checkbox"/> New <input type="checkbox"/> Modified		PM	
		VOC	
		CO <sub>2</sub>	
		Total HAPs	
		Worst Case Individual HAP	
		Other:	

7. Does your proposed project involve coating and/or printing operation(s)? ☐ Yes\* ☒ No

\*If Yes, complete and attach to this application Form BWP AQ Coatings & Inks.

<sup>2</sup> Xylene emissions are presented for worst-case Individual HAP



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Facility ID (if known)

8. Are you proposing an Air Pollution Control Device (PCD)?

☐ Yes\* ☒ No

\*If Yes, complete Table 4 on the next page to summarize the details of each PCD being proposed.

**B. Equipment Description** (continued)

**Note:** If you are proposing one or more Air Pollution Control Devices (PCDs), you must also submit the applicable Supplemental Form(s). See Page 6 for additional information.

Table 4A					
Facility-Assigned Identifying Number & Description of Air Pollution Control Device (PCD)	Emission Unit No. Served by PCD	Air Contaminant(s) Controlled	Capture Efficiency (CE), Percent by Weight (CE is Presumed to be 100% Based on Permanent Total Enclosure (PTE), 40 CFR 51 Appendix B Method 204)	Destruction Efficiency (DE) or Removal Efficiency (Percent by Weight)	Overall Control (Percent by Weight (CE*DE)/100)
Facility I.D. No.  Description  <input type="checkbox"/> New  <input type="checkbox"/> Existing		PM <sup>1</sup>			
		VOC			
		Total HAPs			
		Individual HAP*			
		Other:			

<sup>1</sup> PM includes particulate matter having a diameter of 10 microns or less (PM<sub>10</sub>) and particulate matter having a diameter of 2.5 microns or less (PM<sub>2.5</sub>).

**Note:** If you are proposing more than two Air Pollution Control Devices (PCDs), complete additional copies of these tables.

Table 4B					
Facility-Assigned Identifying Number & Description of Air Pollution Control Device (PCD)	Emission Unit No. Served by PCD	Air Contaminant(s) Controlled	Capture Efficiency (CE) (Percent by Weight; CE is Presumed to be 100% Based on Permanent Total Enclosure (PTE), 40 CFR 51 Appendix B Method 204)	Destruction Efficiency (DE) or Removal Efficiency (Percent by Weight)	Overall Control (Percent by Weight (CE*DE)/100)
Facility I.D. No.  Description  <input type="checkbox"/> New  <input type="checkbox"/> Existing		PM			
		VOC			
		Total HAPs			
		Individual HAP			
		Other:			



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Facility ID (if known)

**B. Equipment Description** (continued)

**Supplemental Forms Required**

If you are proposing one or more PCDs, you will also need to submit the applicable form(s) below.

If Your Project Includes:	You Must File Form(s):
Wet or Dry Scrubbers	BWP AQ Scrubber
Cyclone or Inertial Separators	BWP AQ Cyclone
Fabric Filter	BWP AQ Baghouse/Filter
Adsorbers	BWP AQ Adsorption Equipment
Afterburners or Oxidizers	BWP AQ Afterburner/Oxidizer
Electrostatic Precipitators	BWP AQ Electrostatic Precipitator
Selective Catalytic Reduction	BWP AQ Selective Catalytic Reduction
Sorbent/Reactant Injection	BWP AQ Sorbent/Reactant Injection

**Note:** The installation of some process equipment can cause off-site noise if proper precautions are not taken. For additional guidance, see the MassDEP Noise Pollution Policy Interpretation.

9. Complete the table below to summarize all associated noise suppression equipment, if any is being proposed, and attach a completed Form BWP AQ Sound to this application (unless MassDEP waives this requirement).

Table 5			
Emission Unit No(s). Served by Noise Suppression Equipment	Type of Noise Suppression Equipment (e.g. Mufflers, Acoustical Enclosures)	Equipment Manufacturer	Equipment Model No.
N/A	N/A	N/A	N/A

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Facility ID (if known)

**B. Equipment Description** (continued)

10. Is there any external noise generating equipment associated with the proposed project? ☒ Yes ☐ No – Skip to 12

11. Have you attached a completed Form BWP AQ Sound to this application? ☒ Yes ☐ No\*

\*If No, explain:

12. Describe the potential for visible emissions from the proposed project and how they will be controlled:

No visible emissions from the proposed project will be expected due to the nature of operations and use of natural gas as fuel.

13. Describe the potential for odor impacts from the proposed project and how they will be controlled:

No odor impacts from the proposed project will be expected due to the nature of operations and use of natural gas as fuel.

**C. Stack Description**

**Note:** Discharge must meet Good Air Pollution Control Engineering Practice. When designing stacks, special consideration must be given to nearby structures and terrain to prevent emissions downwash and adverse impacts upon sensitive receptors. Stack must be vertical, must not impede vertical exhaust gas flow, and must be a minimum of 10 feet above rooftop or fresh air intake, whichever is higher. For additional guidance, refer to the MassDEP "Stack Design General Guidelines." See the instructions for a link.

Complete the table below to summarize the details of the proposed project's stack configuration.

Table 6						
Emission Unit No.	Stack Height Above Ground (Feet)	Stack Height Above Roof (Feet)	Stack Exit Diameter or Dimensions (Feet)	Exhaust Gas Exit Temperature Range (Degrees Fahrenheit)	Exhaust Gas Exit Velocity Range (Feet per Second)	Stack Liner Material
EU2 <sup>3</sup>	N/A	N/A	N/A	N/A	N/A	N/A
EU3 <sup>3</sup>	N/A	N/A	N/A	N/A	N/A	N/A

<sup>3</sup> EU2 and EU3 are fugitive emissions from gas releases and piping components and do not vent to a stack.



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Facility ID (if known)

**D. Best Available Control Technology (BACT) Emissions**

1. Complete the table(s) below to summarize the proposed project's BACT emissions.

Table 7A						
Emission Unit No.	Air Contaminant	Uncontrolled Emissions (Pounds per Hour [lbs/hr], Grains per Actual Cubic Foot [gr/acf], Grains per Dry Standard Cubic Foot [gr/dscf], or Parts per Million on a Dry Volume Corrected Basis [ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> ])	Proposed BACT Emissions (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions, if Any (Tons) (Enter "N/A" if not requesting a long-term emissions cap)	Proposed Monthly Time Period Emissions Restrictions <sup>1</sup> (Tons) (Enter "N/A" if not requesting a monthly emissions cap)	Proposed Production or Operational Limits <sup>2</sup> (Enter "N/A" if not requesting a production or operational limit)
EU2	PM <sup>3</sup>	N/A	N/A	N/A	N/A	N/A
	VOC	4.32 lb/hr	N/A	18.93	N/A	N/A
	Total HAPs	0.25 lb/hr	N/A	1.09	N/A	N/A
	Individual HAP <sup>1</sup>	0.19 lb/hr	N/A	0.82	N/A	N/A
	CO <sub>2</sub>	2.84 lb/hr	N/A	12.46	N/A	N/A
	Other: CO <sub>2</sub> e	2,992 lb/hr	N/A	13,103	N/A	N/A

<sup>1</sup> Provide a monthly emission restriction if proposing a 12-month time period restriction.

<sup>2</sup> Provide a definitive method to monitor and document compliance with any emission(s) limit(s) to be contained in a written

MassDEP Approval. Production or operational limits are but one method that may be used. To foster pollution prevention,

you may propose other methods, subject to approval by MassDEP.

<sup>3</sup> PM includes particulate matter having a diameter of 10 microns or less (PM<sub>10</sub>) and particulate matter having a diameter of 2.5 microns or less (PM<sub>2.5</sub>).

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Facility ID (if known)

**D. Best Available Control Technology (BACT) Emissions** (continued)

Table 7B						
Emission Unit No.	Air Contaminant	Uncontrolled Emissions (lbs/hr, gr/acf, or ppmvd @ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed BACT Emissions (lbs/hr, gr/acf, or ppmvd @ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions, if Any (Tons)	Proposed Monthly Time Period Emissions Restrictions (Tons)	Proposed Production or Operational Limits
EU3	PM	N/A	N/A	N/A	N/A	N/A
	VOC	See footnote below <sup>4</sup>	See footnote below <sup>4</sup>	2.38	N/A	N/A
	Total HAPs	0.12 lb/hr	0.04 lb/hr	0.18	N/A	N/A
	Individual HAP <sup>2</sup>	0.05 lb/hr	0.02 lb/hr	0.07	N/A	N/A
	CO <sub>2</sub>	0.16 lb/hr	N/A	0.72	N/A	N/A
	Other: CO <sub>2</sub> equivalent	172 lb/hr	N/A	753	N/A	N/A
Table 7C						
Emission Unit No.	Air Contaminant	Uncontrolled Emissions (lbs/hr, gr/acf, or ppmvd @ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed BACT Emissions (lbs/hr, gr/acf, or ppmvd @ %O <sub>2</sub> or CO <sub>2</sub> )	Proposed Consecutive 12-Month Time Period Emissions, if Any (Tons)	Proposed Monthly Time Period Emissions Restrictions (Tons)	Proposed Production or Operational Limits
	PM					
	VOC					
	Total HAPs					
	Individual HAP					
	CO <sub>2</sub>					

**Note:** If you are proposing more than three Emission Units, complete additional copies of these tables.

<sup>4</sup> Piping Components in natural gas service VOC – 0.20 lb/hr

Piping Components in pipeline liquids service VOC – 0.75 lb/hr uncontrolled and 0.22 lb/hr with LDAR (BACT)

Piping Components in oil service VOC – 0.12 lb/hr

Details are provided in Attachment G - Detailed Emission Calculations and Manufacturer Specifications.





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	Other:					
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**D. Best Available Control Technology (BACT) Emissions** (continued)

**Note:** Top-Case BACT is the emission rate identified via the MassDEP BACT Guidance or a pre-application meeting with MassDEP.

2. Are proposed BACT emission limits in the previous table(s) Top-Case BACT as referenced in 310 CMR 7.02(8)(a)2.a? ☒ Yes ☐ No
3. Are proposed BACT emission limits established using the approach defined in 310 CMR 7.02(8)(a)2.b? ☒ Yes ☐ No

If you answered **Yes** to Question 3, provide details below:

Algonquin will maintain good operating practices, along with ESD preventative measures, as BACT for gas release events. More details are provided in Section 5.7 and 5.8 of the original application report. Algonquin proposes to develop an LDAR program consistent with the TCEQ 28 RCT control efficiencies for the piping components in pipeline liquid services at the Weymouth Compressor Station. More details are provided in Section 5.2 of the supplemental submittal.

If you answered **No** to both questions above, you must attach to this application a completed Form BWP AQ BACT to demonstrate that this project meets BACT as provided in 310 CMR 7.02(8)(a)2 or 310 CMR 7.02(8)(a)2.c.

**E. Monitoring Procedures**

Complete the table below to summarize the details of the proposed project's monitoring procedures.

Table 8			
Emission Unit No.	Type or Method of Monitoring (e.g. CEMS <sup>1</sup> , Flow Meter)	Parameter/Emission Monitored	Frequency of Monitoring
EU3	Hand-held monitor	VOC	Quarterly

<sup>1</sup> CEMS = Continuous Emissions Monitoring System



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## F. Record Keeping Procedures

Complete the table below to summarize the details of the proposed project's record keeping procedures. Proposed record keeping procedures need to be able to demonstrate your compliance status with regard to all limitations/restrictions proposed herein. Record keeping may include, but is not limited to, hourly or daily logs, meter charts, time logs, purchase records, raw material records, and CEMS records.

Table 9			
Emission Unit No.	Parameter/Emission (e.g. Temperature, Material Usage, Air Contaminant)	Record Keeping Procedures (e.g. Data Logger or Manual)	Frequency of Data Record (e.g. Hourly, Daily)
EU2	Emissions	Calculation of emissions	Monthly and 12-month rolling
EU3	Emissions	Calculation of emissions	Quarterly
EU3	Results of LDAR monitoring	Documentation of LDAR monitoring	Quarterly

Examples of emissions calculations for record keeping purposes:

- Worst case coating/ink/other contains 5.5 pounds of **VOC** per gallon of coating
- Process application rate = 3.0 gallons of coating/ink/other applied per hour
- Process operates 1,800 hours per consecutive 12-month time period

3.0 gallons per hour X 5.5 lbs of **VOC** per gallon X 1,800 hours per consecutive 12-month time period X 1 ton per 2,000 pounds = 14.8 tons of **VOC** per consecutive 12-month time period

-or-

- Worst case coating/ink/other contains 5.5 pounds of **VOC** per gallon of coating
- Process utilized 5,678 gallons of coating per consecutive 12-month time period

5,678 gallons per consecutive 12-month time period X 5.5 pounds **VOC** per gallon X 1 ton per 2,000 pounds = 15.6 tons of **VOC** per consecutive 12-month time period

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Facility ID (if known)

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**G. Additional Information Checklist**

**Note:** For guidance and specific Top-Case BACT requirements, see the instructions.

Attach a specific facility description and the following required additional information that MassDEP needs to process your application. Check the box next to each item to ensure that your application is complete.

- ☒ Plot Plan
- ☐ Equipment Manufacturer Specifications, including but not limited to Material Safety Data Sheets, Technical Data Composition Sheets, etc.
- ☐ Equipment Standard Operating Procedures
- ☐ Equipment Standard Maintenance Procedures, Including Cleaning Method & Frequency
- ☒ Calculations to Support This Plan Application
- ☐ Air pollution control device manufacturer specifications, if applicable
- ☐ Air pollution control device standard operating procedures, if applicable
- ☐ Air pollution control device standard maintenance procedures, if applicable
- ☐ Process flow diagram
- ☐ BWP AQ BACT Form, if not proposing Top-Case BACT
- ☐ Process flow diagram for the proposed equipment and any PCD, if applicable, including relevant parameters (e.g. flow rate, pressure and temperature)

**Note:** Pursuant to 310 CMR 7.02(5)(c), MassDEP may request additional information.

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**H. Other Regulatory Considerations**

Indicate below whether the proposed project is subject to any additional regulatory requirements.

310 CMR 7.00: Appendix A Nonattainment Review, or is netting used to avoid review under 310 CMR 7.00 Appendix A or 40 CFR 52.21?

☐ Yes ☒ No

40 CFR 60: New Source Performance Standards (NSPS)?

☐ Yes ☒ No

If Yes: Which subpart?

Applicable emission limitation(s):

40 CFR 61: National Emission Standards for Hazardous Air Pollutants (NESHAPS) ☐ Yes ☒ No

If Yes: Which subpart?

Applicable emission limitation(s):



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Facility ID (if known)

**H. Other Regulatory Considerations** (continued)

40 CFR 63: NESHAPS for Source Categories – Maximum Achievable (MACT) or  
Generally Available (GACT) Control Technology ☐ Yes ☒ No

If Yes: Which subpart?

Applicable emission limitation(s):

301 CMR 11.00: Massachusetts Environmental Policy Act (MEPA)?

☐ Yes ☒ No

If Yes: EOE No.:

Other Applicable Requirements?

☐ Yes ☒ No

If Yes: Specify:

Facility-Wide Potential-to-Emit Hazardous Air Pollutants (HAPS):

☐ Major\* ☒ Non-Major

\*A Major source has a facility-wide potential-to-emit of 25 tons per year or more of the sum of all hazardous air pollutants or 10 tons per year or more of any individual hazardous air pollutant.

**I. Professional Engineer's Stamp**

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

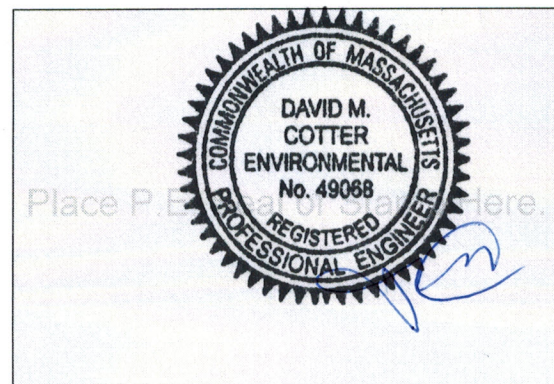
Trinity Consultants

Company

Date (MM/DD/YYYY)

49068

P.E. Number



Continue to Certification by Responsible Official ►



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

X266786

Transmittal Number

**CPA-PROCESS** (BWP AQ 02 Non-Major, BWP AQ 03 Major)

**Comprehensive Plan Application for Process Emission Unit(s)**

For Process Equipment Emitting 10 Tons or More of an Air Contaminant per  
Consecutive 12-Month Time Period.

Facility ID (if known)

**J. Certification by Responsible Official**

The signature below provides the affirmative demonstration pursuant to 310 CMR 7.02(5)(c)8 that any facility(ies) in Massachusetts, owned or operated by the proponent for this project (or by an entity controlling, controlled by or under common control with such proponent) that is subject to 310 CMR 7.00, et seq., is in compliance with, or on a MassDEP approved compliance schedule to meet, all provisions of 310 CMR 7.00, et seq., and any plan approval, order, notice of noncompliance or permit issued thereunder. This Form must be signed by a Responsible Official working at the location of the proposed new or modified facility. Even if an agent has been designated to fill out this Form, the Responsible Official must sign it. (Refer to the definition given in 310 CMR 7.00.)

I certify that I have personally examined the foregoing and am familiar with the information contained

in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete.

I am aware that there are significant penalties for submitting false information, including possible fines and imprisonment.

Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

Responsible Official Signature

VP- Field Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

Date (MM/DD/YYYY)



Continue to Energy Efficiency Evaluation Survey ►



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**CPA-PROCESS** (BWP AQ 02 Non-Major, BWP AQ 03 Major)

**Comprehensive Plan Application for Process Emission Unit(s)**

For Process Equipment Emitting 10 Tons or More of an Air Contaminant per  
Consecutive 12-Month Time Period.

X266786

Transmittal Number

Facility ID (if known)

---

**K. Energy Efficiency Evaluation Survey**

1. Do you know where your electricity and/or fuel and/or water and/or heat and/or compressed air is being used/consumed? ☒ Yes ☐ No
2. Has your facility had an energy audit performed by your utility supplier (or other) in the past two years?<sup>1</sup> ☐ Yes ☒ No
  - a. Did the audit include evaluations for heat loss, lighting load, cooling requirements and compressor usage? ☐ Yes ☐ No
  - b. Did the audit influence how this project is configured? ☐ Yes ☐ No
3. Does your facility have an energy management plan? ☐ Yes ☒ No
  - a. Have you identified and prioritized energy conservation opportunities? ☐ Yes ☒ No
  - b. Have you identified opportunities to improve operating and maintenance procedures by employing an energy management plan? ☐ Yes ☒ No
4. Has each emission unit proposed herein been evaluated for energy consumption including average and peak electrical use; efficiency of electric motors and suitability of alternative motors such as variable speed; added heat load and/or added cooling load as a result of the operation of the proposed process; added energy load due to building air exchange requirements as a result of exhausting heat or emissions to the ambient air; and/or use of compressors? ☐ Yes ☒ No
5. Has your facility considered alternative energy methods such as solar, geothermal or wind power as a means of supplementing all or some of the facility's energy demand? ☐ Yes ☒ No
6. Does your facility comply with Leadership in Energy & Environmental Design (LEED) Green Building Rating System design recommendations?<sup>2</sup> ☐ Yes ☒ No

<sup>1</sup>A facility wide energy audit would include an inspection of such things as lighting, air-conditioning, heating, compressors and other energy-demand equipment. It would also provide you with information on qualifying equipment rebates and incentive programs; analysis of your energy consumption patterns and written cost-savings recommendations and estimated cost savings for installing new, high-efficiency equipment.

<sup>2</sup>To understand the LEED Rating System, it is important to become familiar with its comprising facets. To be considered for LEED New Construction and Major Renovations, a building must meet specific prerequisites and additional credit areas within six categories:

- |                                |                           |                         |
|--------------------------------|---------------------------|-------------------------|
| • Sustainable Sites            | • Materials and Resources | • Water Efficiency      |
| • Indoor Environmental Quality | • Energy and Atmosphere   | • Innovation and Design |

## ATTACHMENT C: SUPPLEMENTAL FORMS

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BWP AQ BACT Forms  
BWP AQ Sound Form





Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**  
Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

X266786

Transmittal Number

Facility ID (if known)

Per 310 CMR 7.02(8)(a), this Form is not required to be submitted if:

- The proposed project will utilize Top-Case BACT (as defined by MassDEP); or
- Emissions from the proposed project are less than 18 tons of Volatile Organic Compounds and Halogenated Organic Compounds combined, less than 18 tons of total organic material Hazardous Air Pollutants (HAPs), and/or less than 10 tons of a single organic material HAP – all tonnages being per consecutive 12-month time period – AND the project proponent proposes a combination of best management practices, pollution prevention and a limitation on hours of operation and/or raw materials usage.

See the MassDEP BACT Guidance for additional information.

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



**A. Project Information**

1. Complete the table below to summarize your proposed air pollution control technology(ies)/ technique(s) to be used to deliver BACT for your proposed project, derived using a top-down BACT analysis as determined via Sections B, C, and D below:

Table 1		
Emission Unit No.(s) Being Controlled	Proposed Air Pollution Control Device(s)/Technique(s)	Proposed Emission(s) Limit(s)
EU1	Dry Low-NOx (DLN) Combustion Technology (SoLoNOx)	9 ppm NOx @ 15% O2

**B. Air Pollution Control Technology/Technique Options**

Complete the table beginning on the next page for available, demonstrated in use, air pollution control technologies/techniques for this proposed project. List in order of lowest to highest resulting air contaminant(s) emissions.

To ensure a sufficiently broad and comprehensive search of control alternatives, sources other than the U.S. Environmental Protection Agency (EPA) RACT/BACT/LAER Clearinghouse database should be investigated and documented.

Copy and complete Table 2 as needed for your top options. Do not include any air pollution control technologies/techniques that result in higher air contaminant emissions than the technology/technique you are proposing.

Continue to Next Page ►



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

X266786

Transmittal Number

## BWP AQ BACT

### Determination of Best Available Control Technology (BACT)

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

Facility ID (if known)

### B. Air Pollution Control Technology/Technique Options (continued)

Table 2			
	Option 1:	Option 2:	Option 3:
<b>Description of Available Air Pollution Control Technologies/Techniques</b>	Selective Catalytic Reduction	Dry Low NO <sub>x</sub> Combustion (SoLoNO <sub>x</sub> )	Water Injection/Good Combustion Practices
<b>Pollutant(s) Controlled<sup>1</sup></b> (e.g. PM, NO <sub>x</sub> , CO, SO <sub>2</sub> , VOC, HAP)	NO <sub>x</sub>	NO <sub>x</sub>	NO <sub>x</sub>
<b>Potential Emissions Before Control</b> (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis)	9 ppm <sup>1</sup>	9 ppm	N/A
<b>Resulting Emissions After Control</b> (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis)	3-9 ppm	9 ppm	N/A
<b>Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed<sup>2</sup></b>	43,805	N/A	N/A

<sup>1</sup> NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

<sup>2</sup> Complete Section C of this Form to determine annualized costs.

Continue to Next Page ►

<sup>1</sup> Selective Catalyst Reduction (SCR) control is assumed on top of SoLoNO<sub>x</sub> on Solar turbine. Algonquin and Solar Turbines believe that SoLoNO<sub>x</sub> is not an add-on control device, but rather it is a type of combustion chamber design that is integral to the design of the entire turbine.



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**

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X266786

Transmittal Number

Facility ID (if known)

**C. Annualized Cost Analysis**

Complete the table below for each air pollution control technology/technique being evaluated for this proposed project. Whenever possible, use vendor quotes. Do not complete this table for those air pollution control technologies/techniques that result in higher air contaminant emissions than those you are proposing.

Table 3			
	Option 1	Option 2	Option 3
Total Capital Investment (TCI)			
Direct Purchase Cost			
1. Primary Control Device & Auxiliary Equipment	\$574,100	\$	\$
2. Fans	\$	\$	\$
3. Ducts	\$	\$	\$
4. Other – Specify:	\$	\$	\$
5. Instrumentation/Controls	\$57,410	\$	\$
Indirect Capital Cost			
6. Construction	\$354,544	\$	\$
7. Labor	\$	\$	\$
8. Sales Taxes	\$22,964	\$	\$
9. Freight Charges	\$28,705	\$	\$
Engineering/Planning			
10. Contracting Fees	\$207,545	\$	\$
11. Testing	\$	\$	\$
12. Supervision	\$186,790	\$	\$
13. Total Capital Investment (Add 1 Through 12)	\$1,432,058	\$	\$
14. Annualized Capital Cost: $C[i(1+i)^n]/[(1+i)^n - 1]^*$	\$135,176	\$	\$

\* C = Total Capital Investment (Line 13) i = Interest Rate (Assume 10%) n = Life of Equipment (Assume 10 Years or Less)



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

X266786

Transmittal Number

Facility ID (if known)

**C. Annualized Cost Analysis** (continued)

Table 3 (Continued)			
	Option 1	Option 2	Option 3
<b>Annual Operating &amp; Maintenance Costs</b>			
<b>Direct Operating Cost</b>			
15. Labor	\$18,889	\$	\$
16. Maintenance	\$16,425	\$	\$
17. Replacement Parts	\$16,425	\$	\$
<b>Indirect Cost</b>			
18. Property Taxes*	\$0	\$	\$
19. Insurance	\$0	\$	\$
20. Fees	\$0	\$	\$
21. Total Annual Operating Costs (Add 15 Through 20)	\$51,739	\$	\$
<b>Energy Cost</b>			
22. Annual Electrical Energy Expense	\$95,997	\$	\$
23. Annual Auxiliary Fuel Cost	\$99,212	\$	\$
24. Total Annual Energy Cost (Add 22 and 23)	\$	\$	\$
25. Annual Waste Treatment & Disposal Costs	\$10,532	\$	\$
26. Miscellaneous Annual Expenses	\$	\$	\$
27. Annual Resource Recovery & Resale	\$	\$	\$
28. Total Annualized Control Costs (14+21+24+25+26) - 27	\$392,656	\$	\$
29. Amount of Pollutant Controlled Over Baseline Emissions** (Tons Per Year)	8.96 tpy		
30. Cost of Control (Dollars Per Ton) (Divide 28 By 29)	\$43,805	\$	\$

\*State and federal law may provide for certain tax exemptions and special loans for the purchase of control equipment. Contact the Massachusetts Industrial Finance Agency (MIFA) or Federal Small Business Association (SBA).

\*\* Baseline Emissions are essentially uncontrolled emissions, calculated using realistic upper boundary operating assumptions.



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

X266786

Transmittal Number

Facility ID (if known)

**D. Option Feasibility**

Complete the table below to summarize the basis for elimination of each of the air pollution control technologies/techniques used to determine BACT for your proposed project:

Table 4	
Description of Air Pollution Control Technology/Technique Option	Explain the Basis for Elimination <sup>1</sup>
EM/SCONox Technology	It is designed to operate effectively at temp between 300 to 700 F. The turbine's exhaust temperature is 950 F.
Selective Non-Catalytic Reduction (SNCR)	The temperature for operation is above the exhaust temp of turbine. It has never been applied on a turbine of this size.
Selective Catalytic Reduction (SCR)	The economic cost per ton of NOx removed exceeds the MassDEP guideline for non-attainment pollutants of \$11,000 to \$13,000 per ton.
Water Injection	Results in lower control efficiency than the proposed BACT

<sup>1</sup> **Note:** BACT is defined as an emission limitation based on the maximum degree of reduction of any regulated air contaminant emitted from or which results from any regulated facility which MassDEP, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable. Explanations will be based upon the following:

**Technical Reasons.** Must specifically state the reason(s) why the option is not technically feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**Economic Reason.** Final determination will be based on U.S. Environmental Protection Agency methods or other methods approved by MassDEP.

**Other Reasons.** Must specifically state the reason(s) why the option is not feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**E. Professional Engineer's Stamp**

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this Form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

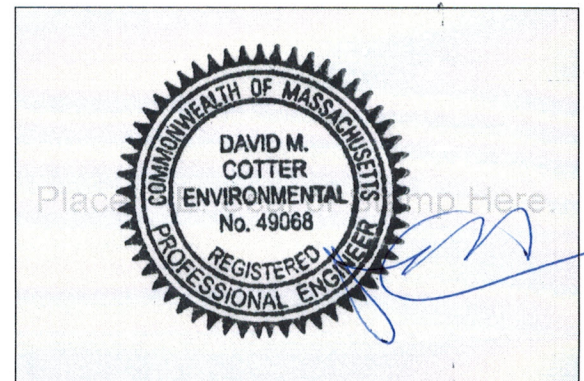
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**Massachusetts Department of Environmental Protection**  
Bureau of Waste Prevention – Air Quality

X266786

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**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

Facility ID (if known)

**F. Certification by Responsible Official**

The signature below provides the affirmative demonstration pursuant to 310 CMR 7.02(5)(c)8 that any facility(ies) in Massachusetts, owned or operated by the proponent for this project (or by an entity controlling, controlled by or under common control with such proponent) that is subject to 310 CMR 7.00, et seq., is in compliance with, or on a MassDEP approved compliance schedule to meet, all provisions of 310 CMR 7.00, et seq., and any plan approval, order, notice of noncompliance or permit issued thereunder. This Form must be signed by a Responsible Official working at the location of the proposed new or modified facility. Even if an agent has been designated to fill out this Form, the Responsible Official must sign it. (Refer to the definition given in 310 CMR 7.00.)

I certify that I have personally examined the foregoing and am familiar with the information contained in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including possible fines and imprisonment.

Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

Responsible Official Signature

VP-Field Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

Date (MM/DD/YYYY)

This space is reserved for  
MassDEP Approval Stamp.



# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

## BWP AQ BACT

### Determination of Best Available Control Technology (BACT)

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

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Transmittal Number

Facility ID (if known)

Per 310 CMR 7.02(8)(a), this Form is not required to be submitted if:

- The proposed project will utilize Top-Case BACT (as defined by MassDEP); or
- Emissions from the proposed project are less than 18 tons of Volatile Organic Compounds and Halogenated Organic Compounds combined, less than 18 tons of total organic material Hazardous Air Pollutants (HAPs), and/or less than 10 tons of a single organic material HAP – all tonnages being per consecutive 12-month time period – AND the project proponent proposes a combination of best management practices, pollution prevention and a limitation on hours of operation and/or raw materials usage.

See the MassDEP BACT Guidance for additional information.

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



## A. Project Information

1. Complete the table below to summarize your proposed air pollution control technology(ies)/ technique(s) to be used to deliver BACT for your proposed project, derived using a top-down BACT analysis as determined via Sections B, C, and D below:

Table 1		
Emission Unit No.(s) Being Controlled	Proposed Air Pollution Control Device(s)/Technique(s)	Proposed Emission(s) Limit(s)
EU1	Oxidation Catalyst	0.20 lb/hr for CO and 0.25 lb/hr for VOC

## B. Air Pollution Control Technology/Technique Options

Complete the table beginning on the next page for available, demonstrated in use, air pollution control technologies/techniques for this proposed project. List in order of lowest to highest resulting air contaminant(s) emissions.

To ensure a sufficiently broad and comprehensive search of control alternatives, sources other than the U.S. Environmental Protection Agency (EPA) RACT/BACT/LAER Clearinghouse database should be investigated and documented.

Copy and complete Table 2 as needed for your top options. Do not include any air pollution control technologies/techniques that result in higher air contaminant emissions than the technology/technique you are proposing.

Continue to Next Page ►





# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

## BWP AQ BACT

### Determination of Best Available Control Technology (BACT)

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

X266786

Transmittal Number

Facility ID (if known)

### B. Air Pollution Control Technology/Technique Options (continued)

Table 2			
	Option 1:	Option 2:	Option 3:
<b>Description of Available Air Pollution Control Technologies/Techniques</b>	Oxidation Catalyst	Good Combustion Practices	
<b>Pollutant(s) Controlled<sup>1</sup></b> (e.g. PM, NO <sub>x</sub> , CO, SO <sub>2</sub> , VOC, HAP)	CO, VOC	CO, VOC	
<b>Potential Emissions Before Control</b> (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis)	4.02 lb/hr for CO and 0.50 lb/hr for VOC	N/A	
<b>Resulting Emissions After Control</b> (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis)	0.20 lb/hr for CO and 0.25 lb/hr for VOC	N/A	
<b>Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed<sup>2</sup></b>	N/A	N/A	

<sup>1</sup> NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

<sup>2</sup> Complete Section C of this Form to determine annualized costs.

Continue to Next Page ►



## BWP AQ BACT

### Determination of Best Available Control Technology (BACT)

Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

Facility ID (if known)

**C. Annualized Cost Analysis - Note: The chosen BACT is the top technically feasible control option as determined through the Top-Down BACT analysis for CO and VOC emissions and hence a cost analysis was not performed.**

Complete the table below for each air pollution control technology/technique being evaluated for this proposed project. Whenever possible, use vendor quotes. Do not complete this table for those air pollution control technologies/techniques that result in higher air contaminant emissions than those you are proposing.

Table 3			
	Option 1	Option 2	Option 3
<b>Total Capital Investment (TCI)</b>			
<b>Direct Purchase Cost</b>			
1. Primary Control Device & Auxiliary Equipment	\$	\$	\$
2. Fans	\$	\$	\$
3. Ducts	\$	\$	\$
4. Other – Specify:	\$	\$	\$
5. Instrumentation/Controls	\$	\$	\$
<b>Indirect Capital Cost</b>			
6. Construction	\$	\$	\$
7. Labor	\$	\$	\$
8. Sales Taxes	\$	\$	\$
9. Freight Charges	\$	\$	\$
<b>Engineering/Planning</b>			
10. Contracting Fees	\$	\$	\$
11. Testing	\$	\$	\$
12. Supervision	\$	\$	\$
13. Total Capital Investment (Add 1 Through 12)	\$	\$	\$
14. Annualized Capital Cost: $C[i(1+i)^n]/[(1+i)^n - 1]^*$	\$	\$	\$

\* C = Total Capital Investment (Line 13) i = Interest Rate (Assume 10%) n = Life of Equipment (Assume 10 Years or Less)



Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

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X266786

Transmittal Number

Facility ID (if known)

**C. Annualized Cost Analysis** (continued) **Note: The chosen BACT is the top technically feasible control option as determined through the Top-Down BACT analysis for CO and VOC emissions and hence a cost analysis was not performed.**

Table 3 (Continued)			
	Option 1	Option 2	Option 3
<b>Annual Operating &amp; Maintenance Costs</b>			
<b>Direct Operating Cost</b>			
15. Labor	\$	\$	\$
16. Maintenance	\$	\$	\$
17. Replacement Parts	\$	\$	\$
<b>Indirect Cost</b>			
18. Property Taxes*	\$	\$	\$
19. Insurance	\$	\$	\$
20. Fees	\$	\$	\$
21. Total Annual Operating Costs (Add 15 Through 20)	\$	\$	\$
<b>Energy Cost</b>			
22. Annual Electrical Energy Expense	\$	\$	\$
23. Annual Auxiliary Fuel Cost	\$	\$	\$
24. Total Annual Energy Cost (Add 22 and 23)	\$	\$	\$
25. Annual Waste Treatment & Disposal Costs	\$	\$	\$
26. Miscellaneous Annual Expenses	\$	\$	\$
27. Annual Resource Recovery & Resale	\$	\$	\$
28. Total Annualized Control Costs (14+21+24+25+26) - 27	\$	\$	\$
29. Amount of Pollutant Controlled Over Baseline Emissions** (Tons Per Year)			
30. Cost of Control (Dollars Per Ton) (Divide 28 By 29)	\$	\$	\$



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Facility ID (if known)

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\*\* Baseline Emissions are essentially uncontrolled emissions, calculated using realistic upper boundary operating assumptions.

**D. Option Feasibility - Note: The chosen BACT is the top technically feasible control option as determined through the Top-Down BACT analysis for CO and VOC emissions and hence a feasibility analysis was not performed.**

Complete the table below to summarize the basis for elimination of each of the air pollution control technologies/techniques used to determine BACT for your proposed project:

Table 4	
Description of Air Pollution Control Technology/Technique Option	Explain the Basis for Elimination <sup>1</sup>

<sup>1</sup> **Note:** BACT is defined as an emission limitation based on the maximum degree of reduction of any regulated air contaminant emitted from or which results from any regulated facility which MassDEP, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable. Explanations will be based upon the following:

**Technical Reasons.** Must specifically state the reason(s) why the option is not technically feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**Economic Reason.** Final determination will be based on U.S. Environmental Protection Agency methods or other methods approved by MassDEP.

**Other Reasons.** Must specifically state the reason(s) why the option is not feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**E. Professional Engineer's Stamp**

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this Form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

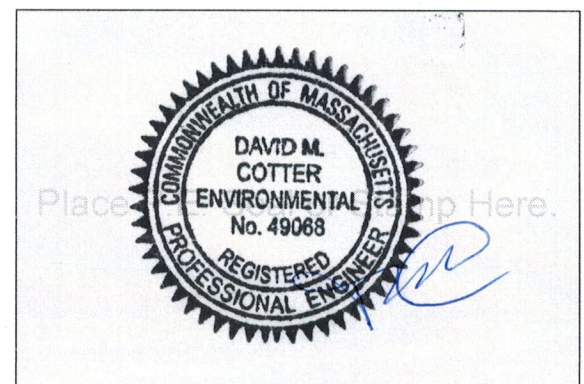
Trinity Consultants

Company

Date (MM/DD/YYYY)

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**F. Certification by Responsible Official**

The signature below provides the affirmative demonstration pursuant to 310 CMR 7.02(5)(c)8 that any facility(ies) in Massachusetts, owned or operated by the proponent for this project (or by an entity controlling, controlled by or under common control with such proponent) that is subject to 310 CMR 7.00, et seq., is in compliance with, or on a MassDEP approved compliance schedule to meet, all provisions of 310 CMR 7.00, et seq., and any plan approval, order, notice of noncompliance or permit issued thereunder. This Form must be signed by a Responsible Official working at the location of the proposed new or modified facility. Even if an agent has been designated to fill out this Form, the Responsible Official must sign it. (Refer to the definition given in 310 CMR 7.00.)

I certify that I have personally examined the foregoing and am familiar with the information contained in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including possible fines and imprisonment.

Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

*Thomas V. Wooden Jr.*

Responsible Official Signature

VP-Field Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

*09/08/2016*

Date (MM/DD/YYYY)







Massachusetts Department of Environmental Protection  
Bureau of Waste Prevention – Air Quality

**BWP AQ BACT**

**Determination of Best Available Control Technology (BACT)**  
Submit with Form CPA-FUEL and/or CPA-PROCESS, as applicable, when performing a top-down, case-by-case BACT analysis for your proposed Comprehensive Plan Application (CPA) project.

X266786

Transmittal Number

Facility ID (if known)

Per 310 CMR 7.02(8)(a), this Form is not required to be submitted if:

- The proposed project will utilize Top-Case BACT (as defined by MassDEP); or
- Emissions from the proposed project are less than 18 tons of Volatile Organic Compounds and Halogenated Organic Compounds combined, less than 18 tons of total organic material Hazardous Air Pollutants (HAPs), and/or less than 10 tons of a single organic material HAP – all tonnages being per consecutive 12-month time period – AND the project proponent proposes a combination of best management practices, pollution prevention and a limitation on hours of operation and/or raw materials usage.

See the MassDEP BACT Guidance for additional information.

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



**A. Project Information**

1. Complete the table below to summarize your proposed air pollution control technology(ies)/ technique(s) to be used to deliver BACT for your proposed project, derived using a top-down BACT analysis as determined via Sections B, C, and D below:

Table 1		
Emission Unit No.(s) Being Controlled	Proposed Air Pollution Control Device(s)/Technique(s)	Proposed Emission(s) Limit(s)
EU1	Fuel selection and good combustion/ operating practices	35,800 tons CO <sub>2</sub> e/year

**B. Air Pollution Control Technology/Technique Options**

Complete the table beginning on the next page for available, demonstrated in use, air pollution control technologies/techniques for this proposed project. List in order of lowest to highest resulting air contaminant(s) emissions.

To ensure a sufficiently broad and comprehensive search of control alternatives, sources other than the U.S. Environmental Protection Agency (EPA) RACT/BACT/LAER Clearinghouse database should be investigated and documented.

Copy and complete Table 2 as needed for your top options. Do not include any air pollution control technologies/techniques that result in higher air contaminant emissions than the technology/technique you are proposing.

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# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

## BWP AQ BACT

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### B. Air Pollution Control Technology/Technique Options (continued)

Table 2				
	Option 1:	Option 2:	Option 3:	Option 4:
<b>Description of Available Air Pollution Control Technologies/Techniques</b>	Carbon Capture and Storage (CCS)	Fuel Selection	High Efficiency Turbine	Good Combustion Practices
<b>Pollutant(s) Controlled<sup>1</sup></b> (e.g. PM, NO <sub>x</sub> , CO, SO <sub>2</sub> , VOC, HAP)	CO <sub>2</sub>	CO <sub>2</sub>	CO <sub>2</sub>	CO <sub>2</sub>
<b>Potential Emissions Before Control</b> (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis)	35,568 tpy CO <sub>2</sub>	35,568 tpy CO <sub>2</sub>	35,568 tpy CO <sub>2</sub>	35,568 tpy CO <sub>2</sub>
<b>Resulting Emissions After Control</b> (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis)	90% control efficiency	N/A	N/A	N/A
<b>Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed<sup>2</sup></b>	\$709/ ton of CO <sub>2</sub> captured	N/A	N/A	N/A

<sup>1</sup> NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

<sup>2</sup> Complete Section C of this Form to determine annualized costs.

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## BWP AQ BACT

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### C. Annualized Cost Analysis – Please see detailed calculations attached in Attachment E

Complete the table below for each air pollution control technology/technique being evaluated for this proposed project. Whenever possible, use vendor quotes. Do not complete this table for those air pollution control technologies/techniques that result in higher air contaminant emissions than those you are proposing.

Table 3			
	Option 1	Option 2	Option 3
Total Capital Investment (TCI)			
Direct Purchase Cost			
1. Primary Control Device & Auxiliary Equipment	\$	\$	\$
2. Fans	\$	\$	\$
3. Ducts	\$	\$	\$
4. Other – Specify:	\$	\$	\$
5. Instrumentation/Controls	\$	\$	\$
Indirect Capital Cost			
6. Construction	\$	\$	\$
7. Labor	\$	\$	\$
8. Sales Taxes	\$	\$	\$
9. Freight Charges	\$	\$	\$
Engineering/Planning			
10. Contracting Fees	\$	\$	\$
11. Testing	\$	\$	\$
12. Supervision	\$	\$	\$
13. Total Capital Investment (Add 1 Through 12)	\$	\$	\$
14. Annualized Capital Cost: $C[i(1+i)^n]/[(1+i)^n - 1]^*$	\$	\$	\$

\* C = Total Capital Investment (Line 13) i = Interest Rate (Assume 10%) n = Life of Equipment (Assume 10 Years or Less)





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**C. Annualized Cost Analysis** (continued) - [Please see detailed calculations attached in Attachment E](#)

Table 3 (Continued)			
	Option 1	Option 2	Option 3
<b>Annual Operating &amp; Maintenance Costs</b>			
<b>Direct Operating Cost</b>			
15. Labor	\$	\$	\$
16. Maintenance	\$	\$	\$
17. Replacement Parts	\$	\$	\$
<b>Indirect Cost</b>			
18. Property Taxes*	\$	\$	\$
19. Insurance	\$	\$	\$
20. Fees	\$	\$	\$
21. Total Annual Operating Costs (Add 15 Through 20)	\$	\$	\$
<b>Energy Cost</b>			
22. Annual Electrical Energy Expense	\$	\$	\$
23. Annual Auxiliary Fuel Cost	\$	\$	\$
24. Total Annual Energy Cost (Add 22 and 23)	\$	\$	\$
25. Annual Waste Treatment & Disposal Costs	\$	\$	\$
26. Miscellaneous Annual Expenses	\$	\$	\$
27. Annual Resource Recovery & Resale	\$	\$	\$
28. Total Annualized Control Costs (14+21+24+25+26) - 27	\$	\$	\$
29. Amount of Pollutant Controlled Over Baseline Emissions** (Tons Per Year)	\$		
30. Cost of Control (Dollars Per Ton) (Divide 28 By 29)	\$	\$	\$

\*State and federal law may provide for certain tax exemptions and special loans for the purchase of control equipment. Contact the Massachusetts Industrial Finance Agency (MIFA) or Federal Small Business Association (SBA).

\*\* Baseline Emissions are essentially uncontrolled emissions, calculated using realistic upper boundary operating assumptions.



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Facility ID (if known)

**D. Option Feasibility**

Complete the table below to summarize the basis for elimination of each of the air pollution control technologies/techniques used to determine BACT for your proposed project:

Table 4	
Description of Air Pollution Control Technology/Technique Option	Explain the Basis for Elimination <sup>1</sup>
Carbon Capture and Sequestration (CCS)	The economic cost per ton of CO <sub>2</sub> captured is infeasible and as such CCS is considered to be cost ineffective for the project

<sup>1</sup> **Note:** BACT is defined as an emission limitation based on the maximum degree of reduction of any regulated air contaminant emitted from or which results from any regulated facility which MassDEP, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable. Explanations will be based upon the following:

**Technical Reasons.** Must specifically state the reason(s) why the option is not technically feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**Economic Reason.** Final determination will be based on U.S. Environmental Protection Agency methods or other methods approved by MassDEP.

**Other Reasons.** Must specifically state the reason(s) why the option is not feasible and specifically why the option cannot be modified to accommodate the proposed emission unit(s).

**E. Professional Engineer's Stamp**

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this Form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

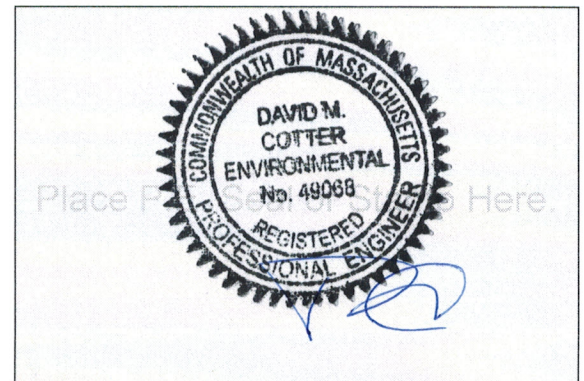
Trinity Consultants

Company

Date (MM/DD/YYYY)

49068

P.E. Number





**Massachusetts Department of Environmental Protection**  
Bureau of Waste Prevention – Air Quality

X266786

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**Determination of Best Available Control Technology (BACT)**

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Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

Responsible Official Signature

VP-Field Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

Date (MM/DD/YYYY)







# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

## BWP AQ Sound

X266786

Transmittal Number

Submit alone and/or with Form CPA-FUEL and/or CPA-PPROCESS whenever the construction or alteration of stationary equipment (e.g. electrical generating equipment, motors, fans, process handling equipment or similar sources of sound) has the potential to cause noise, or in response to a MassDEP enforcement action citing noise as a condition of air pollution.

Facility ID (if known)

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



### Introduction

When proposing sound suppression/mitigation measures, similar to the traditional "top-down" BACT process, the "top case" sound suppression/mitigation measures which deliver the lowest sound level increase above background are required to be implemented, unless these measures can be eliminated based upon technological or economic infeasibility. An applicant cannot "model out" of the use of the "top case" sound suppression/mitigation measures by simply demonstrating that predicted sound levels at the property line when employing a less stringent sound suppression/mitigation strategy will result in a sound level increase of less than or equal to the 10 dBA (decibel, A –Weighted) above background sound level increase criteria contained in the MassDEP Noise Policy. A 10 dBA increase is the maximum increase allowed by MassDEP; it is not the sound level increase upon which the design of sound suppression/mitigation strategies and techniques should be based. Also, take into consideration that the city or town that the project is located in may have a noise ordinance (or similar) that may be more stringent than the criteria in the MassDEP Noise Policy

### A. Sound Emission Sources & Abatement Equipment/Mitigation Measures

1. Provide a description of the source(s) of sound emissions and associated sound abatement equipment and/or mitigation measures. Also include details of sound emission mitigation measures to be taken during construction activities.

Significant sound sources include: 1) noise generated by the turbine/compressor that penetrates the compressor building, 2) turbine exhaust noise (primary noise source that could generate perceptible vibration, 3) noise radiated from aboveground gas piping and related piping components, 4) noise of the outdoor lube oil cooler and outdoor gas cooler, 5) noise generated by the turbine air intake system. The project will use a sound suppressant muffler system for the turbine exhaust system, acoustical pipe insulation for outdoor above ground gas piping, a silencer for each turbine air intake system, a low-noise lube oil cooler for each compressor unit, and a low-noise gas cooler.

### B. Manufacturer's Sound Emission Profiles & Sound Abatement Equipment

Please attach to this form the manufacturer's sound generation data for the equipment being proposed for installation, or the existing equipment as applicable. This data must specify the sound pressure levels for a complete 360° circumference of the equipment and at given distance from the equipment. Also attach information provided by the sound abatement manufacturer detailing the expected sound suppression to be provided by the proposed sound suppression equipment. [Note 1]

### C. Plot Plan

Provide a plot plan and aerial photo(s) (e.g. GIS) that defines: the specific location of the proposed or existing source(s) of sound emissions; the distances from the source(s) to the property lines; the location, distances and use of all inhabited buildings (residences, commercial, industrial, etc.) beyond the property lines; identify any areas of possible future construction beyond the property line; and sound monitoring locations used to assess noise impact on the surrounding community. All information provided in the sound survey shall contain sufficient data and detail to adequately assess any sound impacts to the surrounding community, including elevated receptors as applicable, not necessarily receptors immediately outside the facility's property line.

[1] See attached report: Hoover & Keith, Inc. (H&K), Weymouth Compressor Station (Norfolk County, Massachusetts) Results of the most Recent Ambient Sound Survey and Updated Acoustical Analysis of a New Natural Gas Compressor Station Associated with the Proposed Atlantic Bridge Project ("AB Project"), September 3, 2015.

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## Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

### BWP AQ Sound

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X266786

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Facility ID (if known)

## D. Community Sound Level Criteria

Approval of the proposed new equipment or proposed corrective measures will **not** be granted if the installation:

1. Increases off-site broadband sound levels by more than 10 dBA above “ambient” sound levels. Ambient is defined as the lowest one-hour background A-weighted sound pressure level that is exceeded 90 percent of the time measured during equipment operating hours. Ambient may also be established by other means with the consent of MassDEP.
2. Produces off-site a “pure tone” condition. “Pure tone” is defined as when any octave band center frequency sound pressure level exceeds the two adjacent frequency sound pressure levels by 3 decibels or more.
3. Creates a potential condition of air pollution as defined in 310 CMR 7.01 and the MassDEP Noise Policy.

Note: These criteria are measured both at the property line and at the nearest inhabited building.

