# NON-MAJOR COMPREHENSIVE PLAN APPROVAL PERMIT APPLICATION - TRANSMITTAL NO. X266786 (REVISED JANUARY 2017)

## 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$_X$™ dry low emissions technology and an oxidation catalyst on the turbine.  For this project, Solar has guaranteed nitrogen oxide (NO$_X$) emissions for the new unit at 9 parts per million volumetric dry (ppmvd) at 15 percent oxygen (O$_2$) 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,[1] 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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[1] 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.

## 2.1. 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;[2]
> 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-$NO_X$ (DLN) combustion technology to reduce $NO_X$ 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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[2] 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.

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  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**

| Pollutant | Emission Factor [1] | Source |
|---|---|---|
| $NO_X$ | 9 ppmvd at 15% $O_2$ | Vendor guaranteed emission rate |
| CO | 25 ppmvd at 15% $O_2$ | Vendor guaranteed emission rate |
| VOC | 25 ppmvd TOC at 15% $O_2$ 0.0021 lb/MMBtu (HHV) VOC | TOC: vendor guaranteed emission rate VOC: Table 3.1-2a of AP-42 |
| $CH_4$ | 25 ppmvd TOC at 15% $O_2$ 0.0086 lb/MMBtu (HHV) $CH_4$ | TOC: vendor guaranteed emission rate $CH_4$: Table 3.1-2a of AP-42 |
| $PM_{10}/PM_{2.5}$ | 0.0066 lb/MMBtu (HHV) | Table 3.1-2a of AP-42 |
| $SO_2$ | 14.29 lb/MMscf (HHV) | Table 3.1-2a of AP-42 scaled to 5 gr/100 scf fuel sulfur content |
| $CO_2$ | 53.06 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-1 |
| $N_2O$ | 0.0001 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-2 |
| Total HAPs | 25 ppmvd TOC at 15% $O_2$ Multiple HAP factors | TOC: vendor guaranteed emission rate HAPs: Table 3.1-3 of AP-42 |

[1] 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$_X$™ dry low emissions technology. For this project, Solar has guaranteed $NO_X$ emissions for the new unit at 9 ppmvd at 15 percent $O_2$ 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 – $NO_X$, CO and TOC

$NO_X$, 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 ($CH_4$ – 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), $O_2$ Content (percent, dry), Molecular Weight (lb/lb-mol), Flowrate (lb/hr and acfm)
> Guaranteed Emission Rates for $NO_X$, CO and TOC (ppmvd at 15 percent $O_2$)

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$_X$) 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 $NO_X$, 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.[3]  The emission factor at a given ambient temperature is calculated as illustrated in Equation 3-1 through Equation 3-3:

**Equation 3-1:** $\boldsymbol{NO_x, CO, TOC\ EF\ (ppmw) = ppmvd, 15\%\ O_2 \times nonwater\% \times \dfrac{20.9 - (vol\%\ O_{2,dry} \times 100)}{5.9} = ppmw}$

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

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

*Where:        T = ambient temperature[4]*

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[3] 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.
[4] Maximum hourly emissions are estimated at T = 0.01°F.

### 3.1.1.2. Turbine Emission Factors – VOC, $CH_4$, and HAPs

VOC, $CH_4$, and HAPs emitted by the combustion turbine are calculated using the vendor-guaranteed TOC emission rate and AP-42 emission factors, as VOC, $CH_4$, 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, $CH_4$, 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 $CH_4$ 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, $CH_4$, 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, $CH_4$, and HAPs. For normal operation, the uncontrolled VOC, $CH_4$, and HAP factors are derived as follows:

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

### 3.1.1.3. Turbine Emission Factors – $PM_{10}$, $PM_{2.5}$, and $SO_2$

As indicated in Equation 3-5, particulate matter less than 10 microns in diameter ($PM_{10}$), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and sulfur dioxide ($SO_2$) 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 $SO_2$ 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 $PM_{10}$ and $PM_{2.5}$ are assumed equal to the total PM emission rate. The AP-42 emission factors are converted to lb/MMscf as follows:

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

### 3.1.1.4. Turbine Emission Factors – $CO_2$, $N_2O$ and $CO_2e$

Emission factors for carbon dioxide ($CO_2$) and nitrous oxides ($N_2O$) 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 $CO_2$ equivalents ($CO_2e$) 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 $CO_2e$ emissions for each pollutant emitted by the Project are contained in Table 3-2.

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

| Pollutant [1] | GWP [2] |
|---|---|
| $CO_2$ | 1 |
| $CH_4$ | 25 |
| $N_2O$ | 298 |

[1] Only those GHGs for which quantifiable emissions increases are expected due to this project are listed.

[2] 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) 4th Assessment Report (AR4).

As such, the $CO_2e$ 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 $NO_X$, 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**

| Pollutant | Emission Factor (0 °F ≥ Temp ≥ - 20 °F) | Emission Factor (Temp ≤ - 20 °F) | Source |
|---|---|---|---|
| $NO_X$ | 42 ppmvd at 15% $O_2$ | 120 ppmvd at 15% $O_2$ | Vendor provided emission rate |
| CO | 100 ppmvd at 15% $O_2$ | 150 ppmvd at 15% $O_2$ | Vendor provided emission rate |
| TOC | 50 ppmvd at 15% $O_2$ | 75 ppmvd at 15% $O_2$ | Vendor provided emission rate |

The same emission rates that are used for normal operation for $PM_{10}$, $PM_{2.5}$, $SO_2$, $CO_2$, and $N_2O$ 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**

| Pollutant | Ignition-Idle Phase Emission Factor from Source [1] | Loading/Thermal Stabilization Phase Emission Factor from Source [1] | Source |
|---|---|---|---|
| $NO_X$ | 50 ppmvd at 15% $O_2$ | 60 ppmvd at 15% $O_2$ | Vendor specified emission rate |
| CO | 10,000 ppmvd at 15% $O_2$ | 9,000 ppmvd at 15% $O_2$ | Vendor specified emission rate |
| VOC | 1,000 ppmvd TOC at 15% $O_2$ 0.0021 lb/MMBtu (HHV) VOC | 900 ppmvd TOC at 15% $O_2$ 0.0021 lb/MMBtu (HHV) VOC | TOC: vendor specified emission rate VOC: Table 3.1-2a of AP-42 |
| $CH_4$ | 1,000 ppmvd TOC at 15% $O_2$ 0.0086 lb/MMBtu (HHV) $CH_4$ | 900 ppmvd TOC at 15% $O_2$ 0.0086 lb/MMBtu (HHV) $CH_4$ | TOC: vendor specified emission rate $CH_4$: Table 3.1-2a of AP-42 |
| $PM_{10}/PM_{2.5}$ | Same as normal operation | | |
| $SO_2$ | Same as normal operation | | |
| $CO_2$ | Same as normal operation | | |
| $N_2O$ | Same as normal operation | | |
| Total HAPs | 1,000 ppmvd TOC at 15% $O_2$ Multiple HAP factors | 900 ppmvd TOC at 15% $O_2$ Multiple HAP factors | TOC: vendor specified emission rate HAPs: Table 3.1-3 of AP-42 |

[1] 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:

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

### 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**

| Pollutant | Loading/Thermal Stabilization Phase Emission Factor from Source [1] | Source |
|---|---|---|
| $NO_X$ | 60 ppmvd at 15% $O_2$ | Vendor specified emission rate |
| CO | 9,000 ppmvd at 15% $O_2$ | Vendor specified emission rate |
| VOC | 900 ppmvd TOC at 15% $O_2$<br>0.0021 lb/MMBtu (HHV) VOC | TOC: vendor specified emission rate<br>VOC: Table 3.1-2a of AP-42 |
| $CH_4$ | 900 ppmvd TOC at 15% $O_2$<br>0.0086 lb/MMBtu (HHV) $CH_4$ | TOC: vendor specified emission rate<br>$CH_4$: Table 3.1-2a of AP-42 |
| $PM_{10}/PM_{2.5}$ | Same as normal operation | |
| $SO_2$ | Same as normal operation | |
| $CO_2$ | Same as normal operation | |
| $N_2O$ | Same as normal operation | |
| Total HAPs | 900 ppmvd TOC at 15% $O_2$<br>Multiple HAP factors | TOC: vendor specified emission rate<br>HAPs: Table 3.1-3 of AP-42 |

[1] 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 $CO_2$ (also a regulated pollutant), the controlled portion of the CO emissions is added back to the $CO_2$ 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.[5]
- **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

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[5] 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:** $Normal \frac{ton}{yr} = Average \frac{lb}{hr} \times \frac{8,760\ hr}{yr} \times \frac{ton}{2,000\ lb}$

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

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

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

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

## 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 $NO_X$, 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 [6]**

| Pollutant | Low Ambient Temperature Emissions (lb/hr) |
|---|---|
| PM | 0.49 |
| $PM_{10}$ | 0.49 |
| $PM_{2.5}$ | 0.49 |
| $SO_2$ | 1.05 |
| $NO_X$ | 11.36 |
| VOC [7] | 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 $NO_X$, 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 [7]**

| Pollutant | Extreme Low Ambient Temperature Emissions (lb/hr) |
|---|---|
| PM | 0.49 |
| $PM_{10}$ | 0.49 |
| $PM_{2.5}$ | 0.49 |
| $SO_2$ | 1.05 |
| $NO_X$ | 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 $NO_X$, 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.

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[6] The emission rates can also be found in Table B-1Aj in Attachment G to this report.

[7] 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 [8]**

| Pollutant | Startup Emissions (lb/event) | Shutdown Emissions (lb/event) |
|---|---|---|
| NO$_X$ | 0.80 | 0.38 |
| CO | 77.24 | 1.74 [9] |
| 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$_X$ at 15 percent O$_2$ on a 3-hour average. Since this is a new technology and the resulting NO$_X$ 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$_X$ 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$_X$ 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$_X$ 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$_X$.

## 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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[8] 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.

[9] 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**

| Pollutant | Emission Factor from Source | Source |
|---|---|---|
| NO$_X$ | 2.0 g/bhp-hr | Vendor data. |
| CO | 1.3 g/bhp-hr | Vendor data. |
| Formaldehyde | 0.19 g/bhp-hr | Vendor data. |
| VOC | Formaldehyde: 0.19 g/bhp-hr VOC: 0.119 lb/MMBtu (HHV) | Formaldehyde: Vendor Data VOC: Table 3.2-2 of AP-42 |
| CH$_4$ | Formaldehyde: 0.19 g/bhp-hr CH$_4$: 1.25 lb/MMBtu (HHV) | Formaldehyde: Vendor Data CH$_4$: Table 3.2-2 of AP-42 |
| PM$_{10}$/PM$_{2.5}$ | 0.00999 lb/MMBtu (HHV) | Table 3.2-2 of AP-42 |
| SO$_2$ | 14.29 lb/MMscf | Table 3.2-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content |
| CO$_2$ | 53.06 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-1 |
| N$_2$O | 0.0001 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-2 |
| Total HAPs | Formaldehyde: 0.19 g/bhp-hr Multiple HAP factors | Formaldehyde: Vendor Data Multiple HAPs: 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$_X$, CO, and Formaldehyde

NO$_X$, CO, and Formaldehyde emitted by the emergency generator are calculated based on vendor guaranteed emission factors. Vendor-specified power output and fuel consumption for the engine are used to convert the g/bhp-hr factors. NO$_X$, CO, and Formaldehyde factors are derived as follows:

**Equation 3-15:**
$$NO_x, CO, Formaldehyde\ EF = \frac{g}{bhp-hr} \times \frac{lb}{453.6\ g} \times bhp \times \frac{hr}{scf\ fuel} \times \frac{1,000,000\ scf}{MMscf} = \frac{lb}{MMscf}$$

## 3.2.2. Emergency Generator Emission Factors – VOC, CH$_4$ and HAPs

VOC, CH$_4$ and HAP emissions are calculated using the Formaldehyde emission rate and AP-42 emission factors. Standard emission factors for CH$_4$, Formaldehyde, 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 CH$_4$, Formaldehyde, and HAPs from four-stroke, lean-burn, natural gas-fired engines. A VOC factor is calculated based as the sum of the factors for all trace organic compounds listed in Table 3.2-2 which are VOCs.

Using the similar ratio method used to calculate CH$_4$ and HAPs emitted from the turbine (detailed in Section 3.1.1.2), VOC, CH$_4$ and HAPs emitted from engines are scaled based on the Formaldehyde emission rate from vendor data.

**Equation 3-16:**
$$VOC, CH_4, HAP\ EF = \left[\frac{EF_{Formaldehyde\ Vendor}}{EF_{FormaldehydeAP42}}\right] \times (EF_{VOCAP42}) = lb/mmcf$$

### 3.2.3. Emergency Generator Emission Factors – $PM_{10}$, $PM_{2.5}$, and $SO_2$

$PM_{10}$ and $PM_{2.5}$ 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. $PM_{10}$ and $PM_{2.5}$ emission factors are calculated as the sum of the filterable and condensable PM emission factors. The $SO_2$ 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 – $CO_2$, $N_2O$, and $CO_2e$

$CO_2$ and $N_2O$ 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 $CO_2$, $CH_4$, and $N_2O$. $CO_2e$ 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 [1]**

| Pollutant | Emission Factor from Source | Source |
|---|---|---|
| $NO_X$ | 80 ppmvd at 3% $O_2$ | Vendor specified emission rate |
| CO | 200 ppmvd at 3% $O_2$ | Vendor specified emission rate |
| TOC | 140 ppmvd at 3% $O_2$ | Vendor specified emission rate |
| VOC | 140 ppmvd TOC at 3% $O_2$ 8.18 lb/MMscf VOC | TOC: vendor specified emission rate Table 1.4-3 of AP-42 |
| $CH_4$ | 140 ppmvd TOC at 3% $O_2$ 2.30 lb/MMscf $CH_4$ | TOC: vendor specified emission rate Table 1.4-2 of AP-42 |
| $PM_{10}/PM_{2.5}$ | 7.60 lb/MMscf | Table 1.4-2 of AP-42 |
| $SO_2$ | 14.29 lb/MMscf | Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content |
| $CO_2$ | 53.06kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-1 |
| $N_2O$ | 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 |

[1] New heaters at compressor station and existing heaters at M&R station.

In order to calculate hourly emissions, the emission factors provided in Table 3-7 are converted to factors in lb/MMscf. These converted factors are multiplied by the heater's hourly fuel consumption in scf/hr to obtain hourly emissions. Fuel consumption is calculated from the heat output of the heaters assuming a thermal efficiency of 65 percent for the new proposed heater and 75 percent for the existing heaters and a natural gas heating value of 1,020 Btu/scf. Annual potential emissions are calculated based on average hourly fuel consumption. 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 and existing heaters.

### 3.3.1. Process Heater Emission Factors – $NO_X$, CO, and TOC

$NO_X$, CO, and TOC emitted by the heaters are calculated based on vendor-specified emission rates and vendor-specified fuel consumption for the heaters. $NO_X$, CO, and TOC factors are derived as follows:

**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% $O_2$ = 829 $NO_2$ lb/MMbtu,*
*= 1,360 CO lb/MMbtu and*
*= 2380 TOC (as $CH_4$) lb/MMbtu*

### 3.3.2. Heater Emission Factors – VOC, $CH_4$, and HAPs

VOC, $CH_4$, and HAP emissions are calculated using the vendor-specified TOC emission rate and AP-42 emission factors. Standard emission factors for TOC, VOC, $CH_4$, 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 $CH_4$ 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.

VOC, $CH_4$, and HAP emissions from the heaters are calculated using the same ratio method used to calculate VOC, $CH_4$, and HAPs emitted from the turbine (detailed in Section 3.1.1.2) based on the vendor-specified TOC emission rate.

### 3.3.3. Heater Emission Factors – $PM_{10}$, $PM_{2.5}$, and $SO_2$

$PM_{10}$ and $PM_{2.5}$ emitted by the 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 that PM equals PM10 and PM2.5. The $SO_2$ 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.

### 3.3.4. Heater Emission Factors – $CO_2$, $N_2O$, and $CO_2e$

$CO_2$ and $N_2O$ emitted by the heater 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 3-6 show how factors in lb/MMscf are derived for these

pollutants. GHGs emitted from the heater include $CO_2$, $CH_4$, and $N_2O$. $CO_2e$ 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**

| Pollutant | Emission Factor from Source | Source |
|---|---|---|
| $NO_X$ | 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 |
| $CH_4$ | 2.30 lb/MMscf | Table 1.4-2 of AP-42 |
| $PM_{10}/PM_{2.5}$ | 7.60 lb/MMscf | Table 1.4-2 of AP-42 |
| $SO_2$ | 14.29 lb/MMscf | Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content |
| $CO_2$ | 53.06 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-1 |
| $N_2O$ | 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 – $NO_X$ and CO

$NO_X$ 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.[10] 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 – $PM_{10}$, $PM_{2.5}$, $SO_2$, and $CH_4$

$PM_{10}$ and $PM_{2.5}$ 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 $PM_{10}$ and $PM_{2.5}$ are assumed equal to the total PM emission rate. The $SO_2$ 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 $CH_4$ 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 – $CO_2$, $N_2O$, and $CO_2e$

$CO_2$ and $N_2O$ 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 $CO_2$, $CH_4$, and $N_2O$. $CO_2e$ 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 |
|---|---|---|
| $NO_X$ | 30 ppmvd at 3% $O_2$ | 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 |
| $CH_4$ | 2.30 lb/MMscf | Table 1.4-2 of AP-42 |
| $PM_{10}/PM_{2.5}$ | 7.60 lb/MMscf | Table 1.4-2 of AP-42 |
| $SO_2$ | 14.29 lb/MMscf | Table 1.4-2 of AP-42 scaled to 5 gr/100 scf fuel sulfur content |
| $CO_2$ | 53.06 kg/MMBtu (HHV) | 40 CFR 98, Subpart C, Table C-1 |
| $N_2O$ | 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 |

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[10] For TOC, VOC, $CH_4$, and $CO_2$, 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 – $NO_X$ and CO

$NO_X$ 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, $PM_{10}$ and $PM_{2.5}$, $SO_2$, $CH_4$, $CO_2$, $N_2O$, and $CO_2e$, 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:** $$VOC = 120 \frac{gal\ solvent}{year} \times (0.82 \times 8.34 \frac{lb}{gal}) \times 1 \frac{lb\ VOC}{lb\ solvent} = 0.4103 \frac{tons\ VOC}{yr}$$

## 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.[11] 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.[12]
> Since an emission factor is not provided for leaks from pump seals in heavy liquid service in Table 2-4, the average SOCMI 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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[11] 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.

[12] 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

**Equation 3-19:**

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

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

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

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

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.[13]

## 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.[13]

## 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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[13] 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)[1] | Existing Hanover Heater (tpy) | Existing NATCO Heater (tpy) | Existing Three Lochinvar Boilers (tpy per unit)[1] | Project Combustion Emissions (tpy) |
|---|---|---|---|---|---|---|---|---|
| | Attachment G Table | | | | | | | |
| | B-1Aj | C-1A | D-1D | D-1E | D-1A | D-1B | D-1C | |
| NO$_X$ | 9.96 | 0.39 | 0.10 | 0.03 | 4.03 | 2.88 | 0.29 | 18.38 |
| CO | 16.77 | 0.25 | 0.15 | 0.012 | 6.13 | 4.38 | 0.65 | 29.69 |
| VOC | 1.26 | 0.08 | 0.04 | 0.0025 | 1.48 | 1.06 | 0.06 | 4.11 |
| PM$_{10}$/PM$_{2.5}$ | 1.99 | 0.007 | 0.01 | 0.002 | 0.31 | 0.22 | 0.06 | 2.73 |
| SO$_2$ | 4.23 | 0.01 | 0.014 | 0.004 | 0.58 | 0.42 | 0.11 | 5.60 |
| CO$_2$e | 35,800 | 103 | 119 | 37 | 4,921 | 3,515 | 929 | 47,430 |
| Total HAPs | 0.28 | 0.05 | 0.008 | 0.0006 | 0.34 | 0.24 | 0.015 | 0.97 |

[1] To obtain total emissions multiply indicated value by total number of units.

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

| Pollutant | Truck Loading Fugitive Emissions (tpy) | Piping Component Fugitive Emissions (tpy) [3] | Gas Release Fugitive Emissions (tpy) [3] | Total Project Fugitive Emissions (tpy) |
|---|---|---|---|---|
| | Attachment G Table | | | |
| | F-1H, F-1I, F-1J | H-1Ba | G-1B | |
| $NO_X$ | -- | -- | -- | -- |
| CO | -- | -- | -- | -- |
| VOC | 0.01 | 2.38 | 18.93 | 21.32 |
| $PM_{10}/PM_{2.5}$ | -- | -- | -- | -- |
| $SO_2$ | -- | -- | -- | -- |
| $CO_2e$ | 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 | |
| $NO_X$ | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CO | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| VOC | 0.41 | 0.131 | 0.131 | 0.705 | 0.013 | 0.291 | 0.002 | 0.001 | 1.68 |
| $PM_{10}/PM_{2.5}$ | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| $SO_2$ | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| $CO_2e$ | -- | 7 | 7 | 22 | 1 | 16 | -- | -- | 53 |
| Total HAPs | -- | 0.008 | 0.008 | 0.043 | 0.001 | 0.018 | -- | -- | 0.08 |

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

| Pollutant (tpy) | Combustion Sources (tpy) | Fugitive Sources (tpy) | Parts Washer, Separator Vessels, and Tanks (tpy) | Total Project Emissions (tpy) |
|---|---|---|---|---|
| $NO_X$ | 18.38 | -- | -- | 18.38 |
| CO | 29.69 | -- | -- | 29.69 |
| VOC | 4.11 | 21.32 | 1.70 | 27.13 |
| $PM_{10}/PM_{2.5}$ | 2.73 | -- | -- | 2.73 |
| $SO_2$ | 5.60 | -- | -- | 5.6 |
| $CO_2e$ | 47,430 | 13,857 | 53 | 61,340 |
| Total HAPs | 0.97 | 1.27 | 0.08 | 2.32 |

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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,[14] 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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[14] 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 $NO_X$, 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 $CO_2e$ 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 $CO_2e$ 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: $NO_X$ – 50 tpy and VOC – 50 tpy (NNSR/Title V)
> For greenhouse gases: carbon dioxide equivalent ($CO_2$e) – 100,000 tpy (Title V) [15]
> 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 $NO_X$ emission standard of 25 ppmvd at 15 percent $O_2$ as indicated by the vendor guarantee listed in Table 3-1. Subpart KKKK also includes a $NO_X$ limit of 150 ppmvd at 15 percent $O_2$ 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 $SO_2$ 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 $SO_2$ heat input, pursuant to 40 CFR 60.4330(a)(1) and (2), respectively.

