



Gas Turbine and Cogeneration System Emission Test Report

Prepared for:

Par Sterile Products, LLC

Rochester, Michigan

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APR 19 2017

AIR QUALITY DIV.

Par Sterile Products, LLC
870 Parkdale Road
Rochester, Michigan

Project No. 17-4987.00
April 3, 2017

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070



MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
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RENEWABLE OPERATING PERMIT
REPORT CERTIFICATION

AIR QUALITY DIV.

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating Permit (ROP) program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name Par Sterile Products County Oakland

Source Address 870 Parkdale Rd City Rochester

AQD Source ID (SRN) B2329 ROP No. MI-ROP-B2329 ROP Section No. _____

Please check the appropriate box(es):

Annual Compliance Certification (Pursuant to Rule 213(4)(c))

Reporting period (provide inclusive dates): From _____ To _____

1. During the entire reporting period, this source was in compliance with ALL terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the ROP.

2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference, EXCEPT for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the ROP, unless otherwise indicated and described on the enclosed deviation report(s).

Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))

Reporting period (provide inclusive dates): From _____ To _____

1. During the entire reporting period, ALL monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred.

2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred, EXCEPT for the deviations identified on the enclosed deviation report(s).

Other Report Certification

Reporting period (provide inclusive dates): From Feb 22, 2017 To Feb 22, 2017

Additional monitoring reports or other applicable documents required by the ROP are attached as described:
Gas Turbine and Cogeneration System Emission Test Report is being submitted for Par Sterile Products, LLC. Test Report is Project# 17-4987-00.

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete

<u>Matt Johnson</u>	<u>Director, WF Develop/EHS</u>	<u>248-656-5486</u>
Name of Responsible Official (print or type)	Title	Phone Number

	<u>17 APR 2017</u>
Signature of Responsible Official	Date

* Photocopy this form as needed.

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by BB&E, Inc. (BB&E) on behalf of Par Sterile Products, LLC (Par) to evaluate oxides of nitrogen (NOx) emission rates from one gas turbine cogeneration system at the Par facility in Rochester, Michigan. Sampling of the exhaust from FG-382-COGEN system was conducted on February 22, 2017. The results of this test program are summarized by Table E-I.

**Table E-I
Test Program Results Summary**

Turbine Operating Load (%)	Average NOx Concentration^A (ppmv @ 15% O₂)	Average NOx Emission Rate^B (lbs/MMbtu)
100 (duct burner off)	117.0	0.41
90 (duct burner off)	127.7	0.44
85 (duct burner off)	130.7	0.44
80 (duct burner off)	127.9	0.43
100 (duct burner firing)	86.3	0.31

- A) Average NOx concentration corrected to 15% O₂ and ISO standard day conditions. Emission Limit is 167 ppm for the Turbine.
- B) Calculated using equation 19-1 from USEPA method 19. Emission Limit is 0.50 lbs/MMbtu for the Cogeneration System.

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by BB&E, Inc. (BB&E) on behalf of Par Sterile Products, LLC (Par) to evaluate oxides of nitrogen (NO_x) emission rates from one gas turbine cogeneration system at the Par facility in Rochester, Michigan. The purpose of this document is to present the results of the emissions test program.

The Air Quality Division (AQD) of Michigan's Department of Environmental Quality has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). This document is provided as Appendix A. The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

NO_x concentration (corrected to 15% oxygen (O₂) and ISO standard day conditions) and oxygen (O₂) concentration was evaluated for one gas turbine under five separate operating conditions at Par (870 Parkdale Road, Rochester, Michigan). The testing was performed on February 22, 2017.

1.b Purpose of Testing

AQD Renewable Operating Permit (ROP) No. MI-ROP-B2329-2016 requires verification of NO_x emission rates from the turbine with and without the duct burner firing. In accordance with Title 40, Part 60, Subparts A and GG of the Code of Federal Regulations (40 CFR 60, Subpart A and GG), NO_x emission rates (in terms of concentration corrected to 15% O₂ and ISO standard day conditions) were verified while the duct burner was not firing. In accordance with ROP the requirements of the ROP, NO_x emission rate (in terms of pounds per million Btu heat input) was verified with the turbine and duct burner operating at maximum load conditions.