For equipment that operates, or will be operated intermittently, the ambient or background noise measurements shall be performed during the hours that the equipment will operate and at the quietest times of the day. The quietest time of the day is usually between 1:00 a.m. and 4:00 a.m. on weekend nights. The nighttime sound measurements must be conducted at a time that represents the lowest ambient sound level expected during all seasons of the year.

For equipment that operates, or will operate, continuously and is a significant source of sound, such as a proposed power plant, background shall be established via a minimum of seven consecutive days of continuous monitoring at multiple locations with the dBA L 90 data and pure tone data reduced to one-hour averages.

**In any case, consult with the appropriate MassDEP Regional Office before commencing noise monitoring in order to establish a sound monitoring protocol that will be acceptable to MassDEP.**

## E. Full Octave Band Analysis

The following community sound profiles will require the use of sound pressure level measuring equipment in the neighborhood of the installation. An ANSI S1.4 Type 1 sound monitor or equivalent shall be used for all sound measurements. A detailed description of sound monitor calibration methodology shall be included with any sound survey.

1. Lowest **ambient** sound pressure levels during operating hours of the equipment.

a. At property line: **Note – measurements were taken at nearest residence to site.**

A-Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = No Data



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Facility ID (if known)

**E. Full Octave Band Analysis** (continued)

b. At the nearest inhabited building and if applicable at buildings at higher elevation: **[Note 2]**

A- Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
44.8	57.6	56.4	51.0	43.1	39.7	36.9	40.0	30.1	19.5	ND

**Note:** You are required to complete sound profiles 2a and 2b only if you are submitting this form in response to a MassDEP enforcement action citing a noise nuisance condition. If this is an application for new equipment, Skip to 3.

2. Neighborhood sound pressure levels with source operating without sound abatement equipment.

a. At property line:

A- Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

b. At the nearest inhabited building and if applicable at buildings at higher elevation:

A- Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

**NA = Not Applicable**

**[Note 2] H&K Report, Table 6, Pos. 1 (NSA #1)**

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# Massachusetts Department of Environmental Protection

Bureau of Waste Prevention – Air Quality

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Facility ID (if known)

### E. Full Octave Band Analysis (continued)

3. **Expected** neighborhood sound pressure levels after installation of sound abatement equipment.

a. At property line: **Note – measurements were taken at nearest residence to site**

A- Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

b. At nearest inhabited building and if applicable at buildings at higher elevations: **[Note 3]**

A- Weighted	31.5	63.0	125	250	500	1K	2K	4K	8K	16K
46.9	63	57	51	43	37	37	34	27	17	ND

Note: MassDEP may request that actual measurements be taken after the installation of the noise abatement equipment to verify compliance at all off-site locations.

**[Note 3] H&K Report, Table 7.**

### F. Professional Engineers Stamp

The seal or stamp and signature of a Massachusetts Registered Professional Engineer (P.E.) must be entered below. Both the seal or stamp impression and the P.E. signature must be original. This is to certify that the information contained in this Form has been checked for accuracy, and that the design represents good air pollution control engineering practice.

David M. Cotter

P.E. Name (Type or Print)

P.E. Signature

Managing Consultant

Position/Title

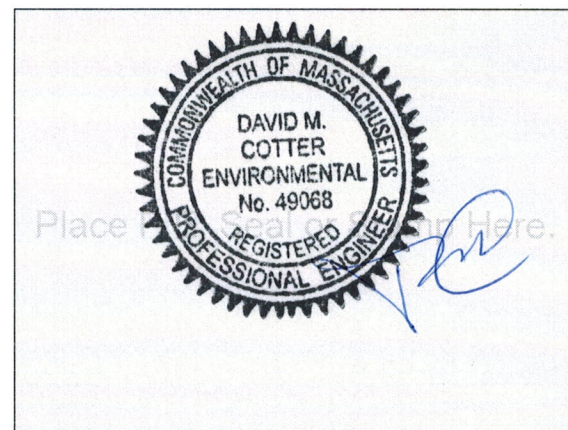
Trinity Consultants

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Massachusetts Department of Environmental Protection  
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Thomas V. Wooden Jr.

Responsible Official Name (Type or Print)

*Thomas V. Wooden Jr.*

Responsible Official Signature

VP Operations

Responsible Official Title

Algonquin Gas Transmission, LLC

Responsible Official Company/Organization Name

*09/08/2016*

Date (MM/DD/YYYY)

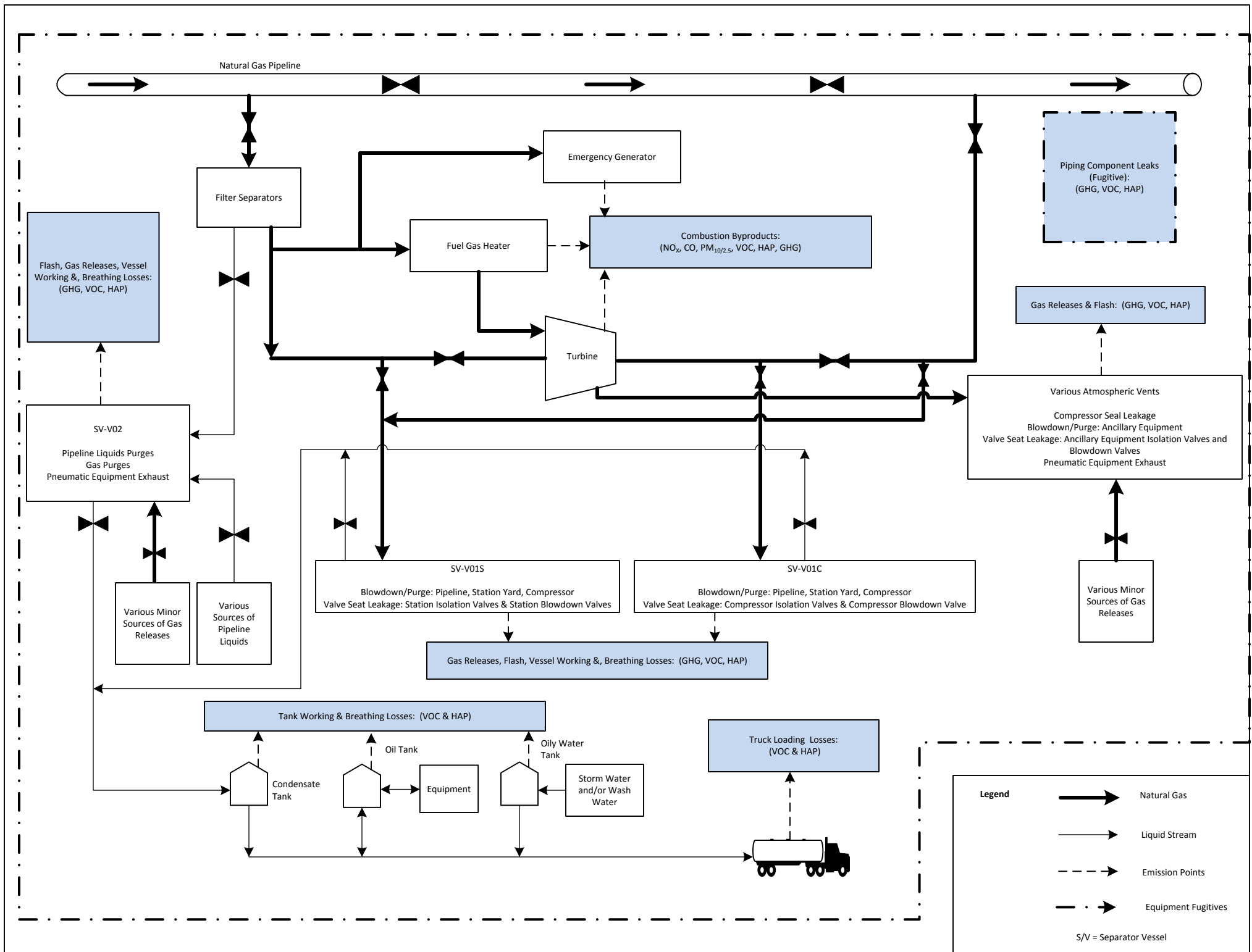
This document is  
MassDEP Approved Form



## ATTACHMENT D: FIGURES

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Site Plan  
Process Flow Diagram





## ATTACHMENT E: BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

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Summary Tables of BACT Determinations  
Detailed Cost Calculations

**PRELIMINARY COST ESTIMATE:  
SCR/CO CATALYST SYSTEMS  
FOR THREE SOLAR ENGINES  
(Mars 100, Mars 90, Taurus 60)**

Prepared for

**Solar Turbines, Inc.**  
Houston, Texas

Prepared by

**Fossil Energy Research Corporation**  
Laguna Hills, California

October 2013

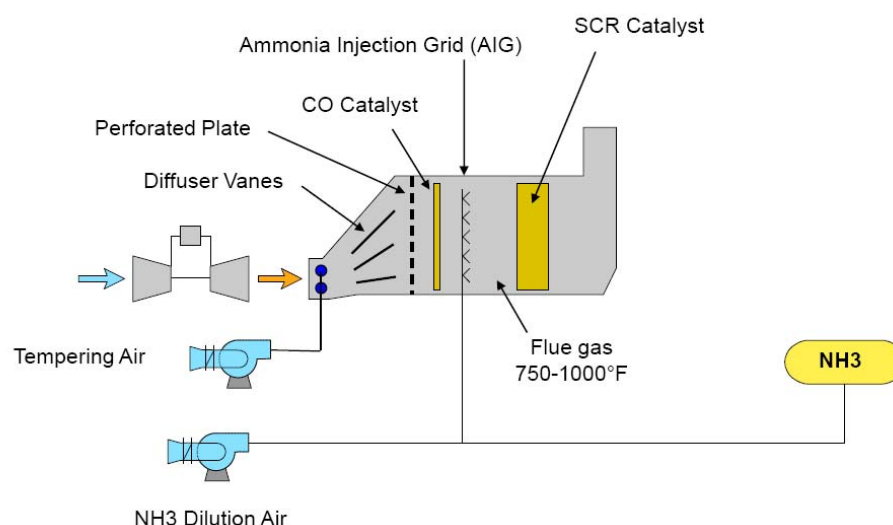


Fossil Energy Research Corp.  
23342-C South Pointe Drive, Laguna Hills, California 92653  
Telephone: (949) 859-4466 Fax: (949) 859-7916

## 1. Background

FERCo is proposing a unique approach for the Solar SCR/CO catalyst systems. Traditionally, the CO/SCR systems are set up such that after leaving the gas turbine the following takes place (see Figure 1):

- Tempering air is added to reduce the temperature conducive with the catalyst requirements
- The flue gas is expanded to reduce the velocity to the range of 15 – 20 ft/sec
- The flue gas flows through the CO catalyst
- Ammonia is added at the AIG
- The flue gas/ammonia mixture flows through the SCR catalyst

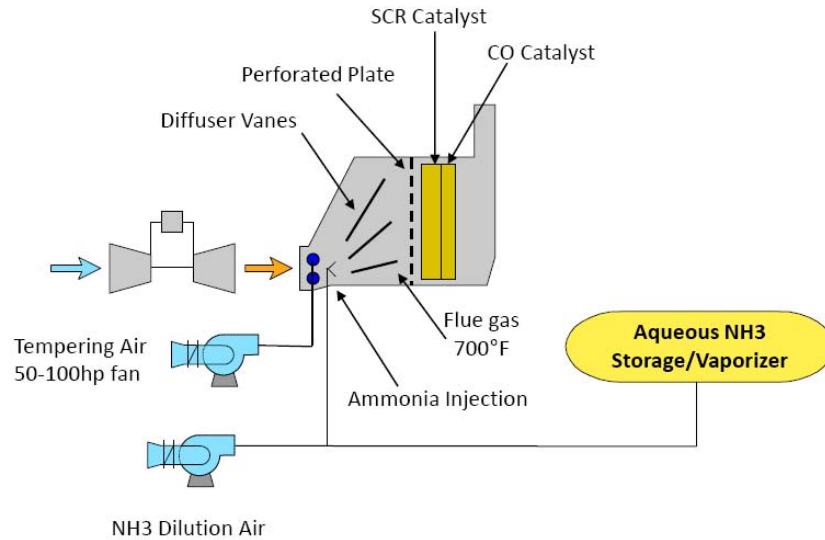


**Figure 1. Traditional Simple Cycle CO/SCR Catalyst Arrangement**

This configuration and sequence is traditionally used because ammonia should not be injected ahead of the CO catalyst, as the CO catalyst will oxidize some of the ammonia to  $\text{NO}_x$ . This means that the AIG must be located between the CO catalyst and the SCR catalyst within a large cross section with low velocity. Thus, the AIG consists of many injection lances to allow for adequate distribution and requires sufficient space between the AIG and SCR catalyst to allow the ammonia to mix with the flue gas.

## 2. Proposed Approach

FERCo is proposing a different arrangement for these Solar engines. Haldor-Topsoe has just introduced a new CO catalyst that is intended to be located downstream of the SCR catalyst. With this arrangement, the ammonia injection can be moved further upstream and injected into the high velocity flue gas stream exiting the engine. FERCo has previously done this arrangement on two small Solar engines installed at St. Agnes hospital in Fresno, CA (this system only had SCR catalyst). In this high velocity stream it is easier to mix the ammonia with the flue gas. Also, space for mixing is not needed in the main reactor so the reactor can be much smaller. This proposed approach is shown in Figure 2.



**Figure 2. Proposed Arrangement (CO Catalyst Downstream of the SCR Catalyst)**

### 3. Estimated Budgetary Costs

In preparing this budgetary estimate, the following was assumed:

- Inlet NO<sub>x</sub>: 15 ppm
- NO<sub>x</sub> reduction: 90%
- NH<sub>3</sub> slip: 5 ppm
- CO oxidation: 95%
- CO catalyst located downstream of the SCR catalyst
- Dilution/tempering air added to reduce the temperature of the flue gas to 750°F
- The reagent was assumed to be 19 wt % aqueous ammonia
- The aqueous ammonia was pre-vaporized and injected close to the gas turbine exit
- The systems for the Mars 100 and Mars 90 are identical

Table 2 provides the ballpark cost estimate for these systems. It should be noted that the engineering costs for either the Mars 100 or Mars 90 will in actuality be smaller than included, since both systems are identical.



## **Detailed Scope:**

### Reagent System

- Tanks (plastic but can be stainless steel), approximately 1000 gallons for each of the Mars turbines, and 500 gal for the Taurus
- Electric vaporizers
- Forwarding pumps
- Transfer skid
- AIG

### SCR and CO Catalyst

- Purchased from Haldor Topsoe

### Reactor/Ductwork/Stack

- Material is carbon steel
- Includes diffuser vanes and perforated plate

### Controls

- PLC and operator interface

### Dilution Air Fans

- 100 HP for the Mars turbines, 75 HP for the Taurus

### Cold Flow Model

- Build and test scale model of the turbines to design diffuser vanes and AIG

### CEMS

- NO<sub>x</sub>, O<sub>2</sub> and CO

### Other Instrumentation

- Inlet NO<sub>x</sub>/O<sub>2</sub> monitor for NH<sub>3</sub> control
- Thermocouples to monitor reactor temperature

### Engineering

- Unit design interacting with vendors to purchase all of the material

### Installation (can be done by others)

- labor that will be associated with putting all of the pieces together on site
- mating the reactor and stack with the gas turbine
- any foundation work that needs to be done
- installing the catalyst
- installing the reagent system

### Startup/Optimization

- Startup
- Tuning the ammonia injection system
- Tuning the SCR control system
- Verifying the NO<sub>x</sub> reduction performance and ammonia slip

**Not Included in Scope:**

- Foundations for reactor and stack
- Power panel for motors and vaporizers

**Table 1 Estimated Utilities**

		Mars 100	Mars 90	Taurus 60
Flue Gas Flow	lb/hr	43	40	30
NOx-in	ppm	15	15	15
NOx Reduction	%	90	90	90
CO Reduction	%	95	95	95
Aqueous NH3 Flow(a)	lb/hr	19	16	9
SCR/CO Catalyst Vol.	m^3	8	8	4.2
SCR/CO Cat Depth	mm	460	460	460
Reactor Cross section	ft x ft	12ft x 15 ft	12ft x 15 ft	9 ft x 10.5 ft
Dilution Air	HP	100	100	75
Flow/Press	lb/hr/"H2O	95,800/21	95,800/21	61,100/22

**Table 2 Estimated Budgetary Costs**

	Mars 100	Mars 90	Taurus 60
Equipment (w/CEMS)	\$ 1,873,100	\$ 1,786,600	\$ 1,673,100
CEMS Only	\$ 375,000	\$ 375,000	\$ 375,000
Commissioning	\$ 625,000	\$ 625,000	\$ 625,000

**Table 3 Estimated Budgetary Cost Allocations**

	Mars 100	Mars 90	Taurus 60
CO Catalyst Cost Allocation	\$ 841,300	\$ 798,100	\$ 724,000
SCR Catalyst Cost Allocation	\$ 1,031,800	\$ 988,500	\$ 949,100

RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - NOx Control

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Column8	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
AK-0062	BADAMI DEVELOPMENT FACILITY	AK	SOLAR MARS 90 TURBINE	NATURAL GAS	11.86	MW	Nitrogen Oxides (NOx)	DRY LOW NOX COMBUSTION TECHNOLOGY (SOLONOX)	28.4	LB/H	85	PPMV
*AK-0083	KENAI NITROGEN OPERATIONS	AK	Five (5) Natural Gas Fired Combustion Turbines	Natural Gas	37.6	MMBtu/hr	Nitrogen Oxides (NOx)	Selective Catalytic Reduction	7	PPMV	0	
AL-0208	EXXON MOBILE BAY -- NORTHWEST GULF FIELD	AL	TURBINE, SIMPLE CYCLE	NATURAL GAS	6000	bhp	Nitrogen Oxides (NOx)	SOLONOX COMBUSTOR	25	PPM @ 15%O2	0	
AL-0209	EXXON MOBILE -- MOBILE BAY - BON SECURE BAY FIELD	AL	TURBINE, SIMPLE CYCLE	NATURAL GAS	3600	bhp	Nitrogen Oxides (NOx)	SOLONOX COMBUSTION	25	PPM @ 15% O2	0	
CA-1174	EL CAJON ENERGY LLC	CA	Gas turbine simple cycle	Natural gas	49.95	MW	Nitrogen Oxides (NOx)	Water injection and SCR	2.5	PPMV	0	
CA-1175	ESCONDIDO ENERGY CENTER LLC	CA	Gas turbine simple cycle	Natural gas	46.5	MW	Nitrogen Oxides (NOx)	SCR water injection	2.5	PPMV@15% OXYGEN	0	
CA-1176	ORANGE GROVE PROJECT	CA	Gas turbine simple cycle	Natural gas	49.8	MW	Nitrogen Oxides (NOx)	SCR water injection	2.5	PPM	0	
*CO-0073	PUEBLO AIRPORT GENERATING STATION	CO	Three simple cycle combustion turbines	natural gas	799.7	mmbtu/hr	Nitrogen Oxides (NOx)	Good combustor design, Water Injection and Selective Catalytic Reduction (SCR)	5	PPMVD AT 15% O2	15.5	LB/HR
*CO-0076	PUEBLO AIRPORT GENERATING STATION	CO	Turbines - two simple cycle gas	natural gas	799.7	mmbtu/hr each	Nitrogen Oxides (NOx)	SCR and dry low NOx burners	23	LB/HR	0	
CO-0059	CHEYENNE STATION	CO	PHASE II TURBINE	NATURAL GAS	71.42	MMBTU/H	Nitrogen Oxides (NOx)	SOLONOX II (DRY LOW NOX)	15	PPM @ 15% O2	0	
FL-0266	PAYNE CREEK GENERATING STATION/SEMINOLE ELECTRIC	FL	SIMPLE CYCLE COMBUSTION TURBINES	NATURAL GAS	30	MW	Nitrogen Oxides (NOx)	WATER INJECTION AND LOW OPERATING HOURS	20	PPM	42	PPM
LA-0219	CREOLE TRAIL LNG IMPORT TERMINAL	LA	GAS TURBINE GENERATOR NOS. 1-4	LNG	30	MW EA.	Nitrogen Oxides (NOx)	DRY LOW EMISSIONS (DLE) COMBUSTION TECHNOLOGY WITH LEAN PREMIX OF AIR AND FUEL	29	LB/H	118.79	T/YR
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Refrigeration Compressor Turbines (16)	Natural Gas	286	MMBTU/H	Nitrogen Oxides (NOx)	water injection	22.94	LB/H	0	
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Generation Turbines (2)	Natural Gas	286	MMBTU/H	Nitrogen Oxides (NOx)	water injection	28.68	LB/H	0	
LA-0232	STERLINGTON COMPRESSOR STATION	LA	COMPRESSOR TURBINE NO. 1	NATURAL GAS	79.1	MMBTU/H	Nitrogen Oxides (NOx)	DRY LOW NOX BURNERS AND GOOD COMBUSTION PRACTICES	0.057	LB/MMBTU	19.72	T/YR
LA-0232	STERLINGTON COMPRESSOR STATION	LA	COMPRESSOR TURBINE NO. 2	NATURAL GAS	79.1	MMBTU/H	Nitrogen Oxides (NOx)	DRY LOW NOX BURNERS AND GOOD COMBUSTION PRACTICES	0.057	LB/MMBTU	19.72	T/YR
MD-0035	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	21.7	MW	Nitrogen Oxides (NOx)	DRY LOW-NOX COMBUSTORS AND SCR	2.5	PPMVD	1	LB/MW-H
MD-0036	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	12.2	MW	Nitrogen Oxides (NOx)	EXCLUSIVE USE OF LNG QUALITY, LOW SULFUR NATURAL GAS; LNB AND SCR	5	PPMVD	1.2	LB/MW-H
*MI-0410	THETFORD GENERATING STATION	MI	FG-PEAKERS: 2 natural gas fired simple cycle combustion turbines	natural gas	171	MMBTU/H	Nitrogen Oxides (NOx)	Dry low-NOx combustors	0.09	LB/MMBTU	0	
*ND-0029	PIONEER GENERATING STATION	ND	Natural gas-fired turbines	Natural gas	451	MMBtu/hr	Nitrogen Oxides (NOx)	Water injection plus SCR	5	PPMVD	19	LB
*ND-0030	LONESOME CREEK GENERATING STATION	ND	Natural Gas Fired Simple Cycle Turbines	Natural gas	412	MMBtu/hr	Nitrogen Oxides (NOx)	SCR SELECTIVE CATALYTIC REDUCTION SYSTEM (SCR) AND WET LOW-EMISSION (WLE) COMBUSTORS	5	PPMVD	18.5	LB
NJ-0075	BAYONNE ENERGY CENTER	NJ	COMBUSTION TURBINES, SIMPLE CYCLE , ROLLS ROYCE, 8	NATURAL GAS	603	MMBTU/H	Nitrogen Oxides (NOx)	SUBJECT TO LAER	2.5	PPMVD@15%O2	0.0092	LB/MMBTU
NJ-0076	PSEG FOSSIL LLC KEARNY GENERATING STATION	NJ	SIMPLE CYCLE TURBINE	Natural Gas	8940000	MMBtu/yr for six turbines combined	Nitrogen Oxides (NOx)	SCR and Use of Clean Burning Fuel: Natural gas THE TURBINE WILL UTILIZE WATER INJECTION AND SELECTIVE CATALYTIC REDUCTION (SCR) TO CONTROL NOX EMISSION AND USE CLEAN FUELS NATURAL GAS AND ULTRA LOW SULFUR DISTILLATE OIL TO MINIMIZE NOX EMISSIONS	2.5	PPMVD@15%O2	4.39	LB/H
NJ-0077	HOWARD DOWN STATION	NJ	SIMPLE CYCLE (NO WASTE HEAT RECOVERY)( &gt;25 MW)	NATURAL GAS	590	MMBtu/hr	Nitrogen Oxides (NOx)	THE SOLONOX BURNER IN EACH TURBINE UTILIZES THE DRY LOW-NOX TECHNOLOGY TO CONTROL NOX EMISSIONS.	2.5	PPMVD@15%O2	5.4	LB/H
NM-0051	CUNNINGHAM POWER PLANT	NM	Normal Mode (without Power Augmentation)	natural gas			Nitrogen Dioxide (NO2)	Dry Low NOx Burners Type K & Good Combustion Practice	21	PPMVD	0	
NM-0051	CUNNINGHAM POWER PLANT	NM	Power Augmentation	natural gas			Nitrogen Dioxide (NO2)	Dry Low NOx burners, Type K. Good Combustion Practices as defined in the permit. THE SOLONOX BURNER IN EACH TURBINE UTILIZES THE DRY LOW-NOX TECHNOLOGY TO CONTROL NOX EMISSIONS.	30	PPMVD	0	
NV-0046	GOODSPRINGS COMPRESSOR STATION	NV	LARGE COMBUSTION TURBINE - SIMPLE CYCLE	NATURAL GAS	97.81	MMBTU/H	Nitrogen Oxides (NOx)		25	PPMVD	0.0995	LB/MMBTU

								SOLONOX - A DRY LOW NOX TECHNOLOGY THAT REDUCES THE CONVERSION OF ATMOSPHERIC NITROGEN TO NOX BY OPERATING AT RELATIVELY LOW FUEL-TO-AIR RATIOS TO LOWER THE COMBUSTION TEMPERATURE IN THE TURBINE.				
NV-0048	GOODSPRINGS COMPRESSOR STATION	NV	SIMPLE-CYCLE SMALL COMBUSTION TURBINES (<25 MW)	NATURAL GAS	11.5	MW	Nitrogen Oxides (NOx)		25	PPMVD	0.0995	LB/MMBTU
NV-0050	MGM MIRAGE	NV	TURBINE GENERATORS - UNITS CC007 AND CC008 AT CITY CENTER	NATURAL GAS	4.6	MMBTU/H	Nitrogen Oxides (NOx)	LEAN PRE-MIX TECHNOLOGY AND LIMITING THE FUEL TO NATURAL GAS ONLY	0.178	LB/MMBTU	5	PPMVD
OK-0127	WESTERN FARMERS ELECTRIC ANADARKO	OK	COMBUSTION TURBINE PEAKING UNIT(S)	NATURAL GAS	462.7	MMBTU/H	Nitrogen Oxides (NOx)	WATER INJECTION	25	PPM	42	LB/H
TX-0487	ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT	TX	L-AREA GAS TURBINE	NATURAL GAS			Nitrogen Oxides (NOx)		27.46	LB/H	120.29	T/YR
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE	NATURAL GAS	550	MMBTU/H	Nitrogen Oxides (NOx)	Dry-Low-Nox Combustors	62	LB/H	0	
*TX-0672	CORPUS CHRISTI LIQUEFACTION PLANT	TX	Refrigeration compressor turbines	natural gas	40000	hp	Nitrogen Oxides (NOx)	Dry low emission combustors	25	PPMVD	0	
*TX-0691	PH ROBINSON ELECTRIC GENERATING STATION	TX	(6) simple cycle turbines	natural gas	65	MW	Nitrogen Oxides (NOx)	DLN combustors	15	PPMVD	0	
*TX-0642	SINTON COMPRESSOR STATION	TX	Compression Turbine	natural gas	20000	hp	Nitrogen Oxides (NOx)	Solar's SoLoNOx dry emission control technology	25	PPMVD	0	
WA-0316	NORTHWEST PIPELINE CORP.- MT VERNON COMPRESSOR	WA	TURBINE, SIMPLE CYCLE	NATURAL GAS	12787	HP	Nitrogen Oxides (NOx)	DRY LOW NOX COMBUSTORS	25	PPMDV	258	LB/D
WA-0316	NORTHWEST PIPELINE CORP.- MT VERNON COMPRESSOR	WA	TURBINE, SIMPLE CYCLE	NATURAL GAS	5950	HP	Nitrogen Oxides (NOx)	DRY LOW NOX COMBUSTION	25	PPMVD @ 15% O2	129	LB/D
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP03)	Natural Gas	40	MW	Nitrogen Oxides (NOx)	SCR	5	PPMV AT 15% O2	7.7	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP04)	Natural Gas	40	MW	Nitrogen Oxides (NOx)	SCR	5	PPMV AT 15% O2	7.7	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP05)	Natural Gas	40	MW	Nitrogen Oxides (NOx)	SCR	5	PPMV AT 15% O2	7.7	LB/H
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINES S35-S36	NATURAL GAS	12555	HP	Nitrogen Oxides (NOx)	SOLONOX	15	PPMV	25.6	T/YR
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINE S34	NATURAL GAS	3856	HP	Nitrogen Oxides (NOx)	SOLONOX	25	PPMV	15.8	T/YR

**RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - CO Control**

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
AK-0062	BADAMI DEVELOPMENT FACILITY	AK	SOLAR MARS 90 TURBINE	NATURAL GAS	11.86	MW	GOOD COMBUSTION PRACTICES	385	LB/H	14	LB/H
*AK-0083	KENAI NITROGEN OPERATIONS	AK	Five (5) Natural Gas Fired Combustion Turbines	Natural Gas	37.6	MMBtu/hr		50	PPMV	0	
AL-0208	EXXON MOBILE BAY -- NORTHWEST GULF FIELD	AL	TURBINE, SIMPLE CYCLE	NATURAL GAS	6000	bhp		50	PPM @ 15% O2	0	
AL-0209	EXXON MOBILE -- MOBILE BAY - BON SECURE BAY FIELD	AL	TURBINE, SIMPLE CYCLE	NATURAL GAS	3600	bhp		50	PPM @ 15% O2	0	
*CO-0073	PUEBLO AIRPORT GENERATING STATION	CO	Three simple cycle combustion turbines	natural gas	799.7	mmbtu/hr	Good Combustion Control and Catalytic Oxidation (CatOx)	10	PPMVD AT 15% O2	19.8	LB/HR
*CO-0076	PUEBLO AIRPORT GENERATING STATION	CO	Turbines - two simple cycle gas	natural gas	799.7	mmbtu/hr each	Catalytic Oxidation.	55	LB/HR	0	
CO-0059	CHEYENNE STATION	CO	PHASE II TURBINE	NATURAL GAS	71.42	MMBTU/H	GOOD COMBUSTION PRACTICES	25	PPM @ 15% O2	0	
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Refrigeration Compressor Turbines (16)	Natural Gas	286	MMBTU/H	Good combustion practices and fueled by natural gas	43.6	LB/H	0	
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Generation Turbines (2)	Natural Gas	286	MMBTU/H	Good combustion practices and fueled by natural gas	17.46	LB/H	0	
MD-0035	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	21.7	MW	GOOD COMBUSTION PRACTICES AND OPERATION OF AN OXIDATION CATALYST SYSTEM	6	PPMVD	0	
MD-0036	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	12.2	MW		6	PPMVD	0	
*MI-0410	THETFORD GENERATING STATION	MI	FG-PEAKERS: 2 natural gas fired simple cycle combustion turbines	natural gas	171	MMBTU/H	Efficient combustion	0.11	LB/MMBTU	0	
*ND-0029	PIONEER GENERATING STATION	ND	Natural gas-fired turbines	Natural gas	451	MMBtu/hr	Catalytic oxidation system	6	PPMVD	57.2	LB
*ND-0030	LONESOME CREEK GENERATING STATION	ND	Natural Gas Fired Simple Cycle Turbines	Natural gas	412	MMBtu/hr	Oxidation Catalyst	6	PPMVD	31.5	LB
NJ-0075	BAYONNE ENERGY CENTER	NJ	COMBUSTION TURBINES, SIMPLE CYCLE, ROLLS ROYCE, 8	NATURAL GAS	603	MMBTU/H	CO OXIDATION CATALYST AND CLEAN BURNING FUELS	5	PPMVD@15%O2	0.0112	LB/MMBTU
NJ-0076	PSEG FOSSIL LLC KEARNY GENERATING STATION	NJ	SIMPLE CYCLE TURBINE	Natural Gas	8940000	MMBtu/yr for six turbines combined	Oxidation Catalyst, Good combustion practices	5	PPMVD@15% O2	5.35	LB/H
NJ-0077	HOWARD DOWN STATION	NJ	SIMPLE CYCLE (NO WASTE HEAT RECOVERY)(≥25 MW)	NATURAL GAS	590	MMBtu/hr	THE TURBINE WILL UTILIZE A CATALYTIC OXIDIZER TO CONTROL CO EMISSION, IN ADDITION TO USING CLEAN BURNING	5	PPMVD@15%O2	6.4	LB/H
NM-0051	CUNNINGHAM POWER PLANT	NM	Normal Mode (without Power Augmentation)	natural gas			Good Combustion Practices as defined in the permit.	77.2	LB/H	0	
NM-0051	CUNNINGHAM POWER PLANT	NM	Power Augmentation	natural gas			Good combustion practices as defined in the permit.	138.9	LB/H	0	

NV-0046	GOODSPRINGS COMPRESSOR STATION	NV	LARGE COMBUSTION TURBINE - SIMPLE CYCLE	NATURAL GAS	97.81	MMBTU/H	GOOD COMBUSTION PRACTICE	16	PPMVD	0.038	LB/MMBTU
NV-0048	GOODSPRINGS COMPRESSOR STATION	NV	SIMPLE-CYCLE SMALL COMBUSTION TURBINES (<25 MW)	NATURAL GAS	11.5	MW	GOOD COMBUSTION PRACTICES - THE TURBINE IS OPERATED WITHIN THE PARAMETERS ALLOWING THE PROCESS	16	PPMVD	0.0388	LB/MMBTU
NV-0050	MGM MIRAGE	NV	TURBINE GENERATORS - UNITS CC007 AND CC008 AT CITY CENTER	NATURAL GAS	4.6	MMBTU/H	LEAN PRE-MIX TECHNOLOGY AND OXIDATION CATALYST	0.0056	LB/MMBTU	2.5	PPMVD
OK-0127	WESTERN FARMERS ELECTRIC ANADARKO ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT	OK	COMBUSTION TURBINE PEAKING UNIT(S)	NATURAL GAS	462.7	MMBTU/H	NO CONTROLS FEASIBLE.	63	PPM	65.5	LB/H
TX-0487		TX	L-AREA GAS TURBINE	NATURAL GAS				38.53	LB/H	168.74	T/YR
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE	NATURAL GAS	550	MMBTU/H		52	LB/H	0	
*TX-0672	CORPUS CHRISTI LIQUEFACTION PLANT PH ROBINSON ELECTRIC	TX	Refrigeration compressor turbines	natural gas	40000	hp		29	PPMVD	0	
*TX-0691	GENERATING STATION	TX	(6) simple cycle turbines	natural gas	65	MW		25	PPMVD	0	
*TX-0642	SINTON COMPRESSOR STATION	TX	Compression Turbine	natural gas	20000	hp		50	PPMVD	0	
WA-0334	SUMAS COMPRESSOR STATION	WA	TURBINE, SIMPLE CYCLE	NATURAL GAS	100	MMBTU/H		50	PPMDV	14	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP03)	Natural Gas	40	MW	Oxidation Catalyst	6	PPMV AT 15% O2	5.6	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Trubine (EP04)	Natural Gas	40	MW	Oxidation Catalyst	6	PPMV AT 15% O2	5.6	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP05)	Natural Gas	40	MW	Oxidation Catalyst	6	PPMV AT 15% O2	5.6	LB/H
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINES S35-S36	NATURAL GAS	12555	HP	GOOD COMBUSTION PRACTICES	25	PPMV	26	T/YR
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINE S34	NATURAL GAS	3856	HP	GOOD COMBUSTION PRACTICES	50	PPMV	19.3	T/YR

**RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - VOC Control**

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
*AK-0083	KENAI NITROGEN OPERATIONS	AK	Five (5) Natural Gas Fired Combustion Turbines	Natural Gas	37.6	MMBtu/hr		0.0021	LB/MMBTU	0	
CA-1174	EL CAJON ENERGY LLC	CA	Gas turbine simple cycle	Natural gas	49.95	MW	Oxydation catalyst	2	PPMV	0	
CA-1175	ESCONDIDO ENERGY CENTER LLC	CA	Gas turbine simple cycle	Natural gas	46.5	MW	oxydation catalyst	2	PPMV@15% OXYGEN	0	
CA-1176	ORANGE GROVE PROJECT	CA	Gas turbine simple cycle	Natural gas	49.8	MW	Oxidation catalyst	2	PPM	0	
*CO-0073	PUEBLO AIRPORT GENERATING STATION	CO	Three simple cycle combustion turbines	natural gas	799.7	mmbtu/hr	Good Combustion Control and Catalytic Oxidation (CatOx)	2.5	PPMVD AT 15% O2	0	
CO-0059	CHEYENNE STATION	CO	PHASE II TURBINE	NATURAL GAS	71.42	MMBTU/H	GOOD COMBUSTION PRACTICES	3	PPM @ 15% O2	0	
FL-0266	PAYNE CREEK GENERATING STATION/SEMINOLE	FL	SIMPLE CYCLE COMBUSTION TURBINES	NATURAL GAS	30	MW	OXIDATION CATALYST	90	% REMOVAL	0	
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Refrigeration Compressor Turbines (16)	Natural Gas	286	MMBTU/H	Good combustion practices and fueled by natural gas	0.66	LB/H	0	
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Generation Turbines (2)	Natural Gas	286	MMBTU/H	Good combustion practices and fueled by natural gas	0.66	LB/H	0	
LA-0232	STERLINGTON COMPRESSOR STATION	LA	COMPRESSOR TURBINE NO. 1	NATURAL GAS	79.1	MMBTU/H	GOOD COMBUSTION PRACTICES INCLUDING THE USE OF CLEAN BURNING FUELS SUCH AS NATURAL GAS	2.62	LB/H	11.46	T/YR
LA-0232	STERLINGTON COMPRESSOR STATION	LA	COMPRESSOR TURBINE NO. 2	NATURAL GAS	79.1	MMBTU/H	GOOD COMBUSTION PRACTICES INCLUDING THE USE OF CLEAN BURNING FUELS SUCH AS NATURAL GAS	2.62	LB/H	11.46	T/YR
MD-0035	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	21.7	MW	NATURAL GAS COMBUSTION AND CATALYTIC OXIDATION	0.003	LB/MMBTU	0	
MD-0036	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	12.2	MW	USE OF GOOD COMBUSTION PRACTICES AND OPERATION OF AN OXIDATION CATALYST SYSTEM	0.6	LB/H	0.4	LB/H
*MI-0410	THETFORD GENERATING STATION	MI	FG-PEAKERS: 2 natural gas fired simple cycle combustion turbines	natural gas	171	MMBTU/H	Efficient combustion; natural gas fuel.	0.017	LB/MMBTU	0	
NJ-0075	BAYONNE ENERGY CENTER	NJ	COMBUSTION TURBINES, SIMPLE CYCLE , ROLLS ROYCE, 8	NATURAL GAS	603	MMBTU/H	CO OXIDATION CATALYST AND POLLUTION PREVENTION, BURNING CLEAN FUELS, NATURAL GAS AND	1.93	LB/H	2.5	PPMVD@15%O2
NJ-0076	PSEG FOSSIL LLC KEARNY GENERATING STATION	NJ	SIMPLE CYCLE TURBINE	Natural Gas	8940000	MMBtu/yr for six turbines combined	Oxidation Catalyst and good combustion practices, use of natural gas.	4	PPMVD@15% O2	2.33	LB/H
NV-0046	GOODSPRINGS COMPRESSOR STATION	NV	LARGE COMBUSTION TURBINE - SIMPLE CYCLE	NATURAL GAS	97.81	MMBTU/H	GOOD COMBUSTION PRACTICE	0.0069	LB/MMBTU	0.84	L/H
NV-0048	GOODSPRINGS COMPRESSOR STATION	NV	SIMPLE-CYCLE SMALL COMBUSTION TURBINES (<25 MW)	NATURAL GAS	11.5	MW	GOOD COMBUSTION PRACTICE	0.0069	LB/MMBTU	0.84	LB/H



NV-0050	MGM MIRAGE ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT	NV	TURBINE GENERATORS - UNITS CC007 AND CC008 AT CITY CENTER	NATURAL GAS	4.6	MMBTU/H	LIMITING THE FUEL TO NATURAL GAS ONLY AND OPERATING IN ACCORDANCE WITH THE MANUFACTURER'S	0.024	LB/MMBTU	0.11	LB/H
TX-0487		TX	L-AREA GAS TURBINE	NATURAL GAS				0.59	LB/H	2.56	T/YR
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE	NATURAL GAS	550	MMBTU/H		2.2	LB/H	0	
*TX-0672	CORPUS CHRISTI LIQUEFACTION PLANT	TX	Refrigeration compressor turbines	natural gas	40000	hp	good combustion practices	0.6	LB/HR	0	
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP03)	Natural Gas	40	MW	Oxidation Catalyst	3	PPMV AT 15% O2	3	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Trubine (EP04)	Natural Gas	40	MW	Oxidation Catalyst	3	PPMV AT 15% O2	3	LB/H
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP05)	Natural Gas	40	MW	Oxidation Catalyst	3	PPMV AT 15% O2	3	LB/H
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINES S35-S36	NATURAL GAS	12555	HP	GOOD COMBUSTION PRACTICES	25	PPMV	3	T/YR
WY-0067	ECHO SPRINGS GAS PLANT	WY	TURBINE S34	NATURAL GAS	3856	HP	GOOD COMBUSTION PRACTICES	50	PPMV	1.1	T/YR

**RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - PM Control**

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
AK-0062	BADAMI DEVELOPMENT FACILITY	AK	SOLAR MARS 90 TURBINE	NATURAL GAS	11.86	MW	GOOD OPERATION PRACTICES	10	% OPACITY	0	
AK-0080	ANCHORAGE MUNICIPAL LIGHT & POWER	AK	Combustion	Natural Gas	408	MMBtu/hr	Good operation and combustion practices	0.0066	LB/MMBTU	0	
AK-0081	POINT THOMSON PRODUCTION FACILITY	AK	Combustion	Natural Gas	7520	kW	Good combustion and operating practices	0.0066	LB/MMBTU	0	
*AK-0083	KENAI NITROGEN OPERATIONS	AK	Five (5) Natural Gas Fired Combustion Turbines	Natural Gas	37.6	MMBtu/hr		0.0074	LB/MMBTU	0	
*CO-0073	PUEBLO AIRPORT GENERATING STATION	CO	Three simple cycle combustion turbines	natural gas	799.7	mmbtu/hr	Use of pipeline quality natural gas and good combustor design	6.6	LB/HR	0	
*CO-0075	PUEBLO AIRPORT GENERATING STATION	CO	Turbine - simple cycle gas	natural gas	375	mmbtu/hr	Firing of pipeline quality natural gas as defined in 40 CFR Part 72. Specifically, the owner or the operator shall demonstrate that the natural gas	4.8	LB/HR	0	
FL-0266	PAYNE CREEK GENERATING STATION/SEMINOLE	FL	SIMPLE CYCLE COMBUSTION TURBINES	NATURAL GAS	30	MW	CLEAN FUELS	10	% OPACITY	0	
LA-0219	CREOLE TRAIL LNG IMPORT TERMINAL	LA	GAS TURBINE GENERATOR NOS. 1-4	LNG	30	MW EA.		2.11	LB/H	8.49	T/YR
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Refrigeration Compressor Turbines (16)	Natural Gas	286	MMBTU/H	Good combustion practices and fueled by natural gas	2.08	LB/H	0	
MD-0035	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	21.7	MW		0.0066	LB/MMBTU	0	
MD-0036	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	12.2	MW	USE OF LNG QUALITY, LOW SULFUR NATURAL GAS	0.0066	LB/MMBTU	0	
*MI-0410	THETFORD GENERATING STATION	MI	FG-PEAKERS: 2 natural gas fired simple cycle combustion turbines	natural gas	171	MMBTU/H	Efficient combustion; natural gas fuel.	0.02	LB/MMBTU	0	
*ND-0029	PIONEER GENERATING STATION	ND	Natural gas-fired turbines	Natural gas	451	MMBtu/hr		5.4	LB	0	
*ND-0030	LONESOME CREEK GENERATING STATION	ND	Natural Gas Fired Simple Cycle Turbines	Natural gas	412	MMBtu/hr		5	LB/H	0	
NJ-0075	BAYONNE ENERGY CENTER	NJ	COMBUSTION TURBINES, SIMPLE CYCLE , ROLLS ROYCE, 8	NATURAL GAS	603	MMBTU/H	BURNING CLEAN FUELS, NATURAL GAS AND ULTRA LOW SULFUR DISTILLATE OIL WITH SULFUR CONTENT OF 15 PPM.	5	LB/H	0	
NJ-0076	PSEG FOSSIL LLC KEARNY GENERATING	NJ	SIMPLE CYCLE TURBINE	Natural Gas	8940000	MMBtu/yr for six turbines combined	Good combustion practice, Use of Clean Burning Fuel: Natural gas	6	LB/H	0	
NJ-0077	HOWARD DOWN STATION	NJ	SIMPLE CYCLE (NO WASTE HEAT RECOVERY)(&gt;25 MW)	NATURAL GAS	590	MMBtu/hr	USE OF CLEAN BURNING FUELS; NATURAL GAS AS PRIMARY FUEL AND ULTRA LOW SULFUR DISTILLATE OIL WITH 15	5	LB/H	0	

NM-0051	CUNNINGHAM POWER PLANT	NM	Normal Mode (without Power Augmentation)	natural gas			Good Combustion Practices as described in the permit.	5.4	LB/H	0	
NM-0051	CUNNINGHAM POWER PLANT	NM	Power Augmentation	natural gas			Good combustion practices as defined in the permit.	5.4	LB/H	0	
NV-0046	GOODSPRINGS COMPRESSOR STATION	NV	LARGE COMBUSTION TURBINE - SIMPLE CYCLE	NATURAL GAS	97.81	MMBTU/H	NATURAL GAS IS THE ONLY FUEL FOR THE PROCESS.	0.0066	LB/MMBTU	0.65	L/H
NV-0048	GOODSPRINGS COMPRESSOR STATION	NV	SIMPLE-CYCLE SMALL COMBUSTION TURBINES (<25 MW)	NATURAL GAS	11.5	MW	PROPER OPERATION OF THE TURBINE	0.0066	LB/MMBTU	0.81	LB/H
NV-0050	MGM MIRAGE	NV	TURBINE GENERATORS - UNITS CC007 AND CC008 AT CITY CENTER	NATURAL GAS	4.6	MMBTU/H	GOOD COMBUSTION PRACTICES AND LIMITING THE FUEL TO NATURAL GAS ONLY	0.202	LB/MMBTU	0.93	LB/H
NY-0093	TRIGEN-NASSAU ENERGY CORPORATION	NY	TURBINE, COMBINED CYCLE	NATURAL GAS	79.9	mw		4.66	LB/H	0.0141	LB/MMBTU
OK-0127	WESTERN FARMERS ELECTRIC ANADARKO	OK	COMBUSTION TURBINE PEAKING UNIT(S)	NATURAL GAS	462.7	MMBTU/H	NO CONTROLS FEASIBLE.	4	LB/H	0	
TX-0487	ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT	TX	L-AREA GAS TURBINE	NATURAL GAS				2.09	LB/H	9.16	T/YR
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE	NATURAL GAS	550	MMBTU/H		7	LB/H	0	
*TX-0672	CORPUS CHRISTI LIQUEFACTION PLANT	TX	Refrigeration compressor turbines	natural gas	40000	hp		0.72	LB/HR	0	
*TX-0691	PH ROBINSON ELECTRIC GENERATING	TX	(6) simple cycle turbines	natural gas	65	MW		0		0	
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP03)	Natural Gas	40	MW	good combustion practices	4	LB/H	17.5	TONS
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Trubine (EP04)	Natural Gas	40	MW	good combustion practices	4	LB/H	17.5	TONS
*WY-0070	CHEYENNE PRAIRIE GENERATING STATION	WY	Simple Cycle Turbine (EP05)	Natural Gas	40	MW	good combustion practices	4	LB/H	17.5	TONS

**RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - SO2 Control**

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
AK-0062	BADAMI DEVELOPMENT FACILITY	AK	SOLAR MARS 90 TURBINE GE FRAME 6 INJECTION TURBINES COMPRESSORS (4)	NATURAL GAS	11.86	MW	LIMIT SULFUR CONTENT OF FUEL COMBUSTED	250	PPMV	0	
AK-0067	CENTRAL GAS FACILITY	AK		NATURAL GAS	53665	HP ISO		300	PPMV	0	
FL-0266	PAYNE CREEK GENERATING STATION/SEMINOLE	FL	SIMPLE CYCLE COMBUSTION TURBINES	NATURAL GAS	30	MW	CLEAN FUELS	1	GRAIN/100 C.F. GS	0.05	% SULFUR OIL
FL-0287	OLEANDER POWER PROJECT	FL	SIMPLE CYCLE COMBUSTION TURBINE	NATURAL GAS	190	MW	CLEAN FUELS	1.5	GR S/100 SCF	0.05	% S
FL-0310	SHADY HILLS GENERATING STATION	FL	TWO SIMPLE CYCLE COMBUSTION TURBINE - MODEL 7FA	NATURAL GAS	170	MW	FIRING OF NATURAL GAS WITH A MAXIMUM S CONTENT AT 2GR/100 SCF AND ULTRA LOW SULFUR DIESEL FUEL OIL WITH A MAXIMUM S	2	GR S/100 SCF NG	0.0015	S BY WEIGHT FUEL OIL
MD-0035	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	21.7	MW		0.58	LB/MW-H	0	
MD-0036	DOMINION	MD	COMBUSTION TURBINE	NATURAL GAS	12.2	MW	USE OF LNG QUALITY, LOW SULFUR NATURAL GAS	0.9	LB/MW-H	0	
NJ-0075	BAYONNE ENERGY CENTER	NJ	COMBUSTION TURBINES, SIMPLE CYCLE , ROLLS ROYCE, 8	NATURAL GAS	603	MMBTU/H	BURNING CLEAN FUELS, NATURAL GAS AND ULTRA LOW SULFUR DISTILLATE OIL WITH SULFUR CONTENT OF 15 PPM.	1.22	LB/H	0	
NM-0051	CUNNINGHAM POWER PLANT	NM	Normal Mode (without Power Augmentation)	natural gas	0		5.25 gr/100 SCF total sulfur limit in fuel.	22.1	LB/H	0	
NM-0051	CUNNINGHAM POWER PLANT	NM	Power Augmentation	natural gas	0		5.25 gr/scf total sulfur in fuel	22.1	LB/H	0	
NV-0046	GOODSPRINGS COMPRESSOR STATION	NV	LARGE COMBUSTION TURBINE - SIMPLE CYCLE	NATURAL GAS	97.81	MMBTU/H	LOW-SULFUR NATURAL GAS IS THE ONLY FUEL FOR THE PROCESS.	0.0034	LB/MMBTU	0.33	L/H
NV-0048	GOODSPRINGS COMPRESSOR STATION	NV	SIMPLE-CYCLE SMALL COMBUSTION TURBINES (<25 MW)	NATURAL GAS	11.5	MW	USING LOW-SULFUR NATURAL GAS ONLY	0.0034	LB/MMBTU	0.42	LB/H
NV-0050	MGM MIRAGE	NV	TURBINE GENERATORS - UNITS CC007 AND CC008 AT CITY CENTER	NATURAL GAS	4.6	MMBTU/H	LIMITING THE FUEL TO NATURAL GAS ONLY.	0.0065	LB/MMBTU	0.03	LB/H
OH-0304	ROLLING HILLS GENERATING PLANT	OH	NATURAL GAS FIRED TURBINES (5)	NATURAL GAS	209	MW		5.9	LB/H	11.8	T/YR
OH-0333	DAYTON POWER & LIGHT ENERGY LLC ROHM AND HAAS CHEMICALS LLC	OH	Turbines (4), simple cycle, natural gas	NATURAL GAS	15020	H/YR	Fuel oil with no more than 0.05% by weight sulfur	0.0026	LB/MMBTU	138.6	T/YR
TX-0487	LONE STAR PLANT	TX	L-AREA GAS TURBINE	NATURAL GAS				0.03	LB/H	0.12	T/YR
TX-0504	NAVASOTA POWER GENERATION FACILITY	TX	TURBINES WITH 165 MMBTU/HR DUCT BURNERS	NATURAL GAS	75	MW	USE OF NATURAL GAS	1.7	LB/H	6.2	T/YR