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[15] 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/ $CO_2$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.

*$NO_X$ Monitoring*

Pursuant to 40 CFR 60.4340(a), since the new Taurus 60-7802 will not use water or steam injection to control $NO_X$ emissions, Algonquin will perform annual performance tests in accordance with 40 CFR 60.4400 to demonstrate continuous compliance. If the $NO_X$ emission result from the performance test is less than or equal to 75 percent of the $NO_X$ emission limit for the turbine (≤ 18.75 ppmvd at 15 percent $O_2$ or ≤ 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). [16] If the results of any subsequent performance test exceed 75percent of the $NO_X$ emission limit, Algonquin will be required to resume annual performance testing.

Per 40 CFR 60.8(a), the initial $NO_X$ 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.

*$SO_2$ Monitoring*

Pursuant to 40 CFR 60.4365(a), in order to demonstrate continuous compliance with the applicable 0.0060 lb/MMBtu potential $SO_2$ 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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[16] 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 ≤850 MMBtu/h, 25 ppmvd at 15 percent $O_2$ 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. [17]

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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[17] 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 $NO_X$ Reasonably Available Control Technology (RACT) standards for combustion sources located at major stationary sources of $NO_X$ in the state (uncontrolled PTE greater than 50 tpy). The $NO_X$ 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.[18]

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

This rule limits the $SO_2$ emission rate to no greater than an annual calendar average of 1.2 pounds of $SO_2$ 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 $NO_X$ limit at 15 percent $O_2$ 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 – $NO_X$ 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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[18] 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.

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.[19]  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*),[20] 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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[19] http://www.mass.gov/eea/docs/dep/air/approvals/aq/aqpaguid.pdf

[20] 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,[21] 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 $NO_X$, $SO_2$, CO, PM (including $PM_{10}$ and $PM_{2.5}$), 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 $NO_X$ combustion technology on the new turbine which will meet 9 ppmvd $NO_X$. Algonquin and Solar Turbines believe that $SoLoNO_X$ 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 $NO_X$ 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 $NO_X$ emissions. As such, Algonquin is submitting the BACT analysis for $NO_X$, CO, PM, $SO_2$, 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 $CO_2e$ 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 $CO_2e$ basis from each of the affected emission units at the Site.

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[21] 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$_2$e |
| --- | --- | --- | --- | --- | --- |
| | CO$_2$ (tpy) | CH$_4$ (tpy) | N$_2$O (tpy) | CO$_2$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 [1] | 0.72 | 30.08 | NA | 753 | 1.2% |
| Gas Releases Fugitive Emissions [1] | 12.46 | 524 | NA | 13,103 | 21.4% |
| M&R Station heaters and boilers | 11,197 | 1 | 0.021 | 11,223 | 18.3% |
| | | | **Total** | **61,372** | **100%** |

[1] 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$_X$ limit of 25 ppmvd at 15 percent O$_2$

### 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. [22] 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.

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[22] 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 $NO_X$ 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 – $NO_X$ BACT

In combustion turbines, $NO_X$ is typically formed by two fundamentally different mechanisms: fuel $NO_X$, and thermal $NO_X$. Because the turbine will fire natural gas exclusively, thermal $NO_X$ is the primary $NO_X$ generating mechanism applicable to the proposed project.

"Fuel $NO_X$" forms when the fuel bound nitrogen compounds are converted into nitrogen oxides. The amount of fuel bound nitrogen converted to fuel $NO_X$ 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 $NO_X$ involve creating a minimum amount of excess oxygen available to react with the fuel bound nitrogen throughout the combustion process.[23]

$NO_X$ formed in the high-temperature, post-flame region of the combustion equipment is "thermal $NO_X$." Temperature is the most important factor, and at flame temperatures above 2,200 °F, thermal $NO_X$ formation increases exponentially.[24]

Nitrogen monoxide (NO) formation is inherent in all high temperature combustion processes. $NO_2$ 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 $NO_2$ before being emitted. However, the NO continues to oxidize in the atmosphere. For this reason, all $NO_X$ emissions from combustion stacks are usually reported as $NO_2$.

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[23] 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.
[24] 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 NOx emissions performance data for combustion turbines of all sizes and found differing performance data for turbines based on the size of the unit.[25]  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 $NO_X$ 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 $NO_X$ 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

$NO_X$ 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 $NO_X$ formation (reducing peak flame temperature) or introduce inerts (combustion products, for example) that limit initial $NO_X$ formation, or both.  Several post-combustion $NO_X$ control technologies are potentially applicable to the proposed turbine.  These technologies employ various strategies to chemically reduce $NO_X$ to elemental nitrogen ($N_2$) 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 $NO_X$ control technologies for turbines were identified based on the principles of control technology and engineering experience for general combustion units.

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[25] http://www.epa.gov/ttn/atw/nsps/turbine/turbnsps.html

Combustion control options include:[26]
- Water or Steam Injection
- Dry Low-$NO_X$ (DLN) Combustion Technology (such as $SoLoNO_X$)
- Good Combustion Practices (base case)

Post-combustion control options include:
- $EM_X$™/$SCONO_X$™ 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 $NO_X$. 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 $NO_X$ 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-$NO_X$ (DLN) Combustors

The lean premix technology, also referred to as dry low-$NO_X$ combustion technology, is a pollution prevention technology that controls $NO_X$ emissions by reducing the conversion of atmospheric nitrogen to $NO_X$ 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 $NO_X$ formation rates are an exponential function of temperature, a considerable reduction in $NO_X$ can be achieved by the lean pre-mix system.

$SoLoNO_X$ is a type of dry low $NO_X$ 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, $SoLoNO_X$ and dry low $NO_X$ combustion technology may be used interchangeably when referring to the combustion turbine.

The dry low $NO_X$ 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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[26] 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$_X$), can reach approximately 9 – 15 ppmvd NO$_X$.

The proposed turbine will receive a 9 ppmvd NO$_X$ vendor guarantee from Solar.  This guarantee is possible due to improvements and refinements of several of the technologies implemented in 15 ppmvd NO$_X$ 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$_X$ 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$_X$ emissions include ambient temperature, fuel characteristics, and air-to-fuel ratios.

### 5.4.1.4. EM$_X$/SCONO$_X$

EM$_X$ (the second-generation of the SCONO$_X$ NO$_X$ Absorber Technology) utilizes a coated oxidation catalyst to remove both NO$_X$ and CO without a reagent, such as ammonia (NH$_3$).  Hydrogen (H$_2$) is used as the basis for the proprietary catalyst regeneration process.  The SCONO$_X$ system consists of a platinum-based catalyst coated with potassium carbonate to oxidize NO$_X$ and CO (to CO$_2$).  The catalyst is installed in the flue gas with a temperature range between 300 °F to 700 °F.  The SCONO$_X$ catalyst is susceptible to fouling by sulfur if the sulfur content of the fuel is high.  This then requires the SCONO$_X$ catalyst to be re-coated every six months to one year, with the frequency depending on the sulfur content of the fuel.[27]

Estimates of control efficiency for a SCONO$_X$ system vary depending on the pollutant controlled.  California Energy Commission reports a control efficiency of 78 percent for NO$_X$ reductions up to 2.0 ppm, and even higher NO$_X$ reductions up to 1 ppmvd for some designs.[28]

### 5.4.1.5. Selective Catalytic Reduction

SCR is a post-combustion gas treatment process in which NH$_3$ is injected into the exhaust gas upstream of a catalyst bed.  On the catalyst surface, NH$_3$ and NO react to form diatomic nitrogen and water vapor.  The overall chemical reaction can be expressed as:

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$
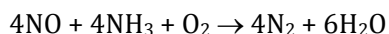
When operated within the optimum temperature range, the reaction can result in removal efficiencies between 70 and 90 percent.[29]  SCR units have the ability to function effectively under fluctuating temperature conditions although fluctuation in exhaust gas temperature reduces removal efficiency slightly by disturbing the NH$_3$/NO$_X$

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[27] BACT Analysis for JEA-Greenland Energy Center Units 1 and 2, Combined Cycle Combustion Turbines. Prepared by Black & Veatch (September 2008).
[28] California Energy Commission, Evaluation of Best Available Control Technology, Appendix 8.1E, Page 8.1E-7.
[29] 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 $NO_X$ 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 $NO_X$ removal efficiency.

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

SNCR is a post-combustion $NO_X$ control technology based on the reaction of urea or $NH_3$ with $NO_X$.  In the SNCR chemical reaction, urea [$CO(NH_2)_2$] or $NH_3$ is injected into the combustion gas path to reduce the $NO_X$ to nitrogen and water.  The overall reaction schemes for both urea and $NH_3$ systems can be expressed as follows:

$$CO(NH_2)_2 + 2NO + \tfrac{1}{2}O_2 \rightarrow 2N_2 + CO_2 + 2H_2O$$
$$4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$$
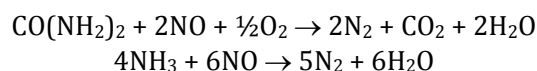
Typical removal efficiencies for SNCR range from 40 to 60 percent.[30]  An important consideration for implementing SNCR is the operating temperature range.  The optimum temperature range is approximately 1,600 to 2,000 °F.[31]  Operation at temperatures below this range results in ammonia slip.  Operation above this range results in oxidation of $NH_3$, forming additional $NO_X$.

## 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$_X$™/SCONO$_X$™ Technology Feasibility

The EM$_X$™/SCONO$_X$™ 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$_X$™/SCONO$_X$™ applications on turbines with outlet temperatures this high have not been identified.  Consequently, it is concluded that EM$_X$™/SCONO$_X$™ is not technically feasible for control of $NO_X$ 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 RBLC 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 $NO_X$ emissions from the proposed turbine.

### 5.4.2.3. Water or Steam Injection Feasibility

Water or steam injection is a $NO_X$ 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

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[30] 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.

[31] U.S. EPA, Clean Air Technology Center.  *Oxides of nitrogen (NO$_X$), 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 $NO_X$ in the combustion turbine due to water or steam injection would reduce $NO_X$ emissions origination from the turbine.

### 5.4.2.4. Dry Low $NO_X$ Combustion Technology

Dry low $NO_X$ combustion technology is a $NO_X$ 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 $NO_X$ 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 $NO_X$ in the combustion turbine due to the dry low $NO_X$ combustion technology would reduce $NO_X$ 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 $NO_X$ 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 $NO_X$ Control Technologies**

| Rank | Control Technology | Potential $NO_X$ Emissions (ppm) or Control Efficiency (%) |
|---|---|---|
| 1 | SCR | 70% to 90% |
| 2 | Dry Low $NO_X$ Combustion Technology (SoLoNO$_X$) | 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 $NO_X$ 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 $NO_X$ limit of 25 ppmvd at 15 percent $O_2$ for combustion turbines burning natural gas. Therefore, NSPS Subpart KKKK sets the floor of allowable $NO_X$ BACT limits. Possible control technologies with $NO_X$ 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 $NO_X$ control technology available for the combustion turbine is dry low $NO_X$ combustion technology, such as SoLoNO$_X$. As a pollution prevention control method, operating SoLoNO$_X$ in the turbine would decrease $NO_X$ 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 $NO_X$ 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 $NO_X$) 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, $NO_X$ 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 $NO_X$ at 15percent $O_2$, without the use of SCR. Based on BACT determinations, only one candidate site was found;

> MGM Mirage, with a permitted $NO_X$ value of 5 ppmvd $NO_X$ at 15 percent $O_2$

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 $NO_X$ emissions by using a recuperator in the combustion turbine. This allows the turbine to provide more power at lower combustion temperatures (reducing thermal $NO_x$ 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 $NO_X$ emissions in the 5 ppmvd range. In addition, the Mercury unit was permitted in warmer climates (i.e., Nevada). Solar's $NO_X$ emission guarantee ends at a minimum temperature of 0 °F. At ambient temperatures lower than 0 °F, $NO_X$ 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$_X$ technology is not needed as it has been determined to be BACT for other natural gas combustion turbines.  Therefore, Algonquin proposes that SoLoNO$_X$ is BACT for the combustion turbine.  Algonquin is proposing a two-stage limit for NO$_X$ from the new turbine.  The final BACT emission rate for the turbine will be 9 ppmvd at 15percent O$_2$ of NO$_X$.  Algonquin will be the first customer of Solar's to receive a 9 ppmvd NO$_X$ vendor guarantee for a Solar Taurus 60-7802 turbine.  Other Taurus 60-7802 units have been guaranteed at 15 ppmvd NO$_X$ (at 15 percent O$_2$).  Because this is a new design and the resulting NO$_X$ 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$_X$ 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$_X$ BACT emission limit of 15 ppmv at 15 percent O$_2$ during normal operation.  The 15 ppmv NO$_X$ 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$_X$ 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$_2$. 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$_2$) 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:

$$CO + \tfrac{1}{2}O_2 \rightarrow CO_2$$
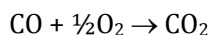
This reaction is promoted by several noble metal-enriched catalysts at high temperatures. Under optimum operating temperatures, this technology can generally achieve between 70 and 95 percent reduction efficiency for CO emissions.[32] An oxidation catalyst designed to control CO would provide a side 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

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[32] 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, an oxidation catalyst is proposed as 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 limits are based on an oxidation catalyst control efficiency of 95% for CO and 50% for VOC. A comparison of the proposed BACT to the determinations from the MassDEP Guidelines (Top-Case BACT), the CTDEEP BACT database, and the RBLC database is included in Attachment E. 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 $SO_2$ BACT

Natural gas-fired turbines, such as the Solar Taurus 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 $SO_2$, 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 $SO_2$ 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 $SO_2$ emissions in comparison to other fuels due to the low ash and sulfur contents. Pipeline quality natural gas will be used for firing the combustion turbine at the Weymouth Compressor Station.

#### 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 $SO_2$ 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. 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 $SO_2$ 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 $SO_2$ 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 the proposed BACT for the new Solar Taurus 60-7802 turbine at the Weymouth Compressor Station. Algonquin proposes an annual $PM_{10}/PM_{2.5}$ emission limit of 1.99 tpy and an annual $SO_2$ emission limit of 4.23 tpy for the new Solar Taurus 60-7802 turbine. A comparison of the proposed BACT to the determinations from the RBLC database, the MassDEP Guidelines and the CTDEEP BACT database is included in Attachment E. The proposed $SO_2$ BACT is based on using pipeline quality natural gas with a sulfur content of 5 grains/100 scf. The annual PM and $SO_2$ 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 $CO_2$, $CH_4$, and $N_2O$. More than 99 percent of these combustion-related GHG emissions are in the form of $CO_2$ on a mass basis, since each carbon atom combusted in the fuel stream essentially results in one molecule of $CO_2$ emissions.[33] $CH_4$ and $N_2O$ emissions are byproducts of the combustion reactions and are formed in much lower quantities. Even when scaling $CH_4$ and $N_2O$ by their relative GWPs, these constituents combined contribute less than one percent of the total GHG emissions (on a $CO_2e$ 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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[33] Although small fractions of fuel carbon convert to combustion byproducts such as CO, or are unreacted $CH_4$, the majority of carbon combusted in the fuel stream is converted to $CO_2$. Consequently, standard emission factors for $CO_2$ are developed by assuming that the fuel carbon completely oxidizes to $CO_2$ (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 $^\circ$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);[34]
> 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;[35] and
> Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boilers.[36]

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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[34] 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
[35] http://www.epa.gov/nsr/ghgdocs/20120914CAAACPermitStreamlining.pdf (September 2012).
[36] 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) (RBLC Code 13.310)
> Large Combustion Turbines (> 25 MW) – Simple Cycle (no waste heat recovery) (RBLC Code 15.100)
> Large Combustion Turbines (> 25 MW) – Simple Cycle (no waste heat recovery) – Natural Gas (includes propane & liquefied petroleum gas) (RBLC Code 15.110)
> Large Internal Combustion Engines (> 500 hp) – Natural Gas (includes propane & liquefied petroleum gas) (RBLC Code 17.130)

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

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 $CO_2$ 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 $CO_2$ 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 $CH_4$ and $N_2O$. 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 $CO_2e$ emissions (i.e., where $CO_2e$ emissions levels are in the order of 1,000,000 tpy $CO_2e$), or for industrial facilities with high-purity $CO_2$ streams. The proposed project's emissions are well below the recommended threshold, and the turbine exhaust cannot be considered a high-purity $CO_2$ stream (turbine exhaust has a high flowrate and relatively low $CO_2$ concentration). Per U.S. EPA's guidance, CCS is not feasible for projects of smaller profiles such as the proposed Project.[37] 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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[37] 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 $CO_2$ Control Strategies for Combustion Turbines**

| Control Strategy | Description |
|---|---|
| Carbon Capture and Storage (CCS) | System that captures $CO_2$ 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 $CO_2$ exhaust stream (i.e., "carbon capture" technology),
> Transportation of $CO_2$ to a storage site, and
> A viable location for long-term storage of $CO_2$.

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

<u>$CO_2$ Capture</u>

CCS would involve post-combustion capture of the $CO_2$ from the combustion turbine and sequestration of the $CO_2$ 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 $CO_2$ 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:[38, 39]

1. *First Energy R.E. Burger* (Dec. 2008-Dec. 2010): First Energy conducted a $CO_2$ capture pilot test using Powerspan's ECO$_2$® 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$_2$® $CO_2$ capture system uses a proprietary ammonia-based solvent in a thermal swing absorption (TSA) process to remove $CO_2$ 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.[40]
2. *AES Warrior Run* (2000-Present) and *Shady Point* (1991-Present)*:* AES captures 66,000 - 110,000 tpy $CO_2$ 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 plantsat its stations in Cumberland, Maryland

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

[39] International Energy Agency GHG Research & Development Program, RD&D Database: $CO_2$ Capture Commercial Projects, http://www.ieaghg.org/index.php?/RDD-Database.html

[40] Powerspan, FirstEnergy ECO$_2$® 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 $CO_2$ 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 $CO_2$ 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 $CO_2$ is used for the carbonation of brine from Searles Lake, and the brine is subsequently used in the soda ash production process.[41]

4. *WE Energy Pleasant Prairie* (June 2008-Oct. 2009): WE Energy captured 15,000 tpy $CO_2$ 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 $CO_2$ was permanently sequestered in any geologic formation or by any other means.[42]

These projects have demonstrated the technical feasibility of small-scale $CO_2$ 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 $CO_2$ capture at a small scale, Florida Power & Light (FP&L) conducted $CO_2$ capture to produce 320-350 tpd $CO_2$ using the Fluor Econamine FG[SM] 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, FP&L changed from a base/intermediate load plant to a peaking plant, which made the continued operation of the capture plant uneconomical. The captured $CO_2$ was compressed and stored on site for sale to two nearby major food processing plants.[43, 44] Although this project indicates small-scale $CO_2$ capture is technically feasible for natural gas combined cycle combustion turbine flue gas, it does not support the availability of full-scale $CO_2$ capture from simple-cycle combustion turbines.

The projects identified do not propose post combustion capture of $CO_2$ 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 $CO_2$ 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).[45]

In addition, prior to sending the $CO_2$ stream to the appropriate sequestration site, it is necessary to compress the $CO_2$ from near atmospheric pressure to pipeline pressure (around 2,000 psia). The compression of the $CO_2$ would require a large auxiliary power load, resulting in additional fuel (and $CO_2$ emissions) to generate the same amount of power.[46]

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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[41] Electrical Power Research Institute, CO2 Capture and Storage Newsletter, "Visit to the Trona plant MEA CO2 Removal System in Trona, California, in September 2006", Issue #2 December 2006, http://mydocs.epri.com/docs/public/000000000001014698.pdf.

[42] 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.

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and Panama, Oklahoma. The $CO_2$ is not stored, but rather is used in the food processing industry and related processes.

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[42] 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.

[43] International Energy Agency GHG Research & Development Program, RD&D Database: Florida Light and Power Bellingham $CO_2$ Capture Commercial Project, http://www.ieaghg.org/index.php?/RDD-Database.html.

[44] Reddy, Satish, et. al., Fluor's Econamine FG PlusSM Technology for $CO_2$ 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.

[45] CCS Task Force Report, August 2010, p. 29.

[46] 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.

<u>$CO_2$ Transport</u>

In addition to the challenges presented for $CO_2$ capture, Since the Weymouth Compressor Station is not located near a geologic formation that would be appropriate for carbon sequestration, transportation of the $CO_2$ would be required. Accordingly, Algonquin is including a discussion on the feasibility of transporting the $CO_2$ captured from the exhaust of the turbine to an appropriate sequestration site. Algonquin would need to either transport the captured $CO_2$ to an existing $CO_2$ pipeline or transport the $CO_2$ 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 $CO_2$, the U.S. Department of Energy (DOE) tasked seven Regional Carbon Sequestration Partnerships (RCSPs) for locating such areas in their respective regions.[47] 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 $CO_2$ 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.[48] 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.[49] 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 $CO_2$ 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 $CO_2$ storage potential.[50] In addition, the New York State Geological Survey (NYSGS) has identified three potential sequestration sites in the state's oil and gas fields.[51] 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 $CO_2$ sequestration site.[52]

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[47] Regional Carbon Sequestration Partnership (RCSP) Initiative. Accessed on Aug 14, 2015.
http://www.netl.doe.gov/research/coal/carbon-storage/carbon-storage-infrastructure/rcsp.
[48] http://www.natcarbviewer.com/
[49] Information on the wetlands reclamation projects being considered for soil carbon sequestration is located at:
http://216.109.210.162/TerrestrialDemonstrationWetlandAndMarshland.aspx.
[50] Information on the results of the Triassic Newark Basin field project is located at:
http://www.netl.doe.gov/publications/factsheets/project/FE0002352.pdf
[51] http://www.nysm.nysed.gov/nysgs/research/carbon/ny.html
[52] This map is taken directly from: http://www.natcarbviewer.com/

**Figure 5-1: $CO_2$ Potential Injection Location**



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

There are no known $CO_2$ pipelines near the station or within the region.[53,54] It is considered technically feasible to construct a $CO_2$ pipeline to either of these sequestration sites for the purposes of this analysis.

