# Preventive Maintenance Plan
# Highland Compressor Station

## Vector Pipeline L.P.
## Highland, Michigan

Project No. 180104
August 2018

Vector Pipeline™

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# Table of Contents



## List of Tables



## List of Attachments



## List of Abbreviations/Acronyms

| | |
|---|---|
| CFR | Code of Federal Regulations |
| CO | carbon monoxide |
| DLN | dry low-$NO_X$ |
| HP | horsepower |
| hr/yr | hours per year |
| ISO | ISO standard day conditions means *288° Kelvin, 60% relative humidity and 101.3 kilopascals pressure* |
| KOH | potassium hydroxide |
| lb/hr | pounds per hour |
| MMBtu/hr | million British thermal units per hour |
| NGP | natural gas producer |
| $NO_X$ | nitrogen oxides |
| O&M | operation and maintenance |
| PMP | Preventive Maintenance Plan |
| RICE MACT | 40 CFR 63 Subpart ZZZZ |
| SI RICE | spark-ignition reciprocating internal combustion engine |
| tpy | tons per year |
| Vector | Vector Pipeline L.P. |

# 1.0 Introduction

Vector Pipeline L.P. (Vector) operates a natural gas compressor station, Highland Compressor Station, in Highland, Michigan. This facility operates two natural gas-fired turbines and a standby generator.

This Preventive Maintenance Plan (PMP) meets the requirements of implementing a preventive maintenance plan as required by FGTURBINES, Condition IX.3 of Renewable Operating Permit MI-ROP-N6638-2014a. This PMP has been developed to reflect facility operation and maintenance (O&M) of emission generating equipment. The Plan includes:

1. Identification of the individual(s) responsible for inspecting, maintaining, and repairing emission control devices
2. A description of the items or conditions that will be inspected and the inspection schedule for said items or conditions
3. Identification and quantity of replacement parts that will be maintained in inventory for quick replacement

This PMP will be updated as deemed necessary, such as in the event a malfunction occurs which needs to be addressed by the PMP or if there is a change in plant operations.

# 2.0 General Plan Information

The Highland Compressor Station emission unit and pollution control equipment consists of two natural gas-fired Solar® Mars Turbines, each rated at 15,000 (ISO) horsepower (HP) and controlled by dry low-nitrogen oxide (DLN) emission controls. The compressor station also includes a natural gas-fired, standby power unit (Cummins GTA50F2) rated at 9.654 million British thermal units per hour (MMBtu/hr).

The following information pertains to the equipment covered under the PMP, including limits or operating restrictions as required by the air permit.

## 2.1 Description of Malfunction

A **malfunction** is defined in Michigan Rule 113(a) as *Any sudden, infrequent and not reasonably preventable failure of a source, process, process equipment or air pollution control equipment to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions*.

## 2.2 Description of Equipment/Limitations

The Solar Turbines, identified as Turbines 1 and 2, are fired with natural gas; discharge to the atmosphere from stacks SVTURBINE1 and SVTURBINE2, respectively; and use DLN control technology. A continuous monitoring system for measuring natural gas producer (NGP) speed is maintained and operated for each turbine. During normal operation, NGP is maintained above 86%. In addition, between 86% and 92% NGP carbon monoxide (CO) emissions are restricted to 400 pounds per hour (lb/hr) each.

The Solar Turbines, identified as Turbines 1 and 2, have emission limits as stated in the air permit, including:

**Table 1 - Turbine Permit Limits**

| Pollutant | Limit | Time Period/Operating Scenario | Equipment |
|---|---|---|---|
| 1. $NO_X$ | 37.9 pounds | Hourly | FGTURBINES*** |
| 2. $NO_X$ | 126.7 tons | Rolling 12-month period | FGTURBINES*** |
| 3. $SO_2$ | 150 ppm, by volume at 15% oxygen and on a dry gas basis and at 100% load[2] | Instantaneous | FGTURBINES |
| 4. $SO_2$ | 13.52 pounds | Hourly | FGTURBINES*** |
| 5. $SO_2$ | 59.21 tons | Rolling 12-month period | FGTURBINES*** |
| 6. CO* | 800 pounds | Hourly | FGTURBINES*** |
| 7. CO** | 25.14 pounds | Hourly | FGTURBINES*** |