TX-0504	NAVASOTA POWER GENERATION FACILITY	TX	TURBINES WITHOUT 165 MMBTU/HR DUCT BURNERS	NATURAL GAS	75	MW	1.5	LB/H	0	
TX-0504	NAVASOTA POWER GENERATION FACILITY	TX	STARTUP, SHUTDOWN, MAINTENANCE	NATURAL GAS	75	MW	1.7	LB/H	0	
TX-0506	NRG TEXAS ELECTRIC POWER GENERATION	TX	TURBINE FIRING NATURAL GAS W/ BURNERS		80	MW	1	LB/H	0	
TX-0506	NRG TEXAS ELECTRIC POWER GENERATION	TX	TURBINE FIRING NATURAL GAS W/O BURNERS		80	MW	0.7	LB/H	0	
TX-0509	PONDEROSA PINE ENERGY PARTNERS COGENERATION	TX	TURBINE AND 375 MMBTU/HR HEAT RECOVERY STEAM SYSTEM	NATURAL GAS	250	MW	87.22	LB/H	92.5	T/YR
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE	NATURAL GAS	550	MMBTU/H	0.7	LB/H	0	
TX-0525	TEXAS GENCO UNITS 1 AND2	TX	80 MW GAS TURBINE		550	MMBTU/H	1	LB/H	0	
*TX-0672	CORPUS CHRISTI LIQUEFACTION PLANT	TX	Refrigeration compressor turbines	natural gas	40000	hp	0.31	LB/HR	0	
*TX-0695	ECTOR COUNTY ENERGY CENTER	TX	(2) combustion turbines	natural gas	180	MW	1	GR/100 DSCF	0	
*TX-0701	ECTOR COUNTY ENERGY CENTER	TX	Simple Cycle Combustion Turbines	natural gas	180	MW	Firing pipeline quality natural gas and good combustion practices.	0	0	
WI-0240	WE ENERGIES CONCORD	WI	COMBUSTION TURBINE, 100 MW, NATURAL GAS	NATURAL GAS	100	MW	USE ONLY NATURAL GAS	0.0068	LB/MMBTU	0

RBLC Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines - CO2 equivalent Control

RBLC ID	Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
AK-0083	Kenai Nitrogen Operations	AK	Solar Turbine/Generator Set	Natural Gas	37.6	MMBtu/hr	No Controls Feasible	59.61	tons/MMcf 3-hr avg	91500	tons/yr combined
AK-0081	EXXONMOBIL CORPORATION - POINT THOMSON PRODUCTION FACILITY	AK	Combustion	Natural Gas	7520	kW	Good Combustion and Operating Practices	0	-	0	-
AK-0080	MUNICIPALITY OF ANCHORAGE - ANCHORAGE MUNICIPAL LIGHT & POWER	AK	Combustion	Natural Gas	408	MMBtu/hr	Good operating and combustion practices	0	-	0	-
MI-0410	THETFORD GENERATING STATION	MI	FG-PEAKERS: 2 natural gas fired simple cycle combustion turbines	Natural Gas	171	MMBtu/hr	Efficient combustion; energy efficiency	20141	tons/yr 12-month rolling time period	0	-
TX-0636	HOUSTON CENTRAL GAS PLANT	TX	Supplemental Heaters	Natural Gas	25	MMBtu/hr	No Controls Feasible	0	-	0	-
CA-1223	PIO PICO ENERGY CENTER	CA	Combustion Turbines (Normal Operations)	Natural Gas	300	MW	Limit use to 600 hours per year and use of Good Combustion Practices.	1328	lb/MW-hr	720	Rolling Operating hour average
CO-0075	BLACK HILLS ELECTRIC GENERATION, LLC - PUEBLO AIRPORT GENERATING STATION	CO	Turbine - simple cycle gas	Natural Gas	375	MMBtu/hr	No Controls Feasible	1600	lb/MW-hr Gross rolling 365-day average	193555	tons/hr rolling 365-day average
LA-0257	SABINE PASS LNG TERMINAL	LA	Simple Cycle Refrigeration Compressor Turbines (16)	Natural Gas	286	MMBtu/hr	Good combustion/operating practices and fueled by natural gas - use GE LM2500+G4 turbines	4872107	tons/yr annual maximum from facilitywide		
MD-0043	PERRYMAN GENERATING STATION	MD	60-MW Simple cycle combustion turbines, firing natural gas	Natural Gas	120	MW	USE OF NATURAL GAS. ENERGY EFFICIENCY DESIGN - USE OF INLET FOGGING/WET COMPRESSION, INSULATION BLANKETS TO REDUCE HEAT LOSS, AND FUEL GAS PREHEATING.	1394	lb/MW-hr 12-month rolling		
ND-0028	MONTANA-DAKOTA UTILITIES CO. - R.M. HESKETT STATION	ND	Combustion Turbines	Natural Gas	986	MMBtu/hr	No Controls Feasible	413198	tons/12 month rolling total		
ND-0029	BASIN ELECTRIC POWER COOPERATIVE PIONEER GENERATING STATION	ND	Natural gas-fired turbines	Natural Gas	451	MMBtu/hr	No Controls Feasible	243147	tons/12 month rolling total per each unit		
ND-0030	BASIN ELECTRIC POWER COOP. LONESOME CREEK GENERATING STATION	ND	Natural Gas Fired Simple Cycle Turbines	Natural Gas	412	MMBtu/hr	No Controls Feasible	220122	tons/12 month rolling total per each unit		
TX-0679	CORPUS CHRISTI LIQUEFACTION PLANT	TX	Refrigeration Compressor Turbines	Natural Gas	40000	hp	High efficiency turbines install efficient turbines, follow the turbine manufacturer's emission-related written instructions for maintenance activities including prescribed maintenance intervals to assure good combustion and efficient operation. Compressors shall be inspected and maintained according to a written maintenance plan to maintain efficiency.	146754	tpy rolling 12-month basis lb/MW-hr		
TX-0735	GOLDEN SPREAD ELECTRIC COOPERATIVE, INC. - ANTELOPE ELK ENERGY CENTER	TX	Simple Cycle Turbine & Generator	Natural Gas	202	MW	Energy efficiency, good design & combustion practices	1304	Operation of each turbine limited to 4,572 hours per year		
TX-0753	GUADALUPE GENERATING STATION	TX	Simple Cycle Turbine & Generator	Natural Gas	10673	Btu/kWh	No Controls Feasible	1293	lb/MW-hr 12-month rolling lb CO2/MW-hr (Gross) 2500 Operational hr	20.8	tons/hr 12-month rolling average basis
TX-0757	INDECK WHARTON, LLC INDECK WHARTON ENERGY CENTER	TX	Simple Cycle Combustion Turbine, SGT-5000F(5)	Pipeline Natural Gas	0		No Controls Feasible	1337	rolling Daily/CT	358529	tpy CO2e 12-month rolling
TX-0758	ECTOR COUNTY ENERGY CENTER	TX	Simple Cycle Combustion Turbine, GE 7FA.03	Natural Gas	11707	Btu/kWh (HHV)	No Controls Feasible	1393	lb CO2/MW-hr (Gross) 2500 Operational hr rolling Daily/CT	239649	tpy CO2e 12-month rolling

CT Database Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines -NOx Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
Middletown Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Water Injection and SCR	4.35	lb/hr	2.5	ppmvd @ 15 % O2
Devon Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	10/15/2008	Water Injection and SCR	4.35	lb/hr	2.5	ppmvd @ 15 % O2
PSEG New Haven LLC	CT	Combustion Turbine	Natural Gas	50	MW	1/13/2011	Selective catalytic reduction	4.38	lb/hr	2.5	ppmvd @ 15 % O2
Alfred L. Pierce Generating Station	CT	GE 7EA Combustion Turbine Generator Set	Natural Gas	1.13	MMft <sup>3</sup> /hr	12/28/2006	Dry Low Nox combustion, and SCR with 50% control efficiency	38	lb/hr	9	ppmvd @ 15 % O2
Iroquois Pipeline Operating Company	CT	Solar Taurus 60 with SoLoNOx Gas Compression Turbine	Natural Gas	73	MMBtu/hr	3/7/2007	Solar SoLoNOx technology	3.9	lb/hr	15	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	5.78 MW Natural gas fired Solar Taurus turbine with oxidation catalyst and SoLoNOx	Natural Gas	5.78	MW	12/22/2014	SoLoNOx	2.38	lb/hr	9	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	8.9 MW Solar Taurus turbine with SoLoNOx II	Natural Gas	98.6	MMBtu	6/28/2006	SoLoNOx II	5.34	lb/hr	15	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	13.5 MW natural gas fired simple cycle turbine with oxidation catalyst and SoLoNOx	Natural Gas	13.5	MW	1/29/2015	SoLoNOx	4.69	lb/hr	9	ppmvd @ 15 % O2
Connecticut Jet Power	CT	Peaking Combustion Turbine	Natural Gas	20	MW	2/15/2008	Water injection, fuel limitation with annual combined emissions for both turbines	0.175	lb/MMBtu	40	ppmvd @ 15 % O2
Kimberly-Clark Corporation	CT	Solar Titan 130 CT#2	Natural Gas	174.84	MMBTU/hr	10/9/2007	SoLoNOx technology or equivalent	9.68	lb/hr	15	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	Natural Gas compressor, turbine	Natural Gas	140	MMBtu/hr	12/27/2006	Lean pre-mix combustion (SoLoNOx)	7.51	lb/hr	15	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	Natural Gas compressor, turbine	Natural Gas	75.525	MMBtu/hr	12/27/2006	Lean pre-mix combustion (SoLoNOx)	3.97	lb/hr	15	ppmvd @ 15 % O2
Waterside Power LLC	CT	Peaking Combustion Turbine	Natural Gas	23.2	MW	5/28/2008	Water injection, fuel limitation; annual limitation is for all (3) turbines	0.091	lb/MMBtu	25	ppmvd @ 15 % O2



## CT Database Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines -CO Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
Middletown Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Add-on Control, Oxidation Catalyst	8	lb/hr	5	ppmvd @ 15 % O2
Devon Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Add-on Control, Oxidation Catalyst	8	lb/hr	5	ppmvd @ 15 % O2
PSEG New Haven LLC	CT	Combustion Turbine	Natural Gas	50	MW	1/13/2011	Add-on Control, Catalytic oxidation	5.12	lb/hr	5	ppmvd @ 15 % O2
Alfred L. Pierce Generating Station	CT	GE 7EA Combustion Turbine Generator Set	Natural Gas	1.13	MMft^3/hr	12/28/2006	Fuel limitation	63	lb/hr		
Iroquois Pipeline Operating Company	CT	Solar Taurus 60 with SoLoNOx Gas Compression Turbine	Natural Gas	73	MMBtu/hr	3/7/2007	Good combustion practices and pipeline quality natural gas	4	lb/hr	25	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	5.78 MW Natural gas fired Solar Taurus turbine with oxidation catalyst and SoLoNOx	Natural Gas	5.78	MW	12/22/2014	Catalytic Oxidizer	0.25	lb/hr	25	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	8.9 MW Solar Taurus turbine with SoLoNOx II	Natural Gas	98.6	MMBtu	6/28/2006	DLN	5.42	lb/hr		
Algonquin Gas Transmission LLC	CT	13.5 MW natural gas fired simple cycle turbine with oxidation catalyst and SoLoNOx	Natural Gas	13.5	MW	1/29/2015	Catalytic Oxidizer	0.4	lb/hr	25	ppmvd @ 15 % O2
Connecticut Jet Power	CT	Peaking Combustion Turbine	Natural Gas	20	MW	2/15/2008	Good combustion practices; fuel limitation;	214.6	lb/hr		
Kimberly-Clark Corporation	CT	Solar Titan 130 CT#2	Natural Gas	174.84	MMBTU/hr	10/9/2007	Oxidation Catalyst	0.982	lb/hr		
Algonquin Gas Transmission LLC	CT	Natural Gas compressor, turbine	Natural Gas	140	MMBtu/hr	12/27/2006	Good Combustion	7.62	lb/hr	25	ppmvd @ 15 % O2
Algonquin Gas Transmission LLC	CT	Natural Gas compressor, turbine	Natural Gas	75.525	MMBtu/hr	12/27/2006	Lean pre-mix combustion (SoLoNOx)	4.02	lb/hr	25	ppmvd @ 15 % O2
Waterside Power LLC	CT	Peaking Combustion Turbine	Natural Gas	23.2	MW	5/28/2008	Good combustion practices; annual limitation is for all (3) turbines	0.117	lb/MMBtu		

CT Database Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines -VOC Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Limit 1 Units	Emission Limit 2	Limit 2 Units
Middletown Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Add-on Control, Oxidation Catalyst	1.11	lb/hr		
Devon Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Add-on Control, Oxidation Catalyst	1.11	lb/hr		
PSEG New Haven LLC	CT	Combustion Turbine	Natural Gas	50	MW	1/13/2011	Both P2 and Add-on, Catalytic Oxidation and good combustion practices	1.11	lb/hr	2	ppmvd @ 15 % O2

CT Database Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines- PM Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
Middletown Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Good combustion practices and optimizaiton of SCR; fuel limitation	6	lb/hr		
Devon Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	10/15/2008	Good combustion practices and optimizaiton of SCR; fuel limitation	6	lb/hr		
PSEG New Haven LLC	CT	Combustion Turbine	Natural Gas	50	MW	1/13/2011	Clean fuels and good combustion practices	6	lb/hr		
Alfred L. Pierce Generating Station	CT	GE 7EA Combustion Turbine Generator Set	Natural Gas	1.13	MMft <sup>3</sup> /hr	12/28/2006	No control- Fuel limitation and low sulfur fuel	10	lb/hr		
Waterside Power LLC	CT	Peaking Combustion Turbine	Natural Gas	23.2	MW	5/28/2008	Fuel limitation to less than 15 tpy; annual limitation is for all (3) turbines	0.006	lb/MMBtu		

CT Database Search Results for Natural Gas-Fired Simple Cycle Combustion Turbines- SO2 Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
Alfred L. Pierce Generating Station	CT	GE 7EA Combustion Turbine Generator Set	Natural Gas	1.13	MMft <sup>3</sup> /hr	12/28/2006	Fuel limitation and low sulfur fuel	1.94	lb/hr		
Connecticut Jet Power	CT	Peaking Combustion Turbine	Natural Gas	20	MW	2/15/2008	Pollution Prevention	-	-	-	
Middletown Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Pollution Prevention	-	-	-	
Devon Power LLC	CT	Peaking Combustion Turbine	Natural Gas	50	MW	8/27/2008	Pollution Prevention	-	-	-	
PSEG New Haven LLC	CT	Combustion Turbine	Natural Gas	50	MW	1/13/2011	Clean Fuels	0.95	lb/hr	0	
Waterside Power LLC	CT	Peaking Combustion Turbine	Natural Gas	23.2	MW	5/28/2008	Fuel limitation; ULSID; annual limitation is for all (3) turbines	0.002	lb/MMBtu		

## CT Database Search Results for - CO2 equivalent Control

Facility Name	State	Process Name	Primary Fuel	Throughput	Throughput Units	Control Method Description	Emission Limit 1	Emission Limit 1 Units	Emission Limit 2	Emission Limit 2 Units
Connecticut Jet Power	CT	Peaking Combustion Turbine	Diesel	20	MW	Fuel limitation; these units are required to offset the CO2 emissions compared to a modern turbine with either RGGI credits or by planting biomass sinks. GHG BACT did not apply to these units when permitted.	-	-	--	--
Electric Boat Corporation	CT	Boiler	Natural Gas	121.4	MMBtu/hr	Energy efficiency and fuel conservation. No permit limitation on emission rates	-	-	-	-
Montville Power LLC	CT	42 MW biomass stoker fired; 82 MW tangentially fired fossile fuel fired utility boiler	Biomass	600	MMBtu/hr	Enforceable heat rate (gross) for all fuels, energy efficiency measures, CO2 CEMs, preventative measures for fugitive GHG emissions	15564	btu/kW-hr	-	-
RockTenn	CT	170 MMBtu/hr natural gas fired boiler	Natural Gas	170.11	MMBtu/hr	Good Combustion, annual tune-up	117.02	lb/MMBtu		
Yale University	CT	Cogen facility: 7.9 MW Solar Taurus 70 Gas Turbine and a Victory Heat Recovery Steam Generator with a Coen Grid Style Duct Burner (No. 1)	Natural Gas	-0.0005T^2 - 0.1859T + 95.555	MMBtu/hr	No Control - Use of state-of-the-art efficient, inherently low emitting equipment.	17988	lb/hr		

**NOx MassDEP Top Case BACT Guidelines**

<b>BACT Determination</b>	<b>State</b>	<b>Source Type</b>	<b>Fuel</b>	<b>BACKUP FUEL</b>	<b>DATE OF DETERMINATION</b>	<b>Control Method Description</b>	<b>Emission Limit 1</b>	<b>Emission Limit 1 Units</b>
Plan Approval, Transmittal Number W120701	MA	Simple Cycle Turbine > 10 MW/hr	Natural Gas	No. 2 Fuel Oil	6/1/2011	Dry Low NOx Combustor, SCR, CEMS	2.5	ppmvd @ 15% O <sub>2</sub>
310 CMR 7.26(43) IRP Regulation	MA	Combustion Turbine 1 MW to 10 MW	Natural Gas		6/1/2011	SCR (possible required technology)	0.14	lb/MW-hr
310 CMR 7.26(43) IRP Regulation	MA	Combustion Turbine Less Than 1 MW	Natural Gas	No. 2 Fuel Oil	6/1/2011		0.47	lb/MW-hr

**CO MassDEP Top Case BACT Guidelines**

<b>BACT Determination</b>	<b>State</b>	<b>Source Type</b>	<b>Fuel</b>	<b>DATE OF DETERMINATION</b>	<b>Control Method Description</b>	<b>Emission Limit 1</b>	<b>Emission Limit 1 Units</b>
Plan Approval, Transmittal Number W120701	MA	Simple Cycle Turbine > 10 MW/hr	Natural Gas	6/1/2011	Oxidation Catalyst, CEMS	5.0	ppmvd @ 15% O <sub>2</sub>
310 CMR 7.26(43) IRP Regulation	MA	Combustion Turbine 1 MW to 10 MW	Natural Gas	6/1/2011	Oxidation Catalyst (possible required technology)	0.09	lb/MW-hr
310 CMR 7.26(43) IRP Regulation	MA	Combustion Turbine Less Than 1 MW	Natural Gas	6/1/2011		0.47	lb/MW-hr



**VOC MassDEP Top Case BACT Guidelines**

<b>BACT Determination</b>	<b>State</b>	<b>Source Type</b>	<b>Fuel</b>	<b>DATE OF DETERMINATION</b>	<b>Control Method Description</b>	<b>Emission Limit 1</b>	<b>Emission Limit 1 Units</b>
Plan Approval, Transmittal Number W120701	MA	Simple Cycle Turbine > 10 MW/hr	Natural Gas	6/1/2011	Oxidation Catalyst	2.5	ppmvd @ 15% O <sub>2</sub>

**PM MassDEP Top Case BACT Guidelines**

**None Found**

**SO2 MassDEP Top Case BACT Guidelines**

**None Found**

**CO2e MassDEP Top Case BACT Guidelines**

BACT Determination	State	Source Type	Fuel	DATE OF DETERMINATION	Control Method Description	Emission Limit 1	Emission Limit 1 Units
Plan Approval, Transmittal Number W120701	MA	Simple Cycle Turbine > 10 MW/hr	Natural Gas	6/1/2011			
310 CMR 7.26(43) IRP Regulation	MA	Combustion Turbine 1 MW to 10 MW	Natural Gas	6/1/2011	Oxidation Catalyst (possible required technology)	1900	lb/MW-hr

Attachment E - SCR Cost Calculations  
Algonquin Gas Transmission, LLC - AB Project

**Table 1. Cost Analysis Supporting Information for SCR**

Parameter	Turbine	Units	Reference	Notes
Maximum Heat Capacity	74.91	MMBtu/hr	1	<b>From Budget Costs from FERCO (Appendix E)</b>
Maximum Output	6,460	kW	1	
Potential Inlet NO <sub>x</sub> Emissions	32.97	lb/MMscf	1	
Potential Emissions NO <sub>x</sub>	9.96	tpy	1	
Removal Efficiency	90	%		
Pollutant Removed	8.96	tpy	3	
Aqueous Ammonia Requirement	39.420	ton/yr		<b>From Budget Costs from FERCO, converted 9 lb/hr to tpy</b>
Catalyst Cost, Disposal	15.00	\$/ft <sup>3</sup>	4	Calculated, Refer to Table 3
Catalyst Cost, Replacement	20,000	\$	4	
Aqueous Ammonia Cost	295.75	\$/ton		
Ammonia Vaporizer Cost	0.75	\$/hr	4	
Dilution Blower Cost	0.10	\$/hr	4	
Natural Gas Cost	11.1	\$/MMBtu	5	
Electricity Cost	0.130	\$/kW-hr	6	
Loss	1.2	%	7	
Catalyst Life	3	years	8	
SCR Equipment Life	20	years	11	
Interest Rate	7%	%	8	
CRF (20 Years)	0.0944		9	
CRF (3 Years)	0.3811		9	
1998 \$ (December)	163.9	n/a	10	
1999 \$	166.6	n/a	10	
2004 \$	188.9	n/a	10	
2015 \$ (July)	238.7	n/a	10	

1. Turbine information for new Taurus 60 to be installed at the Weymouth compressor station.
2. Assumed efficiency based on EPA's Air Pollution Control Technology Fact Sheet: <http://www.epa.gov/ttn/catc/dir1/fscr.pdf>
3. Pollutant Removed (tpy) = (Removal Efficiency, %) × (Potential Emissions, tpy).
4. Estimated value based on previous BACT analysis experience.
5. Industrial natural gas cost obtained from U.S. Energy Information Administration for 2014 for MA: [http://www.eia.gov/dnav/ng/ng\\_pri\\_sum\\_dcu\\_SMA\\_a.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SMA_a.htm)
6. Industrial June 2015 electricity cost for MA: [http://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_5\\_6\\_a](http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a)
7. Loss estimated as 0.2% per inch @ 6 inches.
8. Based on OAQPS Manual, Section 4.2, Chapter 2, page 2-50.
9. Capital Recovery calculated based on Equations 2.54 and 2.55 of OAQPS Manual, Section 4.2, Chapter 2, pages 2-48 and 2-49.
10. Values based on U.S. Historical Consumer Price Index: <ftp://ftp.bls.gov/pub/special.requests/cpi/cpiat.txt>.
11. Based on OAQPS, Section 4, Chapter 2, pg 2-48: <http://www.epa.gov/ttn/catc/dir1/cs4-2ch2.pdf>

**Table 2. Cost Analysis for SCR**

Capital Cost	Turbine	OAQPS Notation <sup>1</sup>	Notes
<i>Purchased Equipment Costs</i>			
Equipment Cost	574,100		From Budget Costs from FERCO October 2013 Quote - SCR Equipment minus CEMS cost.
Instrumentation <sup>3</sup>	57,410	0.10 × A	
Sales Tax <sup>3</sup>	22,964	0.04 × A	
Freight <sup>3</sup>	28,705	0.05 × A	
<i>Total Purchased Equipment Costs</i>	<i>683,179</i>	<i>B</i>	
<i>Direct Installation Costs</i>			
Commissioning	354,544		From Budget Costs from FERCO October 2013 Quote. Total commissioning cost is ratioed based on the cost of the SCR equipment.
<i>Total Direct Costs</i>	<i>1,037,723</i>	<i>D = B + C</i>	
<i>Indirect Installation Costs<sup>4</sup></i>			
General Facilities	51,886	0.05 × D	
Engineering and Home Office Fees	103,772	0.10 × D	
Process Contingency	51,886	0.05 × D	
<i>Total Indirect Installation Costs</i>	<i>207,545</i>	<i>E</i>	
<i>Continuous Emission Monitor, CEMs<sup>5</sup></i>	0		Assuming no CEMS
<i>Project Contingency<sup>4</sup></i>	186,790	G = 0.15 × (D + E + F)	
<b>Total Capital Investment</b>	<b>1,432,058</b>	<b>TCI = D + E + F + G</b>	

Operating Cost	Turbine	OAQPS Notation	
<i>Direct Annual Costs</i>			
Operating Labor <sup>6</sup>	16,425	H	Currently assuming 0.5 hours per shift with 3 shifts per day.
Maintenance Labor <sup>6</sup>	16,425	I	
Supervisory Labor <sup>6</sup>	2,464	J = 0.15 × H	
Maintenance Materials <sup>6</sup>	16,425	I	
Utilities - Natural Gas <sup>7</sup>	87,554	Calculated	Refer to Table 1
Utilities - Electricity <sup>8</sup>	95,997	Calculated	Refer to Table 2
Utilities - Aqueous Ammonia <sup>9</sup>	11,658	Calculated	Refer to Table 3
Catalyst Replacement <sup>10,12</sup>	8,307	Calculated	Refer to Table 4
Catalyst Disposal <sup>11</sup>	2,225	Calculated	Refer to Table 5
CEM Annual Cost <sup>5</sup>	0		Assuming no CEMS
<i>Total Direct Annual Costs</i>	<i>257,480</i>	<i>DAC</i>	
<i>Indirect Annual Costs</i>			
Overhead <sup>14</sup>	0		
Administrative Charges <sup>14</sup>	0		
Property Taxes <sup>14</sup>	0		
Insurance <sup>14</sup>	0		
Capital Recovery on Total Capital Investment <sup>12</sup>	135,176		
<i>Total Indirect Annual Costs</i>	<i>135,176</i>	<i>IDAC</i>	
<b>Total Annual Cost<sup>13</sup></b>	<b>392,656</b>	<b>TAC = DAC + IDAC</b>	
Pollutant Removed (tpy)	8.96		
<b>Cost per ton of NO<sub>x</sub> Removed</b>	<b>43,805</b>	<b>\$/ton = TAC / Pollutant Removed</b>	

1. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, January 2002, Section 4.2, Chapter 2.

2. Estimated value based on previous BACT analysis experience.

3. Based on general OAQPS costs as presented on page 2-27 of Section 1, Chapter 2 of OAQPS Manual.

4. Based on costs as presented in Table 2.5 on page 2-44 of Section 4.2, Chapter 2 of OAQPS Manual.

5. Based on EPA CEM Cost Model, Version 3.0 dated March 7, 2007 from previous BACT analysis experience.

6. Operator and maintenance labor based on \$30/hr × 0.5 hrs/shift × 3 shifts per day (1,095 shifts/yr). It is assumed that the cost of maintenance materials is equal to the cost of maintenance labor.

7. Calculated as Loss % × MMBtu/hr × hr/yr × \$/MMBtu

8. Calculated as Loss % × kW × hr/yr × \$/kW + ( Ammonia Vaporizer Cost \$/hr + Dilution Blower Cost \$/hr ) × 8760 hr/yr.

9. Calculated as aqueous ammonia ton/yr × \$/ton.

10. The cost of catalyst replacement includes the cost of catalyst replacement plus sales tax and freight.

11. Catalyst disposal cost calculated as disposal cost (\$/ft<sup>3</sup>) × kW / (1000 kW / MW) × (6180 ft<sup>3</sup> / 83 MW).

12. Capital Recovery calculated based on Equations 2.54 and 2.55 of OAQPS Manual, Section 4.2, Chapter 2, pages 2-48 and 2-49. (Annual cost = capital cost × capital recovery factor).

13. Based on OAQPS, Section 4, Chapter 2, p. 2-49 <http://www.epa.gov/ttn/catc/dir1/cs4-2ch2.pdf>

14. Based on OAQPS, Section 4, Chapter 2, p. 2-48, assume that overhead costs, administrative charges, property taxes, and insurance are negligible: <http://www.epa.gov/ttn/catc/dir1/cs4-2ch2.pdf>

**Table 3 Facility-Wide Cost Information**

Parameter	Value	Units	Reference	Notes
Operating Labor Cost	30	\$/hr		
Maintenance Labor Cost	30	\$/hr		
Electricity Cost	0.1304	\$/kW-hr	2	
Natural Gas Cost	11.34	\$/1,000 scf	3, 8	
Ammonia Soln Cost	0.15	\$/lb	6, 8	
Reagent (Ammonia) Cost	1.12	\$/gal	7	

**Consumer Price Indices**

Year	Value	Units	Reference	Notes
2015 \$ (July)	238.7		1	
2014 \$ (Average)	236.7		1	
2010 \$ (November)	218.8		1	
2010 \$ (March)	217.6		1	
2004 \$	188.9		1	
2002 \$	179.9		1	
1999 \$	166.6		1	
1998 \$ (December)	163.9		1	
1998 \$ (2nd Quarter)	163.0	June 1998 \$	1	
1997 \$ (March)	160.0		1	
1995 \$ (3rd Quarter)	153.2	Sept 1995 \$	1	
1991 \$ (September)	137.2		1	
1987 \$ (2nd Quarter)	113.5	June 1987 \$	1	

1. U.S. Historical Consumer Price Index: <ftp://ftp.bls.gov/pub/special.requests/cpi/cpi.ai.txt>.

2. Industrial June 2015 electricity cost for MA:

[http://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_5\\_6\\_a](http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a)

3. Industrial natural gas cost obtained from U.S. Energy Information Administration for 2014 for MA:

[http://www.eia.gov/dnav/ng/ng\\_pri\\_sum\\_dcu\\_SMA\\_a.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SMA_a.htm)

4. Based on OAQPS, Section 6, Chapter 1 p.1-48

5. Based on Air Pollution Control Technology Fact Sheet for Flue Gas Desulfurization. Lime ranges from \$60 to \$80 per ton. Used \$60 per ton and adjusted to 2013 values: <http://www.epa.gov/ttn/catc/dir1/ffdg.pdf>

6. Based on OAQPS, Section 4, Chapter 2, p. 2-50, for 29% ammonia solution. <http://www.epa.gov/ttn/catc/dir1/cs4-2ch2.pdf>.

7. Calculated from ammonia solution cost, using the density of aqueous ammonia. Density ranges from 7.46 - 7.71 lbs/gal per MSDS from Tanner Industries: <http://www.tannerind.com/aqua-msds.html>

8. Converted to July 2015 value based on the Consumer Price Index.



Attachment E - CO2 BACT Cost Calculations  
Algonquin Gas Transmission, LLC - AB Project

Inputs	
CO <sub>2</sub> Emissions from Source	35568 Short Tons per Year <sup>a</sup>
Distance to Infrastructure	180 Miles <sup>b</sup>
Project Life	30 Years <sup>c</sup>
Capture Efficiency	90% <sup>d</sup>

a CO<sub>2</sub> emissions based on process design requirements and emission calculations. Source:

\\10.21.1.2\Projects\Client\Boston Office\CLIENTS\Spectra Energy\Atlantic Bridge\Permitting\MA - Weymouth\04 Projects\142201.0010 - AB Weymouth\02 Info from Client

b Distance from the Chaplin compressor station to the nearest potential CO<sub>2</sub> sequestration facility, conservatively assuming the shortest distance as the pipeline route.

c Project life set by engineering judgement. The National Energy Technology Laboratory (NETL) quality guidance documents also use 30 years as a project life.

d Capture efficiency of 90% is assumed by NETL's Estimating Carbon Dioxide Transport and Storage Costs (p. 9)

Volumetric Flow Measurements	
TOTAL - MASS	35,568 tpy CO <sub>2</sub>
CAPTURE EFF.	90%
CAPTURED - MASS	32,011 tpy CO <sub>2</sub>
Density of CO <sub>2</sub> - Metric (MIT) <sup>e</sup>	884 kg/m <sup>3</sup>
Density of CO <sub>2</sub> - English	0.0276 tons / acf
TRANSPORT VOLUME	1.16 MMacf/yr CO <sub>2</sub>

3,557

e Density of CO<sub>2</sub> taken from Carbon Capture and Sequestration Technologies Program Massachusetts Institute of Technology. Carbon Management GIS: CO<sub>2</sub> Pipeline Transport Cost Estimation. October 2006, Updated in June 2009. (p. 4)

kg per tons conversion 907.185

ft<sup>3</sup> per m<sup>3</sup> conversion 35.3147

<b>Weymouth</b>	<b>CO2</b>
Turbine	<b>35,568</b>

**35,568**

**97 tpd rate**

<b>Summary Table: Pipeline and Class VI Well</b>	
Pipeline Cost - NETL	\$428 /ton
Storage Cost - NETL	\$175 /ton
Capture Cost <sup>1</sup>	\$107 /ton
<b>TOTAL COSTS <sup>2</sup></b>	<b>\$709 /ton</b>

<sup>1</sup> Based on the 2010 CCS Task Force Report, the cost factor for post-combustion capture of CO<sub>2</sub> from a NGCC system is selected because it is the most similar process with available cost information to that of the proposed project. Note that the Approximate Cost Factor (ACF) for capturing the CO<sub>2</sub> from the turbines also includes the cost for compressing the CO<sub>2</sub> for transport in pipelines. Monthly data from the Producer Price Index (PPI) is used to convert December 2009 dollars (PPI = 175.1) to June 2015 dollars (PPI = 196.9) (support activities for oil and gas operations, series ID# 213112213112). PPI obtained from the Bureau of Labor Statistics website at [www.bls.gov](http://www.bls.gov).

<sup>2</sup> All costs are presented in present value using the Producer Price Index to calculate the change in currency value.

# Diameter Estimation for CO<sub>2</sub> Transport Pipeline

Method from "Carbon Management GIS: CO<sub>2</sub> Pipeline Transport Cost Estimation"  
published by the Carbon Capture and Sequestration Technologies Program,  
Massachusetts Institute of Technology  
October 2006, Updated June 2009

Input	
CO <sub>2</sub> Mass Flow Rate	0.03 Metric Megatons per Year

Lookup Table			
Pipeline Diameter Inches	Maximum Mass Flow Rate <sup>1</sup> Metric Megatons per Year	Sufficient?	Sufficiently Sized Pipes Inches
4	0.19	TRUE	4
6	0.54	TRUE	6
8	1.13	TRUE	8
12	3.25	TRUE	12
16	6.86	TRUE	16
20	12.26	TRUE	20
24	19.69	TRUE	24
30	35.16	TRUE	30
36	56.46	TRUE	36

Output	
Pipeline Diameter:	4 Inches

<sup>1</sup> From source document, assuming transport conditions of 25 °C and 158 bar.

metric ton per short ton conversion	0.907185
metric ton per metric mega ton conversion	1000000

# Cost Estimation for Transfer of CO<sub>2</sub> via Pipeline - SOURCE TYPES AND EU IDS

Source Document: "Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

## CO<sub>2</sub> Pipeline and Emissions Data

Parameter	Value	Units
Minimum Length of Pipeline	180.0	miles
Average Diameter of Pipeline	4	inches
CO <sub>2</sub> emissions from <b>Source</b>	35,568	Short tons/yr
CO <sub>2</sub> Capture Efficiency	90%	
Captured CO <sub>2</sub>	32,011	Short tons/yr

## CO<sub>2</sub> Transfer Cost Estimation <sup>1</sup>

Cost Type	Units	Cost Equation	Cost (\$)
<b>Pipeline Costs, Present Value (\$)</b>			
	\$		
Materials	Diameter (inches), Length (miles)	$\$64,632 + \$1.85 \times L \times (330.5 \times D^2 + 686.7 \times D + 26,960)$	\$11,717,900.40
	\$		
Labor	Diameter (inches), Length (miles)	$\$341,627 + \$1.85 \times L \times (343.2 \times D^2 + 2,074 \times D + 170,013)$	\$61,547,093.60
	\$		
Miscellaneous	Diameter (inches), Length (miles)	$\$150,166 + \$1.58 \times L \times (8,417 \times D + 7,234)$	\$11,782,694.80
	\$		
Right of Way	Diameter (inches), Length (miles)	$\$48,037 + \$1.20 \times L \times (577 \times D + 29,788)$	\$6,980,773.00
<b>Related Capital Expenditures, Present Value (\$)</b>			
CO <sub>2</sub> Surge Tank	\$	\$1,150,636	\$1,150,636.00
Pipeline Control System	\$	\$110,632	\$110,632.00

<b>Variable Operation &amp; Maintenance (O&amp;M), Annual Basis (\$/yr)</b>			
Fixed O&M	\$/mile/yr	\$8,632	\$1,553,760.00

## Amortized Cost Calculation

Equipment Life <sup>2</sup>	30	years
Interest rate <sup>3</sup>	7%	
Capital Recovery Factor (CRF) <sup>4</sup>	0.08	(years) <sup>-1</sup>
Total of Pipeline Present-Value Costs (TCI)	\$93,289,730	\$ (Pipeline + Other Capital)
Amortized Present-Value Cost (TCI *CRF)	\$7,517,884	\$/yr
<b>Amortized Present-Value + O&amp;M Cost</b>	<b>\$9,071,644</b>	<b>\$/yr</b>
CO <sub>2</sub> Transferred	32,011	Short tons/yr
<b>Annuitized control cost per ton <sup>5</sup></b>	<b>283.39</b>	<b>\$/ton</b>
<b>Producer Price Index <sup>6</sup></b>		
June 2007	113.50	\$
July 2015	171.4	\$
<b>Annuitized control cost per ton - 2015 Dollars <sup>5</sup></b>	<b>427.96</b>	<b>\$/ton</b>

<sup>1</sup> Cost estimation guidelines obtained from "Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

<sup>2</sup> Pipeline life is assumed based on engineering judgment. The National Energy Technology Laboratory (NETL) quality guidance documents also use 30 years as a project life.

<sup>3</sup> Interest rate conservatively set at 7.00%, based on EPA's seven percent social interest rate from the OAQPS CCM Sixth Edition.

<sup>4</sup> Capital Recovery Factor = Interest Rate (%) x (1 + Interest Rate (%)) ^ Pipeline Life / ((1 + Interest Rate (%)) ^ Pipeline Life - 1)

<sup>5</sup> This cost estimation does not include capital and O&M costs associated with necessary compression or processing equipment pre-pipeline.

<sup>6</sup> The ratio of the producer price index (other pipeline transportation, series ID# 4869) of August 2015 to June 2007 is used to estimate costs in present dollars. PPI obtained from the Bureau of Labor Statistics website at [www.bls.gov](http://www.bls.gov).

## Cost Estimation for Storage of CO<sub>2</sub> - SOURCE TYPES AND EU IDS

Source Document: "Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

### CO<sub>2</sub> Pipeline and Emissions Data

Parameter	Value	Units
Captured CO <sub>2</sub>	32,011	Short tons/yr
Number of Injection Wells <sup>1</sup>	1	
Injection Well Depth <sup>1</sup>	1,236.00	meters

### CO<sub>2</sub> Transfer Cost Estimation <sup>1</sup>

Cost Type	Units	Cost Equation	Cost (\$)
<b>Capital Costs</b>			
Site Screening and Evaluation	\$	\$4,738,488	\$4,738,488.00
Injection Wells	\$ / well	$\$240,714 \times e^{(0.0008 \times \text{meters depth})}$	\$647,040.90
Injection Equipment	\$ / well	$\$94,029 \times (7,389 / (280 \times \# \text{ wells}))^{0.5}$	\$483,031.70
Liability Bond	\$	\$5,000,000	\$5,000,000.00
<b>Declining Capital Funds</b>			
Pore Space Acquisition	\$ / ton CO <sub>2</sub>	\$0.334 / ton CO <sub>2</sub>	\$320,750.22
<b>Fixed Operation &amp; Maintenance (O&amp;M), Annual Basis</b>			
Normal Daily Expenses (Fixed)	\$/well/day	\$11,566	\$4,221,590.00
Surface Maintenance (Fixed)	\$	$\$23,478 \times (7,389 / (280 \times \# \text{ wells}))^{.5}$	\$120,607.67
Subsurface Maintenance (Fixed)	\$/well/ft-depth	\$7.08	\$28,710.24
<b>Variable Operation &amp; Maintenance (O&amp;M), Annual Basis</b>			
Consumables (Variable)	(\$/yr) / (tons CO <sub>2</sub> /day)	\$2,995	\$262,665.60

### Amortized Cost Calculation

Equipment Life <sup>2</sup>	30	years
Interest rate <sup>3</sup>	7%	
Capital Recovery Factor (CRF) <sup>4</sup>	0.08	(years) <sup>-1</sup>
Total Storage Installation Cost (TCI)	\$11,189,311	\$ (Installation + Fixed O&M)
Amortized Installation Cost (TCI * CRF)	\$901,706	\$/yr
<b>Amortized Installation + O&amp;M Cost</b>	<b>\$5,535,280</b>	<b>\$/yr</b>
CO <sub>2</sub> Transferred	32,011	Short tons/yr
<b>Annuitized control cost per ton <sup>5</sup></b>	<b>173</b>	<b>\$/ton</b>
<b>Producer Price Index <sup>6</sup></b>	<b>June 2007</b>	<b>194.90</b>
	<b>July 2015</b>	<b>196.9</b>
<b>Annuitized control cost per ton - 2015 Dollars <sup>5</sup></b>	<b>174.69</b>	<b>\$/ton</b>

<sup>1</sup> Cost estimation guidelines obtained from "Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

<sup>2</sup> Pipeline life is assumed based on engineering judgment.

<sup>3</sup> Interest rate conservatively set at 7.00%, based on EPA's seven percent social interest rate from the OAQPS CCM Sixth Edition.

<sup>4</sup> Capital Recovery Factor = Interest Rate (%) x (1 + Interest Rate (%)) ^ Pipeline Life / ((1 + Interest Rate (%)) ^ Pipeline Life - 1)

<sup>5</sup> This cost estimation does not include capital and O&M costs associated with processes upstream of storage.

<sup>6</sup> The ratio of the producer price index (support activities for oil and gas operations, series ID# 213112) of August 2015 to June 2007 is used to estimate costs in present dollars. PPI obtained from the Bureau of Labor Statistics website at [www.bls.gov](http://www.bls.gov).

feet per meter conversion

3.28084

## ATTACHMENT F: NOISE SURVEY REPORT

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# **WEYMOUTH COMPRESSOR STATION**

(NORFOLK COUNTY, MASSACHUSETTS)

## **RESULTS OF THE MOST RECENT AMBIENT SOUND SURVEY AND UPDATED ACOUSTICAL ANALYSIS OF A NEW NATURAL GAS COMPRESSOR STATION ASSOCIATED WITH THE PROPOSED ATLANTIC BRIDGE PROJECT (“AB PROJECT”)**

H&K Report No. 3316

H&K Job No. 4818

Date of Report: October 5, 2015

Prepared for: **Algonquin Gas Transmission, LLC** (“Algonquin”)  
A company of Spectra Energy Partners  
890 Winter Street, Suite 300  
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Submitted by: Paul D. Kiteck, P.E. (primary author)  
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## REPORT SUMMARY

This report includes the results of an updated acoustical analysis for the **Weymouth Compressor Station**, a grass roots natural gas compressor station associated with the proposed **Atlantic Bridge Project** ("Project" or "AB Project") for **Algonquin Gas Transmission** ("Algonquin"). In addition, the results of the most recent ambient sound survey at the proposed site of the Weymouth Compressor Station (abbreviated as "Station" in the report) are included. The purpose of the updated acoustical analyses is to estimate the sound contribution of the Station at the identified receptors/NSAs, including additional receptors recommended by the Siting Board, and determine noise mitigation measures to meet applicable sound level criteria. Included in the report is an expanded noise analysis for receptors recommended by the Siting Board along with an assessment of the noise increases for both nighttime and daytime levels, based on the lowest ambient levels.

The following table summarizes the ambient sound level at the Station site (i.e., ambient  $L_{dn}$ ), the estimated sound contribution of the Station during full load operation at the receptors/NSAs and the "total" cumulative sound level at the NSAs (i.e., Station sound level plus the ambient sound level). The results in this table are defined as the "Noise Quality Analysis" for the Station.

**Noise Quality Analysis for the Weymouth Compressor Station associated with the AB Project**

Identified Receptor/NSA and Type of Receptor/NSA	Distance & Direction of Receptor/NSA	Ambient Ldn (dBA)	Est'd Sound Level (Ldn) of Station at Full Load (dBA)	Est'd Station Sound Level (Ldn) + Ambient Ldn (dBA)	Increase above Ambient Ldn (dB)
NSA #1 (Residences)	610 feet (SSE)	70.4	49.0	70.4	0.0
NSA #2 (Residences)	1,370 feet (north)	54.9	42.1	55.1	0.2
NSA #3 (Residences)	1,560 feet (east)	54.0	40.8	54.2	0.2
NSA #4 (Residences)	900 feet (south)	56.5	45.3	56.8	0.3
NSA #5 (Residences)	1,030 feet (SE)	64.3	43.9	64.3	0.0
NSA #6 (Residences)	2,300 feet (SE)	50.6	35.7	50.7	0.1
NSA #7 (Residences)	1,970 feet (ENE)	49.1	38.2	49.4	0.3
NSA #8 (Residences)	2,400 feet (west)	52.6	35.3	52.7	0.1
NSA #9 (School)	4,200 feet (ESE)	49.8	29.1	49.8	0.0

The acoustical analyses presented in this report indicate that the noise attributable to the **Weymouth Compressor Station** is estimated to be lower than **55 dBA ( $L_{dn}$ )** at all surrounding receptors/NSAs. Consequently, the noise generated by the Station should meet the anticipated FERC sound level requirement for the Station. In addition, the results of the acoustical analyses indicate that the Station sound contribution should also meet the MassDEP noise requirements, including the MassDEP noise guideline for pure tone noise condition, and the noise generated by the Station should have minimum noise impact at the surrounding receptors/NSAs, even during nighttime Station operation. Also, since the Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration (direct, or noise-induced) at any NSA during Station operation.



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## 1.0 **INTRODUCTION**

In this report, **Hoover & Keith Inc.** (H&K) presents the results of an updated acoustical analysis for the **Weymouth Compressor Station**, a grass roots natural gas compressor station associated with the proposed **Atlantic Bridge Project** ("AB Project" or "Project") for **Algonquin Gas Transmission** ("Algonquin"). In addition, the results of the most recent ambient sound survey at the site of the Weymouth Compressor Station (abbreviated as "Station" in the report) are included. The following describes the purpose of the most recent ambient sound survey and the updated acoustical analysis:

- (1) Document the existing acoustic environment prior to the design and installation of the Station and identify nearby noise-sensitive areas (NSAs), such as residences, schools and hospitals, around the Station site including additional receptors recommended by the Massachusetts Energy Facilities Siting Board ("Siting Board");
- (2) Estimate the sound contribution of the compressor installation at the receptors/NSAs assuming full-load operation of the Station; included is an expanded noise analysis for receptors recommended by the Siting Board along with an assessment of the noise increases for both nighttime and daytime levels, based on the lowest ambient levels;
- (3) Determine noise mitigation measures and discuss mitigation practices to insure that applicable sound criteria are not exceeded due to the operation of the Station;
- (4) Project the noise resulting from construction activities at the site of the Station and estimate the noise contribution due to a compressor unit blowdown event; and
- (5) Address noise-related comments/requests by the Siting Board regarding the Weymouth Compressor Station<sup>1</sup>.

## 2.0 **DESCRIPTION OF STATION SITE AND EQUIPMENT**

**Figure 1 (Appendix, p. 16)** is an area layout around the Station site showing the nearby NSAs (i.e., primarily residences) within approximately ½ mile of the Station, the location of the identified receptors/NSAs and the reported sound measurement positions near the identified NSAs. **Figure 2 (Appendix, p. 17)** show a conceptual layout of Station buildings, equipment, area of aboveground piping and Station fenceline. The Station will be located in Norfolk County, Massachusetts, within the city limits of Weymouth, MA, just on the North Side of Bridge Street. There is an existing Algonquin natural gas meter station (i.e., "Weymouth Meter Station") and the MWRA Pumping Station located in the same general area as the proposed Station site.

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<sup>1</sup>Siting Board noise-related comments/requests were included in letters sent via electronic filing to the FERC, dated July 24, 2015 and June 18, 2015 (Re: Algonquin Gas Transmission, L.L.C, PF15-12-000), in advance of FERC's preparation of an EA.

The Station will be equipped with one (1) Solar Model Taurus 60 turbine-driven compressor unit [ISO horsepower (HP) of 7,700 HP]. The turbine and compressor will be installed in an acoustically-insulated metal building ("Compressor Building"), which we understand will be designed and constructed of a brick façade. The following describes the anticipated auxiliary equipment and other notable items associated with the Station.

- Turbine exhaust system, which includes a silencer system and exhaust stack;
- Turbine air intake filter system that includes an in-duct intake silencer system;
- Outdoor lube oil cooler ("LO cooler") that serves the compressor unit;
- Aboveground gas piping and associated components (e.g., valves, suction filter separators);
- Outdoor gas aftercooler that serves the Station; and
- Courtyard barrier/walls will be employed between the Compressor Building and Auxiliary Building; as a result, the gas aftercooler and aboveground piping in the area of the Compressor Building will be located inside this "courtyard area".

In addition, there will be a gas blowdown vent for the compressor unit at the "Source Control", within the fenced area of the Station (defined as the "unit blowdown" via a "case vent separator"), in which the natural gas between the suction/discharge valves and compressor is vented to the atmosphere via a blowdown silencer system, if necessary. During commissioning of the Station, it is estimated that a unit blowdown could occur 3 or 4 times/day and only during the daytime. During normal operation of the Station (i.e., after the commissioning period), a unit blowdown event occurs infrequently (e.g., 2 to 3 times/month), and a unit blowdown event only occurs for a short time frame (e.g., unit blowdown would persist for approximately 1 to 5 minutes). The Station also includes an emergency shutdown ("ESD") that will only occur at required DOT test intervals (e.g., annual test of blowdown system) or in an emergency situation (gas leak or fire), and we understand that an ESD blowdown, if necessary, occurs for less than five (5) minutes.