CO$_2$ Storage

The process of injecting $CO_2$ into subsurface formations for long-term sequestration is referred to as geologic $CO_2$ storage. $CO_2$ can be stored underground in oil/gas fields, unmineable coal seams, and saline formation. In practice, $CO_2$ 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 $CO_2$ 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.[55] 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:[56]

1. The Sleipner Project (1996 – current): One million tonnes of $CO_2$ 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.

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[53] http://www.majorpipe.com/?page_id=1057
[54] http://www.globalccsinstitute.com/publications/global-status-ccs-2012/online/48641
[55] Midwest Regional Carbon Sequestration Partnership (MRCSP) maintains a website at http://216.109.210.162/
[56] CCS Task Force Report, Pages C-1 and C-2.

2. The Weyburn Project (2000 – 2011): 1.8 million tonnes of $CO_2$ per year is injected into 29 horizontal and vertical wells into two adjacent carbonate layers in Saskatchewan, Canada near the North Dakota border. The $CO_2$ originates from a nearby synfuel plant.[57]
3. The Snohvit Project (2010 – current): The Project is expected to inject 0.7 million tonnes $CO_2$ 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 $CO_2$ 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 $CO_2$ storage is a technically feasible option for Algonquin to employ for $CO_2$ 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 $CO_2$ emissions from the turbine. Details of these technologies are provided in Step 1.

➤ CCS, 90 percent[58]

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[57] Petroleum Technology Research Centre, http://www.ptrc.ca/weyburn_overview.php

[58] 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)[59] | Efficiency |
|---|---|---|---|---|
| Solar[60] | Taurus 60 | 7,700 | 7,840 | 32.4% |
| General Electric[61] | NovaLT5-2 | 7,509 | 8,304 | 31.5% |
| Siemens[62] | 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 $NO_X$ 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 $CO_2$ and $CH_4$ emissions. The technologies that are most frequently used to control emissions of $CH_4$ in hydrocarbon-rich streams (e.g., flares and thermal oxidizers) actually convert $CH_4$ emissions to $CO_2$ emissions. Consequently, the reduction of one GHG (i.e., $CH_4$) results in a proportional increase in emissions of another GHG (i.e., $CO_2$).

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: $CO_2$ capture, $CO_2$ transport, and $CO_2$ 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 $CO_2$ from commercial applications. Capture and compression costs vary widely depending on what type of combustion equipment and process is used at the

[59] As reported by the manufacturers at ISO conditions, for shaft output, and based on LHV of natural gas.
[60] Solar Turbines, Taurus 60 Gas Turbine Compressor Set, General Specifications, https://mysolar.cat.com/cda/layout?m=41425&x=7
[61] GE Energy Gas Turbine Data Sheet – Mechanical Drive, https://www.geoilandgas.com/sites/geog.dev.local/files/ge_novalt5_brochure.pdf
[62] 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

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 "$CO_2$-captured" or a "$CO_2$-avoided" basis. The $CO_2$-captured basis accounts for all $CO_2$ 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 $CO_2$-avoided basis takes into account the $CO_2$ losses during transport and storage as well as $CO_2$ emissions from equipment associated with the implementation of the CCS system. It is more appropriate to use the $CO_2$-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 $CO_2$ to pipeline pressures). As such, the cost factor which uses a $CO_2$-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.[63] A ten year lifespan is used for the capital calculations because the acidic nature of $CO_2$ 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 $CO_2$ 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: CO2 Pipeline Transport Cost Estimation".[64] 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 $CO_2$ 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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[63] 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/
[64] Carbon Capture and Sequestration Technologies Program Massachusetts Institute of Technology. Carbon Management GIS: CO2 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 $CO_2$ emissions from the turbine, the cost to transport the $CO_2$ 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 $CO_2$ captured. Considering the quantity of $CO_2$ generated, this figure represents an unreasonable cost for GHG control that Algonquin believes is not cost effective.[65]

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 $CO_2$ concentration than exhaust streams from the projects discussed above that have been used for demonstrating capture of $CO_2$ 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 $CO_2$ at both the Weymouth Compressor Station and at the wellhead, transfer of the $CO_2$ stream and sequestration of the $CO_2$ 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 $CO_2$ 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 $CO_2$ 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 $CO_2$e/year/turbine for the new turbine. The annual $CO_2$e limit includes startup, shutdown and low temperature operation. Because the tpy $CO_2$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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[65] 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 $CO_2$ pipeline using the same document from NETL. ETC found the control cost per ton associated with $CO_2$ transport to be $80.80 per ton of $CO_2$. 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 $CO_2$, 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$_2$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$_2$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$_2$ 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:[66]

> "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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[66] 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."[66]  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[67,68]
> 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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[67] Per Technical Support Document for NSPS OOOO, 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 OOOO 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.
[68] 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 OOOOa, EPA-HQ-OAR-2010-0505-7631, May 2016, p. 41 estimates the overall reduction efficiency from Subpart OOOOa 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 OOOOa 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.

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

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

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 EOEA file number - assigned when an
     Environmental Notification Form is submitted to the MEPA unit:

                                                          EOEA File Number

## F. Amount Due

*DEP Use Only*

*Permit No:*

*Rec'd Date:*

*Reviewer:*

**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).

627145                              $2,370.00                09/14/2015
Check Number                        Dollar Amount            Date

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)**

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.

✓ tab

✗ return

**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)

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

4922
8. Standard Industrial Classification (SIC) Code

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, CO2, NOx, SO2, VOC, HAP, PM or Other [Specify])* | **Existing Facility-Wide Emission Cap(s) Per Consecutive 12-Month Time Period** (Tons) |
| N/A | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

*CO = carbon monoxide, CO₂ = carbon dioxide, NOx = nitrogen oxides, SO₂ = 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

## B. Equipment Description (continued)

## 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)

**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 Baselines Emissions** (Tons per Consecutive 12-Month Time Period)[1] | **New Potential Emissions**[2] (Tons per Consecutive 12-Month Time Period After Control) | **ERC[3] or Emission Offsets, Including Offset Ratio & Required ERC Set Aside** (Tons per Consecutive 12-Month Time Period) |
| N/A | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

[1] 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).
[2] New Potential Emissions means the potential emissions for the source of emission credits or offsets after project completion (310 CMR 7.00: Appendix A).
[3] 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 ☒ New ☐ Modified | Solar Taurus 60-7802 natural gas turbine* | 74,910,000* | Natural Gas | N/A |
| ☐ New ☐ Modified | | | | |
| ☐ New ☐ Modified | | | | |
| ☐ New ☐ Modified | | | | |

## B. Equipment Description (continued)

**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)

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

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

| | | 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 | | | | ☐ Yes ☐ No |
| | | | | ☐ Yes ☐ No |
| | | | | ☐ Yes ☐ No |
| | | | | ☐ Yes ☐ No |

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 |
|---|

# 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)

Facility ID (if known)

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 SoLoNOx to control emissions<br><br>☒ New<br><br>☐ Existing | EU1 | VOC | |
| | | CO | |
| | | PM[1] | |
| | | $NO_x$ | N/A[1] |
| | | $NH_3$ | |
| | | Other: | |

[1] PM includes particulate matter having a diameter of 10 microns or less ($PM_{10}$) and particulate matter having a diameter of 2.5 microns or less ($PM_{2.5}$).

**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<br><br>☒ New<br><br>☐ Existing | EU1 | VOC | 50% |
| | | CO | 95% |
| | | PM[1] | |
| | | $NO_x$ | |
| | | $NH_3$ | |
| | | 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.

---

[1] Algonquin and Solar Turbines believe that $SoLoNO_x$ 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 $NO_x$ BACT baseline for Solar Taurus 60-7802 turbine proposed at the Weymouth Compressor Station.

**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)**

| 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

**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.

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:

**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)

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 Design General Guidelines." See the instructions for a link.

| | | | | **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 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**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)

## 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 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.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Table 9A** | | | | | | |
| **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@ %$O_2$ or $CO_2$])[2] | **Proposed BACT Emissions** (lbs/hr, lb/MMBtu or ppmvd@ %$O_2$ or $CO_2$) | **Proposed Consecutive 12-Month Time Period Emissions Restrictions** (Tons, if Any)[5][3] | **Proposed Monthly Time Period Emissions Restrictions**[4] (Tons, if Any)[5] | **Proposed Fuel Usage Limit(s)** (if Any)[5] |
| Unit No. EU1 | PM[1] | 0.48 lbs/hr | 0.0066 lb/MMBtu | 1.99 | 0.18 | N/A |
| Fuel Used Natural Gas | PM2.5 | 0.48 lbs/hr | 0.0066 lb/MMBtu | 1.99 | 0.18 | N/A |
| | PM10 | 0.48 lbs/hr | 0.0066 lb/MMBtu | 1.99 | 0.18 | N/A |
| | $NO_x$[2] | 2.38 lbs/hr | 9 ppmvd at 15% $O_2$ | 9.96 | 0.93 | N/A |
| | CO | 4.02 lbs/hr | 1.25 ppmvd at 15% $O_2$ or 0.20 lbs/hr[5] | 16.77 | 2.12 | N/A |
| | VOC | 0.50 lbs/hr | 0.25 lbs/hr | 1.26 | 0.12 | N/A |
| | $SO_2$ | 1.03 lbs/hr | 5 grains per 100 scf NG | 4.23 | 0.37 | N/A |
| | HAP[3][6] | 0.17 lbs/hr | N/A | 0.10 | 1.17E-02 | N/A |
| | Total HAPs[3] | 0.25 lbs/hr | N/A | 0.28 | 0.03 | N/A |
| | $CO_2$[4] | 8,625 lbs/hr | N/A | 35,568 | 3,148 | N/A |

[1]PM includes particulate matter having a diameter of 10 microns or less (PM10) and particulate matter having a diameter of 2.5 microns or less (PM2.5).

[2] $NO_x$ emissions from this proposed project need to be included for the purposes of $NO_x$ emissions tracking for 310 CMR 7.00: Appendix A, if applicable.

[3]Operating Permit facilities are required to track emissions of Hazardous Air Pollutants.

[4]Pounds of $CO_2$ per unit product (e.g. pounds $CO_2$ per megawatt, pounds $CO_2$ per 1,000 pounds of steam).

[5]Enter "N/A" if not requesting emissions restrictions and/or fuel usage limit.

---

[2] The uncontrolled emission rates are based on maximum hourly emission rates for normal operations after SoLoNOx but before oxidation catalyst. Algonquin and Solar Turbines believe that SoLoNO$_X$ 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.

[3] Values represent the proposed emissions (tpy) after the implementation of an oxidation catalyst on the turbine.

[4] Proposed tons per month (tpm) emissions are the worst case emissions calculated for a month with 31 days of operation, including 12 hours of low temperature operation between -20 °F and 0 °F and 52 events of startup and shutdown.

[5] Equivalent to 1.25 ppmvd CO at 15% $O_2$ based on use of an oxidation catalyst with a 95% control efficiency for CO.

[6] Formaldehyde emissions are presented for worst-case Individual HAP.

**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)

## 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@ %$O_2$ or $CO_2$]) | **Proposed BACT Emissions** (lbs/hr, lb/MMBtu or ppmvd@ %$O_2$ or $CO_2$) | **Proposed Consecutive 12-Month Time Period Emissions Restrictions** (Tons, if Any)[5] | **Proposed Monthly Time Period Emissions Restrictions** (Tons, if Any)[5] | **Proposed Fuel Usage Limit(s)** (if Any)[5] |
| Unit No.

Fuel Used | PM | | | | | |
| | PM2.5 | | | | | |
| | PM10 | | | | | |
| | NOx | | | | | |
| | CO | | | | | |
| | VOC | | | | | |
| | SO2 | | | | | |
| | HAP | | | | | |
| | Total HAPs | | | | | |
| | CO2 | | | | | |

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

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Facility ID (if known)

## 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@ %O₂ or CO₂]) | **Proposed BACT Emissions** (lbs/hr, lb/MMBtu or ppmvd@ %O₂ or CO₂) | **Proposed Consecutive 12-Month Time Period Emissions Restrictions** (Tons, if Any)[5] | **Proposed Monthly Time Period Emissions Restrictions** (Tons, if Any)[5] | **Proposed Fuel Usage Limit(s)** (if Any)[5] |
| Unit No. | PM | | | | | |
| | PM2.5 | | | | | |
| | PM10 | | | | | |
| | NOₓ | | | | | |
| | CO | | | | | |
| | VOC | | | | | |
| | SO₂ | | | | | |
| | HAP | | | | | |
| | Total HAPs | | | | | |
| | CO₂ | | | | | |

**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..

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## 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[1], Fuel Flow) | **Parameter/Emission Monitored** | **Frequency of Monitoring** |
| EU1 | Performance Test | NOx 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 |
| | | | |

[1] 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.

| 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 pounds per 1,000,000 British thermal units (MMBtu)*(**X** cubic feet)*(1,000 Btu per cubic feet) + (0.10 pounds per MMBtu)*(**Y** gallons of fuel oil)*(130,000 Btu per gallon)}* 1 ton per 2000 pounds = NOx in tons per consecutive twelve month time period

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

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

$SO_2$: {(0.0015 lb per MMBtu)*(**Y** gallons of fuel oil)*(130,000 Btu per gallon)}*1 ton per 2000 pounds = $SO_2$ 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

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## 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

☒ 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 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?  **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 ▶**

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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:    EOEA 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

10-17-16
Date (MM/DD/YYYY)

49068
P.E. Number

COMMONWEALTH OF MASSACHUSETTS
DAVID M. COTTER
ENVIRONMENTAL
No. 49068
REGISTERED PROFESSIONAL ENGINEER

10-17-16

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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)

**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

_____
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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?[1]  ☐ 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?[2]  ☐ Yes ☒ No

[1] 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.

[2] 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 Majo

**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.

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

✓ tab

✗ return

**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)

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

4922
8. Standard Industrial Classification (SIC) Code

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, CO2, NOx, SO2, VOC, HAP, PM or Other [Specify])* | **Existing Facility-Wide Emission Cap(s) Per Consecutive 12-Month Time Period** (Tons) |
| N/A | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

*CO = carbon monoxide, $CO_2$ = carbom dioxide, NOx = nitrogen oxides, $SO_2$ = 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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**CPA-PROCESS** (BWP AQ 02 Non-Major, BWP AQ 03 Majo

**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)

## 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.

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

**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.

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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 Emissions Offsets** | **Transmittal No. of Plan Approval Verifying Generation of ERCs, if Any** | **Air Contaminant** | **Actual Baselines Emissions** (Tons per Consecutive 12-Month Time Period)[1] | **New Potential Emissions**[2] (Tons per Consecutive 12-Month Time Period After Control) | **ERC[3] or Emission Offsets, Including Offset Ratio & Required ERC Set Aside** (Tons per Consecutive 12-Month Time Period) |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

[1] 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).
[2] 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).
[3] 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,[1] Uncontrolled** (Tons per Consecutive 12-Month Time Period) |
| EU2 ☒ New ☐ Modified | Emissions from gas venting | PM[2] | N/A |
|  |  | VOC | 18.93 |
|  |  | $CO_2$ | 12.46 |
|  |  | Total HAPs | 1.09 |
|  |  | Worst Case Individual HAP[1] | 0.82 |
|  |  | Other: CO2 equivalent | 13,103 |

[1] 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.)
[2] PM includes particulate matter having a diameter of 10 microns or less ($PM_{10}$) and particulate matter having a diameter of
2.5 microns or less ($PM_{2.5}$).
[3] Calculate Worst Case Individual Hazardous Air Pollutant (HAP) potential emissions based on use of the raw material with
the highest individual HAP content.

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[1] Hexane(n-) emissions are presented for worst-case Individual HAP

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# CPA-PROCESS (BWP AQ 02 Non-Major, BWP AQ 03 Majo

**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)

## 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<br><br>☒ New<br><br>☐ Modified | Fugitive Emissions from piping components | PM | NA |
| | | VOC | 4.68 |
| | | $CO_2$ | 0.72 |
| | | Total HAPs | 0.52 |
| | | Worst Case Individual HAP[2] | 0.22 |
| | | Other: CO2 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) |
| ☐ New<br><br>☐ Modified | | PM | |
| | | VOC | |
| | | $CO_2$ | |
| | | 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.

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.

---

[2] Xylene emissions are presented for worst-case Individual HAP

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

**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.

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Transmittal Number

Facility ID (if known)

## 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. <br><br> Description <br><br> ☐ New <br><br> ☐ Existing | | PM[1] | | | |
| | | VOC | | | |
| | | Total HAPs | | | |
| | | Individual HAP* | | | |
| | | Other: | | | |

[1] PM includes particulate matter having a diameter of 10 microns or less (PM10) and particulate matter having a diameter
  of 2.5 microns or less (PM2.5).

**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. <br><br> Description <br><br> ☐ New <br><br> ☐ Existing | | PM | | | |
| | | VOC | | | |
| | | Total HAPs | | | |
| | | Individual HAP | | | |
| | | Other: | | | |

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

**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)

## 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 |

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).

**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.

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

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

**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)

## 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[3] | N/A | N/A | N/A | N/A | N/A | N/A |
| EU3[3] | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | | |
| | | | | | | |
| | | | | | | |

[3] EU2 and EU3 are fugitive emissions from gas releases and piping components and do not vent to a stack.

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## 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@ %$O_2$ or $CO_2$]) | Proposed BACT Emissions (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %$O_2$ or $CO_2$) | 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[1] (Tons) [4] (Enter "N/A" if not requesting a monthly emissions cap) | Proposed Production or Operational Limits[2] (Enter "N/A" if not requesting a production or operational limit) |
| EU2 | PM[3] | N/A | N/A | N/A | N/A | N/A |
| | VOC | 4.32 lb/hr | N/A | 18.93 | 15.26 | N/A |
| | Total HAPs | 0.25 lb/hr | N/A | 1.09 | 0.95 | N/A |
| | Individual HAP[5] | 0.19 lb/hr | N/A | 0.82 | 0.73 | N/A |
| | $CO_2$ | 2.84 lb/hr | N/A | 12.46 | 9 | N/A |
| | Other: CO2e | 2,992 lb/hr | N/A | 13,103 | 4,989 | N/A |

[1] Provide a monthly emission restriction if proposing a 12-month time period restriction.

[2] 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.

[3] PM includes particulate matter having a diameter of 10 microns or less (PM10) and particulate matter having a diameter of 2.5 microns or less (PM2.5).

[4] Hexane(n-) emissions are presented for worst-case Individual HAP

[5] Proposed tons per month (tpm) emissions are the worst case emissions calculated for a month with 31 days of operation. The maximum volume of gas released in a month was calculated as the sum of monthly average gas release volume and maximum hourly gas release volume.

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

| **Table 7B** | | | | | |
|---|---|---|---|---|---|
| **Emission Unit No.** | **Air Contaminant** | **Uncontrolled Emissions** (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %O$_2$ or CO$_2$) | **Proposed BACT Emissions** (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %O$_2$ or CO$_2$) | **Proposed Consecutive 12-Month Time Period Emissions, if Any** (Tons) | **Proposed Monthly Time Period Emissions Restrictions** (Tons) [6] | **Proposed Production or Operational Limits** |
| EU3 | PM | N/A | N/A | N/A | N/A | N/A |
| | VOC | See footnote below[7] | See footnote below[6] | 2.38 | 0.41 | N/A |
| | Total HAPs | 0.12 lb/hr | 0.04 lb/hr | 0.18 | 0.03 | N/A |
| | Individual HAP[8] | 0.05 lb/hr | 0.02 lb/hr | 0.07 | 0.01 | N/A |
| | CO$_2$ | 0.16 lb/hr | N/A | 0.72 | 0.13 | N/A |
| | Other: CO2 equivalent | 172 lb/hr | N/A | 753 | 66 | N/A |

| **Table 7C** | | | | | |
|---|---|---|---|---|---|
| **Emission Unit No.** | **Air Contaminant** | **Uncontrolled Emissions** (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %O$_2$ or CO$_2$) | **Proposed BACT Emissions** (lbs/hr, gr/acf, gr/dscf, or ppmvd@ %O$_2$ or CO$_2$) | **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$_2$ | | | | | |
| | Other: | | | | | |

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

---

[6] Proposed tons per month (tpm) emissions are the worst case emissions calculated for a month with 31 days of operation and maximum hourly emission rate (lb/hr) from Tables H-1Ba through H-1Bd included in Attachment G to the application report.

[7] 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.

[8] Xylene emissions are presented for worst-case Individual HAP

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**Massachusetts Department of Environmental Protection**
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# CPA-PROCESS (BWP AQ 02 Non-Major, BWP AQ 03 Majo

**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)

## 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[1], Flow Meter) | **Parameter/Emission Monitored** | **Frequency of Monitoring** |
| EU3 | Hand-held monitor | VOC | Quarterly |
| | | | |
| | | | |
| | | | |
| | | | |

[1] 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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## 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.

## 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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## 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: EOEA 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

10-17-16
Date (MM/DD/YYYY)

49068
P.E. Number

COMMONWEALTH OF MASSACHUSETTS
DAVID M. COTTER
ENVIRONMENTAL
No. 49068
REGISTERED PROFESSIONAL ENGINEER

10-17-16

**Continue to Certification by Responsible Official ▶**

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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)

Continue to Energy Efficiency Evaluation Survey ▶

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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?[1]  ☐ 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?[2]  ☐ Yes ☒ No

[1]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.

[2]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

BWP AQ BACT Forms
BWP AQ Sound Form

**Massachusetts Department of Environmental Protection**
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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.**

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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.

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**Determination of Best Available Control Technology (BACT)**
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## B. Air Pollution Control Technology/Technique Options (continued)

| Table 2 | | | |
|---|---|---|---|
| | **Option 1:** | **Option 2:** | **Option 3:** |
| **Description of Available Air Pollution Control Technologies/Techniques** | Selective Catalytic Reduction | Dry Low NOx Combustion (SoLoNOx) | Water Injection/Good Combustion Practices |
| **Pollutant(s) Controlled[1]** (e.g. PM, NOx, CO, SO₂, VOC, HAP) | NOx | NOx | NOx |
| **Potential Emissions Before Control** (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis) | 9 ppm[1] | 9 ppm | N/A |
| **Resulting Emissions After Control** (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis) | 3-9 ppm | 9 ppm | N/A |
| **Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed[2]** | 43,805 | N/A | N/A |

[1] NOx = nitrogen oxides, SO₂ = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

[2] Complete Section C of this Form to determine annualized costs.