* This limit is applicable at any time that the turbine is operating in the range of 86% to 92% of Natural Gas Producer Speed.
** This limit is applicable any time the turbines are operating at or above 92% of Natural Gas Producer Speed.
*** Represents the total emission limit for both turbines. Individual turbine limits are one half the listed values.

The standby generator is also fired with natural gas. The ROP limits the standby generator to 39.4 lb/hr $NO_x$, 3.06 lb/hr CO and 500 hours of operation per year. In addition, the standby generator must meet the definition of an **emergency stationary spark ignition internal combustion engine**, which includes:

- Limiting operation (except for actual emergencies) to less than 100 hours per year (hr/yr). This 100 hr/yr includes any testing or maintenance checks.
- Installation of a non-resettable hour meter to track hours of operation.
- Tracking the reason for operating, as well as number of hours of operation, to demonstrate compliance with the operating hour limits.

Total facility emissions are limits to 224 tons per year (tpy) CO. Emissions are tracked using a parameter tracking system further described in Section 2.5.

## 2.3 Contact Names

As the Highland Compressor Station operates 24 hours a day, 7 days a week, air pollution control equipment is inspected and maintained by various plant personnel. On any given day, the operator(s) or maintenance personnel will conduct the required inspections and make repairs or replacements as necessary. Table 2 summarizes the individuals responsible for inspecting, maintaining, and repairing the emission sources and emission controls.

**Table 2 - Individuals Responsible for Maintenance**

| Name | Title | Contact Information |
|---|---|---|
| Joseph Richardson | Manager Vector Operations | 269.729.4419 Work<br>219.793.3042 Mobile<br>joe.richardson@enbridge.com |
| James Reno | Technical Maintenance Coordinator | 219.778.8116 Work<br>219.775.5611 Mobile<br>james.reno@enbridge.com |
| Matt DiPaola | Operations Coordinator | Work<br>248.218.4807 Mobile<br>matt.dipaola@enbridge.com |

## 2.4 Inspection and Maintenance Schedule

The turbines and standby generator will follow the inspection schedule recommended in the manufacturer's O&M Manuals and based on equipment history. The manufacturer's manuals for the turbines and the standby generator are located at the Highland Compressor Station. Routine maintenance includes turbine washes, filter replacements, coil cleaning, belt changing, bearing greasing, oil analysis, etc., as recommended by Solar, the turbine manufacturer. In addition, combustor change outs are performed on a routine basis to keep emissions low and ensure proper operation of the equipment. Routine maintenance for the standby generator includes filter changes, fluid level checks, battery checks, and belt replacements, as recommended by the manufacturer.

In addition, the standby generator will be maintained in accordance with the applicable provisions of 40 CFR 63 Subpart ZZZZ (RICE MACT) for area source emergency generators. The standby generator is subject to 40 CFR 63.6603 Table 2d for emergency spark-ignition reciprocating internal combustion engines (SI RICE), which requires the following:

A. Utilize an oil analysis program in accordance with 40 CFR 63.6625(i) or change the engine oil every 500 hours of operation or annually, whichever comes first.[1]
B. Inspect spark plugs every 1,000 hours of operation or annually, whichever comes first, and replace as necessary.
C. Inspect all hoses and belts every 500 hours of operation or annually, whichever comes first, and replace as necessary.

## 2.5 Parameters to be Monitored

The facility takes an active role to ensure complete compliance with its ROP. Turbine parameters that are monitored to ensure compliance include:

### 2.5.1 Natural Gas Producers Speed for the Turbines

The average hourly NGP for each turbine will be recorded using an automated data acquisition system.