### 3.0 **SOUND LEVEL CRITERIA**

#### 3.1 Federal (FERC) Sound Requirements

Conditions of the Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) require that the sound attributable to a natural gas compressor station not exceed the day-night average sound level (i.e.,  $L_{dn}$ ) of **55 dBA** at any nearby NSA. In addition, a sound level of **55 dBA** ( $L_{dn}$ ) can be used as a "guideline" for assessing the noise impact of temporary or intermittent noise such as construction noise or blowdown event. The  $L_{dn}$  is an energy average of the equivalent A-weighted ("A-wt.") sound level (" $L_{eq}$ ") during the daytime (" $L_d$ ") and the nighttime  $L_{eq}$  (" $L_n$ ") plus **10 dB**. For a steady sound source that operates over a 24-hour period and controls the environmental sound level, the  $L_{dn}$  is approximately **6.4 dB** above the measured  $L_{eq}$ . As a result, an  $L_{dn}$  of **55 dBA** corresponds to a  $L_{eq}$  (e.g.,  $L_d$ ) of **48.6 dBA**. If both the  $L_d$  and  $L_n$  are measured, then the  $L_{dn}$  is calculated using the following formula:

$$L_{dn} = 10 \log_{10} \left( \frac{15}{24} 10^{L_d/10} + \frac{9}{24} 10^{(L_n+10)/10} \right)$$

### 3.2 State, County and/or Local Noise Regulations

Commonwealth of Massachusetts: The following policy was adopted by the Division of Air Quality Control ("DAQC") for The Commonwealth of Massachusetts, which is intended to enforce and provide a guideline for the current noise regulation (i.e., 310 CMR Section 7.10). DAQC's Policy 90-001, as stated by Barbara Kwetz (DAQC Acting Director) on Feb. 1, 1990 is as follows:

A source of sound will be considered to be violating the Massachusetts Department of Environmental Protection ("MassDEP") noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than **10 dB** above ambient (referred to as the "10 dBA above ambient limit"), or
2. Produces a "pure tone" condition—when any O.B. center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by **3 decibels** or more.

These criteria are measured both at the property line and at the nearest inhabited residence. The "ambient" is defined as the lowest background A-wt. sound level that is exceeded 90% of the time ("L<sub>90</sub>"). Although not stated, it is assumed that the "pure tone" condition includes the O.B. SPLs of 31.5 Hz to 8000 Hz. The ambient may also be established by other means with the consent of the Department. Based on the reported lowest background sound level (i.e., nighttime L<sub>90</sub>), the DAQC A-wt. noise guideline for the identified NSAs is greater than the FERC sound level requirement. Consequently, in general, if the FERC sound level requirement is achieved, which will be required by the FERC, the DAQC A-wt. noise limit should also be attained. We have not identified any applicable Township or County noise regulations for this facility, although any local noise regulations, if required, will be addressed during the local permitting process.

## 4.0 MEASUREMENT METHODOLOGY, CONDITIONS, SOUND MEASUREMENT LOCATIONS

### 4.1 Measurement Methodology and Conditions

The most recent sound survey around the Station was performed by Garrett Porter of H&K during the daytime and nighttime of August 14, 2015, and the nighttime sound tests were conducted between 12:00 PM and 4:00 AM (i.e., considered by the Siting Board as the most typical quiet hours). During the daytime sound tests, the temperature was 78 deg. F with clear sky conditions and a south wind. During the nighttime, there were clear sky conditions and the wind was from the east. During the nighttime tests, there was no construction activities at the Fore River Bridge related to the current Fore River Bridge Replacement Project.

At each sound measurement location, the ambient L<sub>d</sub>, L<sub>n</sub> and nighttime L<sub>90</sub> and the associated unweighted octave-band (O.B.) sound pressure levels (i.e., L<sub>eq</sub> SPLs and L<sub>90</sub> SPLs) were measured at 5 feet above the ground. Periodic samples of the ambient noise level were typically performed at the sound measurement positions. To measure ambient sound levels that are representative of "long-term average" ambient levels, the sound measurements attempted to exclude "extraneous sound" such as a vehicle passing immediately by the sound measurement

location or other intermittent sources. The acoustical measurement system consisted of a Norsonic Model Nor140 Sound Level Meter (a Type 1 "SLM" per ANSI S1.4 & S1.11) equipped with a ½-inch condenser microphone with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the sound test date).

#### 4.2 Description of Sound Measurement Locations and Receptors/NSAs

During a recent sound survey, ambient levels were measured at the identified closest NSAs (i.e., primarily residences) within each cardinal direction of the Station along with other "receptor locations" in which a noise analysis impact was requested by the Siting Board. Consequently, there are a total of nine (9) "identified receptors/NSAs" [i.e., closest NSA ("NSA #1") plus 8 other additional receptors designated by the Siting Board]. The following is a description of the identified receptors/NSAs and chosen sound measurement positions during the sound survey:

Pos. 1: "NSA #1" (considered the "closest NSA"); Residences located on the North Side of Bridge Street, in Weymouth, approximately 610 feet south-southeast (SSE) of the Station site "acoustic center" (i.e., anticipated location of Compressor Building);

Pos. 2: "NSA #2"; Residences at the end of Saint German St. (area of Germantown Point; Town of Quincy), approximately 1,370 feet north of the Station site center;

Pos. 3: "NSA #3"; Residences located along Kings Cove Beach Road (near Hunt Hills Point, Weymouth), approximately 1,560 feet east of the Station site center;

Pos. 4: "NSA #4"; Residences located near the intersection of Monatiquot Street and Vaness Road (Weymouth), approximately 900 feet south of the Station site center;

Pos. 5: "NSA #5"; Residences located along Kings Cove Way (Weymouth), approximately 1,030 feet southeast (SE) of the Station site center;

Pos. 6: "NSA #6"; Residences located in the area of Roslind Road and Evans Road (Weymouth), approximately 2,300 feet SE of the Station site center;

Pos. 7: "NSA #7"; Residences located in the area of Weybosset Street and Fore River Ave. (Weymouth), approximately 1,970 feet east-northeast (ENE) of the Station site center;

Pos. 8: "NSA #8"; Residences located along Dee Road (Quincy), approximately 2,400 feet west of the Station site center; and

Pos. 9: "NSA #9"; Johnson School (Pearl Street, Weymouth), located approximately 4,200 feet east-southeast (ESE) of the Station site center.

## 5.0 MEASUREMENT RESULTS AND OBSERVATIONS

The following summarizes the sound data tables included in the **Appendix** of the report that provide the results of the most recent sound survey:

- **Table 1 (Appendix, p. 18)** summarizes the measured  $L_d$ , measured  $L_n$ , measured daytime  $L_{90}$  and the measured nighttime  $L_{90}$  at the chosen NSA sound measurement locations; also provided in **Table 1** is the resulting ambient  $L_{dn}$ , as calculated from the measured  $L_d$  and  $L_n$ ;
- **Table 2 (Appendix, p. 18)** includes the meteorological conditions during the sound survey;
- **Table 3 (Appendix, p. 19)** includes the measured daytime A-wt. sound levels ( $L_d$ ) and unweighted O.B. SPLs at the NSA sound measurement positions;
- **Table 4 (Appendix, p. 20)** includes the measured nighttime A-wt. sound levels ( $L_n$ ) and related unweighted O.B. SPLs at the NSA sound measurement positions;
- **Table 5 (Appendix, p. 2)** includes the measured daytime  $L_{90}$  and related unweighted O.B.  $L_{90}$  SPLs at the NSA sound measurement positions; and
- **Table 6 (Appendix, p. 22)** includes the measured nighttime  $L_{90}$  and related unweighted O.B.  $L_{90}$  SPLs at the NSA sound measurement positions.

The following **Table A** summarizes the measured ambient  $L_d$ , measured ambient  $L_n$  and the resulting  $L_{dn}$  (i.e., calculated via the measured  $L_d$  and  $L_n$ ) at the identified receptors/NSAs along with a brief description of the sound measurement location.

Meas. Position	Identified Receptors/NSAs and Description of Sound Measurement Location near the Respective NSA	Meas'd Ambient $L_d$ (dBA)	Meas'd Ambient $L_n$ (dBA)	Resulting Ambient $L_{dn}$ (dBA)
Pos. 1	NSA #1: Residences approx. 610 ft. SSE of the Station site center	72.4	46.7	70.4
Pos. 2	NSA #2: Residences approx. 1,370 ft. north of Station site center	50.3	48.1	54.9
Pos. 3	NSA #3: Residences approx. 1,560 ft. east of the Station site center	50.1	46.9	54.0
Pos. 4	NSA #4: Residences approx. 900 ft. south of the Station site center	51.0	49.9	56.5
Pos. 5	NSA #5: Residences approx. 1,030 ft. SE of the Station site center	66.2	42.6	64.3
Pos. 6	NSA #6: Residences approx. 2,300 ft. SE of the Station site center	45.1	44.0	50.6
Pos. 7	NSA #7: Residences approx. 1,970 ft. ENE of the Station site center	46.9	41.3	49.1
Pos. 8	NSA #8: Residences approx. 2,400 ft. west of the Station site center	48.2	45.7	52.6
Pos. 9	NSA #9: Johnson School approx. 4,200 ft. ESE of Station site center	47.0	42.4	49.8

**Table A:** Summary of the Measured Ambient  $L_d$ , Measured Ambient  $L_n$  and Resulting Ambient  $L_{dn}$  at the Identified Receptors/NSAs based on the Most Recent Sound Survey, conducted 8/14/15.

The following **Table B** includes the measured daytime L90 and the measured nighttime L90 (considered the "lowest ambient sound level") along with the resulting DAQC A-wt. noise level guideline at the NSAs (i.e., based on "10 dBA above ambient limit" adopted by the MassDAQC).

Meas. Pos.	Identified Receptors/NSAs and Description of Sound Measurement Location near the Respective NSA	Meas'd Daytime L90 (dBA)	Meas'd Nighttime L90 (dBA)	Calc'd DAQC Noise Limit (dBA)
Pos. 1	NSA #1: Residences approx. 610 ft. SSE of the Station site center	66.4	44.8	54.8
Pos. 2	NSA #2: Residences approx. 1,370 ft. north of Station site center	46.8	46.8	56.8
Pos. 3	NSA #3: Residences approx. 1,560 ft. east of the Station site center	48.4	44.0	54.0
Pos. 4	NSA #4: Residences approx. 900 ft. south of the Station site center	49.3	48.5	58.5
Pos. 5	NSA #5: Residences approx. 1,030 ft. SE of the Station site center	55.1	41.3	51.3
Pos. 6	NSA #6: Residences approx. 2,300 ft. SE of the Station site center	42.6	41.4	51.4
Pos. 7	NSA #7: Residences approx. 1,970 ft. ENE of the Station site center	44.5	39.3	49.3
Pos. 8	NSA #8: Residences approx. 2,400 ft. west of the Station site center	46.1	44.5	54.5
Pos. 9	NSA #9: Johnson School approx. 4,200 ft. ESE of Station site center	43.3	41.0	51.0

**Table B:** Summary of Measured Ambient Daytime L90 (i.e., "Lowest Ambient Daytime Level") and Ambient Nighttime L90 (i.e., "Lowest Ambient Level") at the Identified Receptors/NSAs and Calculated DAQC Noise Limit based on the Lowest Ambient Level.

In our opinion, the measured ambient sound data adequately quantifies and is representative of the existing ambient environment at the identified receptors/NSAs for the meteorological conditions that occurred during the sound survey.

During the daytime ambient sound measurements near the NSAs, the audible noise sources that contributed to the measured ambient A-wt. sound level included primarily the noise of vehicle traffic (primarily traffic along Bridge Street), noise of industrial activity (e.g., noise of Power Plant and other industrial facilities in the area), and at times, some sound of insects and the noise of small boats in the river and waterways.

During the nighttime ambient sound measurements near the NSAs, the audible noise sources that contributed to the measured ambient A-wt. sound level included the noise of distant vehicle traffic (noise of traffic notably lower than during the daytime), the noise of industrial activity in the area, and at times, the sound of insects.

Note that there was no construction activities at the Fore River Bridge, as related to the Fore River Bridge Replacement Project, during the nighttime sound tests. In addition, the noise of construction activities at the Fore River Bridge during the daytime sound measurements did not appear to be a significant noise contributor to the daytime A-wt. sound levels since the noise of traffic along Bridge Street was the dominant noise contributor during the daytime sound tests.

## 6.0 **NOISE IMPACT ANALYSIS (COMPRESSOR STATION)**

The following section addresses the potential noise impact due to the full load operation of the Station at the identified receptors/NSAs. Also included is a noise assessment of the noise associated with a unit blowdown that occurs occasionally and a discussion perceptible vibration during Station operation. The noise contribution of the Station at more distant NSAs should be lower than the predicted noise level at the identified receptors/NSAs.

### 6.1 Sound Contribution of the Station

The acoustical analysis considers the noise produced by all continuously-operated equipment that could impact the sound contribution at the identified nine (9) receptors/NSAs. The following sound sources associated with the Station compressor installation were considered significant.

- Noise generated by the turbine/compressor that penetrates the Compressor Building;
- Noise of the turbine exhaust, which is considered the primary noise source that could generate perceptible vibration;
- Noise radiated from aboveground gas piping and associated components;
- Noise of the outdoor LO cooler;
- Noise generated by the turbine air intake system; and
- Noise of the outdoor gas aftercooler.

For this acoustical analysis, the sound contribution of the Station was estimated for the identified receptors/NSAs along with the total cumulative sound level at the receptors/NSAs [i.e., Station sound level contribution plus the measured ambient  $L_{dn}$  or the "lowest ambient sound level" (daytime or nighttime  $L_{90}$ )]. A description of the acoustical analysis methodology and source of sound data are provided in the **Appendix** (pp. 28–29). The acoustical analysis includes the effect of anticipated noise mitigation measures for the Station/equipment, as described in more detail in **Section 8.0**.

For those receptors in which there is mostly land between the receptor and Station (i.e., NSA #1, NSA #4, NSA #5, NSA #6, NSA #8 & NSA #9), **Tables 7–12 (Appendix, pp. 23–25)** provide the spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs at the respective NSA contributed by the Station if operated at full load. Also the total cumulative sound level at the respective NSA is estimated in these tables (i.e., Station sound level plus the lowest ambient sound level or ambient  $L_{dn}$ ). The spreadsheet analyses in **Tables 8–12** are based on the estimated Station sound level contribution at NSA #1 (i.e., **Table 7**), which is the closest NSA.

For those receptors in which there is a large body of water (e.g., Kings Cove or Weymouth Fore River) between the receptor and the Station (i.e., NSA #2, NSA #3 & NSA #7), the acoustical analysis in **Tables 13–15 (Appendix, pp. 26–27)** includes the estimated noise impact of the Station noise traveling over water along with the total cumulative sound level. The spreadsheet analyses in **Tables 14 & 15** are based on the estimated Station sound contribution at NSA #2 (i.e.,



**Table 13)**, which is the closest NSA with a large water body between the Station and receptor. The Station sound contribution for these NSAs were analyzed separately to address comments regarding the impact of Station noise traveling over a large body of water. The acoustical analysis methodology related to noise dispersion over water is discussed in more detail in the "description of the acoustical analysis methodology" (i.e., **Appendix**).

The following **Table C** summarizes the estimated A-wt. sound level contribution of the Station at the identified receptors/NSAs assuming full load operation of Station equipment along with the resulting  $L_{dn}$  of the Station, based on the estimated A-wt. sound level contribution.

Location (Receptor/NSA) and Operating Condition	Estimated A-Wt. Sound Level (dBA)	Resulting Ldn (dBA)
Est'd sound level contribution of the Station during full load at NSA #1	42.6	49.0
Est'd sound level contribution of the Station during full load at NSA #2	35.7	42.1
Est'd sound level contribution of the Station during full load at NSA #3	34.4	40.8
Est'd sound level contribution of the Station during full load at NSA #4	38.9	45.3
Est'd sound level contribution of the Station during full load at NSA #5	37.5	43.9
Est'd sound level contribution of the Station during full load at NSA #6	29.3	35.7
Est'd sound level contribution of the Station during full load at NSA #7	31.8	38.2
Est'd sound level contribution of the Station during full load at NSA #8	28.9	35.3
Est'd sound level contribution of the Station during full load at NSA #9	22.7	29.1

**Table C:** Estimated A-Wt. Sound Level Contribution of the Compressor Station and Resulting Ldn at the Identified Receptors/NSAs during Full Load Operation of the Station

## 6.2 Noise Impact of the Station compared to Lowest Ambient Daytime/Nighttime Levels

Based on the results of the ambient sound survey and acoustical analyses, the following **Table D** summarizes the measured ambient "lowest daytime levels" at the identified receptors/NSAs (i.e., based on L90 measurements), the estimated sound level contribution of the Station and the estimated noise increase above the lowest daytime levels at the identified receptors/NSAs.

Identified Receptor/NSA and Type of Receptor/NSA	Distance & Direction of Receptor/NSA	Measured Ambient Daytime L90 (dBA)	Est'd A-Wt. Sound Level of the Station at Full Load (dBA)	Est'd Station Sound Level + Ambient Daytime L90 (dBA)	Increase above Lowest Daytime Ambient (dB)
NSA #1 (Residences)	610 feet (SSE)	66.4	42.6	66.4	0.0
NSA #2 (Residences)	1,370 feet (north)	46.8	35.7	47.1	0.3
NSA #3 (Residences)	1,560 feet (east)	48.4	34.4	48.6	0.2
NSA #4 (Residences)	900 feet (south)	49.3	38.9	49.7	0.4
NSA #5 (Residences)	1,030 feet (SE)	55.1	37.5	55.2	0.1
NSA #6 (Residences)	2,300 feet (SE)	42.6	29.3	42.8	0.2
NSA #7 (Residences)	1,970 feet (ENE)	44.5	31.8	44.7	0.2
NSA #8 (Residences)	2,400 feet (west)	46.1	28.9	46.2	0.1
NSA #9 (School)	4,200 feet (ESE)	43.3	22.7	43.3	0.0

**Table D:** Estimated A-Wt. Sound Level Contribution of the Compressor Station at the Identified Receptors/NSAs and Potential Noise Increase above the Lowest Daytime Levels.

The following **Table E** summarizes the measured ambient "lowest nighttime level" at the identified receptors/NSAs (i.e., based on L90 measurements and considered to be the "lowest ambient level"), the estimated sound level contribution of the Station compared to the established DAQC Noise Limit and the estimated noise increase above the lowest ambient level at the identified receptors/NSAs.

Identified Receptor/NSA and Type of Receptor/NSA	Distance & Direction of Receptor/NSA	Measured Ambient Nighttime L90 (dBA)	Calc'd DAQC Noise Limit (dBA)	Est'd A-Wt. Sound Level of Station (dBA)	Est'd Station Level + Lowest Ambient Level (dBA)	Increase above Lowest Ambient Level (dB)
NSA #1 (Residences)	610 feet (SSE)	44.8	54.8	42.6	46.9	2.1
NSA #2 (Residences)	1,370 feet (north)	46.8	56.8	35.7	47.1	0.3
NSA #3 (Residences)	1,560 feet (east)	44.0	54.0	34.4	44.4	0.4
NSA #4 (Residences)	900 feet (south)	48.5	58.5	38.9	48.9	0.4
NSA #5 (Residences)	1,030 feet (SE)	41.3	51.3	37.5	42.8	1.5
NSA #6 (Residences)	2,300 feet (SE)	41.4	51.4	29.3	41.7	0.3
NSA #7 (Residences)	1,970 feet (ENE)	39.3	49.3	31.8	40.0	0.7
NSA #8 (Residences)	2,400 feet (west)	44.5	54.5	28.9	44.6	0.1
NSA #9 (School)	4,200 feet (ESE)	41.0	51.0	22.7	41.1	0.1

**Table E:** Estimated A-Wt. Sound Contribution of the Compressor Station at the Receptors/NSAs, as compared to the DAQC Noise Limit, and Noise Increase above the "Lowest Ambient Level".

Consequently, the results provided in **Table E** indicated that the noise generated by the Station should be notably lower than the MassDEP noise requirements. In addition, the results of the acoustical analyses (i.e., **Tables 7–15** in the **Appendix**) indicate the Station noise should meet the MassDEP noise guideline for pure tone noise condition.

Regarding the potential noise impact of the Station at the surrounding receptors/NSAs, if an intruding noise (e.g., noise generated by the Station during operation) causes less than a **3 dB** increase in the overall environmental (ambient) sound level at the receptors (i.e., defined as "increase above ambient level"), the noise generated by the Station should be barely perceivable by the human ear and should have minimum impact on the acoustical environment. As a result, since the estimated increase above the lowest ambient level should be less than **3 dB** at all of the identified receptors/NSAs, even during nighttime Station operation, the noise generated by the Station should have minimum noise impact at the surrounding receptors/NSAs.

### 6.3 Perceptible Vibration of the Station Compressor Unit

In general, the noise sources at the Station that could generate "perceptible vibration", such as the noise associated with the turbine exhaust, will be adequately mitigated to insure that the operation of the new compressor unit at the Station will not result in any increase in perceptible vibration (i.e., "direct", or "noise-induced") at any NSA. For clarification, in our opinion, the following defines "direct perceptible vibration" and "noise-induced perceptible vibration":

- "Direct perceptible vibration" is considered to be perceptible groundborne vibration generated by equipment operation (i.e., equipment vibration, which is in contact with the ground, transmitted to and through the ground); in general, the potential groundborne vibration due to the operation of a turbine-driven centrifugal compressor unit should be imperceptible, noting that any ground vibration due to this type of compressor unit during operation should only be perceptible at distances of less than 200 feet from the compressor unit.
- "Noise-induced perceptible vibration" or "airborne vibration" is low-frequency airborne noise that generates perceptible vibration (e.g., "rattling" of windows at a house; vibration of objects inside a house); note that low-frequency noise levels that generate airborne vibration may not be audible by the human ear (i.e., below the threshold for perception of the noise).

Regarding "noise-induced perceptible vibration", the acoustical analysis (RE: **Table 7**, p. 23) indicates that the low-frequency noise levels generated by the Station (i.e., unweighted O.B. SPL for the 31.5 Hz O.B. & 63 Hz O.B. center frequencies) at the closest NSA will be **63 dB** (31.5 Hz O.B. SPL) and **57 dB** (63 Hz O.B. SPL). Typically, low-frequency noise levels above **65 dB** (e.g., 31.5 Hz O.B. SPL & 63 Hz O.B. SPL) are potentially perceived as noise-induced vibration. Since the predicted low-frequency airborne noise levels at the closest NSAs should be below **65 dB**, there should not be any noise-induced perceptible vibration at any NSA.

In conclusion, there should not result in any increase in perceptible vibration (direct, or noise-induced) at any NSA since Station noise sources that could generate perceptible vibration will be adequately mitigated (i.e., turbine exhaust systems will include a 2-stage silencer system).

#### 6.4 Sound Contribution of a Unit Blowdown Event at the Station

The noise of a unit blowdown venting via a blowdown silencer will be specified to meet an A-wt. sound level of **60 dBA** at a distance of 300 feet. If this sound requirement is achieved, the noise of a unit blowdown will be approximately **46 dBA** (i.e.,  $L_{dn}$  of approximately **52 to 53 dBA**) at the closest NSA (NSA #1), located approximately 700 feet from the blowdown silencer, which would be significantly lower than **55 dBA** ( $L_{dn}$ ). Consequently, although the noise of a unit blowdown event could be slightly audible at the nearby NSAs, it is not expected to present a noise impact, noting also that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). A description of the acoustical analysis methodology and source of sound data related to blowdown noise are provided in the **Appendix** (p. 29)

#### 7.0 NOISE IMPACT ANALYSIS (SITE CONSTRUCTION ACTIVITIES)

The noise impact analysis of the construction-related activities at the Station site considers the noise produced by any significant sound sources associated with the primary construction equipment that could impact the sound contribution at the nearby NSAs. The predicted sound contribution of construction activities was performed only for the closest NSA (i.e., NSA #1). Construction of the Station will consist of earth work (e.g., site grading, clearing & grubbing) and

construction of the site buildings, and the highest level of construction noise would occur during earth work (i.e., period when the largest amount of construction equipment would operate).

**Table 16 (Appendix, p. 30)** shows the calculation of the estimated maximum A-wt. sound level at the closest NSA contributed by the construction activities for standard day propagating conditions. A description of the analysis methodology and source of sound data for the analysis of construction noise are provided in the **Appendix** (p. 31). The acoustical analysis indicates that the maximum A-wt. noise level of construction activities at the closest NSA would be equal to or less than **56 dBA** ( $L_{dn}$  of **54 dBA** since nighttime construction activities are not anticipated).

## 8.0 **NOISE CONTROL MEASURES AND EQUIPMENT SOUND REQUIREMENTS**

The following section provides recommended noise control measures and equipment sound requirements associated with the compressor installation along with other assumptions that may affect the noise and vibration generated by the Station during normal operation. It is anticipated that all of the recommended noise mitigation measures will be implemented by Algonquin, noting that Algonquin has successfully utilized these type of noise mitigation measures for similar situations/facilities and have proven to be very effective.

### 8.1 Building Enclosing the Turbine and Compressor

We understand that noise control measures will be applied to the building enclosing the turbine and compressor rather than to the equipment themselves. The following describes specific requirements and other items related to the building components.

- As a minimum, walls/roof should be constructed with an exterior skin of 22-gauge metal. In addition, building interior surfaces should be covered with a minimum of 6-inch thick "high-density" mineral wool (i.e., 6.0-8.0 pcf uniform density) covered with a perforated liner. Note that "low-density" insulation (e.g., 0.6 to 0.75 pcf density) should **not** be substituted for the high-density material;
- No windows or louvers should be installed in the building walls although a minimum number of skylights could be installed in the building roof to provide natural light. Personnel entry doors should be a **STC-36 sound rating**, even if glazing is employed, and should be self-closing and should seal well when closed. The large access door system ("roll-up door") should be consist of an insulated-type door (e.g., designed with 18-ga. exterior facing, 24-ga. backskin with insulation core), and should be installed on the West Side or North Side of the building;
- Building Ventilation: It is anticipated that the building air ventilation system will be designed with air supply fans mounted in the building walls along with roof-mounted air exhaust vents. Assuming this type of air ventilation system, the sound level for each wall air-supply fan should not exceed **50 dBA** at 50 feet, which will require that each supply fan employ an exterior dissipative-type silencer (e.g., 3-ft. length) and an acoustically-lined weatherhood.

## 8.2 Turbine Exhaust System

The turbine exhaust system for the Station compressor unit should include a silencer system that provides the following dynamic sound insertion loss ("DIL") values, which should minimize any perceptible increase in vibration.

**DIL Values for the Exhaust Muffler System in dB per Octave-Band (O.B.) Center Freq. (Hz)**

31.5	63	125	250	500	1000	2000	4000	8000
5	18	25	35	45	45	45	35	25

To meet the DIL values and minimize turbine exhaust noise, it is recommended two (2) exhaust silencers (i.e., 2-stage silencer system) be employed. For example, one (1) silencer section should be employed horizontally in the exhaust ducting located inside the Compressor Building ("1<sup>st</sup> stage horizontal silencer") and the other silencer section could be integrated into the vertical outdoor exhaust stack ("2<sup>nd</sup> stage vertical silencer"). If a CO converter is employed, which is anticipated, it is assumed that a CO converter system would be inserted upstream of the 1<sup>st</sup> stage silencer, inside the Compressor Building.

## 8.3 Aboveground Gas Piping and associated Components

The acoustical analysis indicates that noise control measures, such as acoustical pipe insulation, will be required for outdoor aboveground gas piping associated with the Station, noting that most of the Station gas piping will need to be located above ground. The following items associated with the gas piping and piping components should be addressed:

- Acoustical insulation should be employed for the aboveground suction and discharge piping for the new compressor unit and for aboveground piping associated with the new gas aftercooler. Acoustical pipe insulation should consist of 3-inch thick mineral wool or equivalent type of material (e.g., 6.0 to 8.0 pcf density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020-inch thick aluminum);
- All outdoor exposed pipe support guides for the outdoor aboveground piping should be covered with an acoustical material and/or acoustical cover. Aboveground valves located outdoors should be covered with an acoustical type of insulation/material. It is also recommended that the suction pipe strainer for the new compressor unit be removed soon after the unit is placed in service, if feasible.

#### 8.4 Lube Oil Cooler

The LO cooler should not exceed **58 dBA** at **50 feet** from the cooler perimeter at the full rated operating conditions (i.e., equivalent to a PWL of **92–93 dBA**), noting that a "standard" Solar LO cooler is not capable of meeting this sound requirement. Consequently, a "special" or "custom" Solar LO cooler will be required to meet the recommended sound requirement.

#### 8.5 Turbine Air Intake System

The turbine air intake system for the Station compressor unit should be designed with at least one (1) in-duct dissipative-type silencer (e.g., minimum 5-ft. length), and the silencer should be installed in the intake ductwork located inside the Compressor Building. The air intake silencer should be capable of providing the following DIL values.

DIL Values in dB per O.B. Center Frequency for the Turbine Air Intake System

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
2	5	12	15	30	45	50	60	60

#### 8.6 Gas Aftercooler

The sound level generated by the new multi-fan gas aftercooler should not exceed **62 dBA** at **50 feet** at the full rated operating conditions (i.e., all fans operating at maximum design speed). To meet this recommended sound requirement, the gas aftercooler will need to be designed with "low-noise" fans that operate at relatively low fan tip speeds. In addition, aboveground inlet pipe risers and inlet header for the gas cooler should be covered with acoustical pipe insulation but the outlet pipe risers should not have to be covered with acoustical pipe insulation.

#### 8.7 Station Unit Blowdown Silencer

The unit blowdown silencer should attenuate the unsilenced blowdown noise to a noise level equal to or less than **55 dBA** at 300 feet from the outlet of the silencer, which includes the noise radiated from the shell of the silencer during the blowdown event.

## 9.0 SUMMARY AND FINAL COMMENT

The following **Table F** summarizes the ambient noise environment at the Station site (i.e., ambient  $L_{dn}$ ), the estimated sound contribution of the Station during full load operation at the receptors/NSAs and the "total" cumulative sound level at the NSAs (i.e., Station sound level plus the ambient sound level). The results in **Table F** are defined as the "Noise Quality Analysis" for the Station.

Identified Receptor/NSA and Type of Receptor/NSA	Distance & Direction of Receptor/NSA	Ambient Ldn (dBA)	Est'd Sound Level (Ldn) of Station at Full Load (dBA)	Est'd Station Sound Level (Ldn) + Ambient Ldn (dBA)	Increase above Ambient Ldn (dB)
NSA #1 (Residences)	610 feet (SSE)	70.4	49.0	70.4	0.0
NSA #2 (Residences)	1,370 feet (north)	54.9	42.1	55.1	0.2
NSA #3 (Residences)	1,560 feet (east)	54.0	40.8	54.2	0.2
NSA #4 (Residences)	900 feet (south)	56.5	45.3	56.8	0.3
NSA #5 (Residences)	1,030 feet (SE)	64.3	43.9	64.3	0.0
NSA #6 (Residences)	2,300 feet (SE)	50.6	35.7	50.7	0.1
NSA #7 (Residences)	1,970 feet (ENE)	49.1	38.2	49.4	0.3
NSA #8 (Residences)	2,400 feet (west)	52.6	35.3	52.7	0.1
NSA #9 (School)	4,200 feet (ESE)	49.8	29.1	49.8	0.0

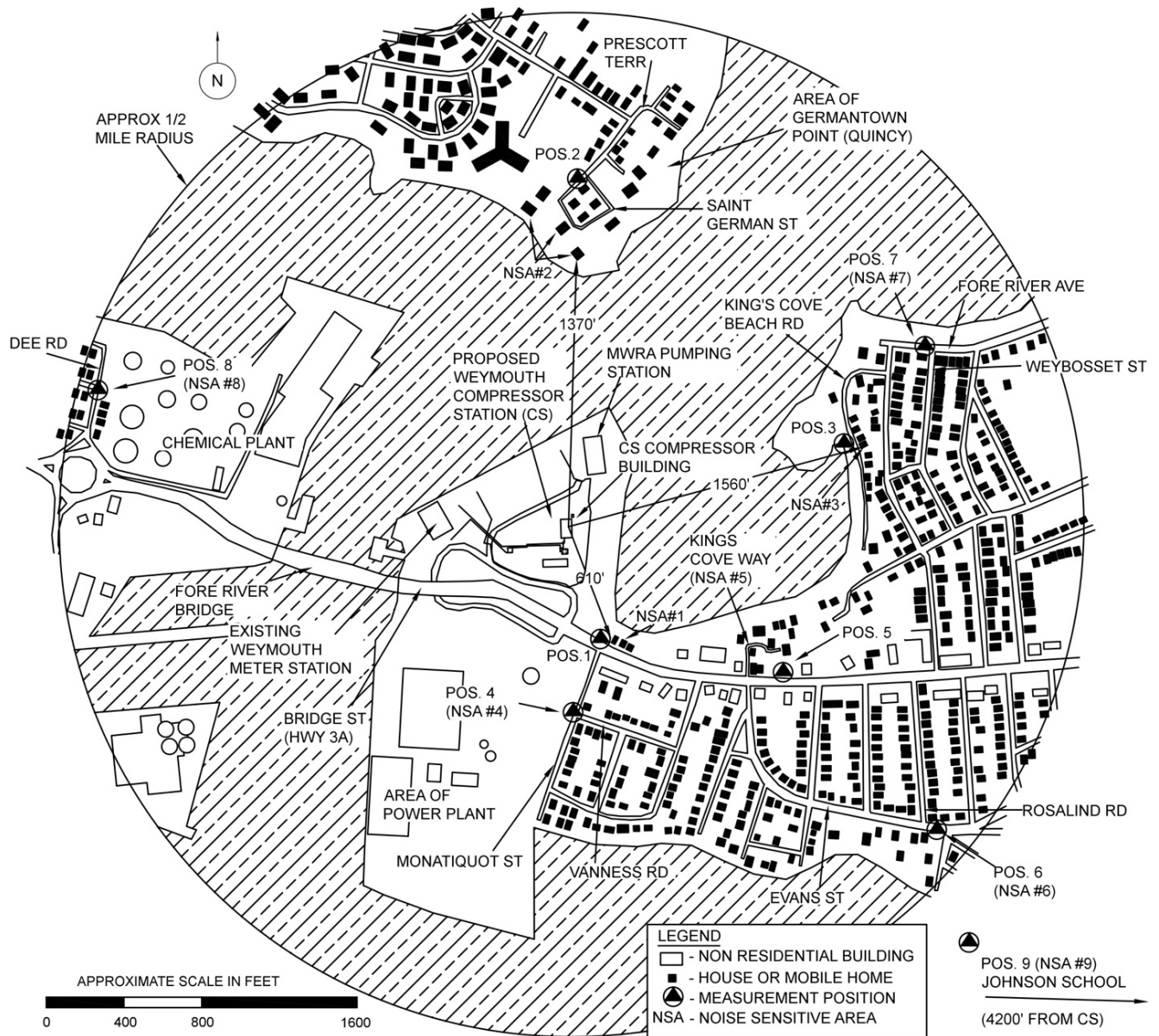
**Table F:** Noise Quality Analysis for the Weymouth Compressor Station associated with the AB Project

The acoustical analyses presented in this report indicate that the noise attributable to the **Weymouth Compressor Station** is estimated to be lower than **55 dBA ( $L_{dn}$ )** at all surrounding receptors/NSAs. Consequently, the noise generated by the Station should meet the anticipated FERC sound level requirement for the Station. In addition, the results of the acoustical analyses indicate that the Station sound contribution should also meet the MassDEP noise requirements, including the MassDEP noise guideline for pure tone noise condition, and the noise generated by the Station should have minimum noise impact at the surrounding receptors/NSAs, even during nighttime Station operation. The acoustical analyses also show that the noise of construction activities and the noise resulting from a unit blowdown event at the Station should have minimum noise impact on the surrounding environment. In addition, since the Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration (direct, or noise-induced) at any NSA during Station operation.

## **APPENDIX**

- **FIGURE 1: AREA LAYOUT SHOWING NSAs WITHIN APPROXIMATELY ½ MILE, LOCATION OF THE CHOSEN SOUND MEASUREMENT POSITIONS AT THE SURROUNDING RECEPTORS AND NSAs FOR THE MOST RECENT AMBIENT SOUND SURVEY**
- **FIGURE 2: CONCEPTUAL LOCATION OF STATION EQUIPMENT/BUILDINGS/PIPING AND STATION FENCELINE**
- **SUMMARY OF THE MEASURED AMBIENT SOUND DATA**
- **ACOUSTICAL ANALYSES (COMPRESSOR STATION)**
- **ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO THE STATION AND A BLOWDOWN EVENT) AND THE SOURCE OF SOUND DATA**
- **ACOUSTICAL ANALYSIS (CONSTRUCTION ACTIVITIES)**
- **DESCRIPTION OF THE ANALYSES METHODOLOGY (CONSTRUCTION ACTIVITIES) AND THE SOURCE OF SOUND DATA**





**Figure 1:** Weymouth Compressor Station: Area Layout showing Receptors/NSAs within 1/2 Mile Radius, Closest Identified NSAs, Conceptual Layout of the Station and Location of the Chosen Sound Measurements Positions near the Identified Receptors/NSAs.

**FIGURE 2 BOUND SEPARATELY UNDER VOLUME IV – CRITICAL ENERGY  
INFRASTRUCUTRE INFORMATION – NOT FOR PUBLIC RELEASE**

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)					Avg. of Daytime L90	Avg. of N-time L90	Notes/Observations
		Day-time Leq(Ld)	Avg'd of Ld	Night-time Leq(Ln)	Avg'd of Ln	Calc'd Ldn Note (1)			
Meas. Pos. & NSA	Date of Test								
Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site	(8/14/15)	71.9		47.2					Primary noise during day: traffic along Bridge Street, as would be expected
	(8/14/15)	72.8	72.4	46.6	46.7	70.4	66.4	44.8	
	(8/14/15)	72.4		46.3					Primary noise during night: industrial, insects, power plant, distant traffic
Pos. 2 (NSA #2) Residences in area of Germantown Point, 1,370 ft. north of CS Site	(8/14/15)	51.5		48.1					Primary noise during day: insects, industrial, and at times, sound of birds
	(8/14/15)	50.4	50.3	48.1	48.1	54.9	46.8	46.8	
	(8/14/15)	49.0		48.1					Primary noise during night: industrial & insects (no work at Fore River Bridge)
Pos. 3 (NSA #3) Residences along Kings Cove Beach Rd., 1,560 ft. east of CS Site	(8/14/15)	50.7		46.0					Primary noise during day: traffic along Bridge St., industrial, sound of waves
	(8/14/15)	50.0	50.1	46.2	46.9	54.0	48.4	44.0	
	(8/14/15)	49.5		48.7					Primary noise during night: industrial & traffic (no work at Fore River Bridge)
Pos. 4 (NSA #4) Residences at Vanness Road & Monatiquot St., 900 ft. south of CS Site	(8/14/15)	51.4		50.0					Primary noise during day: power plant & traffic on Bridge Street
	(8/14/15)	50.4	51.0	49.9	49.9	56.5	49.3	48.5	
	(8/14/15)	51.2		49.9					Primary noise during night: power plant & insects (no work at Fore River Bridge)
Pos. 5 (NSA #5) Residences along Kings Cove Way, 1,030 ft. SE of CS Site	(8/14/15)	64.5		42.4					Primary noise during day: traffic along Bridge Street, as would be expected
	(8/14/15)	70.6	66.2	42.2	42.6	64.3	55.1	41.3	
	(8/14/15)	63.4		43.1					Primary noise during night: industrial, power plant & insects
Pos. 6 (NSA #6) Residences at Evans Street & Rosalind Road, 2,300 ft. SE of CS Site	(8/14/15)	47.3		44.0					Primary noise during day: industrial, traffic along Bridge St. & insects
	(8/14/15)	44.4	45.1	43.6	44.0	50.6	42.6	41.4	
	(8/14/15)	43.6		44.4					Primary noise during night: distant traffic, industrial & some insects.
Pos. 7 (NSA #7) Residences at Fore River Ave. & Weybosset St., 1,970 ft. ENE of CS Site	(8/14/15)	45.2		41.1					Primary noise during day: industrial, distant small boats & some insects
	(8/14/15)	47.9	46.9	40.5	41.3	49.1	44.5	39.3	
	(8/14/15)	47.6		42.2					Primary noise during night: industrial & some sound of insects
Pos. 8 (NSA #8) Residences along Dee Road, 2,400 ft. west of CS Site	(8/14/15)	49.5		45.9					Primary noise during day: industrial, traffic along Bridge St. & some insects
	(8/14/15)	48.0	48.2	45.9	45.7	52.6	46.1	44.5	
	(8/14/15)	47.1		45.4					Primary noise during night: industrial, distant traffic & some insects
Pos. 9 (NSA #9) Johnson School, approx. 4,200 ft. ESE of the CS Site	(8/14/15)	47.2		42.7					Primary noise during day: distant traffic and at times, sound of wind in trees.
	(8/14/15)	47.6	47.0	42.2	42.4	49.8	43.3	41.0	
	(8/14/15)	46.3		42.2					Primary noise during night: distant traffic and at times, sound of insects

**Table 1: Site of Weymouth Compressor Station ("CS Site"): Summary of Measured Ambient Daytime Sound Levels (Ld), Daytime L90, Ambient Nighttime Sound Levels (Ln) and Nighttime L90 at the Receptors/NSAs as Measured on August 14, 2014 along with Resulting Ambient Ldn.**

Note (1): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{dn} = 10 \log_{10} \left( \frac{15}{24} 10^{L_d/10} + \frac{9}{24} 10^{(L_n+10)/10} \right)$$

Note (2): Nighttime L90 levels were measured between 12:00 AM & 3:00 AM and represents lowest ambient A-wt. sound level

Measurement Set		Temp. (°F)	R.H. (%)	Wind Direction	Wind Speed	Peak Wind	Sky Conditions
Meas. Positions/Period	Time Frame/Date of Tests						
Pos. 1 to 9 (Daytime)	10:00 AM to 12:30 PM (8/14/15)	78	47	From the south	1-3 mph	3 mph	Clear Skies
Pos. 1 to 9 (Nighttime)	12:00 AM to 3:00 AM (8/14/15)	71	61	From the east	0-1 mph	2 mph	Clear Skies

**Table 2: Site of Weymouth Compressor Station: Summary of the Meteorological Conditions during the Sound Survey on August 14, 2015.**

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Freq. (in Hz)										A-Wt.
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	Level	
Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site	12:25 PM (8/14/15)	70.0	68.2	64.8	63.1	66.0	69.6	64.5	55.9	47.0	71.9	
	12:26 PM (8/14/15)	73.3	73.2	70.5	67.2	68.0	70.2	64.9	56.5	48.5	72.8	
	12:27 PM (8/14/15)	69.1	72.0	69.0	67.4	65.7	70.1	64.7	55.5	47.1	72.4	
	Avg. A-Wt. & SPL	70.8	71.1	68.1	65.9	66.6	70.0	64.7	56.0	47.5	72.4	
Pos. 2 (NSA #2) Residences in area of Germantown Point, 1,370 ft. north of CS Site	10:57 AM (8/14/15)	71.2	61.2	56.2	49.0	42.9	41.9	39.2	44.8	47.4	51.5	
	10:58 AM (8/14/15)	71.5	61.1	56.5	51.8	46.4	41.7	36.9	39.7	43.9	50.4	
	11:00 AM (8/14/15)	72.1	61.3	56.1	49.7	44.6	42.4	37.4	37.5	38.3	49.0	
	Avg. A-Wt. & SPL	71.6	61.2	56.3	50.2	44.6	42.0	37.8	40.7	43.2	50.3	
Pos. 3 (NSA #3) Residences along Kings Cove Beach Rd., 1,560 ft. east of CS Site	12:01 PM (8/14/15)	63.0	63.5	60.9	49.9	44.8	45.9	39.0	33.7	27.5	50.7	
	12:02 PM (8/14/15)	62.6	64.3	61.5	50.0	43.3	43.6	38.2	33.1	28.2	50.0	
	12:03 PM (8/14/15)	63.2	62.8	58.8	48.7	44.0	44.4	39.1	35.3	30.1	49.5	
	Avg. A-Wt. & SPL	62.9	63.5	60.4	49.5	44.0	44.6	38.8	34.0	28.6	50.1	
Pos. 4 (NSA #4) Residences at Vanness Road & Monatiquot St., 900 ft. south of CS Site	12:16 PM (8/14/15)	64.7	64.2	60.4	51.0	46.0	46.6	41.9	33.4	28.1	51.4	
	12:17 PM (8/14/15)	64.7	63.8	57.5	49.9	44.8	46.1	41.5	33.2	27.1	50.4	
	12:18 PM (8/14/15)	64.7	63.9	57.9	51.8	46.5	46.6	41.6	33.6	25.5	51.2	
	Avg. A-Wt. & SPL	64.7	64.0	58.6	50.9	45.8	46.4	41.7	33.4	26.9	51.0	
Pos. 5 (NSA #5) Residences along Kings Cove Way, 1,030 ft. SE of CS Site	12:08 PM (8/14/15)	65.3	64.3	58.8	57.2	58.7	62.6	55.7	46.6	39.7	64.5	
	12:11 PM (8/14/15)	64.8	72.7	66.1	64.1	66.0	68.3	62.2	53.3	44.4	70.6	
	12:12 PM (8/14/15)	62.9	60.8	57.9	57.2	58.8	61.4	53.9	44.9	36.2	63.4	
	Avg. A-Wt. & SPL	64.3	65.9	60.9	59.5	61.2	64.1	57.3	48.3	40.1	66.2	
Pos. 6 (NSA #6) Residences at Evans Street & Rosalind Road, 2,300 ft. SE of CS Site	11:26 AM (8/14/15)	54.0	56.0	53.2	46.6	41.5	42.7	39.1	36.3	29.6	47.3	
	11:30 AM (8/14/15)	54.1	55.3	52.3	44.9	39.6	38.8	34.9	31.9	27.1	44.4	
	11:37 AM (8/14/15)	52.2	54.8	50.9	43.2	38.5	38.2	34.9	32.4	24.5	43.6	
	Avg. A-Wt. & SPL	53.4	55.4	52.1	44.9	39.9	39.9	36.3	33.5	27.1	45.1	
Pos. 7 (NSA #7) Residences at Fore River Ave. & Weybosset St., 1,970 ft. ENE of CS Site	11:54 AM (8/14/15)	56.6	58.0	55.7	47.6	41.1	36.3	32.2	28.6	32.4	45.2	
	11:55 AM (8/14/15)	57.8	61.9	59.4	50.6	43.0	39.2	32.7	27.7	24.1	47.9	
	11:57 AM (8/14/15)	58.5	60.4	60.8	49.2	39.6	37.8	33.5	27.4	20.7	47.6	
	Avg. A-Wt. & SPL	57.6	60.1	58.6	49.1	41.2	37.8	32.8	27.9	25.7	46.9	
Pos. 8 (NSA #8) Residences along Dee Road, 2,400 ft. west of CS Site	11:15 AM (8/14/15)	60.2	59.3	54.4	48.2	45.1	43.4	40.9	40.9	34.1	49.5	
	11:17 AM (8/14/15)	60.6	58.9	53.3	46.0	42.3	42.0	39.4	40.2	33.1	48.0	
	11:18 AM (8/14/15)	59.3	59.4	53.2	46.2	40.7	41.1	38.2	39.1	32.1	47.1	
	Avg. A-Wt. & SPL	60.0	59.2	53.6	46.8	42.7	42.2	39.5	40.1	33.1	48.2	
Pos. 9 (NSA #9) Johnson School, approx. 4,200 ft. ESE of the CS Site	11:44 AM (8/14/15)	56.2	53.6	52.8	46.0	41.6	41.3	38.6	38.8	35.4	47.2	
	11:47 AM (8/14/15)	54.5	53.7	53.0	45.9	42.7	43.5	39.0	35.1	30.1	47.6	
	11:48 AM (8/14/15)	50.9	52.8	54.0	48.9	40.2	41.0	37.0	31.2	25.7	46.3	
	Avg. A-Wt. & SPL	53.9	53.4	53.3	46.9	41.5	41.9	38.2	35.0	30.4	47.0	

**Table 3: Weymouth Compressor Station: Measured Ambient Daytime Leq (Ld) and associated Ambient Unweighted Octave-Band (O.B.) SPLs at Receptors/NSAs, as Meas'd on 8/14/15.**

Algonquin AB Project and new Weymouth Compressor Station ("Station")  
Results of Most Recent Sound Survey and Updated Acoustical Analysis

Hoover & Keith Inc.  
H&K Job No. 4818  
H&K Report No. 3316 (Date: 10/05/15)

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Freq. (in Hz)										A-Wt. Level
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000		
Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site	2:01 AM (8/14/15)	62.0	58.8	53.1	44.8	41.8	39.6	42.5	31.7	23.6		47.2
	2:04 AM (8/14/15)	60.2	58.3	52.3	44.7	41.1	38.4	42.2	31.3	20.2		46.6
	2:14 AM (8/14/15)	60.3	58.9	53.4	45.1	40.7	38.2	41.0	32.3	20.6		46.3
	<b>Avg. A-Wt. &amp; SPL</b>	<b>60.8</b>	<b>58.7</b>	<b>52.9</b>	<b>44.9</b>	<b>41.2</b>	<b>38.7</b>	<b>41.9</b>	<b>31.8</b>	<b>21.5</b>		<b>46.7</b>
Pos. 2 (NSA #2) Residences in area of Germantown Point, 1,370 ft. north of CS Site	12:21 AM (8/14/15)	63.7	59.1	55.8	49.3	42.9	42.1	40.2	32.8	25.2		48.1
	12:22 AM (8/14/15)	62.8	59.3	56.0	49.4	43.2	41.6	40.2	32.9	25.2		48.1
	12:24 AM (8/14/15)	62.8	58.8	55.8	49.2	43.1	41.8	40.5	33.6	25.4		48.1
	<b>Avg. A-Wt. &amp; SPL</b>	<b>63.1</b>	<b>59.1</b>	<b>55.9</b>	<b>49.3</b>	<b>43.1</b>	<b>41.8</b>	<b>40.3</b>	<b>33.1</b>	<b>25.3</b>		<b>48.1</b>
Pos. 3 (NSA #3) Residences along Kings Cove Beach Rd., 1,560 ft. east of CS Site	1:34 AM (8/14/15)	58.6	57.7	53.8	43.1	39.5	39.6	40.3	32.3	20.6		46.0
	1:36 AM (8/14/15)	58.1	57.1	53.7	43.4	39.7	39.7	40.7	32.6	21.7		46.2
	1:37 AM (8/14/15)	57.6	56.8	52.9	44.1	40.6	45.4	42.2	34.3	21.4		48.7
	<b>Avg. A-Wt. &amp; SPL</b>	<b>58.1</b>	<b>57.2</b>	<b>53.5</b>	<b>43.5</b>	<b>39.9</b>	<b>41.6</b>	<b>41.1</b>	<b>33.1</b>	<b>21.2</b>		<b>46.9</b>
Pos. 4 (NSA #4) Residences at Vanness Road & Monatiquot St., 900 ft. south of CS Site	1:55 AM (8/14/15)	63.3	60.7	54.4	48.1	44.4	43.7	44.6	38.2	28.4		50.0
	1:56 AM (8/14/15)	63.1	60.9	55.0	48.1	44.8	43.9	43.7	37.7	29.1		49.9
	1:57 AM (8/14/15)	63.8	61.0	54.8	48.0	45.0	43.7	44.2	36.5	28.0		49.9
	<b>Avg. A-Wt. &amp; SPL</b>	<b>63.4</b>	<b>60.9</b>	<b>54.7</b>	<b>48.1</b>	<b>44.7</b>	<b>43.8</b>	<b>44.2</b>	<b>37.5</b>	<b>28.5</b>		<b>49.9</b>
Pos. 5 (NSA #5) Residences along Kings Cove Way, 1,030 ft. SE of CS Site	1:48 AM (8/14/15)	52.1	53.2	49.3	43.9	37.3	37.1	33.5	27.3	23.8		42.4
	1:50 AM (8/14/15)	52.2	53.6	49.9	44.5	37.8	35.4	33.0	27.5	23.8		42.2
	1:51 AM (8/14/15)	52.8	53.6	50.9	45.1	38.5	37.1	33.9	27.9	24.7		43.1
	<b>Avg. A-Wt. &amp; SPL</b>	<b>52.4</b>	<b>53.5</b>	<b>50.0</b>	<b>44.5</b>	<b>37.9</b>	<b>36.5</b>	<b>33.5</b>	<b>27.6</b>	<b>24.1</b>		<b>42.6</b>
Pos. 6 (NSA #6) Residences at Evans Street & Rosalind Road, 2,300 ft. SE of CS Site	1:06 AM (8/14/15)	52.9	54.2	48.9	42.5	38.3	38.1	32.5	38.0	25.0		44.0
	1:08 AM (8/14/15)	51.7	52.6	48.0	42.6	36.8	37.2	31.7	38.5	25.5		43.6
	1:10 AM (8/14/15)	51.1	52.9	48.7	43.0	37.7	38.9	32.2	38.8	26.5		44.4
	<b>Avg. A-Wt. &amp; SPL</b>	<b>51.9</b>	<b>53.2</b>	<b>48.5</b>	<b>42.7</b>	<b>37.6</b>	<b>38.1</b>	<b>32.1</b>	<b>38.4</b>	<b>25.7</b>		<b>44.0</b>
Pos. 7 (NSA #7) Residences at Fore River Ave. & Weybosset St., 1,970 ft. ENE of CS Site	1:25 AM (8/14/15)	56.7	52.8	47.5	41.9	37.7	36.2	30.9	25.0	18.9		41.1
	1:27 AM (8/14/15)	56.1	53.2	47.6	40.4	36.5	35.8	30.2	24.6	18.3		40.5
	1:28 AM (8/14/15)	56.2	52.7	46.6	42.1	38.2	38.5	31.7	25.1	19.3		42.2
	<b>Avg. A-Wt. &amp; SPL</b>	<b>56.3</b>	<b>52.9</b>	<b>47.2</b>	<b>41.5</b>	<b>37.5</b>	<b>36.8</b>	<b>30.9</b>	<b>24.9</b>	<b>18.8</b>		<b>41.3</b>
Pos. 8 (NSA #8) Residences along Dee Road, 2,400 ft. west of CS Site	12:44 AM (8/14/15)	57.1	54.0	49.0	42.3	37.4	37.6	36.1	41.6	33.7		45.9
	12:45 AM (8/14/15)	57.0	53.6	47.7	41.2	37.1	37.8	36.5	41.7	33.9		45.9
	12:47 AM (8/14/15)	57.0	53.3	47.2	40.3	36.6	36.9	35.4	41.6	33.8		45.4
	<b>Avg. A-Wt. &amp; SPL</b>	<b>57.0</b>	<b>53.6</b>	<b>48.0</b>	<b>41.3</b>	<b>37.0</b>	<b>37.4</b>	<b>36.0</b>	<b>41.6</b>	<b>33.8</b>		<b>45.7</b>
Pos. 9 (NSA #9) Johnson School, approx. 4,200 ft. ESE of the CS Site	1:15 AM (8/14/15)	51.2	55.2	49.0	41.7	37.0	36.7	35.5	32.5	24.3		42.7
	1:16 AM (8/14/15)	50.4	54.6	49.2	41.0	36.8	36.1	34.0	32.8	24.8		42.2
	1:18 AM (8/14/15)	51.1	54.5	50.1	41.4	37.2	34.9	34.2	32.8	23.8		42.2
	<b>Avg. A-Wt. &amp; SPL</b>	<b>50.9</b>	<b>54.8</b>	<b>49.4</b>	<b>41.4</b>	<b>37.0</b>	<b>35.9</b>	<b>34.6</b>	<b>32.7</b>	<b>24.3</b>		<b>42.4</b>

**Table 4:** Weymouth Compressor Station: Measured Ambient Nighttime Leq (Ln) and associated Ambient Unweighted Octave-Band (O.B.) SPLs at Receptors/NSAs, as Meas'd on 8/14/15.