[1] Selective Catalyst Reduction (SCR) control is assumed on top of SoLoNOₓ on Solar turbine. Algonquin and Solar Turbines believe that SoLoNOₓ 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.

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## BWP AQ BACT
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## 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)

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## C. Annualized Cost Analysis (continued)

| Table 3 (Continued) | | | |
|---|---|---|---|
| | **Option 1** | **Option 2** | **Option 3** |
| **Annual Operating & Maintenance Costs** | | | |
| **Direct Operating Cost** | | | |
| 15. Labor | $18,889 | $ | $ |
| 16. Maintenance | $16,425 | $ | $ |
| 17. Replacement Parts | $16,425 | $ | $ |
| **Indirect Cost** | | | |
| 18. Property Taxes* | $0 | $ | $ |
| 19. Insurance | $0 | $ | $ |
| 20. Fees | $0 | $ | $ |
| 21. Total Annual Operating Costs (Add 15 Through 20) | $51,739 | $ | $ |
| **Energy Cost** | | | |
| 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[1]** |
| 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 |
| | |

[1] **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

9/7/16
Date (MM/DD/YYYY)

49068
P.E. Number

COMMONWEALTH OF MASSACHUSETTS
DAVID M. COTTER
ENVIRONMENTAL
No. 49068
REGISTERED
PROFESSIONAL ENGINEER

**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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top-down, case-by-case BACT analysis for your proposed Comprehensive Plan
Application (CPA) project.

X266786
Transmittal Number

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

09/08/2016
Date (MM/DD/YYYY)

The space 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.**

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 | 1.25 ppmvd CO at 15% $O_2$ or 0.20 lb/hr for CO |
| EU1 | Oxidation Catalyst | 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:** |
| **Description of Available Air Pollution Control Technologies/Techniques** | Oxidation Catalyst | Good Combustion Practices | |
| **Pollutant(s) Controlled[1]** (e.g. PM, $NO_x$, CO, $SO_2$, VOC, HAP) | CO, VOC | CO, VOC | |
| **Potential Emissions Before Control** (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis) | 25 ppmvd CO at 15% $O_2$ or 4.02 lb/hr for CO And 0.50 lb/hr for VOC | N/A | |
| **Resulting Emissions After Control** (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis) | 1.25 ppmvd CO at 15% $O_2$ or 0.20 lb/hr for CO And 0.25 lb/hr for VOC | N/A | |
| **Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed[2]** | N/A | N/A | |

[1] $NO_x$ = nitrogen oxides, $SO_2$ = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

[2] Complete Section C of this Form to determine annualized costs.

**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)

## 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** |
| **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: $C[i(1+i)^n]/[(1+i)^n - 1]$* | $ | $ | $ |

**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 = Total Capital Investment (Line 13)  i = Interest Rate (Assume 10%)  n = Life of Equipment (Assume 10 Years or Less)

## 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** |
| **Annual Operating & Maintenance Costs** | | | |
| **Direct Operating Cost** | | | |
| 15. Labor | $ | $ | $ |
| 16. Maintenance | $ | $ | $ |
| 17. Replacement Parts | $ | $ | $ |
| **Indirect Cost** | | | |
| 18. Property Taxes* | $ | $ | $ |
| 19. Insurance | $ | $ | $ |
| 20. Fees | $ | $ | $ |
| 21. Total Annual Operating Costs (Add 15 Through 20) | $ | $ | $ |
| **Energy Cost** | | | |
| 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) | | | |

**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)

| 30. Cost of Control (Dollars Per Ton)<br>(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.

## 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[1]** |
| | |
| | |

[1] **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

10-17-16
Date (MM/DD/YYYY)

49068
P.E. Number

COMMONWEALTH OF MASSACHUSETTS
DAVID M. COTTER
ENVIRONMENTAL
No. 49068
REGISTERED PROFESSIONAL ENGINEER

10-17-16

Place P.E. Seal of Stamp Here

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)

## 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)

# 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.**

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.

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**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 | use of pipeline quality natural gas and good combustion and operating practices | 0.0066 lb/MMBtu for PM/PM$_{10}$/PM$_{2.5}$ |
| EU1 | use of pipeline quality natural gas and good combustion and operating practices | 14.29 lb/MMscf for SO$_2$ (based on 5 grains per 100 scf NG) |
| | | |

## 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**
**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:** |
| **Description of Available Air Pollution Control Technologies/Techniques** | Clean fuel selection | Good Combustion Practices | |
| **Pollutant(s) Controlled[1]** (e.g. PM, $NO_x$, CO, $SO_2$, VOC, HAP) | $PM/PM_{10}/PM_{2.5}/SO_2$ | $PM/PM_{10}/PM_{2.5}/SO_2$ | |
| **Potential Emissions Before Control** (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis) | N/A | N/A | |
| **Resulting Emissions After Control** (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis) | 0.0066 lb/MMBtu for $PM/PM_{10}/PM_{2.5}$  14.29 lb/MMscf for $SO_2$ (based on 5 grains per 100 scf NG) | | |
| **Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed[2]** | N/A | N/A | |

[1]  $NO_x$ = nitrogen oxides, $SO_2$ = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

[2] Complete Section C of this Form to determine annualized costs.

**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)**
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X266786
Transmittal Number

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### 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** |
| **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: $C[i(1+i)^n]/[(1+i)^n - 1]$* | $ | $ | $ |

**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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\* C = Total Capital Investment (Line 13)  i = Interest Rate (Assume 10%)  n = Life of Equipment (Assume 10 Years or Less)

## 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** |
| **Annual Operating & Maintenance Costs** | | | |
| **Direct Operating Cost** | | | |
| 15. Labor | $ | $ | $ |
| 16. Maintenance | $ | $ | $ |
| 17. Replacement Parts | $ | $ | $ |
| **Indirect Cost** | | | |
| 18. Property Taxes* | $ | $ | $ |
| 19. Insurance | $ | $ | $ |
| 20. Fees | $ | $ | $ |
| 21. Total Annual Operating Costs (Add 15 Through 20) | $ | $ | $ |
| **Energy Cost** | | | |
| 22. Annual Electrical Energy Expense | $ | $ | $ |
| 23. Annual Auxiliary Fuel Cost | $ | $ | $ |
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| 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) | | | |

## 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)

| 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.

### D. Option Feasibility - Note: The chosen BACT is the top technically feasible control option as determined through the Top-Down BACT analysis for PM and $SO_2$ 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[1] |
|  |  |
|  |  |

[1] 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

10-17-16
Date (MM/DD/YYYY)

49068
P.E. Number

Place Professional Engineer's Stamp Here.

*[P.E. Stamp: COMMONWEALTH OF MASSACHUSETTS — DAVID M. COTTER — ENVIRONMENTAL — No. 49068 — REGISTERED PROFESSIONAL ENGINEER]*
10-17-16

**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)

## 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)

**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
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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 $CO_2e$/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.

**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)**
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## B. Air Pollution Control Technology/Technique Options (continued)

| Table 2 | | | | |
|---|---|---|---|---|
| | **Option 1:** | **Option 2:** | **Option 3:** | **Option 4:** |
| **Description of Available Air Pollution Control Technologies/Techniques** | Carbon Capture and Storage (CCS) | Fuel Selection | High Efficiency Turbine | Good Combustion Practices |
| **Pollutant(s) Controlled[1]** (e.g. PM, NO$_x$, CO, SO$_2$, VOC, HAP) | CO$_2$ | CO$_2$ | CO$_2$ | CO$_2$ |
| **Potential Emissions Before Control** (Pounds Per Hour, Pounds Per Million British Thermal Units, or Parts Per Million, Dry Volume Basis) | 35,568 tpy CO$_2$ | 35,568 tpy CO$_2$ | 35,568 tpy CO$_2$ | 35,568 tpy CO$_2$ |
| **Resulting Emissions After Control** (Pounds Per Hour, Pounds Per Million Btu, or Parts Per Million, Dry Volume Basis) | 90% control efficiency | N/A | N/A | N/A |
| **Annualized Cost in U.S. Dollars Per Ton of Pollutant Removed[2]** | $709/ ton of CO$_2$ captured | N/A | N/A | N/A |

[1] NO$_x$ = nitrogen oxides, SO$_2$ = sulfur dioxide, VOC = volatile organic compounds, HAP = hazardous air pollutant, PM = particulate matter, CO = carbon monoxide

[2] Complete Section C of this Form to determine annualized costs.

**Continue to Next Page ▶**

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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** |
| **Annual Operating & Maintenance Costs** | | | |
| **Direct Operating Cost** | | | |
| 15. Labor | $ | $ | $ |
| 16. Maintenance | $ | $ | $ |
| 17. Replacement Parts | $ | $ | $ |
| **Indirect Cost** | | | |
| 18. Property Taxes* | $ | $ | $ |
| 19. Insurance | $ | $ | $ |
| 20. Fees | $ | $ | $ |
| 21. Total Annual Operating Costs (Add 15 Through 20) | $ | $ | $ |
| **Energy Cost** | | | |
| 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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**BWP AQ BACT**

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## 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[1]** |
| Carbon Capture and Sequestration (CCS) | The economic cost per ton of CO2 captured is infeasible and as such CCS is considered to be cost ineffective for the project |
| | |
| | |
| | |
| | |

[1] **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

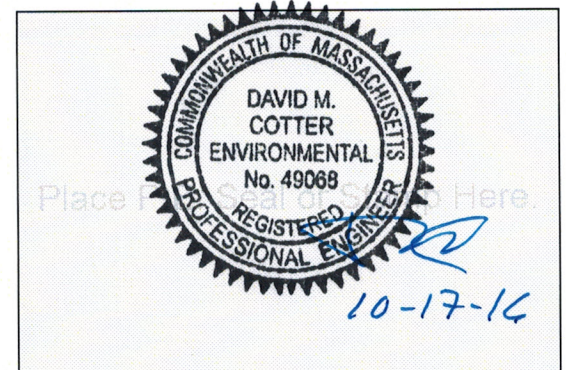Managing Consultant
Position/Title

Trinity Consultants
Company

9/7/16
Date (MM/DD/YYYY)

49068
P.E. Number

*Place P.E. Seal or Stamp Here.*

COMMONWEALTH OF MASSACHUSETTS
DAVID M. COTTER
ENVIRONMENTAL
No. 49068
REGISTERED
PROFESSIONAL ENGINEER

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

**BWP AQ BACT**

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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)

_____
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)

# BWP AQ Sound

**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.
.

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

**BWP AQ Sound**

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X266786
Transmittal Number

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 use 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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## 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)**

**Massachusetts Department of Environmental Protection**
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**BWP AQ Sound**

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## 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
Company

9/7/16
Date (MM/DD/YYYY)

49068
P.E. Number

*Commonwealth of Massachusetts Registered Professional Engineer Seal — DAVID M. COTTER ENVIRONMENTAL No. 49068*

Place the Seal or Stamp Here.

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

## BWP AQ Sound

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**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 Operations
Responsible Official Title

Algonquin Gas Transmission, LLC
Responsible Official Company/Organization Name

09/08/2016
Date (MM/DD/YYYY)

Site Plan
Process Flow Diagram

Natural Gas Pipeline

Emergency Generator

Filter Separators

Fuel Gas Heater

Combustion Byproducts:
($NO_X$, CO, $PM_{10/2.5}$, VOC, HAP, GHG)

Piping Component Leaks
(Fugitive):
(GHG, VOC, HAP)

Flash, Gas Releases, Vessel
Working &, Breathing Losses:
(GHG, VOC, HAP)

Gas Releases & Flash: (GHG, VOC, HAP)

Turbine

SV-V02

Pipeline Liquids Purges
Gas Purges
Pneumatic Equipment Exhaust

Various Atmospheric Vents

Compressor Seal Leakage
Blowdown/Purge: Ancillary Equipment
Valve Seat Leakage: Ancillary Equipment Isolation Valves and
Blowdown Valves
Pneumatic Equipment Exhaust

SV-V01S

Blowdown/Purge: Pipeline, Station Yard, Compressor
Valve Seat Leakage: Station Isolation Valves & Station Blowdown Valves

SV-V01C

Blowdown/Purge: Pipeline, Station Yard, Compressor
Valve Seat Leakage: Compressor Isolation Valves & Compressor Blowdown Valve

Various Minor
Sources of Gas
Releases

Various Minor
Sources of Gas
Releases

Various
Sources of
Pipeline
Liquids

Gas Releases, Flash, Vessel Working &, Breathing Losses: (GHG, VOC, HAP)

Tank Working & Breathing Losses: (VOC & HAP)

Oil Tank

Oily Water
Tank

Truck Loading Losses:
(VOC & HAP)

Condensate
Tank

Equipment

Storm Water
and/or Wash
Water

Legend

Natural Gas

Liquid Stream

Emission Points

Equipment Fugitives

S/V = Separator Vessel

WEYMOUTH FORE RIVER

N

Models $MODELNAME$
Username: $$$$$USERNAME$$$$
Drawing: $$$$$$$$$$$$$$$$$ODONSPEC$$$$$$$$
Plotted: $$$$$PLTTIME$$$$$

N7+00'-0"
N6+00'-0"
N5+00'-0"
N4+00'-0"
N3+00'-0"
N2+00'-0"
N1+00'-0"
0+00'-0"

50' FOOT WIDE
MWRA SUBSURFACE TUNNEL
EASEMENT

AGT EASEMENT

NATIONAL GRID
EASEMENT

MWRA PE1

MWRA PE1

ESD BLOWDOWN STACK
TOP OF STACK EL. 49'
(APPROX. 33' ABOVE GRADE)

BENCHMARK #1
6+19'-3"N
8+20'-8⅛"E
UTM ZONE 19 COORDINATE

SOURCE CONTROL

LIQUID STORAGE
BLOWDOWN SEPARATOR
CASE VENT SEPARATOR

TAURUS 60
EXHAUST STACK
96" SQUARE BODY
60'-1" HEIGHT

LUBE OIL
COOLER

COMPRESSOR BUILDING
96'-0"L×60'-0"W
EAVE HEIGHT 37'-3"
PEAK HEIGHT 45'-3"

FIVE (5) - HEATER,
CATALYTIC, BRUEST
MODEL CSA24X72,
72,000 BTU/HR
INPUT RATING.

MWRA PE5

FUEL GAS HEATER EXHAUST
8" ⌀ I.D.
15'-1" HEIGHT

ESD RESERVOIR

MAIN GAS
COOLERS

SUCTION FILTER
SEPARATORS

AIR RECEIVER

AUXILLIARY BUILDING
153'-0"L×40'-0"W
EAVE HEIGHT 19'-0"
PEAK HEIGHT 25'-8"

GENERATOR EXHAUST
10" ⌀ I.D.
30'-0" HEIGHT

BENCHMARK #2
3+21'-6"N
5+021-5⅞"E
UTM ZONE 19 COORDINATE
N15350253.99'
E1108736.20'

50 FOOT WIDE
MWRA SUBSURFACE TUNNEL
EASEMENT

ELECTRIC
EASEMENT

STATE ROUTE 3A

BRIDGE STREET

KING'S COVE

NATIONAL GRID EASEMENT

MWRA PE5

BENCHMARK #3
1+13'-9¾"N
3+81-1⅝"E
UTM ZONE 19 COORDINATE
N15350046.27'
E1108614.85'

NATIONAL GRID
EASEMENT

0+00'-0"  E1+00'-0"  E2+00'-0"  E3+00'-0"  E4+00'-0"  E5+00'-0"  E6+00'-0"  E7+00'-0"  E8+00'-0"  E9+00'-0"  E10+00'-0"  E11+00'-0"  E12+00'-0"  E13+00'-0"

DWG.# WEYM00020.16

ENGINEERING APPROVALS

| | BID | CONSTRUCTION |
|---|---|---|
| DRAWN BY: DAJ | | |
| DRAFTING SUPERVISOR | | |
| DESIGN ENGINEER | | |
| DESIGN MANAGER | | |
| TITLE | SIGNATURE | DATE | SIGNATURE | DATE |

BASIC SYSTEMS
BASIC SYSTEMS, INC.
CAMBRIDGE, OHIO   U.S.A.
(740) 432-5001

AIR PERMIT PLAN

LOC.   WEYMOUTH, MASSACHUSETTS

YEAR: 2017   W.O.CE.000089.005   SCALE:  1"=40'   DWG. WEYM-A-0020   REV. 4

Spectra Energy Partners

Algonquin Gas Transmission, LLC
5400 Westheimer Ct. Houston, TX 77056-5310 713 / 627-5400

| DWG. NO. | REFERENCE DWG. | REV | DSN | CK | DESCRIPTION |
|---|---|---|---|---|---|

# ATTACHMENT E: BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

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

## 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
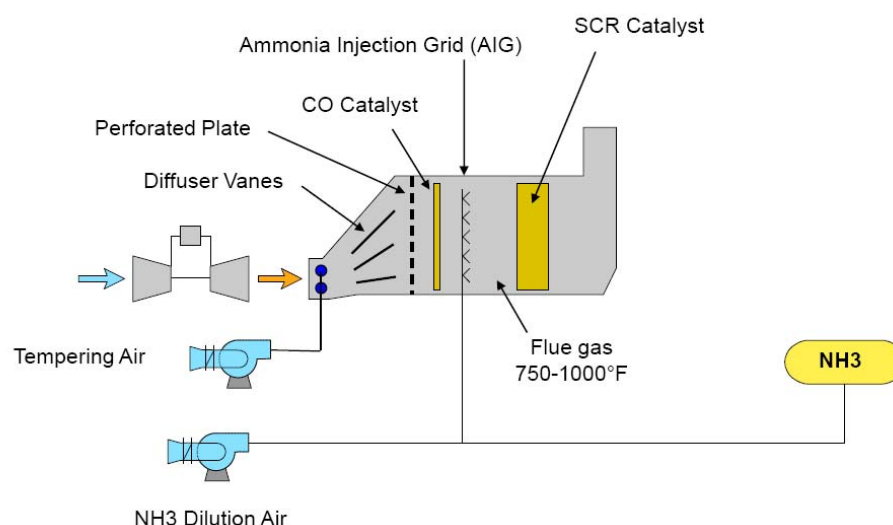


**Figure 1. Traditional Simple Cycle CO/SCR Catalyst Arrangement**

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 $NO_x$.  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.

FERCo-P2169
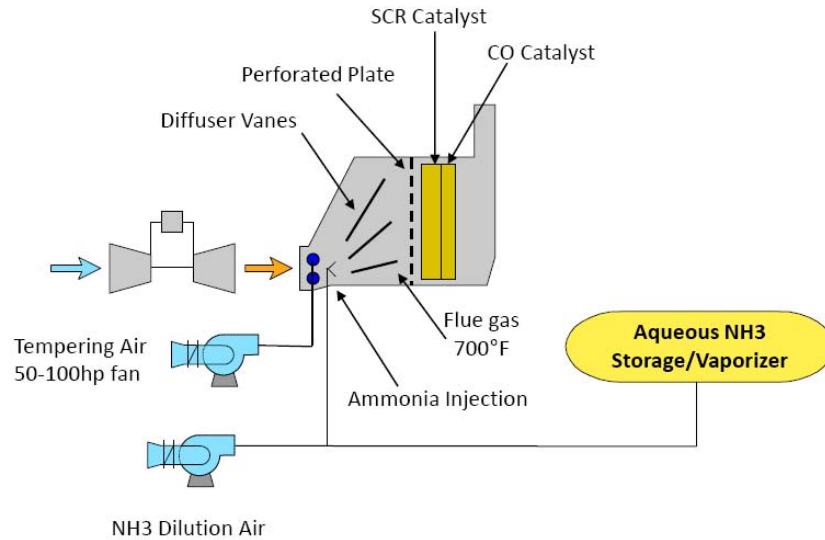
**Figure 2. Proposed Arrangement (CO Catalyst Downstream of the SCR Catalyst)**

## 3.    Estimated Budgetary Costs

In preparing this budgetary estimate, the following was assumed:

- Inlet $NO_x$:       15 ppm
- $NO_x$ reduction:        90%
- $NH_3$ 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
- NOx, O2 and CO

Other Instrumentation
- Inlet NOx/O2 monitor for NH3 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 NOx 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 |

FERCo-P2169

**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 | PPPMVD | 19 | LB |
| *ND-0030 | LONESOME CREEK GENERATING STATION | ND | Natural Gas Fired Simple Cycle Turbines | Natural gas | 412 | MMBtu/hr | Nitrogen Oxides (NOx) | SCR | 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) | SELECTIVE CATALYTIC REDUCTION SYSTEM (SCR) AND WET LOW-EMISSION (WLE) COMBUSTORS 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 | 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 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 | 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. | 30 | PPMVD | 0 | |
| NV-0046 | GOODSPRINGS COMPRESSOR STATION | NV | LARGE COMBUSTION TURBINE - SIMPLE CYCLE | NATURAL GAS | 97.81 | MMBTU/H | Nitrogen Oxides (NOx) | THE SOLONOX BURNER IN EACH TURBINE UTILIZES THE DRY LOW-NOX TECHNOLOGY TO CONTROL NOX EMISSIONS. | 25 | PPMVD | 0.0995 | LB/MMBTU |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NV-0048 | GOODSPRINGS COMPRESSOR STATION | NV | SIMPLE-CYCLE SMALL COMBUSTION TURBINES (&lt;25 MW) | NATURAL GAS | 11.5 | MW | Nitrogen Oxides (NOx) | 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. | 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 Trubine (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 | | 6 | PPMVD | 0 | |
| MD-0036 | DOMINION | MD | COMBUSTION TURBINE | NATURAL GAS | 12.2 | MW | GOOD COMBUSTION PRACTICES AND OPERATION OF AN OXIDATION CATALYST SYSTEM | 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)(&gt;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 (&lt;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 | OK | COMBUSTION TURBINE PEAKING UNIT(S) | NATURAL GAS | 462.7 | MMBTU/H | NO CONTROLS FEASIBLE. | 63 | PPM | 65.5 | LB/H |
| TX-0487 | ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT | 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 | TX | Refrigeration compressor turbines | natural gas | 40000 | hp | | 29 | PPMVD | 0 | |
| *TX-0691 | PH ROBINSON ELECTRIC 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 (&lt;25 MW) | NATURAL GAS | 11.5 | MW | GOOD COMBUSTION PRACTICE | 0.0069 | LB/MMBTU | 0.84 | LB/H |