### 2.5.2 Horsepower Levels for the Turbines

The average horsepower levels for each turbine is calculated within the data acquisition system. To show compliance with emission limits included in the permit, the method outlined in Section 2.2 must be followed.

### 2.5.3 Startup, Shutdown, or Malfunction

The Highland Compressor Station shall record the occurrence and duration of any startup, shutdown, or malfunction for each turbine. A malfunction only occurs when an exceedance for an emission limit or operating parameter occurs.

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[1] Sources have the option to utilize an oil analysis program to extend the specified oil change requirement in Table 2d of this subpart (ZZZZ). The oil analysis must be performed at the same frequency specified for changing the oil. The analysis program must, at minimum, analyze the following three parameters: total acid number, viscosity, and percent water content. The condemning limits for these parameters are as follows: Total Acid Number increases by more than 3.0 mg of KOH per gram from the Total Acid Number of the oil when new; viscosity of the oil has changed more than 20% from the viscosity of the oil when new; or percent water content (by volume) is greater than 0.5. If all these condemning limits are not exceeded, the engine owner or operator is not required to change the oil. If any of the limits are exceeded, the engine owner or operator must change the oil within 2 days of receiving the results of the analysis; if the engine is not in operation when the results of the analysis are received, the engine owner or operator must change the oil within 2 days or before commencing operation, whichever is later. The owner or operator must keep records of the parameters that are analyzed as part of the program, the results of the analysis, and the oil changes for the engine. The analysis program must be part of the maintenance plan for the engine.

### 2.5.4 Operating Hours

The Highland Compressor Station records the total operating hours of each turbine as well as of the emergency engine. The reason for operating the emergency engine will also be recorded.

### 2.5.5 Fuel Usage

The Highland Compressor Station shall monitor and record the amount of fuel combusted in each turbine during each calendar day and shall monitor and record the amount of fuel combusted in the emergency engine each calendar month.

### 2.5.6 Sulfur Content of Fuel

The Highland Compressor Station currently demonstrates compliance with sulfur in fuel limits using a current, valid tariff sheet, though purchase contracts or transportation contracts showing the sulfur in fuel can be used as well. The facility can also choose to monitor the total sulfur content of the fuel fired in each turbine using methods described in 40 CFR 60.4415; sulfur in fuel shall not exceed 0.8% by weight.

## 2.6 Spare Parts Inventory

The spare parts inventory, which is maintained for quick replacement, is summarized in Attachment 1.

## 2.7 Corrective Action Measures

The Highland Compressor Station will implement preventive maintenance practices recommended in the manufacturer's manuals, and based on equipment history, to prevent permit noncompliance. In the event a malfunction causing excess emissions occurs, staff will take corrective actions to restore the unit to proper operating conditions.

## 2.8 Emissions Tracking

Emissions are tracked to demonstrate compliance as follows.
Monthly CO emissions for Turbines 1 and 2, combined, are calculated using the following equation:

$$COMX = [(EFNGP > 92\% \times HRNgP > 92\%) + (EFNGP < 92\% \times HRNgG < 92\%)] \times {}^{1}/_{2{,}000}\ (lb/ton)$$

Where:

COMX = CO emissions from the month (tons/month)
EFNGP>92% = Emission factor when the NGP speed is greater than 92% full load (lb CO/hr)
HRNPG>92% = Operating hours for the month, as obtained from the automated data acquisition system, when the NGP speed is greater than 92% of full load.
EFNGP<92% = Emission factor when the NGP speed is less than 92% full load (lb CO/hr)
HRNPG<92% = Operating hours for the month, as obtained from the automated data acquisition system, when the NGP speed is less than 92% of full load.

Monthly $NO_X$ emissions for Turbines 1 and 2, combined, using the following equation:

$$NO_XMX = \left[\left(EFNO_X \times HR\right) + (\text{EFNGP} < 92\% \text{ x HRNgG} < 92\%)\right] \times {}^{1}/_{2{,}000}\ (lb/ton)$$

Where:

$NO_X$MX = $NO_X$ emissions from the month (tons/month)
$EFNO_X$ = Emission factor (lb $NO_X$/hr)
HR = Hours of operation for the month, as obtained from the automated data acquisition system.