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Freq. (in Hz)									A-Wt. Level
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	
Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site	12:25 PM (8/14/15)	66.1	64.9	61.0	58.8	60.5	65.3	60.1	51.0	40.9	67.4
	12:26 PM (8/14/15)	68.5	67.8	62.7	60.9	58.7	63.9	57.9	47.8	37.8	65.9
	12:27 PM (8/14/15)	66.1	65.3	61.2	58.9	58.2	63.9	58.0	47.2	35.7	65.8
	<b>Avg. A-Wt. &amp; SPL</b>	<b>66.9</b>	<b>66.0</b>	<b>61.6</b>	<b>59.5</b>	<b>59.1</b>	<b>64.4</b>	<b>58.7</b>	<b>48.7</b>	<b>38.1</b>	<b>66.4</b>
Pos. 2 (NSA #2) Residences in area of Germantown Point, 1,370 ft. north of CS Site	10:57 AM (8/14/15)	68.4	59.5	54.7	47.3	41.5	40.5	36.8	37.1	31.3	46.9
	10:58 AM (8/14/15)	68.7	59.1	54.7	47.0	42.0	40.1	35.6	35.8	30.7	46.5
	11:00 AM (8/14/15)	69.9	59.3	54.5	47.9	42.7	40.5	36.4	35.1	32.4	47.0
	<b>Avg. A-Wt. &amp; SPL</b>	<b>69.0</b>	<b>59.3</b>	<b>54.6</b>	<b>47.4</b>	<b>42.1</b>	<b>40.4</b>	<b>36.3</b>	<b>36.0</b>	<b>31.5</b>	<b>46.8</b>
Pos. 3 (NSA #3) Residences along Kings Cove Beach Rd., 1,560 ft. east of CS Site	12:01 PM (8/14/15)	60.3	61.4	57.6	48.2	43.8	44.4	37.9	31.9	24.7	48.8
	12:02 PM (8/14/15)	59.5	61.8	59.2	48.1	42.2	42.5	37.2	31.6	24.5	48.3
	12:03 PM (8/14/15)	58.6	60.3	56.9	47.2	43.0	43.0	37.9	33.2	27.3	48.0
	<b>Avg. A-Wt. &amp; SPL</b>	<b>59.5</b>	<b>61.2</b>	<b>57.9</b>	<b>47.8</b>	<b>43.0</b>	<b>43.3</b>	<b>37.7</b>	<b>32.2</b>	<b>25.5</b>	<b>48.4</b>
Pos. 4 (NSA #4) Residences at Vanness Road & Monatiquot St., 900 ft. south of CS Site	12:16 PM (8/14/15)	62.0	62.1	57.8	49.4	44.3	44.4	39.8	31.7	25.8	49.3
	12:17 PM (8/14/15)	61.9	61.8	56.0	48.5	43.6	44.8	40.3	31.0	25.1	49.0
	12:18 PM (8/14/15)	62.2	62.1	56.3	49.5	44.4	45.4	40.6	32.3	22.8	49.6
	<b>Avg. A-Wt. &amp; SPL</b>	<b>62.0</b>	<b>62.0</b>	<b>56.7</b>	<b>49.1</b>	<b>44.1</b>	<b>44.9</b>	<b>40.2</b>	<b>31.7</b>	<b>24.6</b>	<b>49.3</b>
Pos. 5 (NSA #5) Residences along Kings Cove Way, 1,030 ft. SE of CS Site	12:08 PM (8/14/15)	59.7	57.2	53.1	49.1	46.6	48.0	42.0	34.1	26.3	51.0
	12:11 PM (8/14/15)	60.5	59.6	57.8	56.9	54.5	58.4	53.1	45.5	36.4	60.9
	12:12 PM (8/14/15)	59.7	57.4	54.0	51.2	48.4	51.1	43.5	35.2	28.1	53.4
	<b>Avg. A-Wt. &amp; SPL</b>	<b>60.0</b>	<b>58.1</b>	<b>55.0</b>	<b>52.4</b>	<b>49.8</b>	<b>52.5</b>	<b>46.2</b>	<b>38.3</b>	<b>30.3</b>	<b>55.1</b>
Pos. 6 (NSA #6) Residences at Evans Street & Rosalind Road, 2,300 ft. SE of CS Site	11:26 AM (8/14/15)	51.5	53.9	50.7	43.3	39.7	40.5	35.8	30.5	24.3	44.6
	11:30 AM (8/14/15)	50.3	52.8	49.9	42.8	37.8	36.5	31.8	30.2	25.4	42.1
	11:37 AM (8/14/15)	49.4	52.9	49.3	41.8	36.6	35.5	30.6	26.5	21.6	41.0
	<b>Avg. A-Wt. &amp; SPL</b>	<b>50.4</b>	<b>53.2</b>	<b>50.0</b>	<b>42.6</b>	<b>38.0</b>	<b>37.5</b>	<b>32.7</b>	<b>29.1</b>	<b>23.8</b>	<b>42.6</b>
Pos. 7 (NSA #7) Residences at Fore River Ave. & Weybosset St., 1,970 ft. ENE of CS Site	11:54 AM (8/14/15)	54.3	55.5	52.7	43.1	37.8	34.7	30.0	24.8	17.3	42.0
	11:55 AM (8/14/15)	55.5	58.2	57.3	49.2	40.4	37.6	30.8	24.9	17.5	45.9
	11:57 AM (8/14/15)	56.4	58.8	58.2	47.7	38.6	36.6	31.7	25.9	18.9	45.6
	<b>Avg. A-Wt. &amp; SPL</b>	<b>55.4</b>	<b>57.5</b>	<b>56.1</b>	<b>46.7</b>	<b>38.9</b>	<b>36.3</b>	<b>30.8</b>	<b>25.2</b>	<b>17.9</b>	<b>44.5</b>
Pos. 8 (NSA #8) Residences along Dee Road, 2,400 ft. west of CS Site	11:15 AM (8/14/15)	57.3	56.9	52.0	44.5	41.4	41.3	37.8	39.1	32.6	46.9
	11:17 AM (8/14/15)	57.0	56.9	51.4	44.0	40.8	40.6	37.7	39.1	31.7	46.5
	11:18 AM (8/14/15)	56.7	57.0	50.9	43.3	39.0	38.5	35.5	38.1	30.5	45.0
	<b>Avg. A-Wt. &amp; SPL</b>	<b>57.0</b>	<b>56.9</b>	<b>51.4</b>	<b>43.9</b>	<b>40.4</b>	<b>40.1</b>	<b>37.0</b>	<b>38.8</b>	<b>31.6</b>	<b>46.1</b>
Pos. 9 (NSA #9) Johnson School, approx. 4,200 ft. ESE of the CS Site	11:44 AM (8/14/15)	50.5	50.4	49.7	42.7	38.4	38.0	35.8	33.7	29.1	43.6
	11:47 AM (8/14/15)	50.0	50.8	50.2	42.9	39.8	40.6	36.8	31.1	22.7	44.7
	11:48 AM (8/14/15)	47.4	50.2	48.5	41.8	36.4	36.9	33.6	26.4	18.2	41.6
	<b>Avg. A-Wt. &amp; SPL</b>	<b>49.3</b>	<b>50.5</b>	<b>49.5</b>	<b>42.5</b>	<b>38.2</b>	<b>38.5</b>	<b>35.4</b>	<b>30.4</b>	<b>23.3</b>	<b>43.3</b>

**Table 5: Weymouth Compressor Station: Measured Ambient Daytime L90 and associated Ambient Unweighted Octave-Band (O.B.) SPLs at Receptors/NSAs, as Meas'd on 8/14/15.**



Algonquin AB Project and new Weymouth Compressor Station ("Station")  
Results of Most Recent Sound Survey and Updated Acoustical Analysis

Hoover & Keith Inc.  
H&K Job No. 4818  
H&K Report No. 3316 (Date: 10/05/15)

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Freq. (in Hz)									A-Wt. Level
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	
Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site	2:01 AM (8/14/15)	58.3	56.6	51.0	42.7	39.9	37.7	40.5	30.4	19.8	45.2
	2:04 AM (8/14/15)	57.2	56.1	50.8	43.3	40.0	37.2	40.3	29.7	19.5	45.0
	2:14 AM (8/14/15)	57.3	56.5	51.1	43.2	39.1	35.8	39.3	30.1	19.3	44.3
	<b>Avg. A-Wt. &amp; SPL</b>	<b>57.6</b>	<b>56.4</b>	<b>51.0</b>	<b>43.1</b>	<b>39.7</b>	<b>36.9</b>	<b>40.0</b>	<b>30.1</b>	<b>19.5</b>	<b>44.8</b>
Pos. 2 (NSA #2) Residences in area of Germantown Point, 1,370 ft. north of CS Site	12:21 AM (8/14/15)	60.0	57.1	54.3	48.1	42.0	40.9	38.9	32.1	24.5	46.9
	12:22 AM (8/14/15)	59.2	57.1	54.5	48.1	41.9	40.4	38.9	32.2	24.0	46.8
	12:24 AM (8/14/15)	59.2	56.9	54.3	48.1	41.9	40.4	39.3	32.6	24.5	46.8
	<b>Avg. A-Wt. &amp; SPL</b>	<b>59.5</b>	<b>57.0</b>	<b>54.4</b>	<b>48.1</b>	<b>41.9</b>	<b>40.6</b>	<b>39.0</b>	<b>32.3</b>	<b>24.3</b>	<b>46.8</b>
Pos. 3 (NSA #3) Residences along Kings Cove Beach Rd., 1,560 ft. east of CS Site	1:34 AM (8/14/15)	55.3	55.5	52.0	41.9	38.6	36.3	38.3	30.1	19.6	43.9
	1:36 AM (8/14/15)	55.0	55.1	51.7	41.8	38.8	36.4	38.2	30.3	19.6	43.9
	1:37 AM (8/14/15)	54.5	55.0	51.4	42.0	39.1	36.7	38.6	31.2	20.0	44.1
	<b>Avg. A-Wt. &amp; SPL</b>	<b>54.9</b>	<b>55.2</b>	<b>51.7</b>	<b>41.9</b>	<b>38.8</b>	<b>36.5</b>	<b>38.4</b>	<b>30.5</b>	<b>19.7</b>	<b>44.0</b>
Pos. 4 (NSA #4) Residences at Vanness Road & Monatiquot St., 900 ft. south of CS Site	1:55 AM (8/14/15)	60.4	58.6	53.0	46.7	43.2	42.5	43.2	36.2	27.1	48.6
	1:56 AM (8/14/15)	60.1	59.0	53.5	46.8	42.9	42.5	42.3	35.6	27.1	48.3
	1:57 AM (8/14/15)	60.6	58.9	53.2	46.4	43.4	42.5	42.8	35.1	26.4	48.5
	<b>Avg. A-Wt. &amp; SPL</b>	<b>60.4</b>	<b>58.8</b>	<b>53.2</b>	<b>46.6</b>	<b>43.2</b>	<b>42.5</b>	<b>42.8</b>	<b>35.6</b>	<b>26.9</b>	<b>48.5</b>
Pos. 5 (NSA #5) Residences along Kings Cove Way, 1,030 ft. SE of CS Site	1:48 AM (8/14/15)	49.3	51.2	48.0	42.8	36.1	34.6	32.3	26.6	21.3	40.8
	1:50 AM (8/14/15)	49.5	51.7	48.5	43.5	37.0	34.6	32.3	26.8	21.3	41.2
	1:51 AM (8/14/15)	50.1	51.6	49.4	43.4	37.7	35.8	33.2	27.1	22.5	41.9
	<b>Avg. A-Wt. &amp; SPL</b>	<b>49.6</b>	<b>51.5</b>	<b>48.6</b>	<b>43.2</b>	<b>36.9</b>	<b>35.0</b>	<b>32.6</b>	<b>26.8</b>	<b>21.7</b>	<b>41.3</b>
Pos. 6 (NSA #6) Residences at Evans Street & Rosalind Road, 2,300 ft. SE of CS Site	1:06 AM (8/14/15)	49.9	52.3	47.4	41.0	36.8	36.3	30.5	33.2	21.1	41.5
	1:08 AM (8/14/15)	49.1	50.6	46.4	40.3	35.2	36.0	30.5	34.1	21.9	41.2
	1:10 AM (8/14/15)	48.8	51.0	46.7	41.0	36.2	36.9	30.4	33.2	21.4	41.5
	<b>Avg. A-Wt. &amp; SPL</b>	<b>49.3</b>	<b>51.3</b>	<b>46.8</b>	<b>40.8</b>	<b>36.1</b>	<b>36.4</b>	<b>30.5</b>	<b>33.5</b>	<b>21.5</b>	<b>41.4</b>
Pos. 7 (NSA #7) Residences at Fore River Ave. & Weybosset St., 1,970 ft. ENE of CS Site	1:25 AM (8/14/15)	54.0	50.8	46.0	40.2	36.1	33.8	28.8	22.8	16.7	39.2
	1:27 AM (8/14/15)	53.3	51.2	45.2	38.6	34.6	33.4	28.2	22.6	16.5	38.3
	1:28 AM (8/14/15)	52.8	50.8	45.1	40.8	36.2	36.3	30.0	23.4	16.4	40.2
	<b>Avg. A-Wt. &amp; SPL</b>	<b>53.4</b>	<b>50.9</b>	<b>45.4</b>	<b>39.9</b>	<b>35.6</b>	<b>34.5</b>	<b>29.0</b>	<b>22.9</b>	<b>16.5</b>	<b>39.3</b>
Pos. 8 (NSA #8) Residences along Dee Road, 2,400 ft. west of CS Site	12:44 AM (8/14/15)	54.6	52.0	47.2	40.0	36.2	36.6	35.2	40.2	32.6	44.5
	12:45 AM (8/14/15)	54.5	51.6	46.1	39.4	35.7	36.6	35.1	40.6	32.8	44.6
	12:47 AM (8/14/15)	54.6	51.3	45.7	38.9	35.5	36.2	34.6	40.5	32.6	44.4
	<b>Avg. A-Wt. &amp; SPL</b>	<b>54.6</b>	<b>51.6</b>	<b>46.3</b>	<b>39.4</b>	<b>35.8</b>	<b>36.5</b>	<b>35.0</b>	<b>40.4</b>	<b>32.7</b>	<b>44.5</b>
Pos. 9 (NSA #9) Johnson School, approx. 4,200 ft. ESE of the CS Site	1:15 AM (8/14/15)	47.4	53.4	47.9	40.2	35.5	34.7	33.7	31.3	22.7	41.1
	1:16 AM (8/14/15)	47.7	53.0	48.0	40.0	35.8	34.4	33.4	31.6	23.4	41.1
	1:18 AM (8/14/15)	48.3	52.8	48.4	40.3	36.1	33.5	33.2	31.6	22.1	40.9
	<b>Avg. A-Wt. &amp; SPL</b>	<b>47.8</b>	<b>53.1</b>	<b>48.1</b>	<b>40.2</b>	<b>35.8</b>	<b>34.2</b>	<b>33.4</b>	<b>31.5</b>	<b>22.7</b>	<b>41.0</b>

**Table 6: Weymouth Compressor Station: Measured Ambient Nighttime L90 and associated Ambient Unweighted Octave-Band (O.B.) SPLs at Receptors/NSAs, as Meas'd on 8/14/15.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
1)	PWL of Turbine/Compressor inside Building	110	110	112	112	110	110	112	118	112	121	
	Attenuation of the Building	-8	-12	-18	-26	-32	-35	-38	-40	-40		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	-1	-1	-3	-4	-4		
	610 Hemispherical Radiation	-53	-53	-53	-53	-53	-53	-53	-53	-53		
	610 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8		
	610	Source Sound Level Contribution	49	45	40	32	23	20	16	16	6	29
2)	PWL of Unsilenced Turbine Exhaust	120	123	120	123	127	119	112	104	96	126	
	Atten. of Noise Control (Custom 2-Silencer System)	-7	-18	-28	-35	-45	-45	-45	-35	-25		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	0	0	0	0	0		
	680 Hemispherical Radiation	-54	-54	-54	-54	-54	-54	-54	-54	-54		
	680 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-9		
	680	Source Sound Level Contribution	59	51	38	33	27	19	11	9	7	31
3)	PWL of Aboveground Piping & Components	98	98	102	95	96	105	110	108	100	114	
	Atten. of Noise Control (Insulation & Courtyard Effect)	4	4	0	-4	-10	-15	-18	-20	-20		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	-1	-1	-3	-4	-4		
	600 Hemispherical Radiation	-53	-53	-53	-53	-53	-53	-53	-53	-53		
	600 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8		
	600	Source Sound Level Contribution	49	49	49	37	31	35	34	26	15	40
4)	PWL of LO Cooler	105	100	94	90	88	84	80	78	75	90	
	NR of Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	-1	-1	-3	-4	-4		
	680 Hemispherical Radiation	-54	-54	-54	-54	-54	-54	-54	-54	-54		
	680 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	0	-1	-2	-5	-9		
	680	Source Sound Level Contribution	51	46	40	34	32	28	21	14	7	33
5)	PWL of Unsilenced Turbine Air Intake	108	114	120	121	122	124	129	152	144	153	
	Attenuation of Intake Silencer System ("Custom")	-2	-5	-12	-15	-30	-45	-50	-60	-60		
	Attenuation of Air Intake Filter	-1	-6	-12	-18	-22	-25	-25	-25	-20		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	-1	-1	-3	-4	-4		
	680 Hemispherical Radiation	-54	-54	-54	-54	-54	-54	-54	-54	-54		
	680	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-9	
680	Source Sound Level Contribution	51	49	42	33	14	0	0	3	0	29	
6)	PWL of the Gas Aftercooler	112	108	96	94	92	90	85	82	80	95	
	NR of Noise Control (Attenuation by Courtyard)	0	-2	-3	-4	-6	-7	-8	-8	-8		
	Misc. Atten. (Shielding, Land Contour, Ground Effect)	0	0	0	0	-1	-1	-3	-4	-4		
	560 Hemispherical Radiation	-53	-53	-53	-53	-53	-53	-53	-53	-53		
	560 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-4	-8		
	560	Source Sound Level Contribution	59	53	40	37	32	28	20	13	8	35
Est'd Total Sound Contribution of the Station at NSA #1		63	57	51	43	37	37	34	27	17	42.6	49.0
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											44.8	70.4
Est'd Sound Level of Station plus Lowest Ambient Level											46.9	70.4
Increase above Lowest Ambient Sound Level (dB)											2.1	0.0

**Table 7: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at Closest NSA (i.e., NSA #1; Residences along Bridge Street, approx. 610 Ft. SSE of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Level) and Potential Increase above Lowest Ambient Sound Level.**

Note (1): Lowest ambient sound levels based on the results of a 2015 sound survey by H&K around the site of the Station.

**NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should not be used as the specified values. Refer to "Noise Control Measures" section in report or company specifications for actual specified values.**



Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 610 Ft. (RE: Table 7)	63	57	51	43	37	37	34	27	17	42.6	
900	Hemisph Radiation [20*log(900/610) = 3.4 dB]	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4		Calc'd
900	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-4		Ldn
Est'd Total Sound Contribution of the Station at NSA #4		59	54	47	39	34	33	30	22	10	38.9	45.3
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											48.5	56.5
Est'd Sound Level of Station plus Lowest Ambient Level											48.9	56.8
Increase above Lowest Ambient Sound Level (dB)											0.4	0.3

**Table 8: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at NSA #4 (i.e., Residences at Vanness Rd. & Monatiquot St., 900 Ft. South of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 610 Ft. (RE: Table 7)	63	57	51	43	37	37	34	27	17	42.6	
1030	Hemisph Radiation [20*log(1030/610) = 4.6 dB]	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6		Calc'd
1030	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-6		Ldn
Est'd Total Sound Contribution of the Station at NSA #5		58	53	46	38	32	31	29	19	7	37.5	43.9
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											41.3	64.3
Est'd Sound Level of Station plus Lowest Ambient Level											42.8	64.3
Increase above Lowest Ambient Sound Level (dB)											1.5	0.0

**Table 9: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at NSA #5 (i.e., Residences along Kings Cove Way, approx. 1,030 Ft. SE of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 610 Ft. (RE: Table 7)	63	57	51	43	37	37	34	27	17	42.6	
2300	Hemisph Radiation [20*log(2300/610) = 11.5 dB]	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5	-11.5		Calc'd
2300	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-13	-23		Ldn
Est'd Total Sound Contribution of the Station at NSA #6		51	46	39	31	25	22	18	3	0	29.3	35.7
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											41.4	50.6
Est'd Sound Level of Station plus Lowest Ambient Level											41.7	50.7
Increase above Lowest Ambient Sound Level (dB)											0.3	0.1

**Table 10: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at NSA #6 (i.e., Residences in Area of Evans St. & Rosalind Road, 2,300 Ft. SE of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 610 Ft. (RE: Table 7)	63	57	51	43	37	37	34	27	17	42.6	
2400	Hemisph Radiation [20*log(2400/610) = 11.9 dB]	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9		Calc'd
2400	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-14	-25		Ldn
Est'd Total Sound Contribution of the Station at NSA #8		51	45	39	30	24	22	17	2	0	28.9	35.3
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											44.5	52.6
Est'd Sound Level of Station plus Lowest Ambient Level											44.6	52.7
Increase above Lowest Ambient Sound Level (dB)											0.1	0.1

**Table 11: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at NSA #8 (i.e., Residences in the Area of Dee Road, approx. 2,400 Ft. West of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 610 Ft. (RE: Table 7)	63	57	51	43	37	37	34	27	17	42.6	
4200	Hemisph Radiation [20*log(4200/610) = 16.8 dB]	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8		Calc'd
4200	Atm. Absorption (70% R.H., 60 deg F)	0	0	-1	-1	-3	-5	-11	-27	-49		Ldn
Est'd Total Sound Contribution of the Station at NSA #9		46	40	33	25	18	14	7	0	0	22.7	29.1
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											41.0	49.8
Est'd Sound Level of Station plus Lowest Ambient Level											41.1	49.8
Increase above Lowest Ambient Sound Level (dB)											0.1	0.0

**Table 12: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at NSA #9 (i.e., Johnson School, approximately 4,200 ESE of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus the Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
1)	PWL of Turbine/Compressor inside Building	110	110	112	112	110	110	112	118	112	121	
	Attenuation of the Building	-8	-12	-18	-26	-32	-35	-38	-40	-40		
	Misc. Atten. (Shielding, Land Contour)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-19		
	1370	Source Sound Level Contribution	41	37	33	25	17	13	9	7	0	22
2)	PWL of Unsilenced Turbine Exhaust	120	123	120	123	127	119	112	104	96	126	
	Atten. of Noise Control (Custom 2-Silencer System)	-7	-18	-28	-35	-45	-45	-45	-35	-25		
	Misc. Atten. (Shielding, Land Contour)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-19		
	1370	Source Sound Level Contribution	52	44	31	27	21	12	2	0	0	24
3)	PWL of Aboveground Piping & Components	98	98	102	95	96	105	110	108	100	114	
	Atten. of Noise Control (Insulation & Courtyard Effect)	4	4	0	-4	-10	-15	-18	-20	-20		
	Misc. Atten. (Shielding, Land Contour)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-19		
	1370	Source Sound Level Contribution	41	41	41	30	25	28	27	17	1	33
4)	PWL of LO Cooler	105	100	94	90	88	84	80	78	75	90	
	NR of Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Shielding, Land Contour)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-2	-4	-10	-19		
	1370	Source Sound Level Contribution	44	39	33	28	27	22	15	7	0	28
5)	PWL of Unsilenced Turbine Air Intake	108	114	120	121	122	124	129	152	144	153	
	Attenuation of Intake Silencer System ("Custom")	-2	-5	-12	-15	-30	-45	-50	-60	-60		
	Attenuation of Air Intake Filter	-1	-6	-12	-18	-22	-25	-25	-25	-20		
	Misc. Atten. (Shielding, Land Contour)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-19	
1370	Source Sound Level Contribution	44	42	35	27	9	0	0	0	0	23	
6)	PWL of the Gas Aftercooler	112	108	96	94	92	90	85	82	80	95	
	NR of Noise Control (Attenuation by Courtyard)	0	-2	-3	-4	-6	-7	-8	-8	-8		
	Misc. Atten. (Shielding or Ground Effect)	0	0	0	0	0	0	0	0	0		
	1370 Hemispherical Radiation	-60	-60	-60	-60	-60	-60	-60	-60	-60		
	1370 Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-10	-19		
	1370	Source Sound Level Contribution	51	45	32	29	25	21	12	3	0	27
Est'd Total Sound Contribution of the Station at NSA #2		56	50	44	36	31	29	28	18	1	35.7	42.1
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											46.8	54.9
Est'd Sound Level of Station plus Lowest Ambient Level											47.1	55.1
Increase above Lowest Ambient Sound Level (dB)											0.3	0.2

**Table 13: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at the Closest NSA with Water Body between the CS Site and the NSA (i.e., NSA #2; Residences in the Area of Germantown Point, approx. 1,370 Ft. North of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Note (1): Lowest ambient sound levels based on the results of a 2015 sound survey by H&K around the site of the Station.

**NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should not be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 1,370 Ft. (RE: Table 13)	56	50	44	36	31	29	28	18	1	35.7	
1560	Hemisph Radiation [20*log(1560/1370) = 1.1 dB]	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1		Calc'd
1560	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-1	-3		Ldn
Est'd Total Sound Contribution of the Station at NSA #3		55	49	43	35	30	28	26	16	0	34.4	40.8
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											44.0	54.0
Est'd Sound Level of Station plus Lowest Ambient Level											44.4	54.2
Increase above Lowest Ambient Sound Level (dB)											0.4	0.2

**Table 14: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at another NSA with Water Body between the Station Site and the NSA (i.e., NSA #3; Residences along King's Cove Beach Road, approx. 1,560 Ft. East of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Sound Level) and Potential Increase above Lowest Ambient Sound Level.**

Source No. & Dist. (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Station A-Wt. Level & SPLs at 1,370 Ft. (RE: Table 13)	56	50	44	36	31	29	28	18	1	35.7	
1970	Hemisph Radiation [20*log(1970/1370) = 3.2 dB]	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2		Calc'd
1970	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8		Ldn
Est'd Total Sound Contribution of the Station at NSA #7		53	47	41	32	27	25	23	10	0	31.8	38.2
Measured Lowest Ambient L90 and Ldn at NSA: Note (1)											39.3	49.1
Est'd Sound Level of Station plus Lowest Ambient Level											40.0	49.4
Increase above Lowest Ambient Sound Level (dB)											0.7	0.3

**Table 15: Weymouth Compressor Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit) at another NSA with Water Body between the Station Site and the NSA (i.e., NSA #7; Residences at Fore River Ave. & Weybossett St., approx. 1,970 Ft. ENE of the Compressor Building), Total Cumulative Sound Level (i.e., Station Level plus Lowest Ambient Level) and Potential Increase above Lowest Ambient Sound Level.**

## **DESCRIPTION OF THE ANALYSIS METHODOLOGY AND THE SOURCE OF SOUND DATA**

Analysis Methodology: In general, the predicted sound level contributed by the Station was calculated as a function of frequency from estimated octave-band (O.B.) sound power levels (PWLs) for each significant Station sound source. The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWLs of the significant noise sources associated with the compressor unit and Station were determined from actual sound level measurements performed by H&K at similar type of facilities and/or from acceptable equipment supplier data/tests;
- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below\*) and atmospheric sound absorption (discussed in more detail below\*\*) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source;
- Finally, the resulting estimated O.B. SPLs for all noise sources associated with the Station (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the compressor unit at the closest NSA. The predicted sound contribution of the compressor unit at the closest NSA was utilized to estimate the station noise contribution at the other nearby NSAs that are more distant than the closest NSA.

\*Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source PWL:

- Decrease in SPL ("hemispherical propagation") from a noise source =  **$20 \cdot \log(r) - 2.3 \text{ dB}$**   
(where "r" is distance of the receiver from the noise source)

Since the analysis methodology incorporates hemispherical sound propagation, this methodology is actually more applicable to sound propagation over "acoustically-hard" surfaces, such as concrete or water. Therefore, for those receptors in which there is a water body between the receptor and the Station, we believe that the noise modeling accounts for the sound propagation over water although temporary temperature inversion conditions could elevate sound levels at a receptor located across a body of water but there is no reliable "industrial standard" method to predict the frequency and duration of these inversions as well as the degree of sound level elevation (RE: ISO 9613<sup>2</sup>). For receptors in which there is mostly land between the receptor and Station, existing topography, ground effect and shielding by structures-roadways can influence the sound contributed by the Station at a receptor. Therefore, if applicable, the attenuation due to topography, ground effect and/or shielding effect was included for those receptors with land between the receptor and Station. The sound attenuation effect due to foliage/trees

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<sup>2</sup>ISO Standard 9613-1 1993 (E) & ISO Standard 9613-2: 1996 (E), entitled "Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere; and Part 2: General method of calculation".

was not considered in the analysis since there is minimal foliage between the Station and the identified closest receptors/NSAs.

\*\*Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz octave band SPL is approximately **1.5 dB** per 1,000 feet for standard day conditions (i.e., no wind, 59 deg. F. and 70% R.H.).

Analysis and Methodology (Noise Attributable to a Unit Blowdown Event): The noise resulting from a blowdown event was estimated by using the "inverse-square law" and included some attenuation due to atmospheric sound absorption. Consequently, the estimated noise of a blowdown event at the receptor (i.e., closest NSA) was calculated as follows:

$$\text{SPL (receptor)} = (\text{Blowdown SPL at R1}) - 20 \cdot \log(R2/R1) - \text{Atm. Atten.} = 55 \text{ dBA} - 20 \cdot \log(700/300) - 2 \text{ dB} = 46 \text{ dBA}$$

Where: R1 = Distance of Specified Blowdown Noise Level Requirement (i.e., 300 ft.)

R2 = Distance of the Closest Receptor (NSA #1) from the Blowdown Silencer (700 ft.)

Source of Sound Data: The following describes the source of sound data for estimating the source sound levels and source PWLs used in the acoustical analysis. Note that equipment noise levels utilized in the acoustical analysis (i.e., spreadsheet analysis) are generally higher than the sound level requirement for the equipment to insure that the design incorporates an acoustical "margin of safety."

- (1) PWL values of the specific equipment inside the building (i.e., noise of turbine/compressor) was calculated from sound data measured by H&K on similar type of gas compressor installation;
- (2) Turbine exhaust PWL values were calculated from sound data provided in Solar Noise Prediction Manual and sound data measured by H&K on a similar turbine installation;
- (3) Noise radiated from gas piping is primarily a result the noise generated by the gas compressor. Consequently, measurement of both near field and far field sound data on gas piping is assumed to be an accurate method of quantifying the noise associated with the new gas piping, and the estimated PWL values for gas piping used in the analysis were determined from near field and far field sound data by H&K on a similar type of compressor to that of the planned compressor unit.
- (4) PWL values for Station coolers were designated to meet the design noise goal. Note that the estimated PWL for the cooler utilized in the acoustical analysis assumes some noise associated with piping associated with the coolers. The noise level for the cooler(s) used in the acoustical analysis is generally higher than the sound level requirement in order that the noise design analysis incorporates an acoustical "margin of safety." In addition, there can be other noise associated with the cooler that is not directly related to the operation of the cooler fans.
- (5) PWL values for the turbine air intake were calculated from sound data in Solar Noise Prediction Manual, although the low-frequency SPLs were modified as a result of field tests by H&K;
- (6) Estimated A-wt. sound level of a unit blowdown event, via a blowdown vent/silencer, was calculated from sound data measured by H&K on similar type of blowdown operations.

Type of Equipment	Equipment Power Rating or Capacity	Est'd Number Required	Est'd A-Wt. Sound Level at 50 Ft.: Note (1)	Resulting A-Wt. PWL of Single Piece of Equip.	Assumed Max. No. Operating at One Time	Est'd Max. A-Wt. PWL or Sound Level of Equip.	
Diesel Generator	250 to 400 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Bulldozer	250 to 700 HP	1 to 2	75 - 80 dBA	110 dBA	1	110	
Grader	450 to 600 HP	1 to 2	70 - 75 dBA	105 dBA	1	105	
Backhoe	130 to 210 HP	1 to 2	65 - 72 dBA	104 dBA	1	104	
Front End Loader	150 to 250 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Truck Loaded	40 Ton	As needed	70 - 75 dBA	105 dBA	1	105	
Est'd Total Maximum A-Wt. PWL (dBA) of Construction Site Equipment						113	Calc'd
Atten. (dB) due to Hemispherical Sound Propagation (650 Ft.): Note (2)						-54	Ldn
Est'd Attenuation (in dB) due to Air Absorption and Topography: Note (3)						-3	Note (4)
<b>Est'd A-Wt. Sound Level (dBA) at the Closest NSA Considering a Maximum Number of Equipment Operating at One Time</b>						<b>56 dBA</b>	<b>54 dBA</b>

**Table 16: Algonquin Weymouth Station: Est'd Sound Contribution at the Closest NSA (i.e., approx. 650 Ft. SSE of Site) during Construction Activity at the Site of the Compressor Station. Sound Contribution assumes Operation of the "Loudest" Equipment during a Time Frame with the Largest Amount of Equipment Operating (e.g., Site Grading & Clearing/Grubbing)**

Note (1): Noise Emission Levels of construction equipment based on an EPA Report (meas'd sound data for a railroad construction project) and measured sound data in the field by H&K or other published sound data.

Note (2): Noise attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically from the source.

The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source sound power level (PWL):

Decrease in SPL ("hemispherical propagation") from a noise source =  $20 \cdot \log(r) - 2.3 \text{ dB}$ , where "r" is distance of the receiver from the noise source. For example, if the distance "r" is 650 feet between the site and closest NSA, the "hemispherical propagation" =  $20 \cdot \log(650) - 2.3 \text{ dB} = 54 \text{ dB}$ .

Note (3): Noise attenuation due to air absorption, foliage, shielding, topography: Air absorbs sound energy and amount of absorption ("attenuation") is dependent on temperature & relative humidity (R.H.) of the air and frequency of sound. For standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.), the attenuation due to air absorption for the medium frequency" (i.e., 1000 Hz octave band SPL) is approximately **1.5 dB** per 1,000 feet. In addition, foliage, shielding and topography between the Station and receptors/NSAs, can have a sound attenuation effect. For example, the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest greater than 500 feet thick is approximately **10 dB**. For this site, there will be existing topography (berm) between the Station and closest NSA that should provide a minimum of **2 dB** attenuation; adding to the air absorption attenuation (approx. **1 dB**), an overall attenuation of **3 dB** was utilized as the estimated attenuation due to air absorption and existing topography.

Note (4): Calc'd Ldn is approx. 2 dB lower than A-wt. sound level since construction activities will occur only during daytime.

## **ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA (CONSTRUCTION ACTIVITIES)**

The predicted sound level contributed by the construction-related activity (i.e., construction of the compressor station) was calculated from estimated A-wt. PWL of noise sources (i.e., construction equipment noise) that typically operate during the specific construction activity. The following summarizes the acoustical analysis procedure utilized for the construction activity at the site:

- Initially, the A-wt. PWL of noise sources associated with the construction activity were determined from published sound data and/or actual sound level measurements by H&K, and the total PWL of each noise source (equipment) was based on the anticipated number of equipment operating;
- Next, A-wt. PWL of all sources were logarithmically summed to provide the overall A-wt. PWL contributed by construction activity. It is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when largest amount of equipment operate);
- Finally, the estimated A-wt. sound level of the construction activity at the specific distance was determined by compensating for sound attenuation due to propagation (hemispherical radiation), atmospheric sound absorption and any sound attenuation effect of foliage/topography\*\*\*.

The noise levels of construction equipment were based on an EPA Report (i.e., measured sound data from railroad construction equipment taken during the Northeast Corridor Improvement Project) that was summarized in a 1995 Report to the Federal Transit Administration as prepared by Harris Miller Miller & Hanson Inc. Also, construction equipment noise levels listed in an article in the Journal of Noise Control Engineering and sound data measured by H&K was utilized. The following list some references used by H&K to determine construction equipment noise emission levels:

- (1) "Transit Noise and Vibration Impact Assessment", dated April 1995, prepared by Harris Miller Miller & Hanson Inc. for the Office of Planning of the Federal Transit Administration.
- (2) Erich Thalheimer, "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", J of Noise Control Eng., 48 (5), pp. 157-165 (2000 Sep-Oct).
- (3) "Noise Control for Building Manufacturing Plant Equipment and Products", course handout notes for a noise course given each year by Hoover & Keith Inc.

\*\*\*Discussion of noise attenuation due to foliage, shielding and/or existing topography: Foliage, shielding and existing topography between a Station and receptors/NSAs, can have a sound attenuation effect. For example, based on our experience and ISO Standard, (previously referenced ISO Standard 9613-1 & ISO Standard 9613-2) the "medium-frequency" attenuation (1000 Hz) due to foliage/trees greater than 500 feet thick is approximately **10 dB**. For this Station site, there will be minimal foliage between the site and closest receptors, but there is existing topography (berm/mound) between the Station and closest NSA that should provide a minimum of **2 dB** attenuation; adding attenuation due to air absorption (approx. **1 dB**) to the attenuation due to the topography, an overall attenuation of **3 dB** was utilized as the attenuation due to air absorption and existing topography.

**End of Report**



## ATTACHMENT G: DETAILED EMISSIONS CALCULATIONS AND MANUFACTURER SPECIFICATIONS

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TABLE B-1Aa Ambient Temperature, Start Model, and Utilization Data PTE - 100% Fuel Utilization at 100% Power Output			
Month	#Days	Daily Average	Weighted Daily Average
JAN	31.00	22.85	1.94
FEB	28.50	24.75	1.93
MAR	31.00	33.65	2.85
APR	30.00	44.35	3.64
MAY	31.00	55.50	4.71
JUN	30.00	64.20	5.27
JUL	31.00	69.70	5.91
AUG	31.00	67.95	5.76
SEP	30.00	60.10	4.93
OCT	31.00	50.00	4.24
NOV	30.00	39.35	3.23
DEC	31.00	27.40	2.32
Annual	365.50	46.65	46.74
Low Temperature Data			
Below 0°F Hours		12 hrs/yr	
Below -20°F Hours		0 hrs/yr	
NOTES			
1. Please refer to TABLE B-0.			
Start Model and Utilization			
Utilization		100.00%	
Start Model		AGT - Medium	
Starts		416.00 starts/yr	

**TABLE B-1Ab**  
**Manufacturer's Operating and Emissions Data**  
**Normal Operations**  
**PTE - 100% Fuel Utilization at 100% Power Output**

Parameters			Curve Fitting			Vendor Data						
Ambient	Temperature	°F	-20.00	-20.00	46.65	-0.01	0.01	20.00	40.00	60.00	80.00	100.00
	Altitude	ft	0	0	0	0	0	0	0	0	0	0
	Pressure	psia	14.702	14.702	14.702	14.702	14.702	14.702	14.702	14.702	14.702	14.702
	Relative Humidity	%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>	0.0003	0.0003	0.0035	0.0006	0.0006	0.0013	0.0028	0.0058	0.0124	0.0262
Fuel	Lower Heating Value (LHV)	BTU/scf	939.2	939.2	939.2	939.2	939.2	939.2	939.2	939.2	939.2	939.2
	Higher Heating Value (HHV)	BTU/scf	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6
Turbine	Net Output Power	hp	8,664	8,664	7,758	8,414	8,414	8,164	7,876	7,473	6,883	6,242
	Fuel Consumption	scf/hr	71,786	71,786	66,080	70,241	70,241	68,697	66,823	64,342	60,850	57,261
	Heat Input at LHV	MMBTU/hr	67.42	67.42	62.06	65.97	65.97	64.52	62.76	60.43	57.15	53.78
	Heat Input at HHV	MMBTU/hr	74.91	74.91	68.96	73.30	73.30	71.69	69.73	67.14	63.50	59.76
	Heat Rate at LHV	BTU/hp-hr	7,782	7,782	8,000	7,841	7,841	7,903	7,969	8,086	8,303	8,616
	Heat Rate at HHV	BTU/hp-hr	8,646	8,646	8,889	8,712	8,712	8,781	8,854	8,985	9,226	9,573
Exhaust	Temperature	°F	865	865	943	889	889	913	936	957	976	999
	Water Fraction	%, by vol	5.67%	5.67%	6.38%	5.82%	5.82%	5.97%	6.25%	6.75%	7.67%	9.34%
	Non-Water Fraction	%, by vol	94.33%	94.33%	93.62%	94.18%	94.18%	94.03%	93.75%	93.25%	92.33%	90.66%
	O <sub>2</sub> Content	%, by vol (dry)	15.42%	15.42%	15.34%	15.39%	15.39%	15.36%	15.34%	15.34%	15.36%	15.36%
	Molecular Weight	lb/lb-mol	28.62	28.62	28.53	28.60	28.60	28.58	28.55	28.49	28.39	28.20
	Flow Rate	lb/hr	192,068	192,068	174,087	186,881	186,881	181,699	176,118	169,591	161,072	151,663
		scfm (1 atm, 68°F)	43,161	43,161	39,209	42,000	42,000	40,880	39,649	38,247	36,473	34,566
	acfm	108,268	108,268	104,162	107,265	107,265	106,263	104,789	102,604	99,157	95,478	
NO <sub>x</sub> Emissions		lb/lb-mol	46.01	46.01	46.01	46.01	46.01	46.01	46.01	46.01	46.01	46.01
		ppmvd, 15% O <sub>2</sub>	120	42	9	42	9	9	9	9	9	9
		ppmvw	105.14	36.80	7.94	36.94	7.92	7.95	7.95	7.91	7.80	7.66
		lb/hr	32.46	11.36	2.23	11.11	2.38	2.32	2.26	2.17	2.04	1.90
CO Emissions		lb/lb-mol	28.01	28.01	28.01	28.01	28.01	28.01	28.01	28.01	28.01	28.01
		ppmvd, 15% O <sub>2</sub>	150	100	25	100	25	25	25	25	25	25
		ppmvw	131.42	87.61	22.06	87.95	21.99	22.07	22.09	21.97	21.67	21.28
		lb/hr	24.70	16.47	3.77	16.10	4.02	3.93	3.82	3.66	3.44	3.21
UHC Emissions		lb/lb-mol	18.37	18.37	18.37	18.37	18.37	18.37	18.37	18.37	18.37	18.37
		ppmvd, 15% O <sub>2</sub>	75	50	25	50	25	25	25	25	25	25
		ppmvw	65.71	43.81	22.06	43.98	21.99	22.07	22.09	21.97	21.67	21.28
		lb/hr	8.10	5.40	2.47	5.28	2.64	2.58	2.50	2.40	2.26	2.10

**NOTES**

- Operating and emissions data was provided by the manufacturer for the following ambient temperatures: 0°F, 20°F, 40°F, 60°F, 80°F, and 100°F.  
 Specific Humidity is estimate using curve fitting equation:  $6.15E-04e^{3.75E-02T}$   
 All other parameter values estimated using cubic spline.
- Pollutant concentrations (ppmvd at 15% O<sub>2</sub>) for 0°F and -20°F based on information provided in a document published by the manufacturer.
- Ambient pressure and humidity will vary. However, it is believed that any variation would not affect compliance with the proposed emission representations.
- The heating value of the natural gas used to fuel the turbine will vary. However, it is believed that any variation would not affect compliance with the proposed emission representations.