1.c Source Description

The gas turbine operated by Par is a Centaur[®] Model T4700 industrial gas turbine manufactured by Solar Turbines, Inc. (Solar), rated at a maximum heat input of 42.18 MMBtu/hr. The turbine compressor compresses air to feed to the turbine combustor. The compressed air is mixed with natural gas. The increased gas pressure in the combustor section causes the exhaust gases to exit through the power turbine. The power turbine is connected to a single shaft that drives the turbine compressor as well as an electrical generator.

The exhaust gases that exit the power turbine are routed to a waste heat boiler where plant steam is produced. Located in the exhaust duct between the gas turbine and the heat boiler is a duct burner used to supply supplemental heat to the turbine exhaust gases. This duct burner fires natural gas only.

1.d Test Program Contact

The contact for information regarding the test program as well as the test report is as follows:

Ms. Annette Sommers
Par Sterile Products, LLC
870 Parkdale Road
Rochester, Michigan 48307
(248) 656-5370

1.e Testing Personnel

Names and affiliations for all personnel who were present during the testing program are summarized by Table 1.

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions test program.

2.a Operating Data

The following turbine operating data was recorded for each test run:

- Turbine operating load
- Turbine temperature
- Turbine natural gas combusted
- Turbine power produced (MW)
- Duct Burner fuel flowrate
- Heat recovery boiler steam load

The data recorded during the emissions test program is summarized by Appendix B.

2.b Applicable Permit

The Gas Turbine is included in Permit No. MI-ROP-B2329-2016.

2.c Results

Permit No. MI-ROP-B2329-2016 limits the concentration of NO_x in the exhaust gas from the gas turbine to not more than 167 parts per million by volume (corrected to 15% O₂ and ISO standard day conditions). Three test runs were conducted at each of four turbine operating load points (80%, 85%, 90%, and 100% of maximum load). Permit No. MI-ROP-B2329-2016 limits NO_x emission rate from the gas turbine to not more than 0.50 lbs/MMBtu with the duct burner firing. Three test runs were conducted at 100% turbine

operating load with the duct burner firing. Results are summarized by Tables 2 and 3. Analyzer raw data is provided in electronic form on the CD included as Appendix D.

2.d Emission Regulation Comparison

Emission limitations for the Gas Turbine are summarized by AQD Renewable Operating Permit No. MI-ROP-B2329-2016. These emission limitations are summarized by Table 4.

As summarized by Tables 2 and 3, NO_x emission rates were less than the corresponding emission limitations.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

The gas turbine operated by Par is a Centaur[®] Model T4700 industrial gas turbine manufactured by Solar Turbines, Inc. (Solar), rated at a maximum heat input of 42.18 MMBtu/hr. The turbine compressor compresses air to feed to the combustor. The compressed air is mixed with natural gas. The increase in gas pressure in the combustor forces the exhaust gases to exit through the power turbine section. This power turbine is connected to a single shaft that drives the turbine compressor as well as a 2.8 Megawatt electrical generator.

The exhaust gases that exit the power turbine are diverted to a waste heat boiler where plant steam is produced. Located in the exhaust duct between the gas turbine and the heat boiler is a duct burner used to supply supplemental heat to the turbine exhaust gases. This duct burner fires natural gas only, is rated at a maximum of 20.9 MMBtu/hr, and the heat recovery boiler is rated at a maximum of 41,200 lbs steam/hr.

3.b Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not necessary.

3.c Raw and Finished Materials

The raw materials used by the gas turbine and duct burner include natural gas and water and the finished materials are electricity and steam. The flowrate of each raw material and the electricity generation rate during the test program are summarized by Appendix B.