The emission factors used for CO and $NO_X$ emissions shall be the following:

1. $EF_{NGP>92\%}$ = 13.43 lb CO/hr
2. $EF_{NGP<92\%}$ = 400 lb CO/hr
3. $EF_{NOx}$ = 20.0 lb $NO_X$/hr

Emissions from the most recent stack test can be substituted for the emissions listed above.

# 3.0 Monitoring Operating Conditions

A number of operating conditions must be followed as part of the Highland Compressor Station air permits. As part of this PMP, the following information must be recorded:

- The automated data acquisition system will record average hourly NGP for each turbine. This system will be properly calibrated and maintained to ensure information recorded is accurate.
- Monthly operating hours for each turbine and the emergency engine. The reason for operating the emergency engine will also be recorded.
- Monthly fuel consumption for each turbine and the emergency engine. Fuel consumption will be used with emission factors to calculate the rolling 12-month total emissions.

# Attachment 1

# Solar® Spare Parts List

Vector Pipeline, Highland Compressor Station, Highland, Michigan

| Quantity | Part Number | Description |
|---|---|---|
| 3 | 1014598 | Sensor, RTD, Non-Spring Loaded |
| 1 | 1027212 | Sensor, RTD, Single Element |
| 30 | 1028903 | Gasket, T5 |
| 1 | 10124347-1 | Sensor, Speed |
| 4 | 1025324-1 | Element, PICO Fuel Filter Kit |
| 4 | 1025324-2 | Element, PICO Fuel Filter Top |
| 4 | 173942-1 | Gasket, Injector |
| 6 | 1090886-1600 | Lube Oil Filter |
| 20 | 195017-1 | Gasket, Fuel Injector |
| 36 | 6B735-6 | Enclosure Fan Filter |
| 2 | 903316C1 | CS-Spark Plug |
| 1 | 917560C2 | Ignition, Exciter |
| 1 | 919340C2 | Cable, Ignition |
| 1 | 918801C1 | Sensor High Temp RTD T1 |
| 1 | 1788-CN2DN | Controlnet to devicenet linking device |
| 1 | 1756-L73 | Control logix 8 MB card |
| 1 | 1756CN2R | Control Logix Comm Module |
| 1 | 1756-DHRIO | Control logix DH plus/RIO comms module |
| 1 | 1606-XLDC92D | 14 to 34 V DC IN |
| 1 | 1794-OB8EPXT | Flex XT 8 point digital input module |
| 1 | 1794-1B16XT | Flex XT 16 point digital input module |
| 1 | 1794-IR8 | 8 point RTD in |
| 1 | 1794-IB10X0B6XT | Flex XT 10 in 6 out digital Module |
| 2 | 1794-IE8XT | Flex I/O analog |
| 1 | 1794-OBI6PXT | Flex XT 16 point digital output module |
| 1 | 1794-IF2XOF21XT | Flex 2 in 2 out analog module |
| 1 | 1756-EN2T | Ethernet IP comm module |
| 1 | 1794-ACNR15 | Flex XT Controlnet Adpt. |
| 1 | 1794-IB16 | 24v DC sink input |
| 2 | 1794-OE4 | Flex I/O 4 output analog module |
| 1 | 1785-ENET | Ethernet interface module |
| 3 | 1794-OW8 | Flex I/O 8 output relay module |
| 2 | 1794-TB3 | Flex I/O terminal base |
| 1 | 1440-ACNR | Network adaptor |
| 1 | 1794-ACNR15XT | Flex redundent media adaptor |
| 1 | 1440-DYN02-01RJ | XM Dynamic measurement module |
| 1 | 1794-IRT8XT | Flex XT 8 point |
| 1 | 1794-OBI6 | 24v 16 source output |

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