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|---|---|---|---|---|---|---|---|---|---|---|
| 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 AND OPERATING IN ACCORDANCE WITH THE MANUFACTURER'S | 0.024 | LB/MMBTU | 0.11 | LB/H |
| TX-0487 | ROHM AND HAAS CHEMICALS LLC LONE STAR PLANT | 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 | |

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|---|---|---|---|---|---|---|---|---|---|
| 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 (&lt;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 | NATURAL GAS | 11.86 | MW | LIMIT SULFUR CONTENT OF FUEL COMBUSTED | 250 | PPMV | 0 | |
| AK-0067 | CENTRAL GAS FACILITY | AK | GE FRAME 6 INJECTION TURBINES COMPRESSORS (4) | 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 (&lt;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 | 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 | ROHM AND HAAS CHEMICALS LLC 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 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 Limit use to 600 hours per year and use of Good Combustion Practices. | 0 | - | 0 | - |
| CA-1223 | PIO PICO ENERGY CENTER | CA | Combustion Turbines (Normal Operations) | Natural Gas | 300 | MW | No Controls Feasible | 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 | Good Combustion Control | 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 | High efficiency turbines | 220122 | tons/12 month rolling total per each unit | | |
| TX-0679 | CORPUS CHRISTI LIQUEFACTION PLANT | TX | Refrigeration Compressor Turbines | Natural Gas | 40000 | hp | 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 | | |
| 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 | lb/MW-hr 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 | 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 | lb CO2/MW-hr (Gross) 2500 Operational hr 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^3/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^3/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^3/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; ULSD; 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 fossil 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**

| BACT Determination | State | Source Type | Fuel | BACKUP 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 | No. 2 Fuel Oil | 6/1/2011 | Dry Low NOx Combustor, SCR, CEMS | 2.5 | ppmvd @ 15% $O_2$ |
| 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**

| 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 | Oxidation Catalyst, CEMS | 5.0 | ppmvd @ 15% $O_2$ |
| 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**

| 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 | Oxidation Catalyst | 2.5 | ppmvd @ 15% $O_2$ |

**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 - Summary of Proposed BACT | |

| Pollutant | RBLC | MA Top Case BACT | CT BACT | Proposed BACT | Notes |
|---|---|---|---|---|---|
| CO | 5 ppmvd at 15% $O_2$ | 5 ppmvd at 15% $O_2$ | 5 ppmvd at 15% $O_2$ | 25 ppmvd at 15% $O_2$ (before control)<br>1.25 ppmvd at 15% $O_2$ (after control)<br>or 0.20 lb/hr (after control) | The before control BACT limit is based on the Solar guarantee for SoLoNOx.  The after control proposed BACT limit is based on the the use of an oxidation catalyst with a 95% control efficiency for CO.  The 0.2 lb/hr CO limit corresponds to a concentration of 1.25 ppmvd at 15% $O_2$.  This concentration is lower than RBLC, MA or CT BACT determinations. |
| VOC | 2-4 ppmvd at 15% $O_2$ (with Oxidation Catalyst control) | 2.5 ppmvd at 15% $O_2$ (with Oxidation Catalyst Control) | 2 ppmvd at 15% $O_2$ (with Oxidation Catalyst Control) | 0.25 lb/hr (after Oxidation Catalyst control) | The after control proposed BACT limit is based on the use of an oxidation catalyst with a 50% control efficiency for VOC.  The oxidation catalyst is the top ranked BACT for control of VOC as discussed in Section 5.5 of the application report and is the system cited in the RBLC and MassDEP BACT determinations.  The 0.25 lb/hr VOC limit corresponds to a concentration of 2.4 ppmvd at 15% $O_2$ (based on an average VOC molecular weight of 18.37 lb/lb-mole).  This concentration is lower than the MassDEP Top-Case BACT and within the RBLC range.  Both of the determinations are based on 50 megawatt (MW) units.  The Solar unit is significantly smaller at 6.46 MW. |
| PM | 0.0066 lb/MMBtu | N/A | 0.0066 lb/MMBtu | 0.0066 lb/MMBtu | The proposed BACT limit is equal to the RBLC, MA, and CT determinations.  The limit will be achieved through the use of  pipeline quality natural gas along with good combustion and operating practices. |
| $SO_2$ | 1 grain per 100 scf NG | N/A | 0.002 lb/MMBtu | 14.29 lb/MMscf<br>(based on 5 grains per 100 scf NG) | The RBLC and CT BACT determinations are based on the sulfur content of natural gas supplied to the sources by the local distribution company. As the new Solar Taurus 60-7802 turbine at the Weymouth Compressor Station will be fired using the pipeline gas, the proposed BACT is based on a sulfur content of 5 grains/100 scf per Algonquin's tariff for pipeline quality natural gas. |

**Table 1. Cost Analysis Supporting Information for SCR**

| Parameter | Turbine | Units | Reference | Notes |
|---|---|---|---|---|
| Maximum Heat Capacity | 74.91 | MMBtu/hr | 1 | |
| Maximum Output | 6,460 | kW | 1 | |
| Potential Inlet $NO_X$ Emissions | 32.97 | lb/MMscf | 1 | |
| Potential Emissions $NO_X$ | 9.96 | tpy | 1 | |
| | | | | **From Budget Costs from FERCO (Appendix E)** |
| Removal Efficiency | 90 | % | | |
| Pollutant Removed | 8.96 | tpy | 3 | |
| | | | | **From Budget Costs from FERCO, converted 9 lb/hr to tpy** |
| Aqueous Ammonia Requirement | 39.420 | ton/yr | | |
| Catalyst Cost, Disposal | 15.00 | $/ft$^3$ | 4 | |
| Catalyst Cost, Replacement | 20,000 | $ | 4 | |
| Aqueous Ammonia Cost | 295.75 | $/ton | | Calculated, Refer to Table 3 |
| 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

6. Industrial June 2015 electricity cost for MA: 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/cpiai.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[1] | Notes |
|---|---|---|---|
| *Purchased Equipment Costs* | | | |
|    Equipment Cost | 574,100 | | From Budget Costs from FERCO October 2013 Quote - SCR Equipment minus CEMS cost. |
|    Instrumentation[3] | 57,410 | $0.10 \times A$ | |
|    Sales Tax[3] | 22,964 | $0.04 \times A$ | |
|    Freight[3] | 28,705 | $0.05 \times A$ | |
| *Total Purchased Equipment Costs* | 683,179 | B | |
| *Direct Installation Costs* | | | |
|    Commissioning | 354,544 | | From Budget Costs from FERCO October 2013 Quote. Total commissioning cost is ratioed based on the cost of the SCR equipment. |
| *Total Direct Costs* | 1,037,723 | $D = B + C$ | |
| *Indirect Installation Costs*[4] | | | |
|    General Facilities | 51,886 | $0.05 \times D$ | |
|    Engineering and Home Office Fees | 103,772 | $0.10 \times D$ | |
|    Process Contingency | 51,886 | $0.05 \times D$ | |
| *Total Indirect Installation Costs* | 207,545 | E | |
| *Continuous Emission Monitor, CEMs*[5] | 0 | | Assuming no CEMS |
| *Project Contingency*[4] | 186,790 | $G = 0.15 \times (D + E + F)$ | |
| **Total Capital Investment** | **1,432,058** | **TCI = D + E + F + G** | |

| Operating Cost | Turbine | OAQPS Notation | |
|---|---|---|---|
| *Direct Annual Costs* | | | |
|    Operating Labor[6] | 16,425 | H | Currently assuming 0.5 hours per shift with 3 shifts per day. |
|    Maintenance Labor[6] | 16,425 | I | |
|    Supervisory Labor[6] | 2,464 | $J = 0.15 \times H$ | |
|    Maintenance Materials[6] | 16,425 | I | |
|    Utilities - Natural Gas[7] | 87,554 | Calculated | Refer to Table 1 |
|    Utilities - Electricity[8] | 95,997 | Calculated | Refer to Table 2 |
|    Utilities - Aqueous Ammonia[9] | 11,658 | Calculated | Refer to Table 3 |
|    Catalyst Replacement[10,12] | 8,307 | Calculated | Refer to Table 4 |
|    Catalyst Disposal[11] | 2,225 | Calculated | Refer to Table 5 |
|    CEM Annual Cost[5] | 0 | | Assuming no CEMS |
| *Total Direct Annual Costs* | 257,480 | DAC | |
| *Indirect Annual Costs* | | | |
|    Overhead[14] | 0 | | |
|    Administrative Charges[14] | 0 | | |
|    Property Taxes[14] | 0 | | |
|    Insurance[14] | 0 | | |
|    Capital Recovery on Total Capital Investment[12] | 135,176 | | |
| *Total Indirect Annual Costs* | 135,176 | IDAC | |
| **Total Annual Cost** [13] | **392,656** | *TAC = DAC + IDAC* | |
| Pollutant Removed (tpy) | 8.96 | | |
| **Cost per ton of NO$_X$ Removed** | **43,805** | *$/ton = TAC / Pollutant Removed* | |

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 x 0.5 hrs/shift x 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 % x MMBtu/hr x hr/yr x $/MMBtu
8. Calculated as Loss % x kW x hr/yr x $/kW + ( Ammonia Vaporizer Cost $/hr + Dilution Blower Cost $/hr ) x 8760 hr/yr.
9. Calculated as aqueous ammonia ton/yr x $/ton.
10. The cost of catalyst replacement includes the cost of catalyst replacement plus sales tax and freight.
11. Catalyst disposal cost calculated as disposal cost ($/ft$^3$) x kW / (1000 kW / MW) x (6180 ft$^3$ / 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 x 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/cpiai.txt.

2. Industrial June 2015 electricity cost for MA:
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

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.

| Inputs | | |
|---|---|---|
| $CO_2$ Emissions from Source | 35568 | Short Tons per Year [a] |
| Distance to Infrastructure | 180 | Miles [b] |
| Project Life | 30 | Years [c] |
| Capture Efficiency | 90% | [d] |

[a] $CO_2$ 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 $CO_2$ 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 $CO_2$ |
| CAPTURE EFF. | 90% | 3,557 |
| CAPTURED - MASS | 32,011 | tpy $CO_2$ |
| Density of $CO_2$ - Metric (MIT)[e] | 884 | kg/m$^3$ |
| Density of $CO_2$ - English | 0.0276 | tons / acf |
| TRANSPORT VOLUME | 1.16 | MMacf/yr $CO_2$ |

[e] Density of $CO_2$ taken from Carbon Capture and Sequestration Technologies Program Massachusetts Institute of Technology. Carbon Management GIS: CO2 Pipeline Transport Cost Estimation. October 2006, Updated in June 2009. (p. 4)

| kg per tons conversion | 907.185 |
|---|---|
| ft3 per m3 conversion | 35.3147 |

| Weymouth | CO2 |
|---|---|
| Turbine | 35,568 |
| | 35,568 |
| | 97 *tpd rate* |

| Summary Table: Pipeline and Class VI Well | |
|---|---|
| Pipeline Cost - NETL | $428 /ton |
| Storage Cost - NETL | $175 /ton |
| Capture Cost [1] | $107 /ton |
| | |
| TOTAL COSTS [2] | **$709** /ton |

[1] Based on the 2010 CCS Task Force Report, the cost factor for post-combustion capture of $CO_2$ 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 $CO_2$ from the turbines also includes the cost for compressing the $CO_2$ 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.

[2] All costs are presented in present value using the Producer Price Index to calculate the change in currency value.

# Diameter Estimation for $CO_2$ Transport Pipeline

**Method from "Carbon Management GIS: CO2 Pipeline Transport Cost Estimation"**
**published by the Carbon Capture and Sequestration Technologies Program,**
**Massechusetts Institute of Technology**
**October 2006, Updated June 2009**

| Input | | |
|---|---|---|
| CO2 Mass Flow Rate | 0.03 | Metric Megatons per Year |

| Lookup Table | | | |
|---|---|---|---|
| Pipeline Diameter | Maximum Mass Flow Rate[1] | Sufficient? | Sufficiently Sized Pipes |
| Inches | Metric Megatons per Year | | 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 |

[1] 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 $CO_2$ 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.**

**$CO_2$ Pipeline and Emissions Data**

| Parameter | Value | Units |
|---|---|---|
| Minimum Length of Pipeline | 180.0 | miles |
| Average Diameter of Pipeline | 4 | inches |
| $CO_2$ emissions from **Source** | 35,568 | Short tons/yr |
| $CO_2$ Capture Efficiency | 90% | |
| Captured $CO_2$ | 32,011 | Short tons/yr |

**$CO_2$ Transfer Cost Estimation [1]**

| Cost Type | Units | Cost Equation | Cost ($) |
|---|---|---|---|
| **Pipeline Costs, Present Value ($)** | | | |
| Materials | $ Diameter (inches), Length (miles) | $64,632 + $1.85 x L x (330.5 x D$^2$ + 686.7 x D + 26,960) | $11,717,900.40 |
| Labor | $ Diameter (inches), Length (miles) | $341,627 + $1.85 x L x (343.2 x D$^2$ + 2,074 x D + 170,013) | $61,547,093.60 |
| Miscellaneous | $ Diameter (inches), Length (miles) | $150,166 + $1.58 x L x (8,417 x D + 7,234) | $11,782,694.80 |
| Right of Way | $ Diameter (inches), Length (miles) | $48,037 + $1.20 x L x (577 x D +29,788) | $6,980,773.00 |
| **Related Capital Expenditures, Present Value ($)** | | | |
| $CO_2$ Surge Tank | $ | $1,150,636 | $1,150,636.00 |
| Pipeline Control System | $ | $110,632 | $110,632.00 |

| Variable Operation & Maintenance (O&M), Annual Basis ($/yr) | | | |
|---|---|---|---|
| Fixed O&M | $/mile/yr | $8,632 | $1,553,760.00 |

**Amortized Cost Calculation**

| | | |
|---|---|---|
| Equipment Life [2] | 30 | years |
| Interest rate [3] | 7% | |
| Capital Recovery Factor (CRF) [4] | 0.08 | (years)$^{-1}$ |
| Total of Pipeline Present-Value Costs (TCI) | $93,289,730 | $ (Pipeline + Other Capital) |
| Amortized Present-Value Cost (TCI *CRF) | $7,517,884 | $/yr |
| **Amortized Present-Value + O&M Cost** | **$9,071,644** | **$/yr** |
| $CO_2$ Transferred | 32,011 | Short tons/yr |
| **Annuitized control cost per ton [5]** | **283.39** | **$/ton** |
| **Producer Price Index [6]    June 2007** | **113.50** | **$** |
| **July 2015** | **171.4** | **$** |
| **Annuitized control cost per ton - 2015 Dollars [5]** | **427.96** | **$/ton** |

[1] 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.

[2] 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.

[3] Interest rate conservatively set at 7.00%, based on EPA's seven percent social interest rate from the OAQPS CCM Sixth Edition.

[4] Capital Recovery Factor = Interest Rate (%) x (1+ Interest Rate (%)) ^ Pipeline Life / ((1 + Interest Rate (%)) ^ Pipeline Life - 1)

[5] This cost estimation does not include capital and O&M costs associated with necessary compression or processing equipment pre-pipeline.

[6] 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.

# Cost Estimation for Storage of $CO_2$ - 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.**

**$CO_2$ Pipeline and Emissions Data**

| Parameter | Value | Units |
|---|---|---|
| Captured $CO_2$ | 32,011 | Short tons/yr |
| Number of Injection Wells [1] | 1 | |
| Injection Well Depth [1] | 1,236.00 | meters |

**$CO_2$ Transfer Cost Estimation [1]**

| Cost Type | Units | Cost Equation | Cost ($) |
|---|---|---|---|
| **Capital Costs** | | | |
| Site Screening and Evaluation | $ | $4,738,488 | $4,738,488.00 |
| Injection Wells | $ / well | $240,714 x e ^ ( 0.0008 x meters depth) | $647,040.90 |
| Injection Equipment | $ / well | $94,029 x (7,389 / (280 x # wells)) $^{0.5}$ | $483,031.70 |
| Liability Bond | $ | $5,000,000 | $5,000,000.00 |
| **Declining Capital Funds** | | | |
| Pore Space Acquisition | $ / ton $CO_2$ | $0.334 / ton $CO_2$ | $320,750.22 |
| **Fixed Operation & Maintenance (O&M), Annual Basis** | | | |
| Normal Daily Expenses (Fixed) | $/well/day | $11,566 | $4,221,590.00 |
| Surface Maintenance (Fixed) | $ | $23,478 x (7,389 / (280 x # wells)) $^{.5}$ | $120,607.67 |
| Subsurface Maintenance (Fixed) | $/well/ft-depth | $7.08 | $28,710.24 |

| Variable Operation & Maintenance (O&M), Annual Basis | | | |
|---|---|---|---|
| Consumables (Variable) | ($/yr) / (tons $CO_2$/day) | $2,995 | $262,665.60 |

**Amortized Cost Calculation**

| | | |
|---|---|---|
| Equipment Life [2] | 30 | years |
| Interest rate [3] | 7% | |
| Capital Recovery Factor (CRF) [4] | 0.08 | (years)$^{-1}$ |
| Total Storage Installation Cost (TCI) | $11,189,311 | $ (Installation + Fixed O&M) |
| Amortized Installation Cost (TCI *CRF) | $901,706 | $/yr |
| **Amortized Installation + O&M Cost** | **$5,535,280** | **$/yr** |
| $CO_2$ Transferred | 32,011 | Short tons/yr |
| **Annuitized control cost per ton [5]** | **173** | **$/ton** |
| **Producer Price Index [6]**     **June 2007** | **194.90** | **$** |
| **July 2015** | **196.9** | **$** |
| **Annuitized control cost per ton - 2015 Dollars [5]** | **174.69** | **$/ton** |

[1] 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.

[2] Pipeline life is assumed based on engineering judgment.

[3] Interest rate conservatively set at 7.00%, based on EPA's seven percent social interest rate from the OAQPS CCM Sixth Edition.

[4] Capital Recovery Factor = Interest Rate (%) x (1+ Interest Rate (%)) ^ Pipeline Life) / ((1 + Interest Rate (%)) ^ Pipeline Life - 1)

[5] This cost estimation does not include capital and O&M costs associated with processes upstream of storage.

[6] 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.

feet per meter conversion       3.28084

# WEYMOUTH COMPRESSOR STATION

## (NORFOLK COUNTY, MASSACHUSETTS)

## RESULTS OF ADDITIONAL 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. 3513

H&K Job No. 4818

Date of Report: January 11, 2017

Prepared for: **Algonquin Gas Transmission, LLC** ("Algonquin")
890 Winter Street, Suite 300
Waltham, MA 02451

Submitted by: Paul D. Kiteck, P.E. (primary author)
**Hoover & Keith, Inc.** (H&K)

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Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

## REPORT SUMMARY

This report includes the results of an updated acoustical analysis for the Weymouth Compressor Station (abbreviated as "Station" in this report), a grass roots natural gas compressor station associated with the Atlantic Bridge Project ("Project" or "AB Project") for Algonquin Gas Transmission, LLC ("Algonquin"). The purpose of the updated acoustical analysis is to include the estimated sound level of the Station at the Station property line and compare to applicable sound criterion. For completeness, included in the report is the previously reported Station acoustical analysis for identified NSAs and for receptors recommended by the Massachusetts Energy Facilities Siting Board ("Siting Board") along with an assessment of the noise increases for both nighttime and daytime levels at the NSAs/receptors, 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 analysis presented in this report indicates 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 analysis indicates that the Station sound contribution should also meet the MassDEP noise requirements at the Station property line, as well as the MassDEP noise guideline for pure tone noise condition. The noise generated by the Station should have minimum noise impact at the surrounding receptors/NSAs, even during nighttime Station operation. It should be noted that <u>very stringent and proven noise control measures will be employed at this Station</u> to meet the FERC level sound requirement and other Commonwealth of Massachusetts/township noise standards.

## TABLE OF CONTENTS

## 1.0    INTRODUCTION

An acoustical analysis report 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, LLC ("Algonquin"), was previously filed with the Federal Energy Regulatory Commission as part of Resource Report 9 of the AB Project Certificate Application.  In this report, Hoover & Keith Inc. (H&K) presents the results of an updated acoustical analysis for the Weymouth Compressor Station.  The purpose of the updated acoustical analysis is to include the estimated sound level contribution of the Station at the closest Station property line and compare to applicable sound criterion.  For completeness, included in the report is the previously reported Station acoustical analysis (i.e., H&K Report No. 3316[1]) for identified noise-sensitive areas (NSAs) and for receptors recommended by the Massachusetts Energy Facilities Siting Board ("Siting Board") along with an assessment of the noise increases for both nighttime and daytime levels at the NSAs/receptors, based on the lowest ambient levels.  The following summarizes the information included in the report:

- Document existing acoustic environment and identify nearby NSAs, such as residences, schools, hospitals and other receptors, around the Station including additional receptors recommended by the Siting Board.

- Estimated sound contribution of the Station at the surrounding receptors/NSAs and closest Station property line including an expanded noise analysis for receptors recommended by the Siting Board (i.e., assessment of the noise increases for both nighttime and daytime levels, based on the lowest ambient levels).

- Determine noise control measures and discuss noise mitigation practices to insure that applicable sound criteria are not exceeded due to the operation of the Station.

- 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 address noise-related comments/requests by the Siting Board regarding the Weymouth Compressor Station[2].

## 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 ½ mile of the Station, the location of the identified NSAs-receptors and reported sound measurement positions near the identified NSAs.  Figure 2 (Appendix, p. 17) show a conceptual layout of Station buildings, equipment, area of

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[1]H&K Report No. 3316, dated 10/5/15, entitled "Weymouth Compressor Station: Results of the Most Recent Ambient Sound Survey and Updated Acoustical Analysis…associated with the AB Project"

[2]Siting Board comments/requests were included in letters sent via electronic filing to 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 EA.

Hoover & Keith Inc.

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aboveground piping and Station property line.  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 Station site.  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 will be constructed of a brick façade.  The following describes the 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 compressor unit; 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 a "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 natural gas between the suction/discharge valves and compressor is vented to the atmosphere via a blowdown silencer.  During commissioning, a unit blowdown could occur 3 or 4 times/day and only during the daytime.  During normal Station operation (i.e., after commissioning), a unit blowdown event occurs infrequently (e.g., 2 to 3 times/month) and only for a short time frame (e.g., unit blowdown 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 Requirement: The Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) requires 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, **55 dBA** ($L_{dn}$) is used as a "guideline" for assessing the noise impact of temporary or intermittent noise such as construction noise or noise of a 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:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

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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 ("$L_{90}$").  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 $L_{90}$), 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.