3.d Process Capacity

The rated capacity of the Gas Turbine is described in Section 3a. It should be noted, however, that the capacity of the turbine (kW) is variable dependent on ambient air

conditions (e.g., temperature, pressure, humidity) as well as site-specific pressure losses (i.e., static pressure losses due to inlet and outlet ducting).

3.e Process Instrumentation

Process instrumentation relevant to the emissions test program includes measurements of the data summarized by the process field data sheets provided in Appendix B.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures that were used to verify NO_x emission rates and O₂ concentrations from the Gas Turbine.

4.a Sampling Train and Field Procedures

The NO_x content of the exhaust gas was measured using a TECO 42i NO_x gas analyzer and the O₂ content was measured using a M&C Products PMA 100-L O₂ gas analyzer. A sample of the gas stream was drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon[®] sample line, and through a Universal Analyzers 3080PV electronic sample conditioner to remove the moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software. A schematic drawing of the test program sampling train is provided as Figure 1.

Sampling and analysis procedures followed the requirements of 40 CFR 60, Subpart GG as well as 40 CFR 60, Appendix A, Methods 3A, 7E, and 20 as follows:

- The sampling location was at the exhaust stack of the cogeneration system (see Figure 2).
- During the first emissions test run, the exhaust duct was traversed during the first test run at 8 points in each direction with sampling at each point for two minutes. Because the exhaust gas was not stratified (as verified by the procedure at 40 CFR 60.335(a)(5)), after the first test, the sampling probe was placed at a single point in the exhaust stack.
- For the testing, the NO_x analyzer was operated in the 0-200 ppmv range with a span of 200 ppmv.

4.b Recovery and Analytical Procedures

Because all measurements were conducted using on-line analyzers, no samples were recovered during the test program.

4.c Sampling Ports

A drawing showing the location of the sampling ports is provided as Figure 2.

4.d Traverse Points

Traverse points were as required by Method 1 and are summarized by Figure 3.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The results of the test program are summarized by Tables 2 and 3.

5.b Discussion of Results

Renewable Operating Permit No. MI-ROP-B2329-2016 limits the concentration of NO_x in the exhaust gas from the gas turbine to 167 ppmv, corrected to 15% O₂ and ISO standard day conditions. Additionally, Renewable Operating Permit No. MI-ROP-B2329-2012 limits NO_x emissions from the cogeneration system to 0.50 lbs/MMBtu. As summarized by Tables 2 and 3, NO_x emissions were below these limits for each turbine operating condition.

5.c Sampling Procedure Variations

No sampling procedure variations were employed during the emissions test program.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

There is no add-on control device for the Gas Turbine.

5.f Re-Test Changes

The test program performed was not previously performed.

5.g Audit Sample Analyses

Audit samples were not applicable to this test program.

5.h Calibration Sheets

Field quality assurance/quality control procedures consisted of the analyzer calibrations required by and in conformance with the performance specifications of Methods 3A, 7E, and 20. In addition, test program quality assurance included a NO₂ to NO conversion efficiency test and system bias checks which can be found in Appendix E. Certificates of analysis for the calibration gases used during testing are also provided in Appendix E.

5.i Sample Calculations

Sample calculations are provided as Appendix C.

5.j Field Data Sheets

Copies of field data sheets and relevant field notes are provided in Appendix D.

5.k Laboratory Data

No laboratory analysis was included in this test program. Weather data used to convert NO_x emission rates to ISO standard day conditions is included in Appendix E.

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**Table 1
Test Personnel**

Name	Affiliation
Annette Sommers	PAR
Naila Hosein Ali	BB&E
Kacie Van Buskirk	BB&E
Todd Wessel	BTEC
Jacob Zott	BTEC
Randal Tysar	BTEC
Mark Dziadosz	MDEQ – AQD
Iranna Konanahalli	MDEQ - AQD

Table 2
Runs 1-12
Test Results Summary
Turbine - Natural Gas, Duct Burner Off
Par Sterile Products
Power Plant
Rochester, Michigan
BTEC Project No. 17-4987.00
Test Date: February 22, 2017