**TABLE B-1Ab**  
**Manufacturer's Operating and Emissions Data**  
**Normal Operations**  
**PTE - 100% Fuel Utilization at 100% Power Output**

Vendor Data											
Make:	Solar										
Model:	060-07802S4										
Rate	7,700 hp (ISO)										
Capacity:	6,800 hp (NEMA)										
Load:	100%										
Ambient	Temperature	°F			-0.01	0.01	20.00	40.00	60.00	80.00	100.00
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>			0.0006	0.0006	0.0014	0.0031	0.0066	0.0133	0.0253
Fuel	Lower Heating Value (LHV)	BTU/scf			939.2	939.2	939.2	939.2	939.2	939.2	939.2
Turbine	Net Output Power	hp			8,414	8,414	8,164	7,876	7,473	6,883	6,242
	Heat Input at LHV	MMBTU/hr			65.97	65.97	64.52	62.76	60.43	57.15	53.78
Exhaust	Temperature	°F			889	889	913	936	957	976	999
	Water Fraction	%			5.82%	5.82%	5.97%	6.25%	6.75%	7.67%	9.34%
	O <sub>2</sub> Content	% (dry)			15.39%	15.39%	15.36%	15.34%	15.34%	15.36%	15.36%
	Molecular Weight	lb/lb-mol			28.60	28.60	28.58	28.55	28.49	28.39	28.20
	Flow Rate	lb/hr			186,881	186,881	181,699	176,118	169,591	161,072	151,663
		acfm			107,265	107,265	106,263	104,789	102,604	99,157	95,478
Guaranteed	NO <sub>x</sub>	ppmvd, 15% O <sub>2</sub>	120	42	42	9	9	9	9	9	
Emissions	CO	ppmvd, 15% O <sub>2</sub>	150	100	100	25	25	25	25	25	
	UHC	ppmvd, 15% O <sub>2</sub>	75	50	50	25	25	25	25	25	

<p align="center"><b>TABLE B-1Ac</b>  <b>Gas-Fired Turbines</b>  <b>Emission Estimates</b>  <b>Normal Operations</b>  <i>PTE - 100% Fuel Utilization at 100% Power Output</i></p>					
Make	Solar				
Model	060-07802S4				
Normal Operating Load	100%				
Fuel	Natural Gas				
Fuel Higher Heating Value (HHV)	1,020 BTU/scf			1,020 BTU/scf	
Ambient Temperature	46.65 °F			0.01 °F	
Power Output	7,758 bhp (mech.)			8,414 bhp (mech.)	
	5,785 kW (elec.)			6,274 kW (elec.)	
Heat Rate at HHV	8,889 BTU/hp-hr			8,712 BTU/hp-hr	
Operating Hours	8,760 hrs/yr				
Fuel Consumption	67,606 scfh			71,863 scfh	
	592,230 MMscf/yr				
Heat Input at HHV	68.96 MMBTU/hr			73.30 MMBTU/hr	
	604,075 MMBTU/yr	Average	Maximum		Maximum
NO <sub>x</sub>	32.97 lb/MMscf	2.2288 lb/hr	9.7621 tpy	33.12 lb/MMscf	2.3799 lb/hr
CO	55.75 lb/MMscf	3.7690 lb/hr	16.5082 tpy	56.00 lb/MMscf	4.0245 lb/hr
SO <sub>2</sub>	14.29 lb/MMscf	0.9658 lb/hr	4.2302 tpy	14.29 lb/MMscf	1.0266 lb/hr
PM <sub>10/2.5</sub>	6.73 lb/MMscf	0.4551 lb/hr	1.9934 tpy	6.73 lb/MMscf	0.4838 lb/hr
CO <sub>2-e</sub>	120,800 lb/MMscf	8,167 lb/hr	35,771 tpy	120,803 lb/MMscf	8,681 lb/hr
CO <sub>2</sub>	120,017 lb/MMscf	8,114 lb/hr	35,539 tpy	120,017 lb/MMscf	8,625 lb/hr
N <sub>2</sub> O	0.23 lb/MMscf	0.0153 lb/hr	0.0670 tpy	0.23 lb/MMscf	0.0163 lb/hr
TOC (Total)	36.57 lb/MMscf	2.4721 lb/hr	10.8278 tpy	36.73 lb/MMscf	2.6397 lb/hr
Methane	28.59 lb/MMscf	1.9327 lb/hr	8.4653 tpy	28.72 lb/MMscf	2.0637 lb/hr
Ethane	1.00 lb/MMscf	0.0674 lb/hr	0.2953 tpy	1.00 lb/MMscf	0.0720 lb/hr
VOC (Total)	6.98 lb/MMscf	0.4719 lb/hr	2.0671 tpy	7.01 lb/MMscf	0.5039 lb/hr
VOC (non-HAP)	3.57 lb/MMscf	0.2411 lb/hr	1.0559 tpy	3.58 lb/MMscf	0.2574 lb/hr
HAP (Total)	3.42 lb/MMscf	0.2309 lb/hr	1.0112 tpy	3.43 lb/MMscf	0.2465 lb/hr
Acetaldehyde	1.33E-01 lb/MMscf	0.0090 lb/hr	0.0394 tpy	1.34E-01 lb/MMscf	0.0096 lb/hr
Acrolein	2.13E-02 lb/MMscf	0.0014 lb/hr	0.0063 tpy	2.14E-02 lb/MMscf	0.0015 lb/hr
Benzene	3.99E-02 lb/MMscf	0.0027 lb/hr	0.0118 tpy	4.01E-02 lb/MMscf	0.0029 lb/hr
Biphenyl					
Butadiene (1,3-)	1.43E-03 lb/MMscf	0.0001 lb/hr	0.0004 tpy	1.44E-03 lb/MMscf	0.0001 lb/hr
Carbon Tetrachloride					
Chlorobenzene					
Chloroform					
Dichloropropene (1,3-)					
Ethylbenzene	1.06E-01 lb/MMscf	0.0072 lb/hr	0.0315 tpy	1.07E-01 lb/MMscf	0.0077 lb/hr
Ethylene Dibromide					
Formaldehyde	2.36E+00 lb/MMscf	0.1596 lb/hr	0.6989 tpy	2.37E+00 lb/MMscf	0.1704 lb/hr
Hexane (n-)					
Methanol					
Methylene Chloride					
Methylnaphthalene (2-)					
Naphthalene	4.32E-03 lb/MMscf	0.0003 lb/hr	0.0013 tpy	4.34E-03 lb/MMscf	0.0003 lb/hr
PAH	7.31E-03 lb/MMscf	0.0005 lb/hr	0.0022 tpy	7.35E-03 lb/MMscf	0.0005 lb/hr
Phenol					
Propylene Oxide	9.64E-02 lb/MMscf	0.0065 lb/hr	0.0285 tpy	9.68E-02 lb/MMscf	0.0070 lb/hr
Styrene					
Tetrachloroethane (1,1,2,2-)					
Toluene	4.32E-01 lb/MMscf	0.0292 lb/hr	0.1280 tpy	4.34E-01 lb/MMscf	0.0312 lb/hr
Trichloroethane (1,1,2-)					
Trimethylpentane (2,2,4-)					
Vinyl Chloride					
Xylenes	2.13E-01 lb/MMscf	0.0144 lb/hr	0.0630 tpy	2.14E-01 lb/MMscf	0.0154 lb/hr
<b>NOTES</b>					
1. Fuel higher heating value selected to correspond to AP-42 emissions factors. 2. Manufacturer provided operating and emissions data (TABLE B-1Ab). 3. The annual emissions are based on a representative annual average ambient temperature (TABLE B-1Aa). Maximum hourly emissions are based on an ambient temperature of 0°F. 4. NO <sub>x</sub> , CO, and TOC (Total) emission factor based on Vendor Guarantee. 5. CO <sub>2</sub> and N <sub>2</sub> O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively. 6. SO <sub>2</sub> emission factor based on AP-42, Section 3.1 (Revised 4/00), Table 3.1-2a using Tariff (5 gr/100 scf). 7. PM <sub>10/2.5</sub> emission factor based on AP-42, Section 3.1 (Revised 4/00), Table 3.1-2a, not Solar's PIL 171 dated 5/6/2015 (which is 127% greater). 8. Methane, Ethane, and VOC (Total) emissions based on scaling of AP-42, Section 3.1 (Revised 4/00), Table 3.1-2a using Vendor Guarantee. Speciated VOC (non-HAP) emissions based on scaling of AP-42, Section 3.1 (Revised 4/00), Table 3.1-2a using Vendor Guarantee. $EF_{Scaled} = (EF_{AP42})(EF_{TOC}/EF_{TOC-AP42})$					

TABLE B-1Ad Manufacturer's Operating and Emissions Data Startup/Shutdown Step 2: Ignition-Idle PTE - 100% Fuel Utilization at 100% Power Output									
Parameters			Interpolated	Vendor Data					
Ambient	Temperature	°F	46.65	0.01	20.00	40.00	60.00	80.00	100.00
	Altitude	ft	0	0	0	0	0	0	0
	Pressure	psia	14.702	14.702	14.702	14.702	14.702	14.702	14.702
	Relative Humidity	%	60%	60%	60%	60%	60%	60%	60%
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>	0.0035	0.0006	0.0013	0.0028	0.0058	0.0124	0.0262
Fuel	Lower Heating Value (LHV)	BTU/scf	939.2	939.2	939.2	939.2	939.2	939.2	939.2
	Higher Heating Value (HHV)	BTU/scf	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6
Turbine	Net Output Power	hp	776	841	816	788	747	688	624
	Fuel Consumption	scf/hr	15,546	15,534	15,534	15,577	15,385	15,002	14,566
	Heat Input at LHV	MMBTU/hr	14.60	14.59	14.59	14.63	14.45	14.09	13.68
	Heat Input at HHV	MMBTU/hr	16.22	16.21	16.21	16.26	16.06	15.66	15.20
	Heat Rate at LHV	BTU/hp-hr	18,815	17,348	17,880	18,566	19,344	20,480	21,923
	Heat Rate at HHV	BTU/hp-hr	20,905	19,276	19,867	20,629	21,493	22,755	24,359
Exhaust	Temperature	°F	598	503	543	584	626	670	715
	Water Fraction	%, by vol	3.32%	2.56%	2.78%	3.15%	3.79%	4.89%	6.76%
	Non-Water Fraction	%, by vol	96.68%	97.44%	97.22%	96.85%	96.21%	95.11%	93.24%
	O <sub>2</sub> Content	%, by vol (dry)	18.40%	18.63%	18.54%	18.44%	18.33%	18.23%	18.10%
	Molecular Weight	lb/lb-mol	28.72	28.80	28.78	28.74	28.68	28.56	28.36
	Flow Rate	lb/hr	81,619	96,424	92,838	83,262	78,987	74,120	68,816
		scfm (1 atm, 68°F)	18,305	21,528	20,744	18,628	17,723	16,683	15,603
acfm		36,660	39,250	39,391	36,819	36,439	35,690	34,709	
NO <sub>x</sub> Emissions	lb/lb-mol	46.01	46.01	46.01	46.01	46.01	46.01	46.01	
	ppmvd, 15% O <sub>2</sub>	50	50	50	50	50	50	50	
	ppmvw	20.45	18.74	19.44	20.19	20.95	21.52	22.12	
	lb/hr	2.67	2.89	2.89	2.69	2.66	2.57	2.47	
CO Emissions	lb/lb-mol	28.01	28.01	28.01	28.01	28.01	28.01	28.01	
	ppmvd, 15% O <sub>2</sub>	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
	ppmvw	4,090.15	3,748.96	3,888.80	4,038.15	4,190.84	4,304.13	4,424.95	
	lb/hr	325.54	351.57	351.37	327.68	323.29	312.88	300.75	
UHC Emissions	lb/lb-mol	18.37	18.37	18.37	18.37	18.37	18.37	18.37	
	ppmvd, 15% O <sub>2</sub>	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
	ppmvw	409.01	374.90	388.88	403.82	419.08	430.41	442.49	
	lb/hr	21.35	23.06	23.05	21.49	21.20	20.52	19.73	
NOTES									
1. Footnotes 1 thru 4 of TABLE B-1Ab.									

TABLE B-1Ad Manufacturer's Operating and Emissions Data Startup/Shutdown Step 2: Ignition-Idle PTE - 100% Fuel Utilization at 100% Power Output									
Vendor Data									
Make:	Solar								
Model:	060-07802S4								
Rate	7,700 hp (ISO)								
Capacity:	6,800 hp (NEMA)								
Load:	10%								
Ambient	Temperature	°F		0.01	20.00	40.00	60.00	80.00	100.00
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>		0.0006	0.0014	0.0031	0.0066	0.0133	0.0253
Fuel	Lower Heating Value (LHV)	BTU/scf		939.2	939.2	939.2	939.2	939.2	939.2
Turbine	Net Output Power	hp		841	816	788	747	688	624
	Heat Input at LHV	MMBTU/hr		14.59	14.59	14.63	14.45	14.09	13.68
Exhaust	Temperature	°F		503	543	584	626	670	715
	Water Fraction	%		2.56%	2.78%	3.15%	3.79%	4.89%	6.76%
	O <sub>2</sub> Content	% (dry)		18.63%	18.54%	18.44%	18.33%	18.23%	18.10%
	Molecular Weight	lb/lb-mol		28.80	28.78	28.74	28.68	28.56	28.36
	Flow Rate	lb/hr		96,424	92,838	83,262	78,987	74,120	68,816
		acfm		39,250	39,391	36,819	36,439	35,690	34,709
Estimated Emissions	NO <sub>x</sub>	ppmvd, 15% O <sub>2</sub>		50	50	50	50	50	50
	CO	ppmvd, 15% O <sub>2</sub>		10,000	10,000	10,000	10,000	10,000	10,000
	UHC	ppmvd, 15% O <sub>2</sub>		1,000	1,000	1,000	1,000	1,000	1,000

<p align="center"><b>TABLE B-1Ae</b>  <b>Manufacturer's Operating and Emissions Data</b>  <b>Startup/Shutdown Step 3: Loading/Thermal Stabilization</b>  <b>PTE - 100% Fuel Utilization at 100% Power Output</b></p>									
Parameters			Interpolated	Vendor Data					
Ambient	Temperature	°F	46.65	0.01	20.00	40.00	60.00	80.00	100.00
	Altitude	ft	0	0	0	0	0	0	0
	Pressure	psia	14.702	14.702	14.702	14.702	14.702	14.702	14.702
	Relative Humidity	%	60%	60%	60%	60%	60%	60%	60%
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>	0.0035	0.0006	0.0013	0.0028	0.0058	0.0124	0.0262
Fuel	Lower Heating Value (LHV)	BTU/scf	939.2	939.2	939.2	939.2	939.2	939.2	939.2
	Higher Heating Value (HHV)	BTU/scf	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6	1,043.6
Turbine	Net Output Power	hp	2,327	2,524	2,449	2,363	2,242	2,065	1,873
	Fuel Consumption	scf/hr	28,688	29,152	29,035	28,822	28,279	27,310	26,256
	Heat Input at LHV	MMBTU/hr	26.94	27.38	27.27	27.07	26.56	25.65	24.66
	Heat Input at HHV	MMBTU/hr	29.94	30.42	30.30	30.08	29.51	28.50	27.40
	Heat Rate at LHV	BTU/hp-hr	11,576	10,848	11,135	11,456	11,847	12,421	13,166
	Heat Rate at HHV	BTU/hp-hr	12,863	12,053	12,372	12,729	13,163	13,801	14,629
Exhaust	Temperature	°F	704	607	649	691	728	762	794
	Water Fraction	%, by vol	4.23%	3.45%	3.69%	4.06%	4.67%	5.71%	7.48%
	Non-Water Fraction	%, by vol	95.77%	96.55%	96.31%	95.94%	95.33%	94.29%	92.52%
	O <sub>2</sub> Content	%, by vol (dry)	17.52%	17.77%	17.66%	17.55%	17.47%	17.41%	17.35%
	Molecular Weight	lb/lb-mol	28.67	28.74	28.72	28.69	28.62	28.51	28.32
	Flow Rate	lb/hr	121,691	132,796	128,069	123,398	118,041	112,104	106,173
		scfm (1 atm, 68°F)	27,296	29,693	28,670	27,643	26,512	25,270	24,101
NO <sub>x</sub> Emissions		acfm	60,139	59,982	60,194	60,237	59,630	58,463	57,218
		lb/lb-mol	46.01	46.01	46.01	46.01	46.01	46.01	46.01
		ppmvd, 15% O <sub>2</sub>	60	60	60	60	60	60	60
		ppmvw	32.91	30.73	31.73	32.68	33.25	33.46	33.40
CO Emissions		lb/hr	6.43	6.53	6.51	6.47	6.31	6.05	5.76
		lb/lb-mol	28.01	28.01	28.01	28.01	28.01	28.01	28.01
		ppmvd, 15% O <sub>2</sub>	9,000	9,000	9,000	9,000	9,000	9,000	9,000
		ppmvw	4,936.89	4,609.85	4,760.00	4,902.70	4,987.86	5,019.74	5,010.19
UHC Emissions		lb/hr	586.91	596.62	594.54	590.64	576.22	552.86	526.12
		lb/lb-mol	18.37	18.37	18.37	18.37	18.37	18.37	18.37
		ppmvd, 15% O <sub>2</sub>	900	900	900	900	900	900	900
		ppmvw	493.69	460.99	476.00	490.27	498.79	501.97	501.02
		lb/hr	38.50	39.13	39.00	38.74	37.79	36.26	34.51
NOTES									
1. Footnotes 1 thru 4 of TABLE B-1Ab.									



TABLE B-1Ae Manufacturer's Operating and Emissions Data Startup/Shutdown Step 3: Loading/Thermal Stabilization PTE - 100% Fuel Utilization at 100% Power Output									
Vendor Data									
Make:	Solar								
Model:	060-07802S4								
Rate	7,700 hp (ISO)								
Capacity:	6,800 hp (NEMA)								
Load:	29%								
Ambient	Temperature	°F		0.01	20.00	40.00	60.00	80.00	100.00
	Specific Humidity	lb <sub>H2O</sub> /lb <sub>Dry Air</sub>		0.0006	0.0014	0.0031	0.0066	0.0133	0.0253
Fuel	Lower Heating Value (LHV)	BTU/scf		939.2	939.2	939.2	939.2	939.2	939.2
Turbine	Net Output Power	hp		2,524	2,449	2,363	2,242	2,065	1,873
	Heat Input at LHV	MMBTU/hr		27.38	27.27	27.07	26.56	25.65	24.66
Exhaust	Temperature	°F		607	649	691	728	762	794
	Water Fraction	%		3.45%	3.69%	4.06%	4.67%	5.71%	7.48%
	O <sub>2</sub> Content	% (dry)		17.77%	17.66%	17.55%	17.47%	17.41%	17.35%
	Molecular Weight	lb/lb-mol		28.74	28.72	28.69	28.62	28.51	28.32
	Flow Rate	lb/hr		132,796	128,069	123,398	118,041	112,104	106,173
		acfm		59,982	60,194	60,237	59,630	58,463	57,218
Estimated Emissions	NO <sub>x</sub>	ppmvd, 15% O <sub>2</sub>		60	60	60	60	60	60
	CO	ppmvd, 15% O <sub>2</sub>		9,000	9,000	9,000	9,000	9,000	9,000
	UHC	ppmvd, 15% O <sub>2</sub>		900	900	900	900	900	900

**TABLE B-1Af**  
**Gas-Fired Turbines**  
**Emission Estimates**  
**Startup**

*PTE - 100% Fuel Utilization at 100% Power Output*

Make	Solar				
Model	060-07802S4				
Fuel	Natural Gas				
Ambient Temperature	46.65 °F			0.01 °F	
Maximum Event Frequency		2 events/hr	416 events/yr		2 events/hr
Maximum Startup Time		18.00 min/hr	62.40 hrs/yr		18.00 min/hr
Fuel Consumption		7,292 scf/hr	1.52 MMscf/yr		7,384 scf/hr
		Average	Maximum		Maximum
NO <sub>x</sub>	0.7764 lbs/event	1.5528 lb/hr	0.1615 tpy	0.7977 lbs/event	1.5955 lb/hr
CO	74.9676 lbs/event	149.9353 lb/hr	15.5933 tpy	77.2408 lbs/event	154.4816 lb/hr
SO <sub>2</sub>	0.0521 lbs/event	0.1042 lb/hr	0.0108 tpy	0.0527 lbs/event	0.1055 lb/hr
PM <sub>10/2.5</sub>	0.0245 lbs/event	0.0491 lb/hr	0.0051 tpy	0.0249 lbs/event	0.0497 lb/hr
CO <sub>2-e</sub>	534 lbs/event	1,068 lb/hr	111 tpy	542 lbs/event	1,085 lb/hr
CO <sub>2</sub>	438 lbs/event	875 lb/hr	91 tpy	443 lbs/event	886 lb/hr
N <sub>2</sub> O	0.0008 lbs/event	0.0016 lb/hr	0.0002 tpy	0.0008 lbs/event	0.0017 lb/hr
TOC (Total)	4.9171 lbs/event	9.8343 lb/hr	1.0228 tpy	5.0662 lbs/event	10.1325 lb/hr
Methane	3.8443 lbs/event	7.6886 lb/hr	0.7996 tpy	3.9609 lbs/event	7.9217 lb/hr
Ethane	0.1341 lbs/event	0.2682 lb/hr	0.0279 tpy	0.1382 lbs/event	0.2763 lb/hr
VOC (Total)	0.9387 lbs/event	1.8775 lb/hr	0.1953 tpy	0.9672 lbs/event	1.9344 lb/hr
VOC (non-HAP)	0.4795 lbs/event	0.9590 lb/hr	0.0997 tpy	0.4940 lbs/event	0.9881 lb/hr
HAP (Total)	0.4592 lbs/event	0.9185 lb/hr	0.0955 tpy	0.4732 lbs/event	0.9463 lb/hr
Acetaldehyde	1.79E-02 lbs/event	0.0358 lb/hr	0.0037 tpy	1.84E-02 lbs/event	0.0368 lb/hr
Acrolein	2.86E-03 lbs/event	0.0057 lb/hr	0.0006 tpy	2.95E-03 lbs/event	0.0059 lb/hr
Benzene	5.36E-03 lbs/event	0.0107 lb/hr	0.0011 tpy	5.53E-03 lbs/event	0.0111 lb/hr
Biphenyl					
Butadiene (1,3-)	1.92E-04 lbs/event	0.0004 lb/hr	0.0000 tpy	1.98E-04 lbs/event	0.0004 lb/hr
Carbon Tetrachloride					
Chlorobenzene					
Chloroform					
Dichloropropene (1,3-)					
Ethylbenzene	1.43E-02 lbs/event	0.0286 lb/hr	0.0030 tpy	1.47E-02 lbs/event	0.0295 lb/hr
Ethylene Dibromide					
Formaldehyde	3.17E-01 lbs/event	0.6348 lb/hr	0.0660 tpy	3.27E-01 lbs/event	0.6540 lb/hr
Hexane (n-)					
Methanol					
Methylene Chloride					
Methylnaphthalene (2-)					
Naphthalene	5.81E-04 lbs/event	0.0012 lb/hr	0.0001 tpy	5.99E-04 lbs/event	0.0012 lb/hr
PAH	9.83E-04 lbs/event	0.0020 lb/hr	0.0002 tpy	1.01E-03 lbs/event	0.0020 lb/hr
Phenol					
Propylene Oxide	1.30E-02 lbs/event	0.0259 lb/hr	0.0027 tpy	1.34E-02 lbs/event	0.0267 lb/hr
Styrene					
Tetrachloroethane (1,1,2,2-)					
Toluene	5.81E-02 lbs/event	0.1162 lb/hr	0.0121 tpy	5.99E-02 lbs/event	0.1197 lb/hr
Trichloroethane (1,1,2-)					
Trimethylpentane (2,2,4-)					
Vinyl Chloride					
Xylenes	2.86E-02 lbs/event	0.0572 lb/hr	0.0060 tpy	2.95E-02 lbs/event	0.0590 lb/hr

**NOTES**

1. Emissions of NO<sub>x</sub>, CO, and UHC are estimated using information provided in TABLE B-1Ad and TABLE B-1Ae.

	46.65 °F		0.01 °F	
	Step 2	Step 3	Step 2	Step 3
Duration	3.00 min/event	6.00 min/event	3.00 min/event	6.00 min/event
NO <sub>x</sub>	0.1337 lb/event	0.6427 lb/event	0.1444 lb/event	0.6534 lb/event
CO	16.2771 lb/event	58.6905 lb/event	17.5787 lb/event	59.6621 lb/event
UHC	1.0676 lb/event	3.8495 lb/event	1.1530 lb/event	3.9132 lb/event
Fuel	777 scf/event	2,869 scf/event	777 scf/event	2,915 scf/event

2. Footnotes 4 thru 8 of TABLE B-1Ac.

3. The frequency of startup events was provided by Technical Services.

**TABLE B-1Ag  
Gas-Fired Turbines  
Emission Estimates  
Shutdown**

**PTE - 100% Fuel Utilization at 100% Power Output**

Make	Solar				
Model	060-07802S4				
Fuel	Natural Gas				
Ambient Temperature	46.65 °F			0.01 °F	
Maximum Event Frequency		2 events/hr	416 events/yr		2 events/hr
Maximum Startup Time		7.00 min/hr	24.27 hrs/yr		7.00 min/hr
Fuel Consumption		3,347 scf/hr	0.70 MMscf/yr		3,401 scf/hr
		Average	Maximum		Maximum
NO <sub>x</sub>	0.3749 lbs/event	0.7498 lb/hr	0.0780 tpy	0.3811 lbs/event	0.7622 lb/hr
CO	34.2361 lbs/event	68.4723 lb/hr	7.1211 tpy	34.8029 lbs/event	69.6058 lb/hr
SO <sub>2</sub>	0.0239 lbs/event	0.0478 lb/hr	0.0050 tpy	0.0243 lbs/event	0.0486 lb/hr
PM <sub>10/2.5</sub>	0.0113 lbs/event	0.0225 lb/hr	0.0023 tpy	0.0114 lbs/event	0.0229 lb/hr
CO <sub>2-e</sub>	245 lbs/event	490 lb/hr	51 tpy	249 lbs/event	498 lb/hr
CO <sub>2</sub>	201 lbs/event	402 lb/hr	42 tpy	204 lbs/event	408 lb/hr
N <sub>2</sub> O	0.0004 lbs/event	0.0008 lb/hr	0.0001 tpy	0.0004 lbs/event	0.0008 lb/hr
TOC (Total)	2.2456 lbs/event	4.4911 lb/hr	0.4671 tpy	2.2827 lbs/event	4.5654 lb/hr
Methane	1.7556 lbs/event	3.5112 lb/hr	0.3652 tpy	1.7847 lbs/event	3.5693 lb/hr
Ethane	0.0612 lbs/event	0.1225 lb/hr	0.0127 tpy	0.0623 lbs/event	0.1245 lb/hr
VOC (Total)	0.4287 lbs/event	0.8574 lb/hr	0.0892 tpy	0.4358 lbs/event	0.8716 lb/hr
VOC (non-HAP)	0.2190 lbs/event	0.4380 lb/hr	0.0455 tpy	0.2226 lbs/event	0.4452 lb/hr
HAP (Total)	0.2097 lbs/event	0.4194 lb/hr	0.0436 tpy	0.2132 lbs/event	0.4264 lb/hr
Acetaldehyde	8.17E-03 lbs/event	0.0163 lb/hr	0.0017 tpy	8.30E-03 lbs/event	0.0166 lb/hr
Acrolein	1.31E-03 lbs/event	0.0026 lb/hr	0.0003 tpy	1.33E-03 lbs/event	0.0027 lb/hr
Benzene	2.45E-03 lbs/event	0.0049 lb/hr	0.0005 tpy	2.49E-03 lbs/event	0.0050 lb/hr
Biphenyl					
Butadiene (1,3-)	8.78E-05 lbs/event	0.0002 lb/hr	0.0000 tpy	8.92E-05 lbs/event	0.0002 lb/hr
Carbon Tetrachloride					
Chlorobenzene					
Chloroform					
Dichloropropene (1,3-)					
Ethylbenzene	6.53E-03 lbs/event	0.0131 lb/hr	0.0014 tpy	6.64E-03 lbs/event	0.0133 lb/hr
Ethylene Dibromide					
Formaldehyde	1.45E-01 lbs/event	0.2899 lb/hr	0.0301 tpy	1.47E-01 lbs/event	0.2947 lb/hr
Hexane (n-)					
Methanol					
Methylene Chloride					
Methylnaphthalene (2-)					
Naphthalene	2.65E-04 lbs/event	0.0005 lb/hr	0.0001 tpy	2.70E-04 lbs/event	0.0005 lb/hr
PAH	4.49E-04 lbs/event	0.0009 lb/hr	0.0001 tpy	4.57E-04 lbs/event	0.0009 lb/hr
Phenol					
Propylene Oxide	5.92E-03 lbs/event	0.0118 lb/hr	0.0012 tpy	6.02E-03 lbs/event	0.0120 lb/hr
Styrene					
Tetrachloroethane (1,1,2,2-)					
Toluene	2.65E-02 lbs/event	0.0531 lb/hr	0.0055 tpy	2.70E-02 lbs/event	0.0540 lb/hr
Trichloroethane (1,1,2-)					
Trimethylpentane (2,2,4-)					
Vinyl Chloride					
Xylenes	1.31E-02 lbs/event	0.0261 lb/hr	0.0027 tpy	1.33E-02 lbs/event	0.0266 lb/hr

**NOTES**

1. Emissions of NO<sub>x</sub>, CO, and UHC are estimated using information provided in TABLE B-1Ad and TABLE B-1Ae.

	46.65 °F		0.01 °F	
	Step 2	Step 3	Step 2	Step 3
Duration	0.00 min/event	3.50 min/event	0.00 min/event	3.50 min/event
NO <sub>x</sub>	0.0000 lb/event	0.3749 lb/event	0.0000 lb/event	0.3811 lb/event
CO	0.0000 lb/event	34.2361 lb/event	0.0000 lb/event	34.8029 lb/event
UHC	0.0000 lb/event	2.2456 lb/event	0.0000 lb/event	2.2827 lb/event
Fuel	0 scf/event	1,673 scf/event	0 scf/event	1,701 scf/event

2. Footnotes 4 thru 8 of TABLE B-1Ac.

3. The frequency of startup events was provided by Technical Services.

**TABLE B-1Ah**  
**Gas-Fired Turbines**  
**Emission Estimates**  
**Low Temperatures**

*PTE - 100% Fuel Utilization at 100% Power Output*

Make	Solar					
Model	060-07802S4					
Normal Operating Load	100%					
Fuel	Natural Gas					
Fuel Higher Heating Value (HHV)	1,020 BTU/scf			1,020 BTU/scf		
Ambient Temperature	-20.00 °F			-20.00 °F		
Power Output	8,664 bhp (mech.)			8,664 bhp (mech.)		
	6,461 kW (elec.)			6,461 kW (elec.)		
Heat Rate at HHV	8,646 BTU/hp-hr			8,646 BTU/hp-hr		
Operating Hours	12 hrs/yr			0 hrs/yr		
Fuel Consumption	73,444 scfh			73,444 scfh		
	0.881 MMscf/yr			0.000 MMscf/yr		
Heat Input at HHV	74.91 MMBTU/hr	0°F ≥ T > -20°F		74.91 MMBTU/hr	T ≤ -20°F	
	899 MMBTU/yr	Hourly	Annual	0 MMBTU/yr	Hourly	Annual
NO <sub>x</sub>	154.71 lb/MMscf	11.3622 lb/hr	0.0682 tpy	442.02 lb/MMscf	32.4635 lb/hr	0.0000 tpy
CO	224.24 lb/MMscf	16.4693 lb/hr	0.0988 tpy	336.37 lb/MMscf	24.7040 lb/hr	0.0000 tpy
SO <sub>2</sub>	14.29 lb/MMscf	1.0492 lb/hr	0.0063 tpy	14.29 lb/MMscf	1.0492 lb/hr	0.0000 tpy
PM <sub>10/2.5</sub>	6.73 lb/MMscf	0.4944 lb/hr	0.0030 tpy	6.73 lb/MMscf	0.4944 lb/hr	0.0000 tpy
CO <sub>2,e</sub>	121,522 lb/MMscf	8,925 lb/hr	54 tpy	122,241 lb/MMscf	8,978 lb/hr	0 tpy
CO <sub>2</sub>	120,017 lb/MMscf	8,815 lb/hr	53 tpy	120,017 lb/MMscf	8,815 lb/hr	0 tpy
N <sub>2</sub> O	0.23 lb/MMscf	0.0166 lb/hr	0.0001 tpy	0.23 lb/MMscf	0.0166 lb/hr	0.0000 tpy
TOC (Total)	73.54 lb/MMscf	5.4011 lb/hr	0.0324 tpy	110.31 lb/MMscf	8.1017 lb/hr	0.0000 tpy
Methane	57.50 lb/MMscf	4.2227 lb/hr	0.0253 tpy	86.24 lb/MMscf	6.3340 lb/hr	0.0000 tpy
Ethane	2.01 lb/MMscf	0.1473 lb/hr	0.0009 tpy	3.01 lb/MMscf	0.2210 lb/hr	0.0000 tpy
VOC (Total)	14.04 lb/MMscf	1.0311 lb/hr	0.0062 tpy	21.06 lb/MMscf	1.5467 lb/hr	0.0000 tpy
VOC (non-HAP)	7.17 lb/MMscf	0.5267 lb/hr	0.0032 tpy	10.76 lb/MMscf	0.7900 lb/hr	0.0000 tpy
HAP (Total)	6.87 lb/MMscf	0.5044 lb/hr	0.0030 tpy	10.30 lb/MMscf	0.7566 lb/hr	0.0000 tpy
Acetaldehyde	2.67E-01 lb/MMscf	0.0196 lb/hr	0.0001 tpy	4.01E-01 lb/MMscf	0.0295 lb/hr	0.0000 tpy
Acrolein	4.28E-02 lb/MMscf	0.0031 lb/hr	0.0000 tpy	6.42E-02 lb/MMscf	0.0047 lb/hr	0.0000 tpy
Benzene	8.02E-02 lb/MMscf	0.0059 lb/hr	0.0000 tpy	1.20E-01 lb/MMscf	0.0088 lb/hr	0.0000 tpy
Biphenyl						
Butadiene (1,3-)	2.87E-03 lb/MMscf	0.0002 lb/hr	0.0000 tpy	4.31E-03 lb/MMscf	0.0003 lb/hr	0.0000 tpy
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene	2.14E-01 lb/MMscf	0.0157 lb/hr	0.0001 tpy	3.21E-01 lb/MMscf	0.0236 lb/hr	0.0000 tpy
Ethylene Dibromide						
Formaldehyde	4.75E+00 lb/MMscf	0.3486 lb/hr	0.0021 tpy	7.12E+00 lb/MMscf	0.5229 lb/hr	0.0000 tpy
Hexane (n-)						
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)						
Naphthalene	8.69E-03 lb/MMscf	0.0006 lb/hr	0.0000 tpy	1.30E-02 lb/MMscf	0.0010 lb/hr	0.0000 tpy
PAH	1.47E-02 lb/MMscf	0.0011 lb/hr	0.0000 tpy	2.21E-02 lb/MMscf	0.0016 lb/hr	0.0000 tpy
Phenol						
Propylene Oxide	1.94E-01 lb/MMscf	0.0142 lb/hr	0.0001 tpy	2.91E-01 lb/MMscf	0.0214 lb/hr	0.0000 tpy
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene	8.69E-01 lb/MMscf	0.0638 lb/hr	0.0004 tpy	1.30E+00 lb/MMscf	0.0957 lb/hr	0.0000 tpy
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes	4.28E-01 lb/MMscf	0.0314 lb/hr	0.0002 tpy	6.42E-01 lb/MMscf	0.0471 lb/hr	0.0000 tpy

**NOTES**

1. Fuel higher heating value selected to correspond to AP-42 emissions factors.
2. Operating hours for low ambient temperatures best on best fit of available data (see TABLE B-1Aa).
3. Manufacturer provided data on: power output, heat rate, along with NO<sub>x</sub>, CO, and UHC (or TOC) emissions.
4. Footnotes 4 thru 8 of TABLE B-1Ac.

<div> <div>TABLE B-1Ai</div> <div>Gas-Fired Turbines</div> <div>Maximum Emission Estimates</div> <div>Normal Operations, Startup, Shutdown, and Low Temperature Operations</div> <div>PTE - 100% Fuel Utilization at 100% Power Output</div> </div>																		
Make	Solar																	
Model	060-07802S4																	
Normal Operating Load	100%																	
Operations	Normal			Startup			Shutdown			Startup/Shutdown w/ Normal			Low Temperatures			Combined Operations		
Maximum Annual Combined Event Frequency	8,760 hrs/yr			62 hrs/yr			24 hrs/yr			8,760 hrs/yr			12 hrs/yr			8,760 hrs/yr		
Pollutant	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual
	Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum	
NO <sub>x</sub>	2.2288 lb/hr	2.3799 lb/hr	9.7621 tpy	1.5528 lb/hr	1.5955 lb/hr	0.1615 tpy	0.7498 lb/hr	0.7622 lb/hr	0.0780 tpy	2.2614 lb/hr	3.7460 lb/hr	9.9050 tpy	11.3622 lb/hr	32.4635 lb/hr	0.0682 tpy	2.2739 lb/hr	32.4635 lb/hr	9.9598 tpy
CO	3.7690 lb/hr	4.0245 lb/hr	16.5082 tpy	149.9353 lb/hr	154.4816 lb/hr	15.5933 tpy	68.4723 lb/hr	69.6058 lb/hr	7.1211 tpy	8.9176 lb/hr	226.4350 lb/hr	39.0593 tpy	16.4693 lb/hr	24.7040 lb/hr	0.0988 tpy	8.9350 lb/hr	226.4350 lb/hr	39.1355 tpy
SO <sub>2</sub>	0.9658 lb/hr	1.0266 lb/hr	4.2302 tpy	0.1042 lb/hr	0.1055 lb/hr	0.0108 tpy	0.0478 lb/hr	0.0486 lb/hr	0.0050 tpy	0.9658 lb/hr	1.0266 lb/hr	4.2302 tpy	1.0492 lb/hr	1.0492 lb/hr	0.0063 tpy	0.9659 lb/hr	1.0492 lb/hr	4.2307 tpy
PM <sub>10/2.5</sub>	0.4551 lb/hr	0.4838 lb/hr	1.9934 tpy	0.0491 lb/hr	0.0497 lb/hr	0.0051 tpy	0.0225 lb/hr	0.0229 lb/hr	0.0023 tpy	0.4551 lb/hr	0.4838 lb/hr	1.9934 tpy	0.4944 lb/hr	0.4944 lb/hr	0.0030 tpy	0.4552 lb/hr	0.4944 lb/hr	1.9937 tpy
CO <sub>2-e</sub>	8,167 lb/hr	8,681 lb/hr	35,771 tpy	1,068 lb/hr	1,085 lb/hr	111 tpy	490 lb/hr	498 lb/hr	51 tpy	8,167 lb/hr	8,681 lb/hr	35,771 tpy	8,925 lb/hr	8,978 lb/hr	54 tpy	8,168 lb/hr	8,978 lb/hr	35,775 tpy
CO <sub>2</sub>	8,114 lb/hr	8,625 lb/hr	35,539 tpy	875 lb/hr	886 lb/hr	91 tpy	402 lb/hr	408 lb/hr	42 tpy	8,114 lb/hr	8,625 lb/hr	35,539 tpy	8,815 lb/hr	8,815 lb/hr	53 tpy	8,115 lb/hr	8,815 lb/hr	35,543 tpy
N <sub>2</sub> O	0.0153 lb/hr	0.0163 lb/hr	0.0670 tpy	0.0016 lb/hr	0.0017 lb/hr	0.0002 tpy	0.0008 lb/hr	0.0008 lb/hr	0.0001 tpy	0.0153 lb/hr	0.0163 lb/hr	0.0670 tpy	0.0166 lb/hr	0.0166 lb/hr	0.0001 tpy	0.0153 lb/hr	0.0166 lb/hr	0.0670 tpy
TOC (Total)	2.4721 lb/hr	2.6397 lb/hr	10.8278 tpy	9.8343 lb/hr	10.1325 lb/hr	1.0228 tpy	4.4911 lb/hr	4.5654 lb/hr	0.4671 tpy	2.7878 lb/hr	16.2377 lb/hr	12.2105 tpy	5.4011 lb/hr	8.1017 lb/hr	0.0324 tpy	2.7918 lb/hr	16.2377 lb/hr	12.2280 tpy
Methane	1.9327 lb/hr	2.0637 lb/hr	8.4653 tpy	7.6886 lb/hr	7.9217 lb/hr	0.7996 tpy	3.5112 lb/hr	3.5693 lb/hr	0.3652 tpy	2.1795 lb/hr	12.6949 lb/hr	9.5464 tpy	4.2227 lb/hr	6.3340 lb/hr	0.0253 tpy	2.1827 lb/hr	12.6949 lb/hr	9.5601 tpy
Ethane	0.0674 lb/hr	0.0720 lb/hr	0.2953 tpy	0.2682 lb/hr	0.2763 lb/hr	0.0279 tpy	0.1225 lb/hr	0.1245 lb/hr	0.0127 tpy	0.0760 lb/hr	0.4428 lb/hr	0.3330 tpy	0.1473 lb/hr	0.2210 lb/hr	0.0009 tpy	0.0761 lb/hr	0.4428 lb/hr	0.3335 tpy
VOC (Total)	0.4719 lb/hr	0.5039 lb/hr	2.0671 tpy	1.8775 lb/hr	1.9344 lb/hr	0.1953 tpy	0.8574 lb/hr	0.8716 lb/hr	0.0892 tpy	0.5322 lb/hr	3.0999 lb/hr	2.3311 tpy	1.0311 lb/hr	1.5467 lb/hr	0.0062 tpy	0.5330 lb/hr	3.0999 lb/hr	2.3344 tpy
VOC (non-HAP)	0.2411 lb/hr	0.2574 lb/hr	1.0559 tpy	0.9590 lb/hr	0.9881 lb/hr	0.0997 tpy	0.4380 lb/hr	0.4452 lb/hr	0.0455 tpy	0.2719 lb/hr	1.5834 lb/hr	1.1907 tpy	0.5267 lb/hr	0.7900 lb/hr	0.0032 tpy	0.2722 lb/hr	1.5834 lb/hr	1.1924 tpy
HAP (Total)	0.2309 lb/hr	0.2465 lb/hr	1.0112 tpy	0.9185 lb/hr	0.9463 lb/hr	0.0955 tpy	0.4194 lb/hr	0.4264 lb/hr	0.0436 tpy	0.2604 lb/hr	1.5165 lb/hr	1.1404 tpy	0.5044 lb/hr	0.7566 lb/hr	0.0030 tpy	0.2607 lb/hr	1.5165 lb/hr	1.1420 tpy
Acetaldehyde	8.99E-03 lb/hr	9.60E-03 lb/hr	3.94E-02 tpy	3.58E-02 lb/hr	3.68E-02 lb/hr	3.72E-03 tpy	1.63E-02 lb/hr	1.66E-02 lb/hr	1.70E-03 tpy	1.01E-02 lb/hr	5.90E-02 lb/hr	4.44E-02 tpy	1.96E-02 lb/hr	2.95E-02 lb/hr	1.18E-04 tpy	1.02E-02 lb/hr	5.90E-02 lb/hr	4.45E-02 tpy
Acrolein	1.44E-03 lb/hr	1.54E-03 lb/hr	6.30E-03 tpy	5.72E-03 lb/hr	5.90E-03 lb/hr	5.95E-04 tpy	2.61E-03 lb/hr	2.66E-03 lb/hr	2.72E-04 tpy	1.62E-03 lb/hr	9.45E-03 lb/hr	7.10E-03 tpy	3.14E-03 lb/hr	4.71E-03 lb/hr	1.89E-05 tpy	1.62E-03 lb/hr	9.45E-03 lb/hr	7.11E-03 tpy
Benzene	2.70E-03 lb/hr	2.88E-03 lb/hr	1.18E-02 tpy	1.07E-02 lb/hr	1.11E-02 lb/hr	1.12E-03 tpy	4.90E-03 lb/hr	4.98E-03 lb/hr	5.10E-04 tpy	3.04E-03 lb/hr	1.77E-02 lb/hr	1.33E-02 tpy	5.89E-03 lb/hr	8.84E-03 lb/hr	3.54E-05 tpy	3.05E-03 lb/hr	1.77E-02 lb/hr	1.33E-02 tpy
Biphenyl																		
Butadiene (1,3-)	9.66E-05 lb/hr	1.03E-04 lb/hr	4.23E-04 tpy	3.84E-04 lb/hr	3.96E-04 lb/hr	4.00E-05 tpy	1.76E-04 lb/hr	1.78E-04 lb/hr	1.83E-05 tpy	1.09E-04 lb/hr	6.35E-04 lb/hr	4.77E-04 tpy	2.11E-04 lb/hr	3.17E-04 lb/hr	1.27E-06 tpy	1.09E-04 lb/hr	6.35E-04 lb/hr	4.78E-04 tpy
Carbon Tetrachloride																		
Chlorobenzene																		
Chloroform																		
Dichloropropene (1,3-)																		
Ethylbenzene	7.19E-03 lb/hr	7.68E-03 lb/hr	3.15E-02 tpy	2.86E-02 lb/hr	2.95E-02 lb/hr	2.98E-03 tpy	1.31E-02 lb/hr	1.33E-02 lb/hr	1.36E-03 tpy	8.11E-03 lb/hr	4.72E-02 lb/hr	3.55E-02 tpy	1.57E-02 lb/hr	2.36E-02 lb/hr	9.43E-05 tpy	8.12E-03 lb/hr	4.72E-02 lb/hr	3.56E-02 tpy
Ethylene Dibromide																		
Formaldehyde	1.60E-01 lb/hr	1.70E-01 lb/hr	6.99E-01 tpy	6.35E-01 lb/hr	6.54E-01 lb/hr	6.60E-02 tpy	2.90E-01 lb/hr	2.95E-01 lb/hr	3.01E-02 tpy	1.80E-01 lb/hr	1.05E+00 lb/hr	7.88E-01 tpy	3.49E-01 lb/hr	5.23E-01 lb/hr	2.09E-03 tpy	1.80E-01 lb/hr	1.05E+00 lb/hr	7.89E-01 tpy
Hexane (n-)																		
Methanol																		
Methylene Chloride																		
Methylnaphthalene (2-)																		
Naphthalene	2.92E-04 lb/hr	3.12E-04 lb/hr	1.28E-03 tpy	1.16E-03 lb/hr	1.20E-03 lb/hr	1.21E-04 tpy	5.31E-04 lb/hr	5.40E-04 lb/hr	5.52E-05 tpy	3.29E-04 lb/hr	1.92E-03 lb/hr	1.44E-03 tpy	6.38E-04 lb/hr	9.57E-04 lb/hr	3.83E-06 tpy	3.30E-04 lb/hr	1.92E-03 lb/hr	1.45E-03 tpy
PAH	4.94E-04 lb/hr	5.28E-04 lb/hr	2.17E-03 tpy	1.97E-03 lb/hr	2.03E-03 lb/hr	2.05E-04 tpy	8.98E-04 lb/hr	9.13E-04 lb/hr	9.34E-05 tpy	5.58E-04 lb/hr	3.25E-03 lb/hr	2.44E-03 tpy	1.08E-03 lb/hr	1.62E-03 lb/hr	6.48E-06 tpy	5.58E-04 lb/hr	3.25E-03 lb/hr	2.45E-03 tpy
Phenol																		
Propylene Oxide	6.52E-03 lb/hr	6.96E-03 lb/hr	2.85E-02 tpy	2.59E-02 lb/hr	2.67E-02 lb/hr	2.70E-03 tpy	1.18E-02 lb/hr	1.20E-02 lb/hr	1.23E-03 tpy	7.35E-03 lb/hr	4.28E-02 lb/hr	3.22E-02 tpy	1.42E-02 lb/hr	2.14E-02 lb/hr	8.54E-05 tpy	7.36E-03 lb/hr	4.28E-02 lb/hr	3.22E-02 tpy
Styrene																		
Tetrachloroethane (1,1,2,2-)																		
Toluene	2.92E-02 lb/hr	3.12E-02 lb/hr	1.28E-01 tpy	1.16E-01 lb/hr	1.20E-01 lb/hr	1.21E-02 tpy	5.31E-02 lb/hr	5.40E-02 lb/hr	5.52E-03 tpy	3.29E-02 lb/hr	1.92E-01 lb/hr	1.44E-01 tpy	6.38E-02 lb/hr	9.57E-02 lb/hr	3.83E-04 tpy	3.30E-02 lb/hr	1.92E-01 lb/hr	1.45E-01 tpy
Trichloroethane (1,1,2-)																		
Trimethylpentane (2,2,4-)																		
Vinyl Chloride																		
Xylenes	1.44E-02 lb/hr	1.54E-02 lb/hr	6.30E-02 tpy	5.72E-02 lb/hr	5.90E-02 lb/hr	5.95E-03 tpy	2.61E-02 lb/hr	2.66E-02 lb/hr	2.72E-03 tpy	1.62E-02 lb/hr	9.45E-02 lb/hr	7.10E-02 tpy	3.14E-02 lb/hr	4.71E-02 lb/hr	1.89E-04 tpy	1.62E-02 lb/hr	9.45E-02 lb/hr	7.11E-02 tpy
NOTES																		
<div> <div>1. See TABLE B-1Ac, TABLE B-1Af, TABLE B-1Ag, and TABLE B-1Ah.</div> <div> <div>2. If <math>E(t)_{\text{normal}} &gt; E(t)_{\text{transient}}</math>, then <math>E(8,760 \text{ hrs/yr})_{\text{all}} = E(8,760 \text{ hrs/yr})_{\text{normal}}</math></div> <div>Otherwise, <math>E(8,760 \text{ hrs/yr})_{\text{all}} = E(8,760 \text{ hrs/yr})_{\text{normal}} - E(t)_{\text{normal}} + E(t)_{\text{transient}}</math></div> <div>where t = the duration of transient operation.</div> </div> </div>																		