Town of Weymouth: There is a Weymouth Regulation #17 (RE: MGL Chapter 111 Section 31 and Section 122, adopted by Board of Health), related to nuisances.  In our opinion, if the Station sound level meets the DAQC noise guideline, the noise-related condition in the Regulation will be achieved (i.e., "noise over **10 dB** over ambient background" is considered a nuisance).

**4.0    MEASUREMENT METHODOLOGY, CONDITIONS, SOUND MEASUREMENT LOCATIONS**

4.1    Measurement Methodology and Conditions

Sound surveys at the identified NSAs/receptors was performed by Garrett Porter of H&K during the daytime and nighttime of August 14, 2015 and 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 nighttime tests, there was no construction activities at the Fore River Bridge related to the current Fore River Bridge Replacement Project.  Additional sound surveys were conducted by Garrett Porter during daytime and nighttime on Sept. 8 & 9 (2016) around the Station property line, which were not performed during the August (2015) sound surveys.

At each sound measurement location, the ambient $L_d$, $L_n$ and nighttime L90 and associated unweighted octave-band (O.B.) sound pressure levels (i.e., $L_{eq}$ SPLs and L90 SPLs) were measured at 5 feet above the ground.  Periodic samples of the ambient noise level were typically

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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 that was calibrated within 1 year of the sound test date.

4.2     Description of Sound Measurement Locations and Receptors/NSAs

During the 2015 sound surveys, ambient levels were measured at the identified closest NSAs (i.e., primarily residences) within each cardinal direction of the Station along with other "receptors" 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 receptors designated by the Siting Board].  The following is a description of the identified receptors-NSAs and chosen sound measurement positions near the receptors/NSAs:

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.

Pos. 9:  "NSA #9"; Johnson School (Pearl Street, Weymouth), located approximately 4,200 feet east-southeast (ESE) of the Station site center.

For the 2016 sound surveys [around the Station property line ("PL")], sound tests were conducted at the north PL (i.e., Meas. Pos. B), West PL (i.e., Meas. Pos. C), south PL (i.e., Meas. Pos. D) and the east PL (i.e., Meas. Pos. A; closest PL to Station site center and adjacent to "King's Cove Park–Conservation Area").

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## 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 sound surveys:

- **Table 1** (**Appendix**, p. 18) summarizes the measured $L_d$, $L_n$, daytime L90 and nighttime L90 at NSA sound measurement positions along with the resulting ambient $L_{dn}$.

- **Table 2** (**Appendix**, p. 18) provides meteorological conditions during 2015 sound surveys.

- **Table 1A** (**Appendix**, p. 19) summarizes the measured $L_d$, $L_n$, measured daytime L90 and nighttime L90 at the PL sound measurement positions (2016 sound surveys).

- **Table 2A** (**Appendix**, p. 19) provides meteorological conditions during 2016 sound surveys.

- **Table 3** (**Appendix**, p. 20) 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. 21) 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. 22) includes the measured daytime $L_{90}$ and related unweighted O.B. $L_{90}$ SPLs at the NSA sound measurement positions.

- **Table 6** (**Appendix**, p. 23) 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 $L_d$, ambient $L_n$ and resulting $L_{dn}$ (i.e., calculated via the measured $L_d$ and $L_n$) at the identified receptors/NSAs.

| Meas. Position | Identified Receptors/NSAs and Description of Sound Measurement Location near the Respective NSA | Meas'd Ambient Ld (dBA) | Meas'd Ambient Ln (dBA) | Resulting Ambient Ldn (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 Ld, Measured Ambient Ln and Resulting Ambient Ldn 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-receptors and East PL of the Station (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 |
| Pos. A | East PL of Station (area of King's Cove Park/Conservation Area) | 47.8 | 49.5 | 57.8 |

**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 surveys.

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 at the Station property line, it is possible that daytime ambient levels can be higher than nighttime ambient levels due to the type of environmental noise sources that influence the measured ambient levels.

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 of 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 (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.
- 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 L90)].  A description of the acoustical analysis methodology and source of sound data are provided in the **Appendix** (pp. 30–31).  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. 24–26) 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. 27–28) 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

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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 "lowest ambient 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.

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The following **Table E** summarizes the measured "lowest ambient 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 estimated noise increase above the lowest ambient level at the 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     Sound Contribution at Closest Station Property Line and King's Cove Park/Conservation Area

**Table 16** (**Appendix**, p. 29) provides a spreadsheet calculation of the estimated A-wt. sound level and unweighted O.B. SPLs during Station operation at the closest Station property limit (i.e., east Station PL), which is adjacent to the "King's Cove Park/Conservation Area".  It is assumed that if the noise limits are achieved at the "closest Station property line", then the noise limits will be achieved at other more distant Station property limits.

The following **Table F** summarizes the estimated A-wt. sound level of the Station at the closest Station property limit, lowest ambient $L_{90}$ and the estimated Station sound level above (+) the

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lowest ambient $L_{90}$ (i.e., based on measured 2016 sound levels at Pos. A, which should be representative of ambient levels in the area of King's Cove Park/Area). The results of **Table F** are presented as a comparison of the most stringent noise limits of the MassDEP (i.e., 10 dBA above ambient limit) to the predicted Station sound level at the closest Station property line.

| Location of Closest Station Property Limit | Distance & Direction of Compressor Bldg. to the Property Line | Lowest A-Wt. Ambient L90 (dBA) | A-Wt. Sound Level of the Station (dBA) | Est'd Total A-Wt. Sound Level of Station (dBA) | Station Level above Lowest Ambient L90 (dB) |
|---|---|---|---|---|---|
| E. Property Line | Approx. 100 ft. (E) | 47.8 | 53.0 | 54.2 | +5.2 |

**Table F**: Estimated A-Wt. Sound Level of the Station at the Closest Station Property Limit (East PL), Lowest Ambient L90, Total Station Sound Level above the Lowest Measured Ambient L90.

The results provided in **Table F** indicate that the Station sound level during operation at the Station property line and in the area of Kings' Cove Park/Conservation Area (i.e., Station east PL) should be lower than the MassDEP (DAQC) noise requirement (i.e., 10 dB above the ambient limit) and should meet the MassDEP noise guideline for pure tone noise condition.

6.4     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 my 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. 24) 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 system will include a 2-stage silencer system).

6.5     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 **55 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 equal to or 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. 31).

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 17** (**Appendix**, p. 32) 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. 33).  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.

- No windows or louvers should be installed in the building walls.  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 ("1st stage horizontal silencer") and the other silencer section could be integrated into the vertical outdoor exhaust stack ("2nd 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 1st 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 gas piping, noting that most gas piping will be located above ground. The following items for the gas piping and associated 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 acoustical blanket material.

- Aboveground <u>inlet</u> pipe risers/header for the gas cooler should be covered with acoustical pipe insulation but the <u>outlet</u> pipe risers should not have to be covered with acoustical insulation. 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**), and 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 should be designed with at least one (1) in-duct silencer (e.g., min. 5-ft. length), and the silencer should be installed in the 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), and the gas cooler will need to be designed with "low-noise" fans that operate at low fan tip speeds.

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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 G** summarizes the ambient noise environment around the Station (i.e., ambient $L_{dn}$), estimated sound contribution of the Station during operation at the receptors/NSAs and "total" cumulative sound level at the NSAs (i.e., Station sound level plus the ambient sound level).  The results in **Table G** 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 G:** Noise Quality Analysis for the Weymouth Compressor Station associated with the AB Project

The acoustical analysis presented in this report indicates 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 analysis 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 analysis also shows 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.

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

# **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**
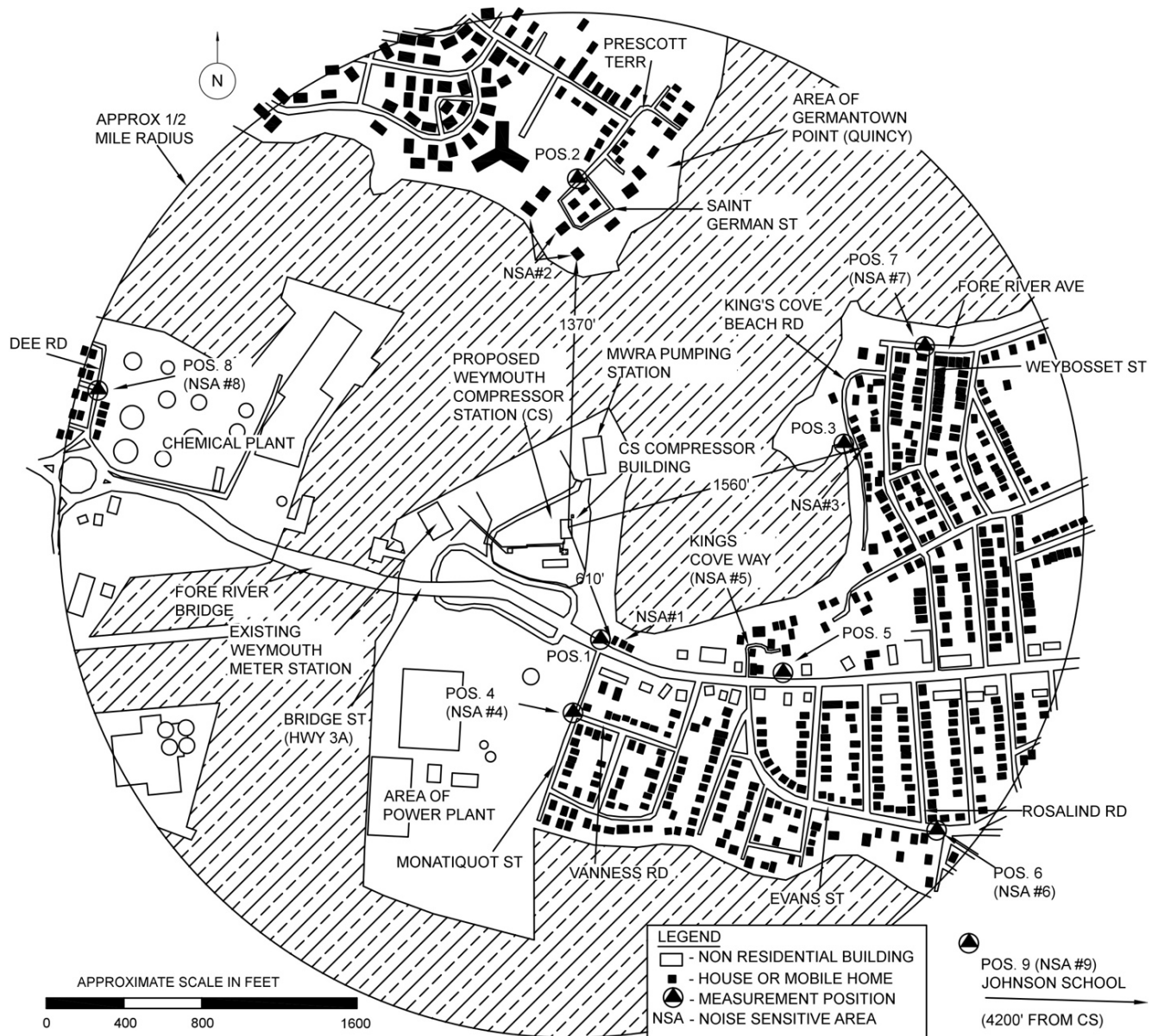
**Figure 1**:          Weymouth Compressor Station: Area Layout showing Receptors/NSAs within ½ Mile Radius, Closest Identified NSAs, Conceptual Layout of the Station and Location of the Chosen Sound Measurements Positions near the Identified Receptors/NSAs.

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

Hoover & Keith Inc.
H&K Job No. 4818
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CRITICAL ENERGY INFRASTRUCTURE INFORMATION

NOT FOR PUBLIC RELEASE

**Figure 2**:        NOT FOR PUBLIC RELEASE

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

**Hoover & Keith Inc.**
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| Measurement Set | | Meas'd/Calc'd A-Wt. Levels (dBA) | | | | | Avg. of Daytime L90 | Avg. of N-time L90 Note (2) | Notes/Observations |
| Meas. Pos. & NSA | Date of Test | Day-time Leq(Ld) | Avg'd of Ld | Night-time Leq(Ln) | Avg'd of Ln | Calc'd Ldn Note (1) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pos. 1 (NSA #1) Closest NSA (residences on N. Side of Bridge St.), 610 ft. SSE of CS Site | (8/14/15) (8/14/15) (8/14/15) | 71.9 72.8 72.4 | 72.4 | 47.2 46.6 46.3 | 46.7 | 70.4 | 66.4 | 44.8 | Primary noise during day: traffic along Bridge Street, as would be expected. 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) (8/14/15) (8/14/15) | 51.5 50.4 49.0 | 50.3 | 48.1 48.1 48.1 | 48.1 | 54.9 | 46.8 | 46.8 | Primary noise during day: insects, industrial, and at times, sound of birds. 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) (8/14/15) (8/14/15) | 50.7 50.0 49.5 | 50.1 | 46.0 46.2 48.7 | 46.9 | 54.0 | 48.4 | 44.0 | Primary noise during day: traffic along Bridge St., industrial, sound of waves. 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) (8/14/15) (8/14/15) | 51.4 50.4 51.2 | 51.0 | 50.0 49.9 49.9 | 49.9 | 56.5 | 49.3 | 48.5 | Primary noise during day: power plant & traffic on Bridge Street. 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) (8/14/15) (8/14/15) | 64.5 70.6 63.4 | 66.2 | 42.4 42.2 43.1 | 42.6 | 64.3 | 55.1 | 41.3 | Primary noise during day: traffic along Bridge Street, as would be expected. 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) (8/14/15) (8/14/15) | 47.3 44.4 43.6 | 45.1 | 44.0 43.6 44.4 | 44.0 | 50.6 | 42.6 | 41.4 | Primary noise during day: industrial, traffic along Bridge St. & insects. 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) (8/14/15) (8/14/15) | 45.2 47.9 47.6 | 46.9 | 41.1 40.5 42.2 | 41.3 | 49.1 | 44.5 | 39.3 | Primary noise during day: industrial, distant small boats & some insects. 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) (8/14/15) (8/14/15) | 49.5 48.0 47.1 | 48.2 | 45.9 45.9 45.4 | 45.7 | 52.6 | 46.1 | 44.5 | Primary noise during day: industrial, traffic along Bridge St. & some insects. 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) (8/14/15) (8/14/15) | 47.2 47.6 46.3 | 47.0 | 42.7 42.2 42.2 | 42.4 | 49.8 | 43.3 | 41.0 | Primary noise during day: distant traffic and at times, sound of wind in trees. 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):  Nightime 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.**

Hoover & Keith Inc.

Algonquin AB Project and Weymouth Compressor Station ("Station")          H&K Job No. 4818
Results of Additional Ambient Sound Data and Updated Acoustical Analysis   H&K Report No. 3513 (Date: 01/11/17)

| Measurement Set | | Meas'd/Calc'd A-Wt. Levels (dBA) | | | | | Avg. of Daytime L90 | Avg. of N-time L90 | |
|---|---|---|---|---|---|---|---|---|---|
| Meas. Pos. & NSA | Date of Test | Day-time Leq(Ld) | Avg'd of Ld | Night-time Leq(Ln) | Avg'd of Ln | Calc'd Ldn Note (1) | | Note (2) | Notes/Observations |
| Pos. D South property line of the CS Site | (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) | 52.8 52.5 55.2 | 53.5 | 50.5 48.8 49.3 | 49.5 | 56.8 | 50.6 | 46.9 | Primary noise during day: construction, traffic, insects. Primary noise during night: refinery, traffic, insects |
| Pos. A East property line of the CS Site | (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) | 49.4 48.7 51.7 | 50.0 | 51.1 50.7 53.3 | 51.7 | 57.9 | 47.8 | 49.5 | Primary noise during day: refinery, construction, traffic, insects. Primary noise during night: refinery, traffic, insects |
| Pos. C West property line of the CS Site | (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) | 57.1 57.1 56.6 | 56.9 | 51.7 51.0 52.3 | 51.7 | 59.4 | 54.9 | 50.2 | Primary noise during day: refinery, construction, traffic, insects. Primary noise during night: refinery, traffic, insects |
| Pos. B North property line of the CS Site | (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) (9/8/16 & 9/9/16) | 51.9 52.0 51.4 | 51.8 | 52.4 54.1 54.9 | 53.8 | 60.0 | 50.5 | 51.7 | Primary noise during day: refinery, sewage plant, construction, traffic, insects. Primary noise during night: refinery, sewage plant, traffic, insects |

**Table 1A:**   **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 CS Site Property Line, as Measured on Sept. 8 & 9, 2016 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): Nightime L90 levels were measured between 12:00 AM & 3:00 AM and represents lowest ambient A-wt. sound levels

| Measurement Set | | Temp. | R.H. | Wind | Wind | Peak | |
|---|---|---|---|---|---|---|---|
| Meas. Positions/Period | Time Frame/Date of Tests | (°F) | (%) | Direction | Speed | Wind | Sky Conditions |
| Pos. A, B, C & D (Daytime) | 12:00 PM to 2:00 PM (9/8/16) | 72 | 90 | From the east | 1-4 mph | 5 mph | Cloudy |
| Pos. A, B, C & D (N-time) | 12:00 AM to 2:00 AM (9/9/16) | 65-70 | 85 | From the north | 1-3 mph | 5 mph | Cloudy |

**Table 2A:**   **Site of Weymouth Compressor Station: Summary of the Meteorological Conditions during Sound Tests on Sept. 8 & 9, 2016 at CS Site Property Line.**

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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) | 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 |
| Closest NSA (residences | 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 |
| on N. Side of Bridge St.), | 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 |
| 610 ft. SSE of CS Site | 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) | 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 |
| Residences in area | 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 |
| of Germantown Point, | 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 |
| 1,370 ft. north of CS Site | 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) | 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 |
| Residences along | 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 |
| Kings Cove Beach Rd., | 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 |
| 1,560 ft. east of CS Site | 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) | 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 |
| Residences at Vanness | 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 |
| Road & Monatiquot St., | 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 |
| 900 ft. south of CS Site | 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) | 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 |
| Residences along | 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 |
| Kings Cove Way, | 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 |
| 1,030 ft. SE of CS Site | 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) | 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 |
| Residences at Evans | 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 |
| Street & Rosalind Road, | 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 |
| 2,300 ft. SE of CS Site | 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) | 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 |
| Residences at Fore River | 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 |
| Ave. & Weybosset St., | 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 |
| 1,970 ft. ENE of CS Site | 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) | 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 |
| Residences along | 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 |
| Dee Road, 2,400 ft. | 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 |
| west of CS Site | 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) | 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 |
| Johnson School, | 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 |
| approx. 4,200 ft. ESE | 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 |
| of the CS Site | 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 Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

**Hoover & Keith Inc.**
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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) | 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 |
| Closest NSA (residences | 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 |
| on N. Side of Bridge St.), | 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 |
| 610 ft. SSE of CS Site | Avg. A-Wt. & SPL | 60.8 | 58.7 | 52.9 | 44.9 | 41.2 | 38.7 | 41.9 | 31.8 | 21.5 | 46.7 |
| Pos. 2 (NSA #2) | 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 |
| Residences in area | 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 |
| of Germantown Point, | 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 |
| 1,370 ft. north of CS Site | Avg. A-Wt. & SPL | 63.1 | 59.1 | 55.9 | 49.3 | 43.1 | 41.8 | 40.3 | 33.1 | 25.3 | 48.1 |
| Pos. 3 (NSA #3) | 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 |
| Residences along | 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 |
| Kings Cove Beach Rd., | 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 |
| 1,560 ft. east of CS Site | Avg. A-Wt. & SPL | 58.1 | 57.2 | 53.5 | 43.5 | 39.9 | 41.6 | 41.1 | 33.1 | 21.2 | 46.9 |
| Pos. 4 (NSA #4) | 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 |
| Residences at Vanness | 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 |
| Road & Monatiquot St., | 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 |
| 900 ft. south of CS Site | Avg. A-Wt. & SPL | 63.4 | 60.9 | 54.7 | 48.1 | 44.7 | 43.8 | 44.2 | 37.5 | 28.5 | 49.9 |
| Pos. 5 (NSA #5) | 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 |
| Residences along | 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 |
| Kings Cove Way, | 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 |
| 1,030 ft. SE of CS Site | Avg. A-Wt. & SPL | 52.4 | 53.5 | 50.0 | 44.5 | 37.9 | 36.5 | 33.5 | 27.6 | 24.1 | 42.6 |
| Pos. 6 (NSA #6) | 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 |
| Residences at Evans | 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 |
| Street & Rosalind Road, | 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 |
| 2,300 ft. SE of CS Site | Avg. A-Wt. & SPL | 51.9 | 53.2 | 48.5 | 42.7 | 37.6 | 38.1 | 32.1 | 38.4 | 25.7 | 44.0 |
| Pos. 7 (NSA #7) | 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 |
| Residences at Fore River | 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 |
| Ave. & Weybosset St., | 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 |
| 1,970 ft. ENE of CS Site | Avg. A-Wt. & SPL | 56.3 | 52.9 | 47.2 | 41.5 | 37.5 | 36.8 | 30.9 | 24.9 | 18.8 | 41.3 |
| Pos. 8 (NSA #8) | 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 |
| Residences along | 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 |
| Dee Road, 2,400 ft. | 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 |
| west of CS Site | Avg. A-Wt. & SPL | 57.0 | 53.6 | 48.0 | 41.3 | 37.0 | 37.4 | 36.0 | 41.6 | 33.8 | 45.7 |
| Pos. 9 (NSA #9) | 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 |
| Johnson School, | 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 |
| approx. 4,200 ft. ESE | 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 |
| of the CS Site | Avg. A-Wt. & SPL | 50.9 | 54.8 | 49.4 | 41.4 | 37.0 | 35.9 | 34.6 | 32.7 | 24.3 | 42.4 |