Test Run	Test Start Time	Turbine Operating Load (%)	Average O ₂ Concentration (% v/v) ^A	Average NOx Concentration (ppmv) ^A	Average O ₂ Concentration (% v/v) ^B	Average NOx Concentration (ppmv) ^B	Average NOx Concentration (ppmv @ 15% O ₂) ^C	Ambient Air Temperature (°F)	Ambient Air Pressure (kPa)	Ambient Air Humidity (g H ₂ O/g air)	Average NOx Result (ppmv @ 15% O ₂) ^D	Average NOx Emission Rate (lbs/MMBtu) ^E
10	13:23	100	16.68	80.91	16.78	83.52	119.66	61	98.5	0.0071	122.4	0.43
11	13:53	100	16.69	80.56	16.53	83.25	112.48	61	98.5	0.0071	115.0	0.40
12	14:25	100	16.67	79.97	16.49	82.99	111.08	61	98.5	0.0071	113.6	0.39
3-Test Average:											117.0	0.41
7	11:46	90	17.05	76.49	17.14	80.22	125.80	61	98.7	0.0071	128.6	0.44
8	12:19	90	17.02	76.95	17.12	79.72	124.30	60	98.7	0.0071	127.2	0.44
9	12:50	90	17.02	77.61	17.10	79.90	124.06	59	98.6	0.0071	127.4	0.44
3-Test Average:											127.7	0.44
4	10:11	85	17.23	72.48	17.27	77.62	126.32	55	98.7	0.0071	131.2	0.43
5	10:42	85	17.22	73.58	17.32	77.06	127.03	58	98.7	0.0071	131.0	0.45
6	11:14	85	17.19	74.11	17.29	77.72	127.02	60	98.7	0.0071	129.9	0.45
3-Test Average:											130.7	0.44
1	8:12	80	17.46	67.54	17.54	69.28	121.62	47	98.8	0.0071	129.5	0.44
2	9:09	80	17.42	68.30	17.51	70.89	123.22	49	98.7	0.0071	130.4	0.44
3	9:40	80	17.24	67.29	17.28	72.55	118.15	53	98.7	0.0071	123.6	0.40
3-Test Average:											127.9	0.43

Notes:

- (A) Average concentrations as measured.
- (B) Average concentrations as corrected for analyzer drift.
- (C) Average NOx concentration corrected to 15% O₂.
- (D) Average NOx concentration corrected to 15% O₂ and ISO standard day conditions.
- (E) Calculated using equation 19-1 from USEPA method 19.

Table 3
Runs 13-15
Test Results Summary
Turbine - Natural Gas, Duct Burner On (at 100%)
Par Sterile Products
Power Plant
Rochester, Michigan
BTEC Project No. 17-4987.00
Test Date: February 22, 2017

Test Run	Test Start Time	Turbine Operating Load (%)	Average O ₂ Concentration (% v/v) ^A	Average NOx Concentration (ppmv) ^A	Average O ₂ Concentration (% v/v) ^B	Average NOx Concentration (ppmv) ^B	NOx Concentration (ppmv @ 15% O ₂) ^C	Ambient Air Temperature (°F)	Ambient Air Pressure (kPa)	Ambient Air Humidity (g H ₂ O/g air)	Average NOx Result (ppmv @ 15% O ₂) ^D	Average NOx Emission Rate (lbs/MMBtu) ^E
13	15:13	100	14.74	85.89	14.82	89.62	86.90	61	98.4	0.0071	88.8	0.32
14	15:44	100	14.67	84.00	14.73	87.62	83.75	62	98.4	0.0071	85.5	0.31
15	16:15	100	14.69	83.17	14.75	86.74	83.15	62	98.4	0.0071	84.7	0.31
3-Test Average:											86.3	0.31

Notes:

- (A) Average concentrations as measured.
- (B) Average concentrations as corrected for analyzer drift.
- (C) Average NOx concentration corrected to 15% O₂.
- (D) Average NOx concentration corrected to 15% O₂ and ISO standard day conditions.
- (E) Calculated using equation 19-1 from USEPA method 19.