<div> <div>TABLE B-1Aj</div> <div>Gas-Fired Turbines</div> <div>Maximum Emission Estimates</div> <div>Normal Operations, Startup, Shutdown, and Low Temperature Operations</div> <div>PTE - 100% Fuel Utilization at 100% Power Output</div> </div>																			
Make		Solar																	
Model		060-07802S4																	
Normal Operating Load		100%																	
Operations		Normal			Startup			Shutdown			Startup/Shutdown w/ Normal			Low Temperatures			Combined Operations		
Maximum Annual Combined Event Frequency		8,760 hrs/yr			62 hrs/yr			24 hrs/yr			8,760 hrs/yr			12 hrs/yr			8,760 hrs/yr		
Pollutant	Control Efficiency	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual	Hourly		Maximum Annual
		Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum		Average	Maximum	
NO <sub>x</sub>		2.2288 lb/hr	2.3799 lb/hr	9.7621 tpy	1.5528 lb/hr	1.5955 lb/hr	0.1615 tpy	0.7498 lb/hr	0.7622 lb/hr	0.0780 tpy	2.2614 lb/hr	3.7460 lb/hr	9.9050 tpy	11.3622 lb/hr	32.4635 lb/hr	0.0682 tpy	2.2739 lb/hr	32.4635 lb/hr	9.9598 tpy
CO	95.00% by weight	0.1884 lb/hr	0.2012 lb/hr	0.8254 tpy	149.9353 lb/hr	154.4816 lb/hr	15.5933 tpy	3.4236 lb/hr	3.4803 lb/hr	0.3561 tpy	3.8280 lb/hr	158.0793 lb/hr	16.7666 tpy	0.8235 lb/hr	1.2352 lb/hr	0.0049 tpy	3.8289 lb/hr	158.0793 lb/hr	16.7704 tpy
SO <sub>2</sub>		0.9658 lb/hr	1.0266 lb/hr	4.2302 tpy	0.1042 lb/hr	0.1055 lb/hr	0.0108 tpy	0.0478 lb/hr	0.0486 lb/hr	0.0050 tpy	0.9658 lb/hr	1.0266 lb/hr	4.2302 tpy	1.0492 lb/hr	1.0492 lb/hr	0.0063 tpy	0.9659 lb/hr	1.0492 lb/hr	4.2307 tpy
PM <sub>10/2.5</sub>		0.4551 lb/hr	0.4838 lb/hr	1.9934 tpy	0.0491 lb/hr	0.0497 lb/hr	0.0051 tpy	0.0225 lb/hr	0.0229 lb/hr	0.0023 tpy	0.4551 lb/hr	0.4838 lb/hr	1.9934 tpy	0.4944 lb/hr	0.4944 lb/hr	0.0030 tpy	0.4552 lb/hr	0.4944 lb/hr	1.9937 tpy
CO <sub>2-e</sub>		8.172 lb/hr	8.687 lb/hr	35,795 tpy	1.068 lb/hr	1.085 lb/hr	111 tpy	592 lb/hr	602 lb/hr	62 tpy	8.172 lb/hr	8.687 lb/hr	35,795 tpy	8.950 lb/hr	9.015 lb/hr	54 tpy	8.173 lb/hr	9.174 lb/hr	35,800 tpy
CO <sub>2</sub>		8,120 lb/hr	8,631 lb/hr	35,564 tpy	875 lb/hr	886 lb/hr	91 tpy	504 lb/hr	512 lb/hr	52 tpy	8,120 lb/hr	8,631 lb/hr	35,564 tpy	8,839 lb/hr	8,851 lb/hr	53 tpy	8,121 lb/hr	8,851 lb/hr	35,568 tpy
N <sub>2</sub> O		0.0153 lb/hr	0.0163 lb/hr	0.0670 tpy	0.0016 lb/hr	0.0017 lb/hr	0.0002 tpy	0.0008 lb/hr	0.0008 lb/hr	0.0001 tpy	0.0153 lb/hr	0.0163 lb/hr	0.0670 tpy	0.0166 lb/hr	0.0166 lb/hr	0.0001 tpy	0.0153 lb/hr	0.0166 lb/hr	0.0670 tpy
TOC (Total)	10.91% by weight	2.2024 lb/hr	2.3517 lb/hr	9.6465 tpy	9.8343 lb/hr	10.1325 lb/hr	1.0228 tpy	4.0012 lb/hr	4.0674 lb/hr	0.4161 tpy	2.5091 lb/hr	15.5717 lb/hr	10.9900 tpy	4.8119 lb/hr	7.2179 lb/hr	0.0289 tpy	2.5127 lb/hr	15.5717 lb/hr	11.0056 tpy
Methane	0.00% by weight	1.9327 lb/hr	2.0637 lb/hr	8.4653 tpy	7.6886 lb/hr	7.9217 lb/hr	0.7996 tpy	3.5112 lb/hr	3.5693 lb/hr	0.3652 tpy	2.1795 lb/hr	12.6949 lb/hr	9.5464 tpy	4.2227 lb/hr	6.3340 lb/hr	0.0253 tpy	2.1827 lb/hr	12.6949 lb/hr	9.5601 tpy
Ethane	50.00% by weight	0.0337 lb/hr	0.0360 lb/hr	0.1477 tpy	0.2682 lb/hr	0.2763 lb/hr	0.0279 tpy	0.0612 lb/hr	0.0623 lb/hr	0.0064 tpy	0.0412 lb/hr	0.3596 lb/hr	0.1805 tpy	0.0737 lb/hr	0.1105 lb/hr	0.0004 tpy	0.0413 lb/hr	0.3596 lb/hr	0.1807 tpy
VOC (Total)	50.00% by weight	0.2360 lb/hr	0.2520 lb/hr	1.0336 tpy	1.8775 lb/hr	1.9344 lb/hr	0.1953 tpy	0.4287 lb/hr	0.4358 lb/hr	0.0446 tpy	0.2884 lb/hr	2.5172 lb/hr	1.2632 tpy	0.5156 lb/hr	0.7733 lb/hr	0.0031 tpy	0.2888 lb/hr	2.5172 lb/hr	1.2648 tpy
VOC (non-HAP)	19.10% by weight	0.1950 lb/hr	0.2083 lb/hr	0.8542 tpy	0.9590 lb/hr	0.9881 lb/hr	0.0997 tpy	0.3543 lb/hr	0.3602 lb/hr	0.0368 tpy	0.2243 lb/hr	1.4697 lb/hr	0.9824 tpy	0.4261 lb/hr	0.6392 lb/hr	0.0026 tpy	0.2246 lb/hr	1.4697 lb/hr	0.9838 tpy
HAP (Total)	8.23E-01 by weight	0.0409 lb/hr	0.0437 lb/hr	0.1793 tpy	0.9185 lb/hr	0.9463 lb/hr	0.0955 tpy	0.0744 lb/hr	0.0756 lb/hr	0.0077 tpy	0.0641 lb/hr	1.0474 lb/hr	0.2808 tpy	0.0894 lb/hr	0.1342 lb/hr	0.0005 tpy	0.0642 lb/hr	1.0474 lb/hr	0.2811 tpy
Acetaldehyde	80.00% by weight	1.80E-03 lb/hr	1.92E-03 lb/hr	7.87E-03 tpy	3.58E-02 lb/hr	3.68E-02 lb/hr	3.72E-03 tpy	3.27E-03 lb/hr	3.32E-03 lb/hr	3.40E-04 tpy	2.71E-03 lb/hr	4.13E-02 lb/hr	1.19E-02 tpy	3.93E-03 lb/hr	5.89E-03 lb/hr	2.36E-05 tpy	2.71E-03 lb/hr	4.13E-02 lb/hr	1.19E-02 tpy
Acrolein	50.00% by weight	7.19E-04 lb/hr	7.68E-04 lb/hr	3.15E-03 tpy	5.72E-03 lb/hr	5.90E-03 lb/hr	5.95E-04 tpy	1.31E-03 lb/hr	1.33E-03 lb/hr	1.36E-04 tpy	8.79E-04 lb/hr	7.67E-03 lb/hr	3.85E-03 tpy	1.57E-03 lb/hr	2.36E-03 lb/hr	9.43E-06 tpy	8.80E-04 lb/hr	7.67E-03 lb/hr	3.85E-03 tpy
Benzene	50.00% by weight	1.35E-03 lb/hr	1.44E-03 lb/hr	5.91E-03 tpy	1.07E-02 lb/hr	1.11E-02 lb/hr	1.12E-03 tpy	2.45E-03 lb/hr	2.49E-03 lb/hr	2.55E-04 tpy	1.65E-03 lb/hr	1.44E-02 lb/hr	7.22E-03 tpy	2.95E-03 lb/hr	4.42E-03 lb/hr	1.77E-05 tpy	1.65E-03 lb/hr	1.44E-02 lb/hr	7.23E-03 tpy
Biphenyl	0.00% by weight																		
Butadiene (1,3-)	50.00% by weight	4.83E-05 lb/hr	5.16E-05 lb/hr	2.12E-04 tpy	3.84E-04 lb/hr	3.96E-04 lb/hr	4.00E-05 tpy	8.78E-05 lb/hr	8.92E-05 lb/hr	9.13E-06 tpy	5.91E-05 lb/hr	5.15E-04 lb/hr	2.59E-04 tpy	1.06E-04 lb/hr	1.58E-04 lb/hr	6.33E-07 tpy	5.91E-05 lb/hr	5.15E-04 lb/hr	2.59E-04 tpy
Carbon Tetrachloride	50.00% by weight																		
Chlorobenzene	50.00% by weight																		
Chloroform	50.00% by weight																		
Dichloropropene (1,3-)	50.00% by weight																		
Ethylbenzene	50.00% by weight	3.60E-03 lb/hr	3.84E-03 lb/hr	1.57E-02 tpy	2.86E-02 lb/hr	2.95E-02 lb/hr	2.98E-03 tpy	6.53E-03 lb/hr	6.64E-03 lb/hr	6.79E-04 tpy	4.39E-03 lb/hr	3.84E-02 lb/hr	1.92E-02 tpy	7.86E-03 lb/hr	1.18E-02 lb/hr	4.71E-05 tpy	4.40E-03 lb/hr	3.84E-02 lb/hr	1.93E-02 tpy
Ethylene Dibromide	50.00% by weight																		
Formaldehyde	95.00% by weight	7.98E-03 lb/hr	8.52E-03 lb/hr	3.49E-02 tpy	6.35E-01 lb/hr	6.54E-01 lb/hr	6.60E-02 tpy	1.45E-02 lb/hr	1.47E-02 lb/hr	1.51E-03 tpy	2.33E-02 lb/hr	6.74E-01 lb/hr	1.02E-01 tpy	1.74E-02 lb/hr	2.61E-02 lb/hr	1.05E-04 tpy	2.33E-02 lb/hr	6.74E-01 lb/hr	1.02E-01 tpy
Hexane (n-)	50.00% by weight																		
Methanol	95.00% by weight																		
Methylene Chloride	50.00% by weight																		
Methylnaphthalene (2-)	50.00% by weight																		
Naphthalene	50.00% by weight	1.46E-04 lb/hr	1.56E-04 lb/hr	6.40E-04 tpy	1.16E-03 lb/hr	1.20E-03 lb/hr	1.21E-04 tpy	2.65E-04 lb/hr	2.70E-04 lb/hr	2.76E-05 tpy	1.79E-04 lb/hr	1.56E-03 lb/hr	7.82E-04 tpy	3.19E-04 lb/hr	4.79E-04 lb/hr	1.91E-06 tpy	1.79E-04 lb/hr	1.56E-03 lb/hr	7.83E-04 tpy
PAH	50.00% by weight	2.47E-04 lb/hr	2.64E-04 lb/hr	1.08E-03 tpy	1.97E-03 lb/hr	2.03E-03 lb/hr	2.05E-04 tpy	4.49E-04 lb/hr	4.57E-04 lb/hr	4.67E-05 tpy	3.02E-04 lb/hr	2.64E-03 lb/hr	1.32E-03 tpy	5.40E-04 lb/hr	8.10E-04 lb/hr	3.24E-06 tpy	3.03E-04 lb/hr	2.64E-03 lb/hr	1.33E-03 tpy
Phenol	50.00% by weight																		
Propylene Oxide	50.00% by weight	3.26E-03 lb/hr	3.48E-03 lb/hr	1.43E-02 tpy	2.59E-02 lb/hr	2.67E-02 lb/hr	2.70E-03 tpy	5.92E-03 lb/hr	6.02E-03 lb/hr	6.16E-04 tpy	3.98E-03 lb/hr	3.48E-02 lb/hr	1.74E-02 tpy	7.12E-03 lb/hr	1.07E-02 lb/hr	4.27E-05 tpy	3.99E-03 lb/hr	3.48E-02 lb/hr	1.75E-02 tpy
Styrene	0.00% by weight																		
Tetrachloroethane (1,1,2,2-)	50.00% by weight																		
Toluene	50.00% by weight	1.46E-02 lb/hr	1.56E-02 lb/hr	6.40E-02 tpy	1.16E-01 lb/hr	1.20E-01 lb/hr	1.21E-02 tpy	2.65E-02 lb/hr	2.70E-02 lb/hr	2.76E-03 tpy	1.79E-02 lb/hr	1.56E-01 lb/hr	7.82E-02 tpy	3.19E-02 lb/hr	4.79E-02 lb/hr	1.91E-04 tpy	1.79E-02 lb/hr	1.56E-01 lb/hr	7.83E-02 tpy
Trichloroethane (1,1,2-)	50.00% by weight																		
Trimethylpentane (2,2,4-)	50.00% by weight																		
Vinyl Chloride	0.00% by weight																		
Xylenes	50.00% by weight	7.19E-03 lb/hr	7.68E-03 lb/hr	3.15E-02 tpy	5.72E-02 lb/hr	5.90E-02 lb/hr	5.95E-03 tpy	1.31E-02 lb/hr	1.33E-02 lb/hr	1.36E-03 tpy	8.79E-03 lb/hr	7.67E-02 lb/hr	3.85E-02 tpy	1.57E-02 lb/hr	2.36E-02 lb/hr	9.43E-05 tpy	8.80E-03 lb/hr	7.67E-02 lb/hr	3.85E-02 tpy
NOTES																			
<div> <div>1. See TABLE B-1Ai.</div> <div>2. It's assumed that oxidation catalyst will be ineffective during startup events.</div> <div>3. CO<sub>2</sub> = CO<sub>2</sub>uncontrolled + CE<sub>CO-control efficiency</sub> * CO<sub>uncontrolled</sub> * (MW<sub>CO2</sub>/MW<sub>CO</sub>) = CO<sub>2</sub>uncontrolled + CE<sub>CO-control efficiency</sub> * CO<sub>uncontrolled</sub> * (44.0095/28.0101).</div> </div>																			

**TABLE C-1A**  
**4-Stroke Lean-Burn Reciprocating Engines**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Type	4slb					
Service	Emergency					
IIII Relevant Date	Manufactured: On or After 01/01/2009					
IIII Status	New RICE at Area HAP Source					
Make	Waukesha					
Model	VGF24GL					
Fuel	Natural Gas					
Fuel Higher Heating Value (HHV)	1,020 BTU/scf				1,020 BTU/scf	
Ambient Temperature	80 °F				80 °F	
Power Output	585 bhp (mech.)				585 bhp (mech.)	
	405 kW (elec.)				405 kW (elec.)	
Heat Rate at HHV	7,911 BTU/hp-hr				7,911 BTU/hp-hr	
Operating Hours	300 hrs/yr					
Fuel Consumption	4,537 scfh				4,537 scfh	
	1.361 MMscf/yr					
Heat Input at HHV	4.63 MMBTU/hr				4.63 MMBTU/hr	
	1,388 MMBTU/yr	Uncontrolled				Uncontrolled
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		568.49 lb/MMscf	2.5794 lb/hr	0.3869 tpy	568.49 lb/MMscf	2.5794 lb/hr
CO		369.52 lb/MMscf	1.6766 lb/hr	0.2515 tpy	369.52 lb/MMscf	1.6766 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.0648 lb/hr	0.0097 tpy	14.29 lb/MMscf	0.0648 lb/hr
PM <sub>10/2.5</sub>		10.19 lb/MMscf	0.0462 lb/hr	0.0069 tpy	10.19 lb/MMscf	0.0462 lb/hr
CO <sub>2,e</sub>		152,049 lb/MMscf	690 lb/hr	103 tpy	152,049 lb/MMscf	690 lb/hr
CO <sub>2</sub>		120,017 lb/MMscf	545 lb/hr	82 tpy	120,017 lb/MMscf	545 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0010 lb/hr	0.0002 tpy	0.23 lb/MMscf	0.0010 lb/hr
TOC (Total)		1,503.58 lb/MMscf	6.8221 lb/hr	1.0233 tpy	1,503.58 lb/MMscf	6.8221 lb/hr
Methane		1,278.55 lb/MMscf	5.8011 lb/hr	0.8702 tpy	1,278.55 lb/MMscf	5.8011 lb/hr
Ethane		102.90 lb/MMscf	0.4669 lb/hr	0.0700 tpy	102.90 lb/MMscf	0.4669 lb/hr
VOC (Total)		122.13 lb/MMscf	0.5541 lb/hr	0.0831 tpy	122.13 lb/MMscf	0.5541 lb/hr
VOC (non-HAP)		48.29 lb/MMscf	0.2191 lb/hr	0.0329 tpy	48.29 lb/MMscf	0.2191 lb/hr
HAP (Total)		73.84 lb/MMscf	0.3351 lb/hr	0.0503 tpy	73.84 lb/MMscf	0.3351 lb/hr
Acetaldehyde		8.55E+00 lb/MMscf	3.88E-02 lb/hr	5.82E-03 tpy	8.55E+00 lb/MMscf	3.88E-02 lb/hr
Acrolein		5.26E+00 lb/MMscf	2.39E-02 lb/hr	3.58E-03 tpy	5.26E+00 lb/MMscf	2.39E-02 lb/hr
Benzene		4.50E-01 lb/MMscf	2.04E-03 lb/hr	3.06E-04 tpy	4.50E-01 lb/MMscf	2.04E-03 lb/hr
Biphenyl		2.17E-01 lb/MMscf	9.84E-04 lb/hr	1.48E-04 tpy	2.17E-01 lb/MMscf	9.84E-04 lb/hr
Butadiene (1,3-)		2.73E-01 lb/MMscf	1.24E-03 lb/hr	1.86E-04 tpy	2.73E-01 lb/MMscf	1.24E-03 lb/hr
Carbon Tetrachloride		3.75E-02 lb/MMscf	1.70E-04 lb/hr	2.55E-05 tpy	3.75E-02 lb/MMscf	1.70E-04 lb/hr
Chlorobenzene		3.11E-02 lb/MMscf	1.41E-04 lb/hr	2.12E-05 tpy	3.11E-02 lb/MMscf	1.41E-04 lb/hr
Chloroform		2.92E-02 lb/MMscf	1.32E-04 lb/hr	1.98E-05 tpy	2.92E-02 lb/MMscf	1.32E-04 lb/hr
Dichloropropene (1,3-)		2.70E-02 lb/MMscf	1.23E-04 lb/hr	1.84E-05 tpy	2.70E-02 lb/MMscf	1.23E-04 lb/hr
Ethylbenzene		4.06E-02 lb/MMscf	1.84E-04 lb/hr	2.76E-05 tpy	4.06E-02 lb/MMscf	1.84E-04 lb/hr
Ethylene Dibromide		4.53E-02 lb/MMscf	2.06E-04 lb/hr	3.08E-05 tpy	4.53E-02 lb/MMscf	2.06E-04 lb/hr
Formaldehyde		5.40E+01 lb/MMscf	2.45E-01 lb/hr	3.68E-02 tpy	5.40E+01 lb/MMscf	2.45E-01 lb/hr
Hexane (n-)		1.14E+00 lb/MMscf	5.15E-03 lb/hr	7.73E-04 tpy	1.14E+00 lb/MMscf	5.15E-03 lb/hr
Methanol		2.56E+00 lb/MMscf	1.16E-02 lb/hr	1.74E-03 tpy	2.56E+00 lb/MMscf	1.16E-02 lb/hr
Methylene Chloride		2.05E-02 lb/MMscf	9.28E-05 lb/hr	1.39E-05 tpy	2.05E-02 lb/MMscf	9.28E-05 lb/hr
Methylnaphthalene (2-)		3.40E-02 lb/MMscf	1.54E-04 lb/hr	2.31E-05 tpy	3.40E-02 lb/MMscf	1.54E-04 lb/hr
Naphthalene		7.61E-02 lb/MMscf	3.45E-04 lb/hr	5.18E-05 tpy	7.61E-02 lb/MMscf	3.45E-04 lb/hr
PAH		2.75E-02 lb/MMscf	1.25E-04 lb/hr	1.87E-05 tpy	2.75E-02 lb/MMscf	1.25E-04 lb/hr
Phenol		2.45E-02 lb/MMscf	1.11E-04 lb/hr	1.67E-05 tpy	2.45E-02 lb/MMscf	1.11E-04 lb/hr
Propylene Oxide						
Styrene		2.41E-02 lb/MMscf	1.10E-04 lb/hr	1.64E-05 tpy	2.41E-02 lb/MMscf	1.10E-04 lb/hr
Tetrachloroethane (1,1,2,2-)		4.35E-02 lb/MMscf	1.97E-04 lb/hr	2.96E-05 tpy	4.35E-02 lb/MMscf	1.97E-04 lb/hr
Toluene		4.17E-01 lb/MMscf	1.89E-03 lb/hr	2.84E-04 tpy	4.17E-01 lb/MMscf	1.89E-03 lb/hr
Trichloroethane (1,1,2-)		3.25E-02 lb/MMscf	1.48E-04 lb/hr	2.21E-05 tpy	3.25E-02 lb/MMscf	1.48E-04 lb/hr
Trimethylpentane (2,2,4-)		2.56E-01 lb/MMscf	1.16E-03 lb/hr	1.74E-04 tpy	2.56E-01 lb/MMscf	1.16E-03 lb/hr
Vinyl Chloride		1.52E-02 lb/MMscf	6.91E-05 lb/hr	1.04E-05 tpy	1.52E-02 lb/MMscf	6.91E-05 lb/hr
Xylenes		1.88E-01 lb/MMscf	8.54E-04 lb/hr	1.28E-04 tpy	1.88E-01 lb/MMscf	8.54E-04 lb/hr

**NOTES**

- Fuel higher heating value selected to correspond to AP-42 emissions factors.
- Maximum hourly emissions based on 100% of rated capacity.
- Vendor provided data on power output and heat rate.
- SO<sub>2</sub> emission factor based on AP-42, Section 3.2 (Revised 7/00), Table 3.2-1 using Tariff (5 gr/100 scf).
- PM<sub>10/2.5</sub> emission factor based on AP-42, Section 3.2 (Revised 7/00), Table 3.2-2.
- CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
- NO<sub>x</sub>, CO, and Formaldehyde emission factors based on Vendor Data.
- TOC (Total) and TOC specie emissions are estimated based on scaling of AP-42 using vendor Formaldehyde data.  
Emission factors based on:  $EF_i = [EF_{\text{Formaldehyde}} / EF_{\text{Formaldehyde-AP42}}] (EF_{i\text{-AP42}})$

**TABLE D-1A**  
**Natural Gas Combustion**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Application		Process Heater				
Combustion Process		Conventional				
Add-on Controls		None				
Package (Make: Model)		Hanover: N/A				
Burner (Make: Model)		Unknown: Unknown				
Fuel		Natural Gas				
Fuel Higher Heating Value (HHV)		1,020 BTU/scf			1,020 BTU/scf	
Heat Output at HHV		7,000 MMBTU/hr			7,350 MMBTU/hr	
Thermal Efficiency		74%			74%	
Operating Hours		8,760 hrs/yr				
Fuel Consumption		9,337 scfh			9,804 scfh	
		81,793 MMscf/yr				
Heat Input at HHV		9,524 MMBTU/hr			10,000 MMBTU/hr	
		83,429 MMBTU/yr	Uncontrolled			Uncontrolled
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		98.43 lb/MMscf	0.9191 lb/hr	4.0255 tpy	98.43 lb/MMscf	0.9650 lb/hr
CO		150.00 lb/MMscf	1.4006 lb/hr	6.1345 tpy	150.00 lb/MMscf	1.4706 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.1334 lb/hr	0.5842 tpy	14.29 lb/MMscf	0.1401 lb/hr
PM <sub>10/2.5</sub>		7.60 lb/MMscf	0.0710 lb/hr	0.3108 tpy	7.60 lb/MMscf	0.0745 lb/hr
CO <sub>2,e</sub>		120,338.86 lb/MMscf	1,123.6122 lb/hr	4,921.4213 tpy	120,338.86 lb/MMscf	1,179.7928 lb/hr
CO <sub>2</sub>		120,017.45 lb/MMscf	1,120.6111 lb/hr	4,908.2768 tpy	120,017.45 lb/MMscf	1,176.6417 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0021 lb/hr	0.0093 tpy	0.23 lb/MMscf	0.0022 lb/hr
TOC (Total)		60.00 lb/MMscf	0.5602 lb/hr	2.4538 tpy	60.00 lb/MMscf	0.5882 lb/hr
Methane		10.16 lb/MMscf	0.0949 lb/hr	0.4155 tpy	10.16 lb/MMscf	0.0996 lb/hr
Ethane		13.69 lb/MMscf	0.1279 lb/hr	0.5600 tpy	13.69 lb/MMscf	0.1343 lb/hr
VOC (Total)		36.15 lb/MMscf	0.3375 lb/hr	1.4782 tpy	36.15 lb/MMscf	0.3544 lb/hr
VOC (non-HAP)		27.83 lb/MMscf	0.2599 lb/hr	1.1382 tpy	27.83 lb/MMscf	0.2728 lb/hr
HAP (Total)		8.32 lb/MMscf	0.0776 lb/hr	0.3401 tpy	8.32 lb/MMscf	0.0815 lb/hr
Acetaldehyde						
Acrolein						
Benzene		9.28E-03 lb/MMscf	8.66E-05 lb/hr	3.79E-04 tpy	9.28E-03 lb/MMscf	9.09E-05 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene						
Ethylene Dibromide						
Formaldehyde		3.31E-01 lb/MMscf	3.09E-03 lb/hr	1.35E-02 tpy	3.31E-01 lb/MMscf	3.25E-03 lb/hr
Hexane (n-)		7.95E+00 lb/MMscf	7.42E-02 lb/hr	3.25E-01 tpy	7.95E+00 lb/MMscf	7.80E-02 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)		1.06E-04 lb/MMscf	9.90E-07 lb/hr	4.34E-06 tpy	1.06E-04 lb/MMscf	1.04E-06 lb/hr
Naphthalene		2.69E-03 lb/MMscf	2.52E-05 lb/hr	1.10E-04 tpy	2.69E-03 lb/MMscf	2.64E-05 lb/hr
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene		1.50E-02 lb/MMscf	1.40E-04 lb/hr	6.14E-04 tpy	1.50E-02 lb/MMscf	1.47E-04 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes						

**NOTES**

- Fuel higher heating value selected to correspond to AP-42 emissions factors.
- Maximum hourly emissions based on 105% of rated capacity.
- Vendor provided data on: heat output and heat input.
- CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
- NO<sub>x</sub>, CO and TOC (Total) emission factors based on vendor data.
- SO<sub>2</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
- PM<sub>10/2.5</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
- Remaining TOC specie emission factors based on scaling of AP-42, Section 1.4 (Revised 3/98), Table 1.4-3 using vendor HC data.  
 $EF_i = (EF_{HC}/EF_{TOC-AP42})(EF_{i-AP42})$



**TABLE D-1B**  
**Natural Gas Combustion**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Application		Process Heater				
Combustion Process		Conventional				
Add-on Controls		None				
Package (Make: Model)		NATCO: N/A				
Burner (Make: Model)		Unknown: Unknown				
Fuel		Natural Gas				
Fuel Higher Heating Value (HHV)		1,020 BTU/scf			1,020 BTU/scf	
Heat Output at HHV		5,000 MMBTU/hr			5,250 MMBTU/hr	
Thermal Efficiency		74%			74%	
Operating Hours		8,760 hrs/yr				
Fuel Consumption		6,669 scfh			7,003 scfh	
		58,423 MMscf/yr				
Heat Input at HHV		6,803 MMBTU/hr			7,143 MMBTU/hr	
		59,592 MMBTU/yr	Uncontrolled			Uncontrolled
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		98.43 lb/MMscf	0.6565 lb/hr	2.8754 tpy	98.43 lb/MMscf	0.6893 lb/hr
CO		150.00 lb/MMscf	1.0004 lb/hr	4.3818 tpy	150.00 lb/MMscf	1.0504 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.0953 lb/hr	0.4173 tpy	14.29 lb/MMscf	0.1000 lb/hr
PM <sub>10/2.5</sub>		7.60 lb/MMscf	0.0507 lb/hr	0.2220 tpy	7.60 lb/MMscf	0.0532 lb/hr
CO <sub>2-e</sub>		120,338.86 lb/MMscf	802.5801 lb/hr	3,515.3010 tpy	120,338.86 lb/MMscf	842.7091 lb/hr
CO <sub>2</sub>		120,017.45 lb/MMscf	800.4365 lb/hr	3,505.9120 tpy	120,017.45 lb/MMscf	840.4584 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0015 lb/hr	0.0066 tpy	0.23 lb/MMscf	0.0016 lb/hr
TOC (Total)		60.00 lb/MMscf	0.4002 lb/hr	1.7527 tpy	60.00 lb/MMscf	0.4202 lb/hr
Methane		10.16 lb/MMscf	0.0678 lb/hr	0.2968 tpy	10.16 lb/MMscf	0.0711 lb/hr
Ethane		13.69 lb/MMscf	0.0913 lb/hr	0.4000 tpy	13.69 lb/MMscf	0.0959 lb/hr
VOC (Total)		36.15 lb/MMscf	0.2411 lb/hr	1.0559 tpy	36.15 lb/MMscf	0.2531 lb/hr
VOC (non-HAP)		27.83 lb/MMscf	0.1856 lb/hr	0.8130 tpy	27.83 lb/MMscf	0.1949 lb/hr
HAP (Total)		8.32 lb/MMscf	0.0555 lb/hr	0.2429 tpy	8.32 lb/MMscf	0.0582 lb/hr
Acetaldehyde						
Acrolein						
Benzene		9.28E-03 lb/MMscf	6.19E-05 lb/hr	2.71E-04 tpy	9.28E-03 lb/MMscf	6.50E-05 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene						
Ethylene Dibromide						
Formaldehyde		3.31E-01 lb/MMscf	2.21E-03 lb/hr	9.68E-03 tpy	3.31E-01 lb/MMscf	2.32E-03 lb/hr
Hexane (n-)		7.95E+00 lb/MMscf	5.30E-02 lb/hr	2.32E-01 tpy	7.95E+00 lb/MMscf	5.57E-02 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)		1.06E-04 lb/MMscf	7.07E-07 lb/hr	3.10E-06 tpy	1.06E-04 lb/MMscf	7.42E-07 lb/hr
Naphthalene		2.69E-03 lb/MMscf	1.80E-05 lb/hr	7.87E-05 tpy	2.69E-03 lb/MMscf	1.89E-05 lb/hr
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene		1.50E-02 lb/MMscf	1.00E-04 lb/hr	4.39E-04 tpy	1.50E-02 lb/MMscf	1.05E-04 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes						

**NOTES**

- Fuel higher heating value selected to correspond to AP-42 emissions factors.
- Maximum hourly emissions based on 105% of rated capacity.
- Vendor provided data on: heat output and heat input.
- CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
- NO<sub>x</sub>, CO and TOC (Total) emission factors based on vendor data.
- SO<sub>2</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
- PM<sub>10/2.5</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
- Remaining TOC specie emission factors based on scaling of AP-42, Section 1.4 (Revised 3/98), Table 1.4-3 using vendor HC data.  
 $EF_i = (EF_{HC}/EF_{TOC-AP42})(EF_{i-AP42})$

**TABLE D-1C**  
**Natural Gas Combustion**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Application		Boiler				
Combustion Process		Low NOx Burners				
Add-on Controls		None				
Package (Make: Model)		Lochinvar: CHN1801				
Burner (Make: Model)		Unknown: Unknown				
Fuel		Natural Gas				
Fuel Higher Heating Value (HHV)		1,020 BTU/scf	Uncontrolled		1,020 BTU/scf	Uncontrolled
Heat Output at HHV		1,512 MMBTU/hr			1,588 MMBTU/hr	
Thermal Efficiency		84%			84%	
Operating Hours		8,760 hrs/yr				
Fuel Consumption		1,765 scfh			1,853 scfh	
		15.459 MMscf/yr				
Heat Input at HHV		1,800 MMBTU/hr			1,890 MMBTU/hr	
		15,768 MMBTU/yr				
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		36.91 lb/MMscf	0.0651 lb/hr	0.2853 tpy	36.91 lb/MMscf	0.0684 lb/hr
CO		84.00 lb/MMscf	0.1482 lb/hr	0.6493 tpy	84.00 lb/MMscf	0.1556 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.0252 lb/hr	0.1104 tpy	14.29 lb/MMscf	0.0265 lb/hr
PM <sub>10/2.5</sub>		7.60 lb/MMscf	0.0134 lb/hr	0.0587 tpy	7.60 lb/MMscf	0.0141 lb/hr
CO <sub>2,e</sub>		120,142.36 lb/MMscf	212.0159 lb/hr	928.6298 tpy	120,142.36 lb/MMscf	222.6167 lb/hr
CO <sub>2</sub>		120,017.45 lb/MMscf	211.7955 lb/hr	927.6643 tpy	120,017.45 lb/MMscf	222.3853 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0004 lb/hr	0.0017 tpy	0.23 lb/MMscf	0.0004 lb/hr
TOC (Total)		13.58 lb/MMscf	0.0240 lb/hr	0.1050 tpy	13.58 lb/MMscf	0.0252 lb/hr
Methane		2.30 lb/MMscf	0.0041 lb/hr	0.0178 tpy	2.30 lb/MMscf	0.0043 lb/hr
Ethane		3.10 lb/MMscf	0.0055 lb/hr	0.0240 tpy	3.10 lb/MMscf	0.0057 lb/hr
VOC (Total)		8.18 lb/MMscf	0.0144 lb/hr	0.0632 tpy	8.18 lb/MMscf	0.0152 lb/hr
VOC (non-HAP)		6.30 lb/MMscf	0.0111 lb/hr	0.0487 tpy	6.30 lb/MMscf	0.0117 lb/hr
HAP (Total)		1.88 lb/MMscf	0.0033 lb/hr	0.0145 tpy	1.88 lb/MMscf	0.0035 lb/hr
Acetaldehyde						
Acrolein						
Benzene		2.10E-03 lb/MMscf	3.71E-06 lb/hr	1.62E-05 tpy	2.10E-03 lb/MMscf	3.89E-06 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene						
Ethylene Dibromide						
Formaldehyde		7.50E-02 lb/MMscf	1.32E-04 lb/hr	5.80E-04 tpy	7.50E-02 lb/MMscf	1.39E-04 lb/hr
Hexane (n-)		1.80E+00 lb/MMscf	3.18E-03 lb/hr	1.39E-02 tpy	1.80E+00 lb/MMscf	3.34E-03 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)		2.40E-05 lb/MMscf	4.24E-08 lb/hr	1.86E-07 tpy	2.40E-05 lb/MMscf	4.45E-08 lb/hr
Naphthalene		6.10E-04 lb/MMscf	1.08E-06 lb/hr	4.71E-06 tpy	6.10E-04 lb/MMscf	1.13E-06 lb/hr
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene		3.40E-03 lb/MMscf	6.00E-06 lb/hr	2.63E-05 tpy	3.40E-03 lb/MMscf	6.30E-06 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes						

**NOTES**

1. Fuel higher heating value selected to correspond to AP-42 emissions factors.
2. Maximum hourly emissions based on 105% of rated capacity.
3. Vendor provided data on: heat output and heat input.
4. CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NO<sub>x</sub> emission factor based on vendor data.
6. SO<sub>2</sub> and PM<sub>10/2.5</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
7. Remaining emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-3.

**TABLE D-1D**  
**Natural Gas Combustion**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Application		Process Heater				
Combustion Process		Conventional				
Add-on Controls		None				
Package (Make: Model)		Sivalls: IH-3005-T2-150M				
Burner (Make: Model)		Unknown: Unknown				
Fuel		Natural Gas				
Fuel Higher Heating Value (HHV)		1,020 BTU/scf			1,020 BTU/scf	
Heat Output at HHV		0.150 MMBTU/hr			0.158 MMBTU/hr	
Thermal Efficiency		65%			65%	
Operating Hours		8,760 hrs/yr				
Fuel Consumption		226 scfh			238 scfh	
		1.982 MMscf/yr				
Heat Input at HHV		0.231 MMBTU/hr			0.242 MMBTU/hr	
		2,022 MMBTU/yr		Uncontrolled		Uncontrolled
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		98.43 lb/MMscf	0.0223 lb/hr	0.0975 tpy	98.43 lb/MMscf	0.0234 lb/hr
CO		150.00 lb/MMscf	0.0339 lb/hr	0.1486 tpy	150.00 lb/MMscf	0.0356 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.0032 lb/hr	0.0142 tpy	14.29 lb/MMscf	0.0034 lb/hr
PM <sub>10/2.5</sub>		7.60 lb/MMscf	0.0017 lb/hr	0.0075 tpy	7.60 lb/MMscf	0.0018 lb/hr
CO <sub>2,e</sub>		120,338.86 lb/MMscf	27.2260 lb/hr	119.2498 tpy	120,338.86 lb/MMscf	28.5873 lb/hr
CO <sub>2</sub>		120,017.45 lb/MMscf	27.1533 lb/hr	118.9313 tpy	120,017.45 lb/MMscf	28.5109 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0001 lb/hr	0.0002 tpy	0.23 lb/MMscf	0.0001 lb/hr
TOC (Total)		60.00 lb/MMscf	0.0136 lb/hr	0.0595 tpy	60.00 lb/MMscf	0.0143 lb/hr
Methane		10.16 lb/MMscf	0.0023 lb/hr	0.0101 tpy	10.16 lb/MMscf	0.0024 lb/hr
Ethane		13.69 lb/MMscf	0.0031 lb/hr	0.0136 tpy	13.69 lb/MMscf	0.0033 lb/hr
VOC (Total)		36.15 lb/MMscf	0.0082 lb/hr	0.0358 tpy	36.15 lb/MMscf	0.0086 lb/hr
VOC (non-HAP)		27.83 lb/MMscf	0.0063 lb/hr	0.0276 tpy	27.83 lb/MMscf	0.0066 lb/hr
HAP (Total)		8.32 lb/MMscf	0.0019 lb/hr	0.0082 tpy	8.32 lb/MMscf	0.0020 lb/hr
Acetaldehyde						
Acrolein						
Benzene		9.28E-03 lb/MMscf	2.10E-06 lb/hr	9.19E-06 tpy	9.28E-03 lb/MMscf	2.20E-06 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene						
Ethylene Dibromide						
Formaldehyde		3.31E-01 lb/MMscf	7.50E-05 lb/hr	3.28E-04 tpy	3.31E-01 lb/MMscf	7.87E-05 lb/hr
Hexane (n-)		7.95E+00 lb/MMscf	1.80E-03 lb/hr	7.88E-03 tpy	7.95E+00 lb/MMscf	1.89E-03 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)		1.06E-04 lb/MMscf	2.40E-08 lb/hr	1.05E-07 tpy	1.06E-04 lb/MMscf	2.52E-08 lb/hr
Naphthalene		2.69E-03 lb/MMscf	6.10E-07 lb/hr	2.67E-06 tpy	2.69E-03 lb/MMscf	6.40E-07 lb/hr
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene		1.50E-02 lb/MMscf	3.40E-06 lb/hr	1.49E-05 tpy	1.50E-02 lb/MMscf	3.57E-06 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes						

**NOTES**

- Fuel higher heating value selected to correspond to AP-42 emissions factors.
- Maximum hourly emissions based on 105% of rated capacity.
- Vendor provided data on: heat output and heat input.
- CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
- NO<sub>x</sub>, CO and TOC (Total) emission factors based on vendor data.
- SO<sub>2</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
- PM<sub>10/2.5</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
- Remaining TOC specie emission factors based on scaling of AP-42, Section 1.4 (Revised 3/98), Table 1.4-3 using vendor HC data.  
 $EF_i = (EF_{HC}/EF_{TOC-AP42}) (EF_{i-AP42})$

**TABLE D-1E**  
**Natural Gas Combustion**  
**Hourly and Annual Emission Estimates**  
**Uncontrolled**

Application		Space Heater				
Combustion Process		Conventional				
Add-on Controls		None				
Package (Make: Model)		Bruest: CSA 24-72				
Burner (Make: Model)		Unknown: Unknown				
Fuel		Natural Gas				
Fuel Higher Heating Value (HHV)		1,020 BTU/scf	Uncontrolled		1,020 BTU/scf	Uncontrolled
Heat Output at HHV		0.058 MMBTU/hr			0.060 MMBTU/hr	
Thermal Efficiency		80%			80%	
Operating Hours		8,760 hrs/yr				
		71 scfh			74 scfh	
Fuel Consumption		0.618 MMscf/yr				
		0.072 MMBTU/hr			0.076 MMBTU/hr	
Heat Input at HHV		631 MMBTU/yr				
Pollutant	Control Efficiency	Uncontrolled	Average Hourly	Maximum Annual	Uncontrolled	Maximum Hourly
NO <sub>x</sub>		94.00 lb/MMscf	0.0066 lb/hr	0.0291 tpy	94.00 lb/MMscf	0.0070 lb/hr
CO		40.00 lb/MMscf	0.0028 lb/hr	0.0124 tpy	40.00 lb/MMscf	0.0030 lb/hr
SO <sub>2</sub>		14.29 lb/MMscf	0.0010 lb/hr	0.0044 tpy	14.29 lb/MMscf	0.0011 lb/hr
PM <sub>10/2.5</sub>		7.60 lb/MMscf	0.0005 lb/hr	0.0023 tpy	7.60 lb/MMscf	0.0006 lb/hr
CO <sub>2,e</sub>		120,142.36 lb/MMscf	8.4806 lb/hr	37.1452 tpy	120,142.36 lb/MMscf	8.9047 lb/hr
CO <sub>2</sub>		120,017.45 lb/MMscf	8.4718 lb/hr	37.1066 tpy	120,017.45 lb/MMscf	8.8954 lb/hr
N <sub>2</sub> O		0.23 lb/MMscf	0.0000 lb/hr	0.0001 tpy	0.23 lb/MMscf	0.0000 lb/hr
TOC (Total)		13.58 lb/MMscf	0.0010 lb/hr	0.0042 tpy	13.58 lb/MMscf	0.0010 lb/hr
Methane		2.30 lb/MMscf	0.0002 lb/hr	0.0007 tpy	2.30 lb/MMscf	0.0002 lb/hr
Ethane		3.10 lb/MMscf	0.0002 lb/hr	0.0010 tpy	3.10 lb/MMscf	0.0002 lb/hr
VOC (Total)		8.18 lb/MMscf	0.0006 lb/hr	0.0025 tpy	8.18 lb/MMscf	0.0006 lb/hr
VOC (non-HAP)		6.30 lb/MMscf	0.0004 lb/hr	0.0019 tpy	6.30 lb/MMscf	0.0005 lb/hr
HAP (Total)		1.88 lb/MMscf	0.0001 lb/hr	0.0006 tpy	1.88 lb/MMscf	0.0001 lb/hr
Acetaldehyde						
Acrolein						
Benzene		2.10E-03 lb/MMscf	1.48E-07 lb/hr	6.49E-07 tpy	2.10E-03 lb/MMscf	1.56E-07 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene						
Ethylene Dibromide						
Formaldehyde		7.50E-02 lb/MMscf	5.29E-06 lb/hr	2.32E-05 tpy	7.50E-02 lb/MMscf	5.56E-06 lb/hr
Hexane (n-)		1.80E+00 lb/MMscf	1.27E-04 lb/hr	5.57E-04 tpy	1.80E+00 lb/MMscf	1.33E-04 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)		2.40E-05 lb/MMscf	1.69E-09 lb/hr	7.42E-09 tpy	2.40E-05 lb/MMscf	1.78E-09 lb/hr
Naphthalene		6.10E-04 lb/MMscf	4.31E-08 lb/hr	1.89E-07 tpy	6.10E-04 lb/MMscf	4.52E-08 lb/hr
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene		3.40E-03 lb/MMscf	2.40E-07 lb/hr	1.05E-06 tpy	3.40E-03 lb/MMscf	2.52E-07 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)						
Vinyl Chloride						
Xylenes						

**NOTES**

- Fuel higher heating value selected to correspond to AP-42 emissions factors.
- Maximum hourly emissions based on 105% of rated capacity.
- Vendor provided data on: heat output and heat input.
- CO<sub>2</sub> and N<sub>2</sub>O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
- NO<sub>x</sub>, CO and TOC (Total) emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-1 : Residential Furnace (< 0.3 MMBTU/hr) - Uncontrolled.
- SO<sub>2</sub> and PM<sub>10/2.5</sub> emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
- Remaining TOC specie emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-3.

**TABLE E-1A**  
**Flash Analysis**  
**Maximum Hourly and Annual Emission Estimates**

Station ID	WEYM-SV-V2				
Service	Pipeline Liquids				
Liquids Holding Capacity	587 gal			587 gal	
Liquids Input Rate	4,400 gal/yr			587 gal/hr	
Flash Gas Density	0.0769 lb/scf			0.0769 lb/scf	
Flash Factor	328.03 scf/bbl			328.03 scf/bbl	
Flash Gas Rate	34,365 scf/yr			4,582 scfh	
Flash Losses	2,644 lb/yr	Average	Maximum	353 lb/hr	Maximum
Flash Gas	100.00% by weight	0.3018 lb/hr	1.3220 tpy	100.00% by weight	352.5405 lb/hr
CO <sub>2-e</sub>	1039.07% by weight	3.1363 lb/hr	13.7368 tpy	1039.07% by weight	3,663 lb/hr
CO <sub>2</sub>	5.17% by weight	0.0156 lb/hr	0.0683 tpy	5.17% by weight	18.2173 lb/hr
TOC (Total)	94.73% by weight	0.2859 lb/hr	1.2523 tpy	94.73% by weight	333.9529 lb/hr
Methane	41.36% by weight	0.1248 lb/hr	0.5467 tpy	41.36% by weight	145.7974 lb/hr
Ethane	11.68% by weight	0.0353 lb/hr	0.1545 tpy	11.68% by weight	41.1888 lb/hr
VOC (Total)	41.69% by weight	0.1258 lb/hr	0.5511 tpy	41.69% by weight	146.9667 lb/hr
HAP (Total)	92.34% by weight	0.2787 lb/hr	1.2208 tpy	92.34% by weight	325.5503 lb/hr
Benzene	0.5089% by weight	0.0015 lb/hr	0.0067 tpy	0.5089% by weight	1.7940 lb/hr
Ethylbenzene	0.0275% by weight	0.0001 lb/hr	0.0004 tpy	0.0275% by weight	0.0970 lb/hr
Hexane (n-)	1.7932% by weight	0.0054 lb/hr	0.0237 tpy	1.7932% by weight	6.3218 lb/hr
Methanol					
Naphthalene					
Toluene	0.6253% by weight	0.0019 lb/hr	0.0083 tpy	0.6253% by weight	2.2044 lb/hr
Trimethylpentane (2,2,4-)	0.0091% by weight	0.0000 lb/hr	0.0001 tpy	0.0091% by weight	0.0322 lb/hr
Xylenes	0.3706% by weight	0.0011 lb/hr	0.0049 tpy	0.3706% by weight	1.3066 lb/hr

**NOTES**

- Separator Characteristics: Flash is represented for separators that receive majority of liquids, but flash may be emitted other separators.

Orientation	Vertical Fixed Roof Tank		
Height/Length	12.00 ft		
Diameter	5.00 ft		
Capacity (physical)	1,763 gal		
Capacity (liquid)	587 gal	33% of physical capacity	
- Liquid input rates:
 

a. maximum hourly based on operator experience;	587 gal
b. maximum annual based on operating experience and safety factor; and	4,400 gal
c. average hourly is just the maximum annual divided by 8,760 hrs/yr.	
- Flash gas density is 110% of the value extracted from TABLE E-0D.
 

Density (TABLE E-0D):	0.0699 lb/scf	Safety Factor:	110%
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- Flash factor extracted from TABLE E-0A.
- Speciated emissions vapor weight percentages extracted from TABLE E-0D.

**TABLE F-1A**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source		WEYM-SV-V1SD						
Service		Pipeline Liquids						
Capacity		530 gal			530 gal			
Temperature of Stored Liquid		59.64 °F			85.22 °F			
Vapor Pressure		5.2170 psia			8.2678 psia			
Pumping Rate		150 gal/min			150 gal/min			
Throughput		0.20 turnover/yr						
Standing Losses		106 gal/yr			530 gal/hr			
					July			
					744 hrs/month			
					40.3036 lbs/month			
					0.0542 lb/hr			
Working Losses		261.9182 lb/yr						
		8.20E-03 lb/gal					1.04E-02 lb/gal	
		0.8664 lb/yr	Average	Maximum	5.5304 lb/hr	Maximum		
Residual Liquid	Stand	358.84% by weight	0.1073 lb/hr	0.4699 tpy	358.84% by weight	0.1944 lb/hr		
	Work		0.0004 lb/hr	0.0016 tpy		19.8453 lb/hr		
	Total		0.1076 lb/hr	0.4715 tpy		20.0397 lb/hr		
CO <sub>2</sub> e		5398.27% by weight	1.6194 lb/hr	7.0929 tpy	5398.27% by weight	301 lb/hr		
CO <sub>2</sub>		7.83% by weight	0.0023 lb/hr	0.0103 tpy	7.83% by weight	0.4375 lb/hr		
TOC (Total)		351.00% by weight	0.1053 lb/hr	0.4612 tpy	351.00% by weight	19.6022 lb/hr		
Methane		215.62% by weight	0.0647 lb/hr	0.2833 tpy	215.62% by weight	12.0414 lb/hr		
Ethane		35.39% by weight	0.0106 lb/hr	0.0465 tpy	35.39% by weight	1.9762 lb/hr		
VOC (Total)		100.00% by weight	0.0300 lb/hr	0.1314 tpy	100.00% by weight	5.5846 lb/hr		
HAP (Total)		6.23% by weight	0.0019 lb/hr	0.0082 tpy	6.23% by weight	0.3478 lb/hr		
Benzene		1.5063% by weight	4.52E-04 lb/hr	1.98E-03 tpy	1.5063% by weight	8.41E-02 lb/hr		
Ethylbenzene		0.0477% by weight	1.43E-05 lb/hr	6.26E-05 tpy	0.0477% by weight	2.66E-03 lb/hr		
Hexane (n-)		2.8866% by weight	8.66E-04 lb/hr	3.79E-03 tpy	2.8866% by weight	1.61E-01 lb/hr		
Methanol								
Naphthalene								
Toluene		1.3668% by weight	4.10E-04 lb/hr	1.80E-03 tpy	1.3668% by weight	7.63E-02 lb/hr		
Trimethylpentane (2,2,4-)		0.0139% by weight	4.17E-06 lb/hr	1.82E-05 tpy	0.0139% by weight	7.75E-04 lb/hr		
Xylenes		0.4073% by weight	1.22E-04 lb/hr	5.35E-04 tpy	0.4073% by weight	2.27E-02 lb/hr		

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Vertical Fixed Roof Tank	Above Ground?	Yes	or less solar absorptance
Height/Length	10.83 ft	10.83 ft	Shell/Roof Color	Gray/Medium
Diameter	5.00 ft		Shell Condition	Good
Capacity (estimated)	1,591 gal		Vacuum Setting	-0.03 psig
Capacity (nominal)	1,590 gal		Pressure Setting	0.03 psig

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Gasoline (RVP 10)	Selection based on VOC vapor pressure (see TABLE F-0).	
Liquid Molecular Weight	92.00 lb/lb-mol	Vapor Molecular Weight	66.00 lb/lb-mol

Monthly Data	Days	Vapor Pressure		Liquid Surface Temperature		TANKS Output		TANKS Flow
		avg	max	avg	max	standing	working	
January	31	3.9399	4.3904	46.21	51.55	8.9064	9.8440	1,590
February	28	4.1158	4.7065	48.35	55.05	10.6806	10.2837	1,590
March	31	4.5882	5.3917	53.76	62.02	16.6384	11.4639	1,590
April	30	5.1466	6.2208	59.61	69.56	22.4244	12.8592	1,590
May	31	5.7769	7.1549	65.63	77.15	31.2891	14.4340	1,590
June	30	6.3503	7.9502	70.66	83.01	37.1114	15.8667	1,590
July	31	6.6403	8.2678	73.07	85.22	40.3036	16.5913	1,590
August	31	6.4129	7.8244	71.19	82.11	34.3226	16.0230	1,590
September	30	5.8414	6.9478	66.21	75.53	24.7418	14.5952	1,590
October	31	5.1535	5.9372	59.68	67.07	17.1043	12.8765	1,590
November	30	4.5697	5.0773	53.56	58.91	10.2237	11.4177	1,590
December	31	4.0686	4.4783	47.78	52.55	8.1721	10.1658	1,590
ALL	365	5.2170	8.2678	59.64	85.22	261.9182	156.4210	19,080

3. Emission Estimate Basis:

USEPA TANKS 4.09d & TCEQ RG-166/01

4. Speciation of emissions is based on vapor weight percentages in TABLE F-0 normalized on VOC to assure methodology is conservative.