**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.

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

# Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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) | 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 |
| Closest NSA (residences | 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 |
| on N. Side of Bridge St.), | 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 |
| 610 ft. SSE of CS Site | Avg. A-Wt. & SPL | 66.9 | 66.0 | 61.6 | 59.5 | 59.1 | 64.4 | 58.7 | 48.7 | 38.1 | 66.4 |
| Pos. 2 (NSA #2) | 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 |
| Residences in area | 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 |
| of Germantown Point, | 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 |
| 1,370 ft. north of CS Site | Avg. A-Wt. & SPL | 69.0 | 59.3 | 54.6 | 47.4 | 42.1 | 40.4 | 36.3 | 36.0 | 31.5 | 46.8 |
| Pos. 3 (NSA #3) | 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 |
| Residences along | 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 |
| Kings Cove Beach Rd., | 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 |
| 1,560 ft. east of CS Site | Avg. A-Wt. & SPL | 59.5 | 61.2 | 57.9 | 47.8 | 43.0 | 43.3 | 37.7 | 32.2 | 25.5 | 48.4 |
| Pos. 4 (NSA #4) | 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 |
| Residences at Vanness | 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 |
| Road & Monatiquot St., | 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 |
| 900 ft. south of CS Site | Avg. A-Wt. & SPL | 62.0 | 62.0 | 56.7 | 49.1 | 44.1 | 44.9 | 40.2 | 31.7 | 24.6 | 49.3 |
| Pos. 5 (NSA #5) | 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 |
| Residences along | 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 |
| Kings Cove Way, | 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 |
| 1,030 ft. SE of CS Site | Avg. A-Wt. & SPL | 60.0 | 58.1 | 55.0 | 52.4 | 49.8 | 52.5 | 46.2 | 38.3 | 30.3 | 55.1 |
| Pos. 6 (NSA #6) | 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 |
| Residences at Evans | 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 |
| Street & Rosalind Road, | 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 |
| 2,300 ft. SE of CS Site | Avg. A-Wt. & SPL | 50.4 | 53.2 | 50.0 | 42.6 | 38.0 | 37.5 | 32.7 | 29.1 | 23.8 | 42.6 |
| Pos. 7 (NSA #7) | 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 |
| Residences at Fore River | 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 |
| Ave. & Weybosset St., | 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 |
| 1,970 ft. ENE of CS Site | Avg. A-Wt. & SPL | 55.4 | 57.5 | 56.1 | 46.7 | 38.9 | 36.3 | 30.8 | 25.2 | 17.9 | 44.5 |
| Pos. 8 (NSA #8) | 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 |
| Residences along | 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 |
| Dee Road, 2,400 ft. | 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 |
| west of CS Site | Avg. A-Wt. & SPL | 57.0 | 56.9 | 51.4 | 43.9 | 40.4 | 40.1 | 37.0 | 38.8 | 31.6 | 46.1 |
| Pos. 9 (NSA #9) | 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 |
| Johnson School, | 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 |
| approx. 4,200 ft. ESE | 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 |
| of the CS Site | Avg. A-Wt. & SPL | 49.3 | 50.5 | 49.5 | 42.5 | 38.2 | 38.5 | 35.4 | 30.4 | 23.3 | 43.3 |

**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 Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

**Hoover & Keith Inc.**
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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) | 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 |
| Closest NSA (residences | 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 |
| on N. Side of Bridge St.), | 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 |
| 610 ft. SSE of CS Site | Avg. A-Wt. & SPL | **57.6** | **56.4** | **51.0** | **43.1** | **39.7** | **36.9** | **40.0** | **30.1** | **19.5** | **44.8** |
| Pos. 2 (NSA #2) | 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 |
| Residences in area | 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 |
| of Germantown Point, | 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 |
| 1,370 ft. north of CS Site | Avg. A-Wt. & SPL | **59.5** | **57.0** | **54.4** | **48.1** | **41.9** | **40.6** | **39.0** | **32.3** | **24.3** | **46.8** |
| Pos. 3 (NSA #3) | 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 |
| Residences along | 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 |
| Kings Cove Beach Rd., | 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 |
| 1,560 ft. east of CS Site | Avg. A-Wt. & SPL | **54.9** | **55.2** | **51.7** | **41.9** | **38.8** | **36.5** | **38.4** | **30.5** | **19.7** | **44.0** |
| Pos. 4 (NSA #4) | 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 |
| Residences at Vanness | 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 |
| Road & Monatiquot St., | 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 |
| 900 ft. south of CS Site | Avg. A-Wt. & SPL | **60.4** | **58.8** | **53.2** | **46.6** | **43.2** | **42.5** | **42.8** | **35.6** | **26.9** | **48.5** |
| Pos. 5 (NSA #5) | 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 |
| Residences along | 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 |
| Kings Cove Way, | 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 |
| 1,030 ft. SE of CS Site | Avg. A-Wt. & SPL | **49.6** | **51.5** | **48.6** | **43.2** | **36.9** | **35.0** | **32.6** | **26.8** | **21.7** | **41.3** |
| Pos. 6 (NSA #6) | 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 |
| Residences at Evans | 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 |
| Street & Rosalind Road, | 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 |
| 2,300 ft. SE of CS Site | Avg. A-Wt. & SPL | **49.3** | **51.3** | **46.8** | **40.8** | **36.1** | **36.4** | **30.5** | **33.5** | **21.5** | **41.4** |
| Pos. 7 (NSA #7) | 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 |
| Residences at Fore River | 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 |
| Ave. & Weybosset St., | 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 |
| 1,970 ft. ENE of CS Site | Avg. A-Wt. & SPL | **53.4** | **50.9** | **45.4** | **39.9** | **35.6** | **34.5** | **29.0** | **22.9** | **16.5** | **39.3** |
| Pos. 8 (NSA #8) | 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 |
| Residences along | 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 |
| Dee Road, 2,400 ft. | 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 |
| west of CS Site | Avg. A-Wt. & SPL | **54.6** | **51.6** | **46.3** | **39.4** | **35.8** | **36.5** | **35.0** | **40.4** | **32.7** | **44.5** |
| Pos. 9 (NSA #9) | 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 |
| Johnson School, | 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 |
| approx. 4,200 ft. ESE | 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 |
| of the CS Site | Avg. A-Wt. & SPL | **47.8** | **53.1** | **48.1** | **40.2** | **35.8** | **34.2** | **33.4** | **31.5** | **22.7** | **41.0** |

**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.**

Hoover & Keith Inc.

Algonquin AB Project and Weymouth Compressor Station ("Station")  H&K Job No. 4818
Results of Additional Ambient Sound Data and Updated Acoustical Analysis  H&K Report No. 3513 (Date: 01/11/17)

| Source No. & Dist. (Ft.) | Noise Sources and Other Conditions/Factors associated with Acoustical Analysis | \multicolumn{9}{}{Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)} | A-Wt. Level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| 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 | Calc'd |
| 560 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | -1 | -2 | -4 | -8 | Ldn |
| 560 | Source Sound Level Contribution | 59 | 53 | 40 | 37 | 32 | 28 | 20 | 13 | 8 | 35 | (dBA) |
| Est'd Total Sound Contribution of the Station at NSA #1 | 63 | 57 | 51 | 43 | 37 | 37 | 34 | 27 | 17 | 42.6 | 49.0 |

| | L90 | Ldn |
|---|---|---|
| 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 <u>not</u> 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.**

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

**Hoover & Keith Inc.**
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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.**

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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. Level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| 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 | Calc'd Ldn |
| 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 <u>not</u> be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.**

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

# Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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.**

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

**Hoover & Keith Inc.**
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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. Level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | |
| 1) | PWL of Turbine/Compressor inside Building | 110 | 110 | 112 | 112 | 110 | 110 | 112 | 118 | 112 | 121 |
| | Attenuation of the Building | -8 | -12 | -18 | -28 | -35 | -38 | -40 | -45 | -45 | |
| | Misc. Atten. (Shielding or Effect of Courtyard Wall) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 100 | Hemispherical Radiation | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | |
| 100 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | |
| 100 | Source Sound Level Contribution | 64 | 60 | 56 | 46 | 37 | 34 | 34 | 35 | 28 | 45 |
| 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. (Stack Directivity) | -1 | -2 | -2 | -3 | -5 | -8 | -9 | -10 | -10 | |
| 150 | Hemispherical Radiation | -41 | -41 | -41 | -41 | -41 | -41 | -41 | -41 | -41 | |
| 150 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -2 | |
| 150 | Source Sound Level Contribution | 71 | 62 | 49 | 44 | 36 | 25 | 16 | 17 | 18 | 41 |
| 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 | -2 | -8 | -12 | -16 | -18 | -18 | |
| | Misc. Atten. (Shielding or Effect of Courtyard Wall) | -2 | -4 | -6 | -8 | -12 | -14 | -16 | -18 | -18 | |
| 130 | Hemispherical Radiation | -40 | -40 | -40 | -40 | -40 | -40 | -40 | -40 | -40 | |
| 130 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -2 | |
| 130 | Source Sound Level Contribution | 60 | 58 | 56 | 45 | 36 | 39 | 38 | 31 | 22 | 45 |
| 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 or Effect of Courtyard Wall) | 0 | 0 | 0 | 0 | -1 | -1 | -2 | -3 | -3 | |
| 120 | Hemispherical Radiation | -39 | -39 | -39 | -39 | -39 | -39 | -39 | -39 | -39 | |
| 120 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | -2 | 0 | 0 | 0 | -1 | -2 | |
| 120 | Source Sound Level Contribution | 66 | 61 | 55 | 49 | 48 | 44 | 38 | 35 | 31 | 49 |
| 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 or Effect of Courtyard Wall) | 0 | 0 | 0 | 0 | -1 | -2 | -4 | -5 | -5 | |
| 140 | Hemispherical Radiation | -41 | -41 | -41 | -41 | -41 | -41 | -41 | -41 | -41 | |
| 140 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -2 | |
| 140 | Source Sound Level Contribution | 64 | 62 | 55 | 47 | 28 | 11 | 9 | 20 | 16 | 43 |
| 6) | PWL of the Gas Aftercooler | 112 | 108 | 96 | 94 | 92 | 90 | 85 | 82 | 80 | 95 |
| | NR of Noise Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | Misc. Atten. (Shielding or Effect of Courtyard Wall) | -2 | -4 | -6 | -8 | -12 | -14 | -16 | -18 | -18 | |
| 160 | Hemispherical Radiation | -42 | -42 | -42 | -42 | -42 | -42 | -42 | -42 | -42 | |
| 160 | Atm. Absorption (70% R.H., 60 deg F) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -2 | |
| 160 | Source Sound Level Contribution | 68 | 62 | 48 | 44 | 38 | 34 | 27 | 21 | 18 | 42 |
| Total Sound Contribution of Station at Closest Property Line | | 75 | 69 | 62 | 54 | 49 | 46 | 42 | 39 | 33 | 53.0 |

| | |
|---|---|
| Meas'd Lowest Ambient L90 at Property Line: Note (1) | 47.8 |
| Est'd Sound Level of Station plus Lowest Ambient Level | **54.2** |
| Est'd Station Sound Level above the Lowest Ambient L90 | **5.2** |

**Table 16:  Algonquin Weymouth Station: Est'd Sound Contribution of the Station (i.e., Solar Taurus 60 Turbine-Driven Compressor Unit #1 & Gas Aftercooler) at Closest Station Property Line (i.e., East Property Limit 100 Ft. East of 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 2016 sound survey by H&K around property line of Station.

**DESCRIPTION OF ACOUSTICAL ANALYSIS METHODOLOGY AND 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 that 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 = **$20*\log(r) – 2.3$ 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[3]).  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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[3]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:

SPL (receptor) = (Blowdown SPL at R1) – 20*log(R2/R1) – Atm. Atten. = **55 dBA** – 20*log (700/300) – 2 dB = **46 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.

Algonquin AB Project and Weymouth Compressor Station ("Station")
Results of Additional Ambient Sound Data and Updated Acoustical Analysis

## Hoover & Keith Inc.
H&K Job No. 4818
H&K Report No. 3513 (Date: 01/11/17)

| 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) |
| **Est'd A-Wt. Sound Level (dBA) at the Closest NSA Considering a Maximum Number of Equipment Operating at One Time** | | | | | | 56 dBA | 54 dBA |

**Table 17:** **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 = $20*\log(r) - 2.3$ 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" = **$20*\log(650) - 2.3$ dB = 54 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 an 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.

**Hoover & Keith Inc.**

Algonquin AB Project and Weymouth Compressor Station ("Station")          H&K Job No. 4818
Results of Additional Ambient Sound Data and Updated Acoustical Analysis     H&K Report No. 3513 (Date: 01/11/17)

## 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

File: Duke\Algonquin\Atlantic Bridge Project\Compressor Stations\Weymouth CS\H&K Report for Weymouth CS – 2016 Updated Analysis including Additional PL Ambient Data (Jan 2017 Report).com

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# ATTACHMENT G: DETAILED EMISSIONS CALCULATIONS AND MANUFACTURER SPECIFICATIONS

| | | 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 | $lb_{H2O}/lb_{Dry\ Air}$ | 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% |
| | $O_2$ 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 |
| $NO_X$ 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% $O_2$ | 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% $O_2$ | 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% $O_2$ | 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**

1. 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: $6.15E\text{-}04e^{3.75E\text{-}02T}$

   All other parameter values estimated using cubic spline.

2. Pollutant concentrations (ppmvd at 15% O2) for 0°F and -20°F based on information provided in a document published by the manufacturer.

3. Ambient pressure and humidity will vary. However, it is believed that any variation would not affect compliance with the proposed emission representations.

4. 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.

| Vendor Data | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Make:** | Solar | | | | | | | | | | |
| **Model:** | 060-07802S4 | | | | | | | | | | |
| Rate Capacity: | 7,700 hp (ISO) 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$_{H2O}$/lb$_{Dry Air}$ | | | | 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$_2$ 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 Emissions | NO$_X$ | ppmvd, 15% O$_2$ | 120 | 42 | | 42 | 9 | 9 | 9 | 9 | 9 | 9 |
| | CO | ppmvd, 15% O$_2$ | 150 | 100 | | 100 | 25 | 25 | 25 | 25 | 25 | 25 |
| | UHC | ppmvd, 15% O$_2$ | 75 | 50 | | 50 | 25 | 25 | 25 | 25 | 25 | 25 |

**TABLE B-1Ac**
**Gas-Fired Turbines**
**Emission Estimates**
**Normal Operations**
*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 | 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 |
| $NO_X$ | 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 |
| $SO_2$ | 14.29 lb/MMscf | 0.9658 lb/hr | 4.2302 tpy | 14.29 lb/MMscf | 1.0266 lb/hr |
| $PM_{10/2.5}$ | 6.73 lb/MMscf | 0.4551 lb/hr | 1.9934 tpy | 6.73 lb/MMscf | 0.4838 lb/hr |
| $CO_{2-e}$ | 120,800 lb/MMscf | 8,167 lb/hr | 35,771 tpy | 120,803 lb/MMscf | 8,681 lb/hr |
| $CO_2$ | 120,017 lb/MMscf | 8,114 lb/hr | 35,539 tpy | 120,017 lb/MMscf | 8,625 lb/hr |
| $N_2O$ | 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 |

**NOTES**

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. NOX, CO, and TOC (Total) emission factor based on Vendor Guarantee.
5. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
6. SO2 emission factor based on AP-42, Section 3.1 (Revised 4/00), Table 3.1-2a using Tariff (5 gr/100 scf).
7. PM10/2.5 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.
   $EF_{Scaled} = (EF_{AP42})(EF_{TOC}/EF_{TOC-AP42})$

| Parameters | | | Interpolated | Vendor Data | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **TABLE B-1Ad** _Manufacturer's Operating and Emissions Data_ _Startup/Shutdown Step 2: Ignition-Idle_ _PTE - 100% Fuel Utilization at 100% Power Output_ | | | | | | | | | |
| 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 | $lb_{H2O}/lb_{Dry Air}$ | 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% |
| | $O_2$ 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 |
| $NO_X$ Emissions | | lb/lb-mol | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 |
| | | ppmvd, 15% $O_2$ | 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% $O_2$ | 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% $O_2$ | 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>
<tr><td colspan="10" align="center">**TABLE B-1Ad**<br>**Manufacturer's Operating and Emissions Data**<br>**Startup/Shutdown Step 2: Ignition-Idle**<br>*PTE - 100% Fuel Utilization at 100% Power Output*</td></tr>
<tr><td colspan="10" align="center">**Vendor Data**</td></tr>
<tr><td>**Make:**</td><td colspan="2" align="center">Solar</td><td colspan="7"></td></tr>
<tr><td>**Model:**</td><td colspan="2" align="center">060-07802S4</td><td colspan="7"></td></tr>
<tr><td>Rate</td><td colspan="2" align="center">7,700 hp (ISO)</td><td colspan="7"></td></tr>
<tr><td>Capacity:</td><td colspan="2" align="center">6,800 hp (NEMA)</td><td colspan="7"></td></tr>
<tr><td>**Load:**</td><td colspan="2" align="center">10%</td><td colspan="7"></td></tr>
<tr><td>Ambient</td><td>Temperature</td><td>°F</td><td></td><td>0.01</td><td>20.00</td><td>40.00</td><td>60.00</td><td>80.00</td><td>100.00</td></tr>
<tr><td></td><td>Specific Humidity</td><td>$lb_{H2O}/lb_{Dry\,Air}$</td><td></td><td>0.0006</td><td>0.0014</td><td>0.0031</td><td>0.0066</td><td>0.0133</td><td>0.0253</td></tr>
<tr><td>Fuel</td><td>Lower Heating Value (LHV)</td><td>BTU/scf</td><td></td><td>939.2</td><td>939.2</td><td>939.2</td><td>939.2</td><td>939.2</td><td>939.2</td></tr>
<tr><td>Turbine</td><td>Net Output Power</td><td>hp</td><td></td><td>841</td><td>816</td><td>788</td><td>747</td><td>688</td><td>624</td></tr>
<tr><td></td><td>Heat Input at LHV</td><td>MMBTU/hr</td><td></td><td>14.59</td><td>14.59</td><td>14.63</td><td>14.45</td><td>14.09</td><td>13.68</td></tr>
<tr><td>Exhaust</td><td>Temperature</td><td>°F</td><td></td><td>503</td><td>543</td><td>584</td><td>626</td><td>670</td><td>715</td></tr>
<tr><td></td><td>Water Fraction</td><td>%</td><td></td><td>2.56%</td><td>2.78%</td><td>3.15%</td><td>3.79%</td><td>4.89%</td><td>6.76%</td></tr>
<tr><td></td><td>$O_2$ Content</td><td>% (dry)</td><td></td><td>18.63%</td><td>18.54%</td><td>18.44%</td><td>18.33%</td><td>18.23%</td><td>18.10%</td></tr>
<tr><td></td><td>Molecular Weight</td><td>lb/lb-mol</td><td></td><td>28.80</td><td>28.78</td><td>28.74</td><td>28.68</td><td>28.56</td><td>28.36</td></tr>
<tr><td></td><td>Flow Rate</td><td>lb/hr</td><td></td><td>96,424</td><td>92,838</td><td>83,262</td><td>78,987</td><td>74,120</td><td>68,816</td></tr>
<tr><td></td><td></td><td>acfm</td><td></td><td>39,250</td><td>39,391</td><td>36,819</td><td>36,439</td><td>35,690</td><td>34,709</td></tr>
<tr><td>Estimated</td><td>$NO_X$</td><td>ppmvd, 15% $O_2$</td><td></td><td>50</td><td>50</td><td>50</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td>Emissions</td><td>CO</td><td>ppmvd, 15% $O_2$</td><td></td><td>10,000</td><td>10,000</td><td>10,000</td><td>10,000</td><td>10,000</td><td>10,000</td></tr>
<tr><td></td><td>UHC</td><td>ppmvd, 15% $O_2$</td><td></td><td>1,000</td><td>1,000</td><td>1,000</td><td>1,000</td><td>1,000</td><td>1,000</td></tr>
</table>

| | TABLE B-1Ae<br>Manufacturer's Operating and Emissions Data<br>Startup/Shutdown Step 3: Loading/Thermal Stabilization<br>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 | $lb_{H2O}/lb_{Dry\ Air}$ | 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% |
| | $O_2$ 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 |
| | | acfm | 60,139 | 59,982 | 60,194 | 60,237 | 59,630 | 58,463 | 57,218 |
| $NO_X$ Emissions | | lb/lb-mol | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 | 46.01 |
| | | ppmvd, 15% $O_2$ | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| | | ppmvw | 32.91 | 30.73 | 31.73 | 32.68 | 33.25 | 33.46 | 33.40 |
| | | lb/hr | 6.43 | 6.53 | 6.51 | 6.47 | 6.31 | 6.05 | 5.76 |
| CO Emissions | | lb/lb-mol | 28.01 | 28.01 | 28.01 | 28.01 | 28.01 | 28.01 | 28.01 |
| | | ppmvd, 15% $O_2$ | 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 |
| | | lb/hr | 586.91 | 596.62 | 594.54 | 590.64 | 576.22 | 552.86 | 526.12 |
| UHC Emissions | | lb/lb-mol | 18.37 | 18.37 | 18.37 | 18.37 | 18.37 | 18.37 | 18.37 |
| | | ppmvd, 15% $O_2$ | 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 | $lb_{H2O}/lb_{Dry\ Air}$ | | | 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% |
| | $O_2$ 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 | $NO_X$ | ppmvd, 15% $O_2$ | | | 60 | 60 | 60 | 60 | 60 | 60 |
| | CO | ppmvd, 15% $O_2$ | | | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 |
| | UHC | ppmvd, 15% $O_2$ | | | 900 | 900 | 900 | 900 | 900 | 900 |

**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 |
| $NO_X$ | 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 |
| $SO_2$ | 0.0521 lbs/event | 0.1042 lb/hr | 0.0108 tpy | 0.0527 lbs/event | 0.1055 lb/hr |
| $PM_{10/2.5}$ | 0.0245 lbs/event | 0.0491 lb/hr | 0.0051 tpy | 0.0249 lbs/event | 0.0497 lb/hr |
| $CO_{2-e}$ | 534 lbs/event | 1,068 lb/hr | 111 tpy | 542 lbs/event | 1,085 lb/hr |
| $CO_2$ | 438 lbs/event | 875 lb/hr | 91 tpy | 443 lbs/event | 886 lb/hr |
| $N_2O$ | 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 NOx, 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 |
| $NO_X$ | 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 |
| $NO_X$ | 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 |
| $SO_2$ | 0.0239 lbs/event | 0.0478 lb/hr | 0.0050 tpy | 0.0243 lbs/event | 0.0486 lb/hr |
| $PM_{10/2.5}$ | 0.0113 lbs/event | 0.0225 lb/hr | 0.0023 tpy | 0.0114 lbs/event | 0.0229 lb/hr |
| $CO_{2-e}$ | 245 lbs/event | 490 lb/hr | 51 tpy | 249 lbs/event | 498 lb/hr |
| $CO_2$ | 201 lbs/event | 402 lb/hr | 42 tpy | 204 lbs/event | 408 lb/hr |
| $N_2O$ | 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 NOx, 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 |
| $NO_X$ | 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 | $0°F \geq T > -20°F$ | | 74.91 MMBTU/hr | $T \leq -20°F$ | |
| | 899 MMBTU/yr | Hourly | Annual | 0 MMBTU/yr | Hourly | Annual |
| $NO_X$ | 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 |
| $SO_2$ | 14.29 lb/MMscf | 1.0492 lb/hr | 0.0063 tpy | 14.29 lb/MMscf | 1.0492 lb/hr | 0.0000 tpy |
| $PM_{10/2.5}$ | 6.73 lb/MMscf | 0.4944 lb/hr | 0.0030 tpy | 6.73 lb/MMscf | 0.4944 lb/hr | 0.0000 tpy |
| $CO_{2-e}$ | 121,522 lb/MMscf | 8,925 lb/hr | 54 tpy | 122,241 lb/MMscf | 8,978 lb/hr | 0 tpy |
| $CO_2$ | 120,017 lb/MMscf | 8,815 lb/hr | 53 tpy | 120,017 lb/MMscf | 8,815 lb/hr | 0 tpy |
| $N_2O$ | 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 NOx, CO, and UHC (or TOC) emissions.
4. Footnotes 4 thru 8 of TABLE B-1Ac.