**Table 4
Emission Limitations Summary**

Permit Condition	Emission Limit	Emission Limit or Standard Units
Section I	167	ppm NOx by volume @ 15% O ₂ firing natural gas without duct burner firing
Section I	0.50	NOx lbs/MMBTU with duct burner firing
Section I	121	NOx Tons per year, 12 month rolling time period

*These emission limits apply to the entire cogeneration system

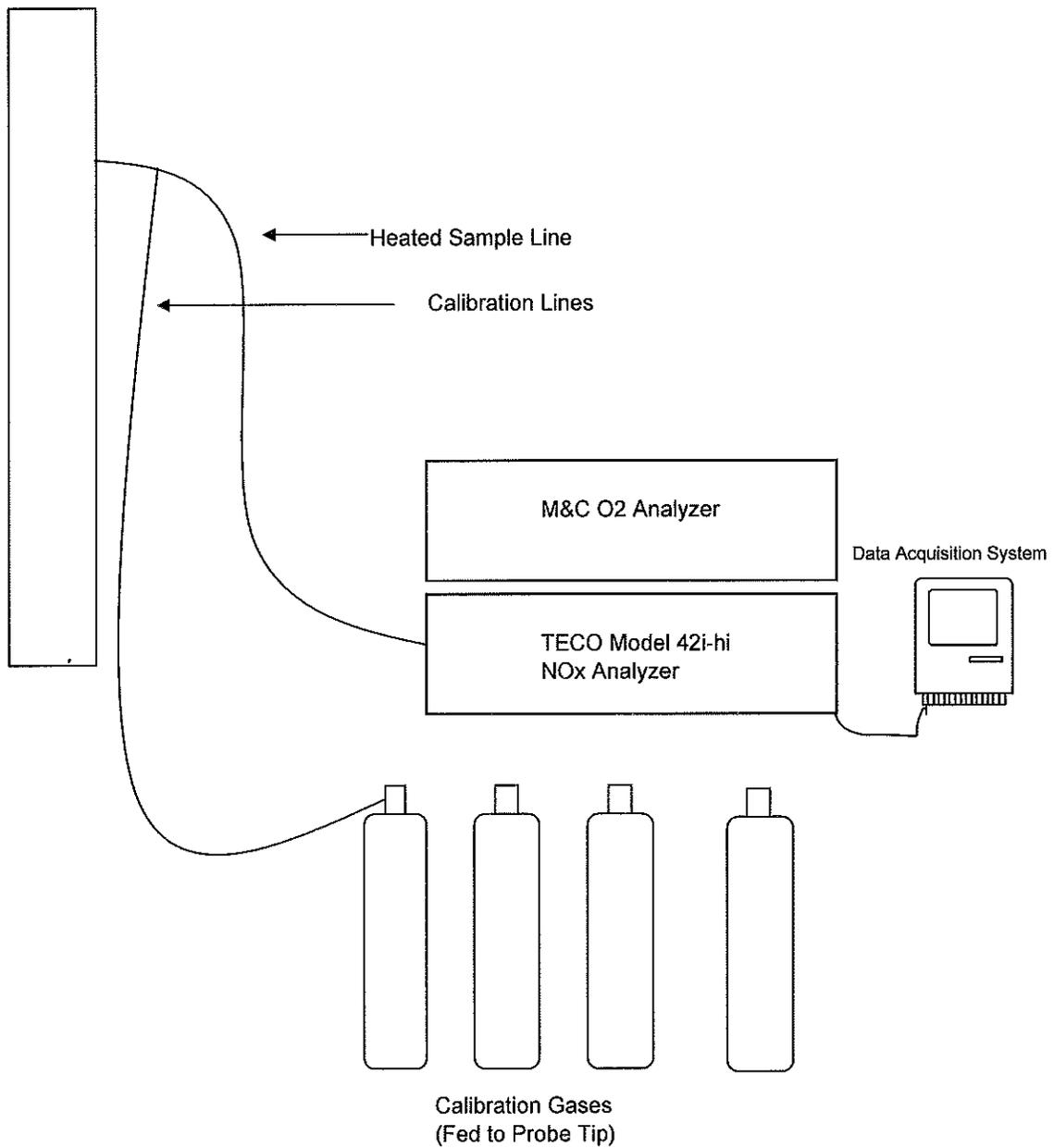


Figure 1

Site:
EPA Methods 3A and 7E
Par Sterile Products, LLC
Rochester, Michigan

Sampling Date:
February 22, 2017

BT Environmental Consulting, Inc.
4949 Fernlee
Royal Oak, Michigan

*Drawing not to scale

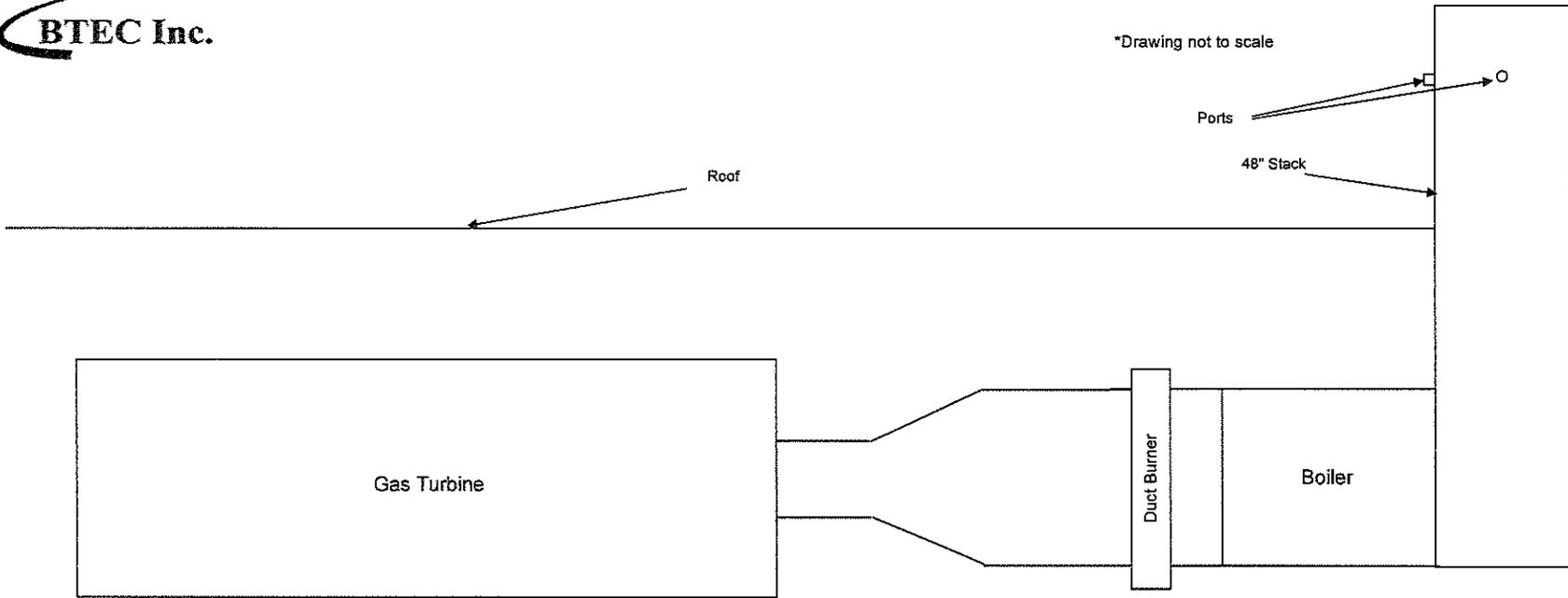