**TABLE F-1B**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source	WEYM-SV-VIC1				
Service	Pipeline Liquids				
Capacity	530 gal			530 gal	
Temperature of Stored Liquid	59.64 °F			85.22 °F	
Vapor Pressure	5.2170 psia			8.2678 psia	
Pumping Rate	150 gal/min			150 gal/min	
Throughput	0.20 turnover/yr				
	106 gal/yr			530 gal/hr	
Standing Losses				<b>July</b>	
				744 hrs/month	
				<b>40.3036</b> lbs/month	
	<b>261.9182</b> lb/yr			0.0542 lb/hr	
Working Losses	<b>8.20E-03</b> lb/gal			<b>1.04E-02</b> lb/gal	
	0.8664 lb/yr	Average	Maximum	5.5304 lb/hr	Maximum
Residual Liquid	Stand	358.84% by weight	0.1073 lb/hr	0.4699 tpy	0.1944 lb/hr
	Work		0.0004 lb/hr	0.0016 tpy	19.8453 lb/hr
	Total		0.1076 lb/hr	0.4715 tpy	20.0397 lb/hr
CO <sub>2-e</sub>	5398.27% by weight	1.6194 lb/hr	7.0929 tpy	5398.27% by weight	301 lb/hr
CO <sub>2</sub>	7.83% by weight	0.0023 lb/hr	0.0103 tpy	7.83% by weight	0.4375 lb/hr
TOC (Total)	351.00% by weight	0.1053 lb/hr	0.4612 tpy	351.00% by weight	19.6022 lb/hr
Methane	215.62% by weight	0.0647 lb/hr	0.2833 tpy	215.62% by weight	12.0414 lb/hr
Ethane	35.39% by weight	0.0106 lb/hr	0.0465 tpy	35.39% by weight	1.9762 lb/hr
VOC (Total)	100.00% by weight	0.0300 lb/hr	0.1314 tpy	100.00% by weight	5.5846 lb/hr
HAP (Total)	6.23% by weight	0.0019 lb/hr	0.0082 tpy	6.23% by weight	0.3478 lb/hr
Benzene	1.5063% by weight	4.52E-04 lb/hr	1.98E-03 tpy	1.5063% by weight	8.41E-02 lb/hr
Ethylbenzene	0.0477% by weight	1.43E-05 lb/hr	6.26E-05 tpy	0.0477% by weight	2.66E-03 lb/hr
Hexane (n-)	2.8866% by weight	8.66E-04 lb/hr	3.79E-03 tpy	2.8866% by weight	1.61E-01 lb/hr
Methanol					
Naphthalene					
Toluene	1.3668% by weight	4.10E-04 lb/hr	1.80E-03 tpy	1.3668% by weight	7.63E-02 lb/hr
Trimethylpentane (2,2,4-)	0.0139% by weight	4.17E-06 lb/hr	1.82E-05 tpy	0.0139% by weight	7.75E-04 lb/hr
Xylenes	0.4073% by weight	1.22E-04 lb/hr	5.35E-04 tpy	0.4073% by weight	2.27E-02 lb/hr

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Vertical Fixed Roof Tank	Above Ground?	Yes	
Height/Length	10.83 ft	10.83 ft	Shell/Roof Color	Gray/Medium
Diameter	5.00 ft		Shell Condition	Good
Capacity (estimated)	1,591 gal		Vacuum Setting	-0.03 psig
Capacity (nominal)	1,590 gal		Pressure Setting	0.03 psig

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Gasoline (RVP 10)	Selection based on VOC vapor pressure (see TABLE F-0).	

Liquid Molecular Weight Monthly Data	Days	92.00 lb/lb-mol		Vapor Molecular Weight		66.00 lb/lb-mol		TANKS Flow
		Vapor Pressure		Liquid Surface Temperature		TANKS Output		
		avg	max	avg	max	standing	working	
January	31	3.9399	4.3904	46.21	51.55	8.9064	9.8440	1,590
February	28	4.1158	4.7065	48.35	55.05	10.6806	10.2837	1,590
March	31	4.5882	5.3917	53.76	62.02	16.6384	11.4639	1,590
April	30	5.1466	6.2208	59.61	69.56	22.4244	12.8592	1,590
May	31	5.7769	7.1549	65.63	77.15	31.2891	14.4340	1,590
June	30	6.3503	7.9502	70.66	83.01	37.1114	15.8667	1,590
July	31	6.6403	8.2678	73.07	85.22	40.3036	16.5913	1,590
August	31	6.4129	7.8244	71.19	82.11	34.3226	16.0230	1,590
September	30	5.8414	6.9478	66.21	75.53	24.7418	14.5952	1,590
October	31	5.1535	5.9372	59.68	67.07	17.1043	12.8765	1,590
November	30	4.5697	5.0773	53.56	58.91	10.2237	11.4177	1,590
December	31	4.0686	4.4783	47.78	52.55	8.1721	10.1658	1,590
ALL	365	5.2170	8.2678	59.64	85.22	261.9182	156.4210	19,080

3. Emission Estimate Basis:

USEPA TANKS 4.09d & TCEQ RG-166/01

4. Speciation of emissions is based on vapor weight percentages in TABLE F-0 normalized on VOC to assure methodology is conservative.

**TABLE F-1C**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source	WEYM-SV-V2				
Service	Pipeline Liquids				
Capacity	587 gal			587 gal	
Temperature of Stored Liquid	59.64 °F			85.22 °F	
Vapor Pressure	5.2170 psia			8.2678 psia	
Pumping Rate	150 gal/min			150 gal/min	
Throughput	7.50 turnover/yr				
	4,400 gal/yr			587 gal/hr	
Standing Losses				<b>July</b>	
				744 hrs/month	
				<b>41.5584</b> lbs/month	
	<b>271.0744</b> lb/yr			0.0559 lb/hr	
Working Losses	<b>8.20E-03</b> lb/gal			<b>1.04E-02</b> lb/gal	
	36.0719 lb/yr	Average	Maximum	6.1217 lb/hr	Maximum
Residual Liquid	Stand	358.84% by weight	0.1110 lb/hr	0.4864 tpy	0.2004 lb/hr
	Work		0.0148 lb/hr	0.0647 tpy	21.9671 lb/hr
	Total		0.1258 lb/hr	0.5511 tpy	22.1675 lb/hr
CO <sub>2-e</sub>	5398.27% by weight	1.8928 lb/hr	8.2903 tpy	5398.27% by weight	333 lb/hr
CO <sub>2</sub>	7.83% by weight	0.0027 lb/hr	0.0120 tpy	7.83% by weight	0.4839 lb/hr
TOC (Total)	351.00% by weight	0.1231 lb/hr	0.5390 tpy	351.00% by weight	21.6836 lb/hr
Methane	215.62% by weight	0.0756 lb/hr	0.3311 tpy	215.62% by weight	13.3199 lb/hr
Ethane	35.39% by weight	0.0124 lb/hr	0.0543 tpy	35.39% by weight	2.1861 lb/hr
VOC (Total)	100.00% by weight	0.0351 lb/hr	0.1536 tpy	100.00% by weight	6.1776 lb/hr
HAP (Total)	6.23% by weight	0.0022 lb/hr	0.0096 tpy	6.23% by weight	0.3848 lb/hr
Benzene	1.5063% by weight	5.28E-04 lb/hr	2.31E-03 tpy	1.5063% by weight	9.31E-02 lb/hr
Ethylbenzene	0.0477% by weight	1.67E-05 lb/hr	7.32E-05 tpy	0.0477% by weight	2.94E-03 lb/hr
Hexane (n-)	2.8866% by weight	1.01E-03 lb/hr	4.43E-03 tpy	2.8866% by weight	1.78E-01 lb/hr
Methanol					
Naphthalene					
Toluene	1.3668% by weight	4.79E-04 lb/hr	2.10E-03 tpy	1.3668% by weight	8.44E-02 lb/hr
Trimethylpentane (2,2,4-)	0.0139% by weight	4.87E-06 lb/hr	2.13E-05 tpy	0.0139% by weight	8.58E-04 lb/hr
Xylenes	0.4073% by weight	1.43E-04 lb/hr	6.26E-04 tpy	0.4073% by weight	2.52E-02 lb/hr

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Vertical Fixed Roof Tank	Above Ground?	Yes	
Height/Length	12.00 ft	Shell/Roof Color	Gray/Medium	or less solar absorptance
Diameter	5.00 ft	Shell Condition	Good	
Capacity (estimated)	1,763 gal	Vacuum Setting	-0.03 psig	
Capacity (nominal)	1,760 gal	Pressure Setting	0.03 psig	

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Gasoline (RVP 10)	Selection based on VOC vapor pressure (see TABLE F-0).	

Liquid Molecular Weight Monthly Data		92.00 lb/lb-mol		Vapor Molecular Weight		66.00 lb/lb-mol		
	Days	Vapor Pressure		Liquid Surface Temperature		TANKS Output		TANKS
		avg	max	avg	max	standing	working	Flow
January	31	3.9399	4.3904	46.21	51.55	9.2920	10.8965	1,760
February	28	4.1158	4.7065	48.35	55.05	11.1316	11.3832	1,760
March	31	4.5882	5.3917	53.76	62.02	17.2971	12.6896	1,760
April	30	5.1466	6.2208	59.61	69.56	23.2510	14.2341	1,760
May	31	5.7769	7.1549	65.63	77.15	32.3594	15.9772	1,760
June	30	6.3503	7.9502	70.66	83.01	38.3028	17.5631	1,760
July	31	6.6403	8.2678	73.07	85.22	41.5584	18.3652	1,760
August	31	6.4129	7.8244	71.19	82.11	35.4171	17.7362	1,760
September	30	5.8414	6.9478	66.21	75.53	25.5820	16.1557	1,760
October	31	5.1535	5.9372	59.68	67.07	17.7342	14.2532	1,760
November	30	4.5697	5.0773	53.56	58.91	10.6293	12.6384	1,760
December	31	4.0686	4.4783	47.78	52.55	8.5195	11.2527	1,760
ALL	365	5.2170	8.2678	59.64	85.22	271.0744	173.1452	21,120

3. Emission Estimate Basis:

USEPA TANKS 4.09d      &      TCEQ RG-166/01

4. Speciation of emissions is based on vapor weight percentages in TABLE F-0 normalized on VOC to assure methodology is conservative.



**TABLE F-1D**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source	WEYM-SV-V4SD				
Service	Pipeline Liquids				
Capacity	43 gal			43 gal	
Temperature of Stored Liquid	59.64 °F			85.22 °F	
Vapor Pressure	5.2170 psia			8.2678 psia	
Pumping Rate	150 gal/min			150 gal/min	
Throughput	0.20 turnover/yr				
	9 gal/yr			43 gal/hr	
Standing Losses				<b>July</b>	
				744 hrs/month	
				<b>3.9707</b> lbs/month	
	<b>25.4567</b> lb/yr			0.0053 lb/hr	
Working Losses	<b>8.20E-03</b> lb/gal			<b>1.04E-02</b> lb/gal	
	0.0708 lb/yr	Average	Maximum	0.4522 lb/hr	Maximum
Residual Liquid	Stand	358.84% by weight	0.0104 lb/hr	0.0457 tpy	0.0192 lb/hr
	Work		0.0000 lb/hr	0.0001 tpy	1.6226 lb/hr
	Total		0.0105 lb/hr	0.0458 tpy	1.6417 lb/hr
CO <sub>2-e</sub>	5398.27% by weight	0.1573 lb/hr	0.6890 tpy	5398.27% by weight	25 lb/hr
CO <sub>2</sub>	7.83% by weight	0.0002 lb/hr	0.0010 tpy	7.83% by weight	0.0358 lb/hr
TOC (Total)	351.00% by weight	0.0102 lb/hr	0.0448 tpy	351.00% by weight	1.6059 lb/hr
Methane	215.62% by weight	0.0063 lb/hr	0.0275 tpy	215.62% by weight	0.9865 lb/hr
Ethane	35.39% by weight	0.0010 lb/hr	0.0045 tpy	35.39% by weight	0.1619 lb/hr
VOC (Total)	100.00% by weight	0.0029 lb/hr	0.0128 tpy	100.00% by weight	0.4575 lb/hr
HAP (Total)	6.23% by weight	0.0002 lb/hr	0.0008 tpy	6.23% by weight	0.0285 lb/hr
Benzene	1.5063% by weight	4.39E-05 lb/hr	1.92E-04 tpy	1.5063% by weight	6.89E-03 lb/hr
Ethylbenzene	0.0477% by weight	1.39E-06 lb/hr	6.08E-06 tpy	0.0477% by weight	2.18E-04 lb/hr
Hexane (n-)	2.8866% by weight	8.41E-05 lb/hr	3.68E-04 tpy	2.8866% by weight	1.32E-02 lb/hr
Methanol					
Naphthalene					
Toluene	1.3668% by weight	3.98E-05 lb/hr	1.74E-04 tpy	1.3668% by weight	6.25E-03 lb/hr
Trimethylpentane (2,2,4-)	0.0139% by weight	4.05E-07 lb/hr	1.77E-06 tpy	0.0139% by weight	6.35E-05 lb/hr
Xylenes	0.4073% by weight	1.19E-05 lb/hr	5.20E-05 tpy	0.4073% by weight	1.86E-03 lb/hr

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Vertical Fixed Roof Tank	Above Ground?	Yes	
Height/Length	8.00 ft	Shell/Roof Color	Gray/Medium	or less solar absorptance
Diameter	1.67 ft	Shell Condition	Good	
Capacity (estimated)	131 gal	Vacuum Setting	-0.03 psig	
Capacity (nominal)	130 gal	Pressure Setting	0.03 psig	

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Gasoline (RVP 10)	Selection based on VOC vapor pressure (see TABLE F-0).	

Liquid Molecular Weight	92.00 lb/lb-mol		Vapor Molecular Weight		66.00 lb/lb-mol	
	Monthly Data					
	Days	Vapor Pressure		Liquid Surface Temperature		TANKS Output
		avg	max	avg	max	standing    working    TANKS Flow
January	31	3.9399	4.3904	46.21	51.55	0.8407    0.8049    130
February	28	4.1158	4.7065	48.35	55.05	1.0118    0.8408    130
March	31	4.5882	5.3917	53.76	62.02	1.5907    0.9373    130
April	30	5.1466	6.2208	59.61	69.56	2.1644    1.0514    130
May	31	5.7769	7.1549	65.63	77.15	3.0486    1.1801    130
June	30	6.3503	7.9502	70.66	83.01	3.6433    1.2973    130
July	31	6.6403	8.2678	73.07	85.22	3.9707    1.3565    130
August	31	6.4129	7.8244	71.19	82.11	3.3722    1.3101    130
September	30	5.8414	6.9478	66.21	75.53	2.4128    1.1933    130
October	31	5.1535	5.9372	59.68	67.07	1.6511    1.0528    130
November	30	4.5697	5.0773	53.56	58.91	0.9771    0.9335    130
December	31	4.0686	4.4783	47.78	52.55	0.7735    0.8312    130
ALL	365	5.2170	8.2678	59.64	85.22	25.4567    12.7891    1,560

3. Emission Estimate Basis:

USEPA TANKS 4.09d      &      TCEQ RG-166/01

4. Speciation of emissions is based on vapor weight percentages in TABLE F-0 normalized on VOC to assure methodology is conservative.

**TABLE F-1E**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source		WEYM-TK-V5				
Service		Pipeline Liquids				
Capacity		2,200 gal			2,200 gal	
Temperature of Stored Liquid		59.64 °F			85.22 °F	
Vapor Pressure		5.2170 psia			8.2678 psia	
Pumping Rate		150 gal/min			150 gal/min	
Throughput		2.00 turnover/yr				
		4,400 gal/yr			2,200 gal/hr	
Standing Losses					July	
					744 hrs/month	
					85.5506 lbs/month	
					0.1150 lb/hr	
		545.1562 lb/yr				
Working Losses		8.20E-03 lb/gal			1.04E-02 lb/gal	
		36.0719 lb/yr	Average	Maximum	22.9565 lb/hr	Maximum
Residual Liquid	Stand	358.84% by weight	0.2233 lb/hr	0.9781 tpy	358.84% by weight	0.4126 lb/hr
	Work		0.0148 lb/hr	0.0647 tpy		82.3766 lb/hr
	Total		0.2381 lb/hr	1.0428 tpy		82.7892 lb/hr
CO <sub>2</sub> e		5398.27% by weight	3.5818 lb/hr	15.6881 tpy	5398.27% by weight	1,245 lb/hr
CO <sub>2</sub>		7.83% by weight	0.0052 lb/hr	0.0228 tpy	7.83% by weight	1.8074 lb/hr
TOC (Total)		351.00% by weight	0.2329 lb/hr	1.0201 tpy	351.00% by weight	80.9819 lb/hr
Methane		215.62% by weight	0.1431 lb/hr	0.6266 tpy	215.62% by weight	49.7461 lb/hr
Ethane		35.39% by weight	0.0235 lb/hr	0.1028 tpy	35.39% by weight	8.1643 lb/hr
VOC (Total)		100.00% by weight	0.0664 lb/hr	0.2906 tpy	100.00% by weight	23.0715 lb/hr
HAP (Total)		6.23% by weight	0.0041 lb/hr	0.0181 tpy	6.23% by weight	1.4370 lb/hr
Benzene		1.5063% by weight	9.99E-04 lb/hr	4.38E-03 tpy	1.5063% by weight	3.48E-01 lb/hr
Ethylbenzene		0.0477% by weight	3.16E-05 lb/hr	1.39E-04 tpy	0.0477% by weight	1.10E-02 lb/hr
Hexane (n-)		2.8866% by weight	1.92E-03 lb/hr	8.39E-03 tpy	2.8866% by weight	6.66E-01 lb/hr
Methanol						
Naphthalene						
Toluene		1.3668% by weight	9.07E-04 lb/hr	3.97E-03 tpy	1.3668% by weight	3.15E-01 lb/hr
Trimethylpentane (2,2,4-)		0.0139% by weight	9.21E-06 lb/hr	4.04E-05 tpy	0.0139% by weight	3.20E-03 lb/hr
Xylenes		0.4073% by weight	2.70E-04 lb/hr	1.18E-03 tpy	0.4073% by weight	9.40E-02 lb/hr

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Vertical Fixed Roof Tank	Above Ground?	Yes	or less solar absorptance
Height/Length	6.00 ft	Shell/Roof Color	Gray/Medium	
Diameter	8.00 ft	Shell Condition	Good	
Capacity (estimated)	2,256 gal	Vacuum Setting	-0.03 psig	
Capacity (nominal)	2,200 gal	Pressure Setting	0.03 psig	

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Gasoline (RVP 10)	Selection based on VOC vapor pressure (see TABLE F-0).	

Liquid Molecular Weight Monthly Data	Days	92.00 lb/lb-mol		Vapor Molecular Weight		66.00 lb/lb-mol		TANKS Flow
		Vapor Pressure		Liquid Surface Temperature		TANKS Output		
		avg	max	avg	max	standing	working	
January	31	3.9399	4.3904	46.21	51.55	17.7688	13.6207	2,200
February	28	4.1158	4.7065	48.35	55.05	21.4211	14.2290	2,200
March	31	4.5882	5.3917	53.76	62.02	33.8101	15.8620	2,200
April	30	5.1466	6.2208	59.61	69.56	46.1992	17.7926	2,200
May	31	5.7769	7.1549	65.63	77.15	65.3509	19.9715	2,200
June	30	6.3503	7.9502	70.66	83.01	78.3712	21.9539	2,200
July	31	6.6403	8.2678	73.07	85.22	85.5506	22.9565	2,200
August	31	6.4129	7.8244	71.19	82.11	72.5640	22.1702	2,200
September	30	5.8414	6.9478	66.21	75.53	51.7437	20.1947	2,200
October	31	5.1535	5.9372	59.68	67.07	35.2443	17.8165	2,200
November	30	4.5697	5.0773	53.56	58.91	20.7648	15.7981	2,200
December	31	4.0686	4.4783	47.78	52.55	16.3673	14.0659	2,200
ALL	365	5.2170	8.2678	59.64	85.22	545.1562	216.4315	26,400

3. Emission Estimate Basis: USEPA TANKS 4.09d & TCEQ RG-166/01

4. Speciation of emissions is based on vapor weight percentages in TABLE F-0 normalized on VOC to assure methodology is conservative.

**TABLE F-1F**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source		WEYM-TK-OIL1			
Service		Oil			
Capacity		570 gal		570 gal	
Temperature of Stored Liquid		59.64 °F		85.22 °F	
Vapor Pressure		0.0067 psia		0.0141 psia	
Pumping Rate		150 gal/min		150 gal/min	
Throughput		365.00 turnover/yr			
		208,050 gal/yr		570 gal/hr	
Standing Losses				<b>July</b>	
				744 hrs/month	
				<b>0.0252</b> lbs/month	
		<b>0.1582</b> lb/yr		0.00003 lb/hr	
Working Losses		<b>2.07E-05</b> lb/gal		<b>3.07E-05</b> lb/gal	
		4.3031 lb/yr	Average	Maximum	0.0175 lb/hr
Liquid	Stand	100.00% by weight	0.0000 lb/hr	0.0001 tpy	0.0000 lb/hr
	Work		0.0005 lb/hr	0.0022 tpy	0.0175 lb/hr
	Total		0.0005 lb/hr	0.0022 tpy	0.0175 lb/hr
TOC (Total)		100.00% by weight	0.0005 lb/hr	0.0022 tpy	100.00% by weight
Methane					
Ethane					
VOC (Total)		100.00% by weight	0.0005 lb/hr	0.0022 tpy	100.00% by weight
HAP (Total)					
Benzene					
Ethylbenzene					
Hexane (n-)					
Methanol					
Naphthalene					
Toluene					
Trimethylpentane (2,2,4-)					
Xylenes					

**NOTES**

1. Tank Characteristics:		TANKS 4.09d						
Orientation	Vertical Fixed Roof Tank	Above Ground?		Yes				
Height/Length	6.00 ft	Shell/Roof Color		Gray/Medium				
Diameter	4.00 ft	Shell Condition		Good				
Capacity (estimated)	564 gal	Vacuum Setting		-0.03 psig				
Capacity (nominal)	570 gal	Pressure Setting		0.03 psig				
2. Stored Liquid Characteristics:								
Basis	USEPA TANKS 4.09d	MET Station: Boston, Massachusetts						
Material	Distillate fuel oil no. 2	Selected purely for a worst-case scenario.						
Liquid Molecular Weight	188.00 lb/lb-mol	Vapor Molecular Weight		130.00 lb/lb-mol				
Monthly Data	Days	Vapor Pressure		TANKS Output		TANKS Flow		
		avg	max	avg	max		standing	working
January	31	0.0040	0.0048	46.21	51.55	0.0046	0.0070	570
February	28	0.0043	0.0055	48.35	55.05	0.0057	0.0075	570
March	31	0.0053	0.0070	53.76	62.02	0.0095	0.0093	570
April	30	0.0064	0.0089	59.61	69.56	0.0135	0.0113	570
May	31	0.0079	0.0111	65.63	77.15	0.0195	0.0139	570
June	30	0.0092	0.0132	70.66	83.01	0.0232	0.0162	570
July	31	0.0099	0.0141	73.07	85.22	0.0252	0.0175	570
August	31	0.0094	0.0128	71.19	82.11	0.0214	0.0165	570
September	30	0.0081	0.0107	66.21	75.53	0.0154	0.0142	570
October	31	0.0064	0.0083	59.68	67.07	0.0102	0.0114	570
November	30	0.0052	0.0063	53.56	58.91	0.0057	0.0092	570
December	31	0.0042	0.0050	47.78	52.55	0.0043	0.0074	570
ALL	365	0.0067	0.0141	59.64	85.22	0.1582	0.1415	6,840
3. Emission Estimate Basis:		USEPA TANKS 4.09d		&		TCEQ RG-166/01		
4. There is no basis for speciation of emissions.								

**TABLE F-1G**  
**Volatile Organic Liquids Storage Tanks**  
**Hourly and Annual Emission Estimates**  
**Standing & Working Losses**

Source	WEYM-TK-OW1				
Service	Oily Water				
Capacity	3,000 gal			3,000 gal	
Temperature of Stored Liquid	59.64 °F			85.22 °F	
Vapor Pressure	0.0067 psia			0.0141 psia	
Pumping Rate	150 gal/min			150 gal/min	
Throughput	12.00 turnover/yr				
	36,000 gal/yr			3,000 gal/hr	
Standing Losses				<b>July</b>	
				744 hrs/month	
				<b>0.1595</b> lbs/month	
	<b>1.0020</b> lb/yr			0.00021 lb/hr	
Working Losses	<b>2.07E-05</b> lb/gal			<b>3.07E-05</b> lb/gal	
	0.7446 lb/yr	Average	Maximum	0.0921 lb/hr	Maximum
Liquid	Stand	100.00% by weight	0.0001 lb/hr	0.0005 tpy	0.0002 lb/hr
	Work		0.0001 lb/hr	0.0004 tpy	0.0921 lb/hr
	Total		0.0002 lb/hr	0.0009 tpy	0.0923 lb/hr
TOC (Total)	100.00% by weight	0.0002 lb/hr	0.0009 tpy	100.00% by weight	0.0923 lb/hr
Methane					
Ethane					
VOC (Total)	100.00% by weight	0.0002 lb/hr	0.0009 tpy	100.00% by weight	0.0923 lb/hr
HAP (Total)					
Benzene					
Ethylbenzene					
Hexane (n-)					
Methanol					
Naphthalene					
Toluene					
Trimethylpentane (2,2,4-)					
Xylenes					

**NOTES**

1. Tank Characteristics:

TANKS 4.09d

Orientation	Horizontal Tank	Above Ground?	Yes	
Height/Length	18.00 ft	Shell/Roof Color	Gray/Medium	or less solar
Diameter	5.38 ft	Shell Condition	Good	absorptance
Capacity (estimated)	3,055 gal	Vacuum Setting	-0.03 psig	
Capacity (nominal)	3,000 gal	Pressure Setting	0.03 psig	

2. Stored Liquid Characteristics:

Basis	USEPA TANKS 4.09d	MET Station:	Boston, Massachusetts
Material	Distillate fuel oil no. 2	Selected purely for a worst-case scenario.	

Liquid Molecular Weight Monthly Data		188.00 lb/lb-mol		Vapor Molecular Weight		130.00 lb/lb-mol		
	Days	Vapor Pressure		Liquid Surface Temperature		TANKS Output		TANKS
		avg	max	avg	max	standing	working	Flow
January	31	0.0040	0.0048	46.21	51.55	0.0294	0.0369	3,000
February	28	0.0043	0.0055	48.35	55.05	0.0362	0.0396	3,000
March	31	0.0053	0.0070	53.76	62.02	0.0605	0.0488	3,000
April	30	0.0064	0.0089	59.61	69.56	0.0853	0.0596	3,000
May	31	0.0079	0.0111	65.63	77.15	0.1237	0.0734	3,000
June	30	0.0092	0.0132	70.66	83.01	0.1469	0.0854	3,000
July	31	0.0099	0.0141	73.07	85.22	0.1595	0.0921	3,000
August	31	0.0094	0.0128	71.19	82.11	0.1355	0.0869	3,000
September	30	0.0081	0.0107	66.21	75.53	0.0973	0.0748	3,000
October	31	0.0064	0.0083	59.68	67.07	0.0643	0.0598	3,000
November	30	0.0052	0.0063	53.56	58.91	0.0363	0.0484	3,000
December	31	0.0042	0.0050	47.78	52.55	0.0271	0.0389	3,000
ALL	365	0.0067	0.0141	59.64	85.22	1.0020	0.7446	36,000

3. Emission Estimate Basis: USEPA TANKS 4.09d & TCEQ RG-166/01

4. There is no basis for speciation of emissions.

**TABLE F-1H**  
**Volatile Organic Liquids Loading (Tanker Trucks)**  
**Hourly and Annual Emission Estimates**

Source	WEYM-TL-PL				
Supply Vessel	WEYM-TK-V5				
	Pipeline Liquids				
	2,200 gal			2,200 gal	
Tanker Truck Service	Dedicated Normal			Dedicated Normal	
Loading Method	Submerged			Submerged	
Saturation Factor	0.60 n.d.			0.60 n.d.	
Vapor Molecular Weight	66.00 lb/lb-mol			66.00 lb/lb-mol	
Bulk Liquid Temperature	59.64 °F			85.22 °F	
	519.64 R			545.22 R	
Vapor Pressure	5.2170 psia			8.2678 psia	
Loading Loss Factor	4.9537 lb/kgal			7.4823 lb/kgal	
Pumping Rate				150 gpm	
Throughput	2.00 turnover/yr				
	4,400 gal/yr			2,200 gal/hr	
Loading Losses	21.7963 lb/yr	Average	Maximum	16.4610 lb/hr	Maximum
Residual Liquid	358.84% by weight	0.0089 lb/hr	0.0391 tpy	358.84% by weight	59.0682 lb/hr
CO <sub>2-e</sub>	5398.27% by weight	0.1343 lb/hr	0.5883 tpy	5398.27% by weight	888.6070 lb/hr
CO <sub>2</sub>	7.83% by weight	0.0002 lb/hr	0.0009 tpy	7.83% by weight	1.2895 lb/hr
TOC (Total)	351.00% by weight	0.0087 lb/hr	0.0383 tpy	351.00% by weight	57.7787 lb/hr
Methane	215.62% by weight	0.0054 lb/hr	0.0235 tpy	215.62% by weight	35.4927 lb/hr
Ethane	35.39% by weight	0.0009 lb/hr	0.0039 tpy	35.39% by weight	5.8251 lb/hr
VOC (Total)	100.00% by weight	0.0025 lb/hr	0.0109 tpy	100.00% by weight	16.4610 lb/hr
HAP (Total)	6.23% by weight	0.0002 lb/hr	0.0007 tpy	6.23% by weight	1.0253 lb/hr
Benzene	1.5063% by weight	3.75E-05 lb/hr	1.64E-04 tpy	1.5063% by weight	2.48E-01 lb/hr
Ethylbenzene	0.0477% by weight	1.19E-06 lb/hr	5.20E-06 tpy	0.0477% by weight	7.85E-03 lb/hr
Hexane (n-)	2.8866% by weight	7.18E-05 lb/hr	3.15E-04 tpy	2.8866% by weight	4.75E-01 lb/hr
Methanol					
Naphthalene					
Toluene	1.3668% by weight	3.40E-05 lb/hr	1.49E-04 tpy	1.3668% by weight	2.25E-01 lb/hr
Trimethylpentane (2,2,4-)	0.0139% by weight	3.45E-07 lb/hr	1.51E-06 tpy	0.0139% by weight	2.29E-03 lb/hr
Xylenes	0.4073% by weight	1.01E-05 lb/hr	4.44E-05 tpy	0.4073% by weight	6.71E-02 lb/hr

**NOTES**

- Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.  $L_L = 12.46[(S)M_v P/T]$
- Physical property, throughput and speciation data based data from supply vessel emission calculation spreadsheet.

**TABLE F-1I**  
**Volatile Organic Liquids Loading (Tanker Trucks)**  
**Hourly and Annual Emission Estimates**

Source	WEYM-TL-OIL				
Supply Vessel	WEYM-TK-OIL1				
	Oil				
	570 gal			570 gal	
Tanker Truck Service	Dedicated Normal			Dedicated Normal	
Loading Method	Splash			Splash	
Saturation Factor	1.45 n.d.			1.45 n.d.	
Vapor Molecular Weight	130.00 lb/lb-mol			130.00 lb/lb-mol	
Bulk Liquid Temperature	59.64 °F			85.22 °F	
	519.64 R			545.22 R	
Vapor Pressure	0.0067 psia			0.0141 psia	
Loading Loss Factor	0.0302 lb/kgal			0.0607 lb/kgal	
Pumping Rate				150 gpm	
Throughput	12.00 turnover/yr				
	6,840 gal/yr			570 gal/hr	
Loading Losses	0.2066 lb/yr	Average	Maximum	0.0346 lb/hr	Maximum
Residual Liquid	100.00% by weight	0.00002 lb/hr	0.0001 tpy	100.00% by weight	0.0346 lb/hr
TOC (Total)	100.00% by weight	0.00002 lb/hr	0.0001 tpy	100.00% by weight	0.0346 lb/hr
Methane					
Ethane					
VOC (Total)	100.00% by weight	0.00002 lb/hr	0.0001 tpy	100.00% by weight	0.0346 lb/hr
HAP (Total)					
Benzene					
Ethylbenzene					
Hexane (n-)					
Methanol					
Naphthalene					
Toluene					
Trimethylpentane (2,2,4-)					
Xylenes					

**NOTES**

- Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.  $L_L = 12.46[(S)M_v P/T]$
- Physical property, throughput and speciation data based data from supply vessel emission calculation spreadsheet.

**TABLE F-1J**  
**Volatile Organic Liquids Loading (Tanker Trucks)**  
**Hourly and Annual Emission Estimates**

Source	WEYM-TL-OW				
Supply Vessel	WEYM-TK-OW1				
	Oily Water				
	3,000 gal			3,000 gal	
Tanker Truck Service	Dedicated Normal			Dedicated Normal	
Loading Method	Splash			Splash	
Saturation Factor	1.45 n.d.			1.45 n.d.	
Vapor Molecular Weight	130.00 lb/lb-mol			130.00 lb/lb-mol	
Bulk Liquid Temperature	59.64 °F			85.22 °F	
	519.64 R			545.22 R	
Vapor Pressure	0.0067 psia			0.0141 psia	
Loading Loss Factor	0.0302 lb/kgal			0.0607 lb/kgal	
Pumping Rate				150 gpm	
Throughput	12.00 turnover/yr				
	36,000 gal/yr			3,000 gal/hr	
Loading Losses	1.0873 lb/yr	Average	Maximum	0.1821 lb/hr	Maximum
Residual Liquid	100.00% by weight	0.00012 lb/hr	0.0005 tpy	100.00% by weight	0.1821 lb/hr
TOC (Total)	100.00% by weight	0.00012 lb/hr	0.0005 tpy	100.00% by weight	0.1821 lb/hr
Methane					
Ethane					
VOC (Total)	100.00% by weight	0.00012 lb/hr	0.0005 tpy	100.00% by weight	0.1821 lb/hr
HAP (Total)					
Benzene					
Ethylbenzene					
Hexane (n-)					
Methanol					
Naphthalene					
Toluene					
Trimethylpentane (2,2,4-)					
Xylenes					

**NOTES**

- Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.  $L_L = 12.46[(S)M_v P/T]$
- Physical property, throughput and speciation data based data from supply vessel emission calculation spreadsheet.

**TABLE G-1B**  
**Gas Releases**  
**Hourly and Annual Emission Estimates**

Category	Station Operations					
Source	WEYM-GR-ST			WEYM-GR-PL		
	Avg. Hourly	Max. Annual	Max. Hourly	Avg. Hourly	Max. Annual	Max. Hourly
Gas Release	1,153 scfh	10,100,000 scf/yr	910,000 scfh	1,621 scfh	14,200,000 scf/yr	5,680,000 scfh
	53 lb/hr	467,437 lb/yr	43,828 lb/hr	75 lb/hr	657,188 lb/yr	273,564 lb/hr
NO <sub>x</sub>						
CO						
SO <sub>2</sub>						
PM <sub>10/2.5</sub>						
CO <sub>2-e</sub>	1,243 lb/hr	5,446 tpy	1,049,186 lb/hr	1,748 lb/hr	7,657 tpy	6,548,767 lb/hr
CO <sub>2</sub>	1.1821 lb/hr	5.1776 tpy	2,056.3934 lb/hr	1.6620 lb/hr	7.2794 tpy	12,835.5108 lb/hr
N <sub>2</sub> O						
TOC (Total)	53 lb/hr	231 tpy	43,629 lb/hr	74 lb/hr	325 tpy	272,321 lb/hr
Methane	50 lb/hr	218 tpy	41,885 lb/hr	70 lb/hr	306 tpy	261,437 lb/hr
Ethane	5 lb/hr	21 tpy	5,638 lb/hr	7 lb/hr	30 tpy	35,188 lb/hr
VOC (Total)	1.4446 lb/hr	6.3272 tpy	4,036.8779 lb/hr	2.8764 lb/hr	12.5986 tpy	25,197.2157 lb/hr
VOC (non-HAP)	1.3756 lb/hr	6.0250 tpy	3,784.4029 lb/hr	2.6965 lb/hr	11.8107 tpy	23,621.3277 lb/hr
HAP (Total)	0.0690 lb/hr	0.3022 tpy	252.4750 lb/hr	0.1799 lb/hr	0.7879 tpy	1,575.8880 lb/hr
Acetaldehyde						
Acrolein						
Benzene	0.0148 lb/hr	0.0648 tpy	61.3994 lb/hr	0.0437 lb/hr	0.1916 tpy	383.2401 lb/hr
Biphenyl						
Butadiene (1,3-)						
Carbon Tetrachloride						
Chlorobenzene						
Chloroform						
Dichloropropene (1,3-)						
Ethylbenzene	0.0038 lb/hr	0.0165 tpy	13.0391 lb/hr	0.0093 lb/hr	0.0407 tpy	81.3871 lb/hr
Ethylene Dibromide						
Formaldehyde						
Hexane (n-)	0.0394 lb/hr	0.1727 tpy	205.8487 lb/hr	0.1467 lb/hr	0.6424 tpy	1,284.8576 lb/hr
Methanol						
Methylene Chloride						
Methylnaphthalene (2-)						
Naphthalene						
PAH						
Phenol						
Propylene Oxide						
Styrene						
Tetrachloroethane (1,1,2,2-)						
Toluene	0.0120 lb/hr	0.0528 tpy	52.0554 lb/hr	0.0371 lb/hr	0.1625 tpy	324.9172 lb/hr
Trichloroethane (1,1,2-)						
Trimethylpentane (2,2,4-)	0.0005 lb/hr	0.0020 tpy	2.8059 lb/hr	0.0020 lb/hr	0.0088 tpy	17.5137 lb/hr
Vinyl Chloride						
Xylenes	0.0087 lb/hr	0.0382 tpy	18.2548 lb/hr	0.0130 lb/hr	0.0570 tpy	113.9419 lb/hr

**NOTES**

1. Gas release estimates based on data for a similar compressor station.

2. Gas chromatograph data (GC) are used to estimate overall mass emissions: GC data collected between 2007 and 2014 at site in NJ, NY, CT, and RI evaluated to be most representative.

	<u>Average</u>	<u>Average Plus</u>	<u>Maximum</u>	<u>Maximum/Average+</u>	<u>Average+/Average</u>
Density (GC):	0.0444 lb/scf	0.0463 lb/scf	0.0482 lb/scf	104%	104%
Density (Lab):	0.0438 lb/scf	0.0452 lb/scf	0.0487 lb/scf	108%	103%
Density (Use):		0.0463 lb/scf	0.0482 lb/scf		

3. Extended analyses (Lab) are used to estimate pollutant emissions: 62 samples collected in NJ, NY, CT, RI, and ME between 2011 and 2015.

Maximum (i.e., short-term) = Max(ALL)

Average Plus (i.e., long-term) = Min( Avg( Avg(ALL), Max(ALL) ), Sum( Avg(ALL) + STDEV.S(ALL) ) ).

	<u>Average</u>	<u>Average Plus</u>	<u>Maximum</u>	<u>Maximum/Average+</u>	<u>Average+/Average</u>
VOC (GC):	1.15% wt%	2.62% wt%	6.41% wt%	244%	228%
VOC (Lab):	1.34% wt%	2.71% wt%	9.21% wt%	340%	203%
VOC (Use):		2.71% wt%	9.21% wt%		



TABLE H-1Ba Piping Components Hourly and Annual Emission Estimates						
Source			WEYM-PC-NG			
Service			Gas			
			Natural Gas			
Minimum hours when component purged with inert gas			0 hrs/yr			
Component	Valves	Count	526 components			
		Emission Factor	4.50E-03 kg/hr/component			
	Connectors	Count	2,030 components			
		Emission Factor	2.00E-04 kg/hr/component			
	Flanges	Count	352 components			
		Emission Factor	3.90E-04 kg/hr/component			
	Open-Ended Lines	Count	2 components			
		Emission Factor	2.00E-03 kg/hr/component			
	Pump Seals	Count	0 components			
		Emission Factor	2.40E-03 kg/hr/component			
Other	Count	49 components	Emissions			
	Emission Factor	8.80E-03 kg/hr/component	Avg. Hourly	Max. Annual	Max. Hourly	
Speciation	CO <sub>2-e</sub>		2330.28% by weight	171.8676 lb/hr	752.7801 tpy	176.5572 lb/hr
	CO <sub>2</sub>		2.22% by weight	0.1634 lb/hr	0.7156 tpy	0.3461 lb/hr
	TOC (Total)		98.90% by weight	7.2941 lb/hr	31.9480 tpy	7.3419 lb/hr
	Methane		93.123% by weight	6.8682 lb/hr	30.0826 tpy	7.0484 lb/hr
	Ethane		9.001% by weight	0.6639 lb/hr	2.9077 tpy	0.9487 lb/hr
	VOC (Total)		2.707% by weight	0.1997 lb/hr	0.8745 tpy	0.6793 lb/hr
	VOC (non-HAP)		2.578% by weight	0.1901 lb/hr	0.8328 tpy	0.6368 lb/hr
	HAP (Total)		0.129% by weight	0.0095 lb/hr	0.0418 tpy	0.0425 lb/hr
	Benzene		0.028% by weight	2.05E-03 lb/hr	8.96E-03 tpy	1.03E-02 lb/hr
	Ethylbenzene		0.007% by weight	5.19E-04 lb/hr	2.27E-03 tpy	2.19E-03 lb/hr
	Hexane (n-)		0.074% by weight	5.45E-03 lb/hr	2.39E-02 tpy	3.46E-02 lb/hr
	Methanol					
	Naphthalene					
	Toluene		0.023% by weight	1.67E-03 lb/hr	7.29E-03 tpy	8.76E-03 lb/hr
	Trimethylpentane (2,2,4-)		0.001% by weight	6.32E-05 lb/hr	2.77E-04 tpy	4.72E-04 lb/hr
Xylenes		0.016% by weight	1.21E-03 lb/hr	5.29E-03 tpy	3.07E-03 lb/hr	
NOTES						
1. Emission factors obtained from Table 2-4 (Oil & Gas Production Operations) of Protocol for Equipment Leak Emission Estimates (EPA 453/R-95-017). The average SOCMi w/o ethylene emission factor is used for pumps in heavy oil service (Table 2-1) since an emission factor isn't provided in Table 2-4.						
2. Piping component counts based on design drawings for a similar compressor station.						
3. The component type "Other" includes blowdown valves, relief valves, and compressor seals.						
4. Weight percents based on gas analysis used to estimate gas release annual emissions (TABLE G-1B). Maximum hourly emissions are based on the worst-case short-term weight percents even though the values are NOT presented.						

**TABLE H-1Bb**  
**Piping Components**  
**Hourly and Annual Emission Estimates**

Source			WEYM-PC-PL			
Service			Light Oil			
			Pipeline Liquids			
Minimum hours when component purged with inert gas			0 hrs/yr			
Component	Valves	Count	75 components			
		Emission Factor	7.50E-05 kg/hr/component			
	Connectors	Count	557 components			
		Emission Factor	1.47E-04 kg/hr/component			
	Flanges	Count	115 components			
		Emission Factor	7.70E-05 kg/hr/component			
	Open-Ended Lines	Count	2 components			
		Emission Factor	4.20E-05 kg/hr/component			
	Pump Seals	Count	1 components			
		Emission Factor	3.25E-03 kg/hr/component			
	Other	Count	1 components	<b>Emissions</b>		
		Emission Factor	1.88E-03 kg/hr/component	<b>Avg. Hourly</b>	<b>Max. Annual</b>	<b>Max. Hourly</b>
Speciation	CO <sub>2-e</sub>		0.96% by weight	0.0021 lb/hr	0.0094 tpy	0.0026 lb/hr
	CO <sub>2</sub>		0.01% by weight	0.0000 lb/hr	0.0001 tpy	0.0000 lb/hr
	TOC (Total)		99.99% by weight	0.2239 lb/hr	0.9806 tpy	0.2687 lb/hr
	Methane		0.04% by weight	0.0001 lb/hr	0.0004 tpy	0.0001 lb/hr
	Ethane		0.09% by weight	0.0002 lb/hr	0.0009 tpy	0.0002 lb/hr
	VOC (Total)		99.86% by weight	0.2236 lb/hr	0.9794 tpy	0.2683 lb/hr
	VOC (non-HAP)					
	HAP (Total)		14.54% by weight	0.0326 lb/hr	0.1426 tpy	0.0391 lb/hr
	Benzene		1.44% by weight	3.23E-03 lb/hr	1.41E-02 tpy	3.87E-03 lb/hr
	Ethylbenzene		0.48% by weight	1.07E-03 lb/hr	4.67E-03 tpy	1.28E-03 lb/hr
	Hexane (n-)		1.69% by weight	3.79E-03 lb/hr	1.66E-02 tpy	4.55E-03 lb/hr
	Methanol					
	Naphthalene					
	Toluene		4.49% by weight	1.01E-02 lb/hr	4.40E-02 tpy	1.21E-02 lb/hr
	Trimethylpentane (2,2,4-)		0.03% by weight	5.78E-05 lb/hr	2.53E-04 tpy	6.94E-05 lb/hr
	Xylenes		6.42% by weight	1.44E-02 lb/hr	6.29E-02 tpy	1.72E-02 lb/hr

**NOTES**

1. Emission factors obtained from Table 2-4 (Oil & Gas Production Operations) of Protocol for Equipment Leak Emission Estimates (EPA 453/R-95-017). The average SOCMi w/o ethylene emission factor is used for pumps in heavy oil service (Table 2-1) since an emission factor isn't provided in Table 2-4.
2. Piping component counts based on design drawings for a similar compressor station.
3. The component type "Other" includes blowdown valves, relief valves, and compressor seals.
4. Weight percents based on composition estimate (TABLE F-1).
5. Maximum hourly emissions are based on 120% of the hourly emissions estimated in an effort to be conservative.

**TABLE H-1Bc**  
**Piping Components**  
**Hourly and Annual Emission Estimates**

Source			WEYM-PC-OIL			
Service			Heavy Oil			
			Oil			
Minimum hours when component purged with inert gas			0 hrs/yr			
Component	Valves	Count	37 components			
		Emission Factor	8.40E-06 kg/hr/component			
	Connectors	Count	252 components			
		Emission Factor	7.50E-06 kg/hr/component			
	Flanges	Count	97 components			
		Emission Factor	3.90E-07 kg/hr/component			
	Open-Ended Lines	Count	0 components			
		Emission Factor	1.40E-04 kg/hr/component			
	Pump Seals	Count	6 components			
		Emission Factor	8.62E-03 kg/hr/component			
	Other	Count	2 components	<b>Emissions</b>		
		Emission Factor	3.20E-05 kg/hr/component	<b>Avg. Hourly</b>	<b>Max. Annual</b>	<b>Max. Hourly</b>
Speciation	CO <sub>2-e</sub>					
	CO <sub>2</sub>					
	TOC (Total)		100.00% by weight	0.1191 lb/hr	0.5216 tpy	0.1429 lb/hr
	Methane					
	Ethane					
	VOC (Total)		100.00% by weight	0.1191 lb/hr	0.5216 tpy	0.1429 lb/hr
	VOC (non-HAP)					
	HAP (Total)					
	Benzene					
	Ethylbenzene					
	Hexane (n-)					
	Methanol					
	Naphthalene					
	Toluene					
	Trimethylpentane (2,2,4-)					
	Xylenes					

**NOTES**

1. Emission factors obtained from Table 2-4 (Oil & Gas Production Operations) of Protocol for Equipment Leak Emission Estimates (EPA 453/R-95-017). The emission factor for pumps in heavy oil service is obtained from Table 2-1.
2. Piping component counts based on design drawings for a similar compressor station.
3. The component type "Other" includes blowdown valves, relief valves, and compressor seals.
4. Weight percents based listed on MSDS.
5. Maximum hourly emissions are based on 120% of the hourly emissions estimated in an effort to be conservative.

TABLE H-1Bd Piping Components Hourly and Annual Emission Estimates						
Source			WEYM-PC-EC			
Service			Water/Oil			
			Coolant			
Minimum hours when component purged with inert gas			0 hrs/yr			
Component	Valves	Count	0 components			
		Emission Factor	9.80E-05 kg/hr/component			
	Connectors	Count	0 components			
		Emission Factor	1.10E-04 kg/hr/component			
	Flanges	Count	0 components			
		Emission Factor	2.90E-06 kg/hr/component			
	Open-Ended Lines	Count	0 components			
		Emission Factor	2.50E-04 kg/hr/component			
	Pump Seals	Count	0 components			
Emission Factor		2.40E-05 kg/hr/component				
Other	Count	0 components	Emissions			
	Emission Factor	1.40E-02 kg/hr/component	Avg. Hourly	Max. Annual	Max. Hourly	
Speciation	CO <sub>2-e</sub>					
	CO <sub>2</sub>					
	TOC (Total)		60.00% by weight	0.0000 lb/hr	0.0000 tpy	0.0000 lb/hr
	Methane					
	Ethane					
	VOC (Total)		60.00% by weight	0.0000 lb/hr	0.0000 tpy	0.0000 lb/hr
	VOC (non-HAP)					
	HAP (Total)		60.00% by weight	0.0000 lb/hr	0.0000 tpy	0.0000 lb/hr
	Benzene					
	Ethylbenzene					
	Hexane (n-)					
	Methanol					
	Naphthalene					
	Toluene					
	Trimethylpentane (2,2,4-)					
Xylenes						
NOTES						
1. Emission factors obtained from Table 2-4 (Oil & Gas Production Operations) of Protocol for Equipment Leak Emission Estimates (EPA 453/R-95-017). The average SOCM I w/o ethylene emission factor is used for pumps in heavy oil service (Table 2-1) since an emission factor isn't provided in Table 2-4.						
2. Piping component counts based on design drawings for a similar compressor station.						
3. The component type "Other" includes blowdown valves, relief valves, and compressor seals.						
4. Weight percents based listed on MSDS.						
5. Maximum hourly emissions are based on 120% of the hourly emissions estimated in an effort to be conservative.						

**TABLE I-1**  
**Parts Washer**  
**Hourly and Annual Emission Estimates**

Solvent			Eversol 143			
Solvent Density			6.84 lb/gal			
Potential Make-up Solvent Requirement	Hourly	Maximum	0.3288 gal/hr			
		Average	0.0137 gal/hr	<b>Emissions</b>		
	Annual		120.00 gal/yr	<b>Avg. Hourly</b>	<b>Max. Hourly</b>	<b>Max. Annual</b>
Speciation	TOC (Total)		100.00% by weight	0.0937 lb/hr	2.2484 lb/hr	0.4103 tpy
	Methane					
	Ethane					
	VOC (Total)		100.00% by weight	0.0937 lb/hr	2.2484 lb/hr	0.4103 tpy
	VOC (non-HAP)		100.00% by weight	0.0937 lb/hr	2.2484 lb/hr	0.4103 tpy
	HAP (Total)					
	Benzene					
	Ethylbenzene					
	Hexane (n-)					
	Naphthalene					
	Toluene					
	Trimethylpentane (2,2,4-)					
	Xylenes					

**NOTES**

1. Although emissions are estimated based on the physical properties and chemical speciation of Eversol 143, other solvents may be used as long as the represented solvent density and chemical species weight percents are not exceeded. MSDS indicate that the vapor pressure at 100°F is less than 5 mmHg (0.097 psia).
2. Potential maximum annual solvent make-up is based on past experience and a safety factor.
3. Potential maximum hourly solvent make-up is the potential maximum annual solvent make-up divided by 365 day/yr.
4. Potential average hourly solvent make-up is the potential maximum annual solvent make-up divided by 8,760 hrs/yr.