Algonquin Gas Transmission, LLC                                    PTE Estimates: Atlantic Bridge Project
Weymouth Compressor Station                                        Revised: August 2016

**TABLE B-1Ai**
**Gas-Fired Turbines**
**Maximum Emission Estimates**
**Normal Operations, Startup, Shutdown, and Low Temperature Operations**
*PTE - 100% Fuel Utilization at 100% Power Output*

| 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 | | |
| | Hourly | | Maximum | Hourly | | Maximum | Hourly | | Maximum | Hourly | | Maximum Annual | Hourly | | Maximum | Hourly | | Maximum |
| Pollutant | Average | Maximum | Annual | Average | Maximum | Annual | Average | Maximum | Annual | Average | Maximum | | Average | Maximum | Annual | Average | Maximum | Annual |
| NOx | 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 |
| SO2 | 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 |
| PM10/2.5 | 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 |
| CO2-e | 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 |
| CO2 | 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 |
| N2O | 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**

1. See TABLE B-1Ac, TABLE B-1Af, TABLE B-1Ag, and TABLE B-1Ah.

2. If $E(t)_{normal} > E(t)_{transient}$, then $E(8,760 \text{ hrs/yr})_{all} = E(8,760 \text{ hrs/yr})_{normal}$

   Otherwise, $E(8,760 \text{ hrs/yr})_{all} = E(8,760 \text{ hrs/yr})_{normal} - E(t)_{normal} + E(t)_{transient}$.

   where t = the duration of transient operation.

**TABLE B-1Aj**
**Gas-Fired Turbines**
**Maximum Emission Estimates**
**Normal Operations, Startup, Shutdown, and Low Temperature Operations**
*PTE - 100% Fuel Utilization at 100% Power Output*

| 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$_X$ | | 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$_2$ | | 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 | 0.1042 lb/hr | 1.0492 lb/hr | 0.0063 tpy | 0.9659 lb/hr | 1.0492 lb/hr | 4.2307 tpy |
| PM$_{10/2.5}$ | | 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$_{2-e}$ | | 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$_2$ | | 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$_2$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**

1. See TABLE B-1Ai.
2. It's assumed that oxidation catalyst will be ineffective during startup events.
3. $CO2 = CO2_{uncontrolled} + CE_{CO\text{-}control\ efficiency} * CO_{uncontrolled} * (MW_{CO2}/MW_{CO}) = CO2_{uncontrolled} + CE_{CO\text{-}control\ efficiency} * CO_{uncontrolled} * (44.0095/28.0101)$.

| Type | 4slb | | | | |
|---|---|---|---|---|---|
| Service | Emergency | | | | |
| JJJJ Relevant Date | Manufactured: On or After 01/01/2009 | | | | |
| ZZZZ 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 | Uncontrolled | | 4.63 MMBTU/hr | Uncontrolled |
| | 1,388 MMBTU/yr | | | | |
| Pollutant | Control Efficiency | Uncontrolled | Average Hourly | Maximum Annual | Uncontrolled | Maximum Hourly |
| $NO_X$ | | 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 |
| $SO_2$ | | 14.29 lb/MMscf | 0.0648 lb/hr | 0.0097 tpy | 14.29 lb/MMscf | 0.0648 lb/hr |
| $PM_{10/2.5}$ | | 10.19 lb/MMscf | 0.0462 lb/hr | 0.0069 tpy | 10.19 lb/MMscf | 0.0462 lb/hr |
| $CO_{2-e}$ | | 152,049 lb/MMscf | 690 lb/hr | 103 tpy | 152,049 lb/MMscf | 690 lb/hr |
| $CO_2$ | | 120,017 lb/MMscf | 545 lb/hr | 82 tpy | 120,017 lb/MMscf | 545 lb/hr |
| $N_2O$ | | 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**

1. Fuel higher heating value selected to correspond to AP-42 emissions factors.
2. Maximum hourly emissions based on 100% of rated capacity.
3. Vendor provided data on power output and heat rate.
4. SO2 emission factor based on AP-42, Section 3.2 (Revised 7/00), Table 3.2-1 using Tariff (5 gr/100 scf).
5. PM10/2.5 emission factor based on AP-42, Section 3.2 (Revised 7/00), Table 3.2-2.
6. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
7. NOX, CO, and Formaldehyde emission factors based on Vendor Data.
8. TOC (Total) and TOC specie emissions are estimated based on scaling of AP-42 using vendor Formaldehyde data.
   Emission factors based on: $EF_i = [EF_{Formaldehyde}/EF_{Formaldehyde-AP42}] (EF_{i-AP42})$

| 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 |
|---|---|---|---|---|---|---|
| $NO_X$ | | 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 |
| $SO_2$ | | 14.29 lb/MMscf | 0.1334 lb/hr | 0.5842 tpy | 14.29 lb/MMscf | 0.1401 lb/hr |
| $PM_{10/2.5}$ | | 7.60 lb/MMscf | 0.0710 lb/hr | 0.3108 tpy | 7.60 lb/MMscf | 0.0745 lb/hr |
| $CO_{2-e}$ | | 120,338.86 lb/MMscf | 1,123.6122 lb/hr | 4,921.4213 tpy | 120,338.86 lb/MMscf | 1,179.7928 lb/hr |
| $CO_2$ | | 120,017.45 lb/MMscf | 1,120.6111 lb/hr | 4,908.2768 tpy | 120,017.45 lb/MMscf | 1,176.6417 lb/hr |
| $N_2O$ | | 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**

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. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NOX, CO and TOC (Total) emission factors based on vendor data.
6. SO2 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
7. PM10/2.5 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
8. 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 |
|---|---|---|---|---|---|---|
| $NO_X$ | | 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 |
| $SO_2$ | | 14.29 lb/MMscf | 0.0953 lb/hr | 0.4173 tpy | 14.29 lb/MMscf | 0.1000 lb/hr |
| $PM_{10/2.5}$ | | 7.60 lb/MMscf | 0.0507 lb/hr | 0.2220 tpy | 7.60 lb/MMscf | 0.0532 lb/hr |
| $CO_{2-e}$ | | 120,338.86 lb/MMscf | 802.5801 lb/hr | 3,515.3010 tpy | 120,338.86 lb/MMscf | 842.7091 lb/hr |
| $CO_2$ | | 120,017.45 lb/MMscf | 800.4365 lb/hr | 3,505.9120 tpy | 120,017.45 lb/MMscf | 840.4584 lb/hr |
| $N_2O$ | | 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**

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. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NOX, CO and TOC (Total) emission factors based on vendor data.
6. SO2 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
7. PM10/2.5 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
8. 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.

$$EF_i = (EF_{HC}/EF_{TOC\text{-}AP42})(EF_{i\text{-}AP42})$$

| 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 | | | 1,020 BTU/scf | |
| 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 | Uncontrolled | | | Uncontrolled |

| Pollutant | Control Efficiency | Uncontrolled | Average Hourly | Maximum Annual | Uncontrolled | Maximum Hourly |
|---|---|---|---|---|---|---|
| NO$_X$ | | 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$_2$ | | 14.29 lb/MMscf | 0.0252 lb/hr | 0.1104 tpy | 14.29 lb/MMscf | 0.0265 lb/hr |
| PM$_{10/2.5}$ | | 7.60 lb/MMscf | 0.0134 lb/hr | 0.0587 tpy | 7.60 lb/MMscf | 0.0141 lb/hr |
| CO$_{2-e}$ | | 120,142.36 lb/MMscf | 212.0159 lb/hr | 928.6298 tpy | 120,142.36 lb/MMscf | 222.6167 lb/hr |
| CO$_2$ | | 120,017.45 lb/MMscf | 211.7955 lb/hr | 927.6643 tpy | 120,017.45 lb/MMscf | 222.3853 lb/hr |
| N$_2$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. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NOX emission factor based on vendor data.
6. SO2 and PM10/2.5 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$_X$ | | 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$_2$ | | 14.29 lb/MMscf | 0.0032 lb/hr | 0.0142 tpy | 14.29 lb/MMscf | 0.0034 lb/hr |
| PM$_{10/2.5}$ | | 7.60 lb/MMscf | 0.0017 lb/hr | 0.0075 tpy | 7.60 lb/MMscf | 0.0018 lb/hr |
| CO$_{2-e}$ | | 120,338.86 lb/MMscf | 27.2260 lb/hr | 119.2498 tpy | 120,338.86 lb/MMscf | 28.5873 lb/hr |
| CO$_2$ | | 120,017.45 lb/MMscf | 27.1533 lb/hr | 118.9313 tpy | 120,017.45 lb/MMscf | 28.5109 lb/hr |
| N$_2$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**

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. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NOX, CO and TOC (Total) emission factors based on vendor data.
6. SO2 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2 using Tariff (5 gr/100 scf).
7. PM10/2.5 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
8. 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 | | | 1,020 BTU/scf | |
| Heat Output at HHV | 0.058 MMBTU/hr | | | 0.060 MMBTU/hr | |
| Thermal Efficiency | 80% | | | 80% | |
| Operating Hours | 8,760 hrs/yr | | | | |
| Fuel Consumption | 71 scfh | | | 74 scfh | |
| | 0.618 MMscf/yr | | | | |
| Heat Input at HHV | 0.072 MMBTU/hr | | | 0.076 MMBTU/hr | |
| | 631 MMBTU/yr | Uncontrolled | | | Uncontrolled |

| Pollutant | Control Efficiency | Uncontrolled | Average Hourly | Maximum Annual | Uncontrolled | Maximum Hourly |
|---|---|---|---|---|---|---|
| $NO_X$ | | 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 |
| $SO_2$ | | 14.29 lb/MMscf | 0.0010 lb/hr | 0.0044 tpy | 14.29 lb/MMscf | 0.0011 lb/hr |
| $PM_{10/2.5}$ | | 7.60 lb/MMscf | 0.0005 lb/hr | 0.0023 tpy | 7.60 lb/MMscf | 0.0006 lb/hr |
| $CO_{2-e}$ | | 120,142.36 lb/MMscf | 8.4806 lb/hr | 37.1452 tpy | 120,142.36 lb/MMscf | 8.9047 lb/hr |
| $CO_2$ | | 120,017.45 lb/MMscf | 8.4718 lb/hr | 37.1066 tpy | 120,017.45 lb/MMscf | 8.8954 lb/hr |
| $N_2O$ | | 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**

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. CO2 and N2O emission factors based on 40 CFR 98, Subpart C, Table C-1 and 40 CFR 98, Subpart C, Table C-2, respectively.
5. NOX, 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.
6. SO2 and PM10/2.5 emission factors based on AP-42, Section 1.4 (Revised 3/98), Table 1.4-2.
7. 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$_{2\text{-}e}$ | 1039.07% by weight | 3.1363 lb/hr | 13.7368 tpy | 1039.07% by weight | 3,663 lb/hr |
| CO$_2$ | 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**

1. Separator Characteristics: <u>Flash is represented for separators that receive majority of liquids, but flash may be emitted other separators.</u>

   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

2. 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.

3. Flash gas density is 110% of the value extracted from TABLE E-0D.

                Density (TABLE E-0D):    0.0699 lb/scf        Safety Factor:    110%

4. Flash factor extracted from TABLE E-0A.

5. 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 | | | | |
| | | 106 gal/yr | | | 530 gal/hr | |
| Standing Losses | | | | | **July** | |
| | | | | | 744 hrs/month | |
| | | | | | **40.3036** lbs/month | |
| | | | | | 0.0542 lb/hr | |
| | | **261.9182** lb/yr | | | | |
| Working Losses | | **8.20E-03** lb/gal | | | **1.04E-02** lb/gal | |
| | | 0.8664 lb/yr | Average | Maximum | 5.5304 lb/hr | Maximum |
| Residual Liquid | Stand | | 0.1073 lb/hr | 0.4699 tpy | | 0.1944 lb/hr |
| | Work | 358.84% by weight | 0.0004 lb/hr | 0.0016 tpy | 358.84% by weight | 19.8453 lb/hr |
| | Total | | 0.1076 lb/hr | 0.4715 tpy | | 20.0397 lb/hr |
| CO$_{2\text{-e}}$ | | 5398.27% by weight | 1.6194 lb/hr | 7.0929 tpy | 5398.27% by weight | 301 lb/hr |
| CO$_2$ | | 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 | or less solar |
| Diameter | 5.00 ft | | Shell Condition | Good | absorptance |
| 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 |
|---|---|---|---|---|---|---|---|---|
| | | avg | max | avg | max | standing | working | Flow |
| 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.

Algonquin Gas Transmission, LLC　　　　　　　　　　　　　　　PTE Estimates: Atlantic Bridge Project
Weymouth Compressor Station　　　　　　　　　　　　　　　　　Revised: July 2015

**TABLE F-1B**
**Volatile Organic Liquids Storage Tanks**
**Hourly and Annual Emission Estimates**
**Standing & Working Losses**

| Source | | WEYM-SV-V1C1 | | | | |
|---|---|---|---|---|---|---|
| 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 | | | | | **July** | |
| | | | | | 744 hrs/month | |
| | | | | | **40.3036** lbs/month | |
| | | **261.9182** lb/yr | | | 0.0542 lb/hr | |
| Working Losses | | **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$_{2\text{-e}}$ | | 5398.27% by weight | 1.6194 lb/hr | 7.0929 tpy | 5398.27% by weight | 301 lb/hr |
| CO$_2$ | | 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 | or less solar |
| Diameter | 5.00 ft | | Shell Condition | Good | absorptance |
| 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 |
| | | avg | max | avg | max | standing | working | Flow |
| 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.

Algonquin Gas Transmission, LLC                   PTE Estimates: Atlantic Bridge Project

Weymouth Compressor Station                          Revised: July 2015

**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 | | | | | **July** | | |
| | | | | | 744 hrs/month | | |
| | | | | | **41.5584** lbs/month | | |
| | | | | | 0.0559 lb/hr | | |
| | | **271.0744** lb/yr | | | | | |
| Working Losses | | **8.20E-03** lb/gal | | | **1.04E-02** 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 | 358.84% by weight | | 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$_{2-e}$ | | 5398.27% by weight | 1.8928 lb/hr | 8.2903 tpy | 5398.27% by weight | | 333 lb/hr |
| CO$_2$ | | 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 |
| Diameter | 5.00 ft | | Shell Condition | Good | absorptance |
| 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 | 92.00 lb/lb-mol | Vapor Molecular Weight    66.00 lb/lb-mol |

| Monthly Data | 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 | | | | | **July** | | | |
| | | | | | 744 hrs/month | | | |
| | | | | | **3.9707** lbs/month | | | |
| | | 25.4567 lb/yr | | | 0.0053 lb/hr | | | |
| Working Losses | | **8.20E-03** lb/gal | | | **1.04E-02** 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 | 358.84% by weight | | 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 |
| CO₂₋ₑ | | 5398.27% by weight | 0.1573 lb/hr | 0.6890 tpy | 5398.27% by weight | | 25 lb/hr |
| CO₂ | | 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 |
| Diameter | 1.67 ft | 1.67 ft | Shell Condition | Good | absorptance |
| 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 | | TANKS |
|---|---|---|---|---|---|---|---|---|
| | | avg | max | avg | max | standing | working | 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.

Algonquin Gas Transmission, LLC             PTE Estimates: Atlantic Bridge Project
Weymouth Compressor Station                     Revised: July 2015

**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 | | |
| | | **545.1562** lb/yr | | 0.1150 lb/hr | | |
| 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 |
| CO₂-e | | 5398.27% by weight | 3.5818 lb/hr | 15.6881 tpy | 5398.27% by weight | 1,245 lb/hr |
| CO₂ | | 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 | |
| Height/Length | 6.00 ft | Shell/Roof Color | Gray/Medium | or less solar |
| Diameter | 8.00 ft | Shell Condition | Good | absorptance |
| 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      92.00 lb/lb-mol      Vapor Molecular Weight      66.00 lb/lb-mol

| Monthly Data | 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 | 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 | | | | | **July** | | |
| | | | | | 744 hrs/month | | |
| | | | | | **0.0252** lbs/month | | |
| | | **0.1582** lb/yr | | | 0.00003 lb/hr | | |
| Working Losses | | **2.07E-05** lb/gal | | | **3.07E-05** lb/gal | | |
| | | 4.3031 lb/yr | Average | Maximum | 0.0175 lb/hr | | Maximum |
| Liquid | Stand | | 0.0000 lb/hr | 0.0001 tpy | | | 0.0000 lb/hr |
| | Work | 100.00% by weight | 0.0005 lb/hr | 0.0022 tpy | 100.00% by weight | | 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 | | 0.0175 lb/hr |
| Methane | | | | | | | |
| Ethane | | | | | | | |
| VOC (Total) | | 100.00% by weight | 0.0005 lb/hr | 0.0022 tpy | 100.00% by weight | | 0.0175 lb/hr |
| 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 | or less solar |
| Diameter | 4.00 ft | Shell Condition | Good | absorptance |
| 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 | | Liquid Surface Temperature | | TANKS Output | | TANKS |
|---|---|---|---|---|---|---|---|---|
| | | avg | max | avg | max | standing | working | Flow |
| 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 | | | | **July** | | |
| | | | | 744 hrs/month | | |
| | | | | **0.1595** lbs/month | | |
| | | **1.0020** lb/yr | | 0.00021 lb/hr | | |
| Working Losses | | **2.07E-05** lb/gal | | **3.07E-05** lb/gal | | |
| | | 0.7446 lb/yr | Average | Maximum | 0.0921 lb/hr | Maximum |
| Liquid | Stand | | 0.0001 lb/hr | 0.0005 tpy | | 0.0002 lb/hr |
| | Work | 100.00% by weight | 0.0001 lb/hr | 0.0004 tpy | 100.00% by weight | 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 | 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 | 188.00 lb/lb-mol | Vapor Molecular Weight | 130.00 lb/lb-mol | | |

| Monthly Data | 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 |
| $CO_{2-e}$ | 5398.27% by weight | 0.1343 lb/hr | 0.5883 tpy | 5398.27% by weight | 888.6070 lb/hr |
| $CO_2$ | 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** | | | | | |

1. Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.   $L_L = 12.46[(S)M_VP/T]$
2. 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**

1. Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.     $L_L = 12.46[(S)M_V P/T]$
2. 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** | | | | | |

1. Emissions calculated using methods provided in USEPA, AP-42 Section 5.2 dated 1/95.  $L_L = 12.46[(S)M_VP/T]$
2. Physical property, throughput and speciation data based data from supply vessel emission calculation spreadsheet.

| 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 |
| $NO_X$ | | | | | | |
| CO | | | | | | |
| $SO_2$ | | | | | | |
| $PM_{10/2.5}$ | | | | | | |
| $CO_{2-e}$ | 1,243 lb/hr | 5,446 tpy | 1,049,186 lb/hr | 1,748 lb/hr | 7,657 tpy | 6,548,767 lb/hr |
| $CO_2$ | 1.1821 lb/hr | 5.1776 tpy | 2,056.3934 lb/hr | 1.6620 lb/hr | 7.2794 tpy | 12,835.5108 lb/hr |
| $N_2O$ | | | | | | |
| 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.

| | Average | Average Plus | Maximum | Maximum/Average+ | Average+/Average |
|---|---|---|---|---|---|
| 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) ) ).

| | Average | Average Plus | Maximum | Maximum/Average+ | Average+/Average |
|---|---|---|---|---|---|
| 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% | | |

<div align="center">

**TABLE H-1Ba**
**Piping Components**
**Hourly and Annual Emission Estimates**

</div>

| 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 | | $CO_{2-e}$ | 2330.28% by weight | 171.8676 lb/hr | 752.7801 tpy | 176.5572 lb/hr |
| | | $CO_2$ | 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 | **Emissions** | |
| | | Emission Factor | 1.88E-03 kg/hr/component | **Avg. Hourly** | **Max. Annual** | **Max. Hourly** |
| Speciation | $CO_{2-e}$ | | 0.96% by weight | 0.0021 lb/hr | 0.0094 tpy | 0.0026 lb/hr |
| | $CO_2$ | | 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 | **Emissions** | | |
| | | Emission Factor | 3.20E-05 kg/hr/component | **Avg. Hourly** | **Max. Annual** | **Max. Hourly** |
| Speciation | CO$_{2\text{-e}}$ | | | | | |
| | CO$_2$ | | | | | |
| | 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 | $CO_{2\text{-}e}$ | | | | | |
| | $CO_2$ | | | | | |
| | 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 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 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 | Hourly | Maximum | 0.3288 gal/hr | | | |
| Make-up Solvent | | Average | 0.0137 gal/hr | | **Emissions** | |
| Requirement | Annual | | 120.00 gal/yr | **Avg. Hourly** | **Max. Hourly** | **Max. Annual** |
| 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. |