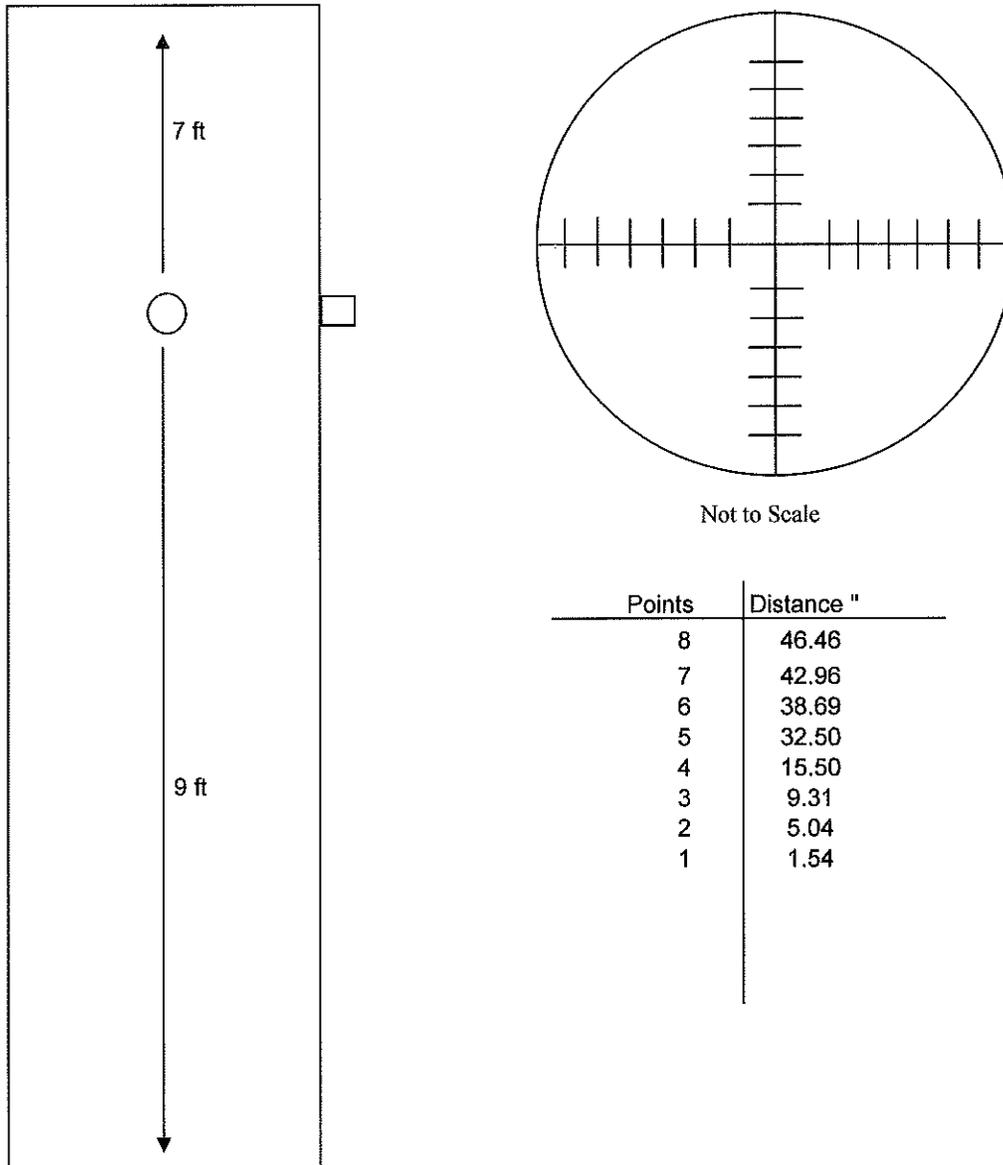
Figure 2

Site:
Test Port Locations
Par Sterile Products, LLC
Rochester, Michigan

Sampling Date:
February 22, 2017

**BT Environmental Consulting,
Inc.**
4949 Fernlee
Royal Oak, Michigan

diameter = 48"



Not to Scale

Figure 3

Site:
FG-382-COGEN Turbine
Par Sterile Products, LLC
Rochester, Michigan

Sampling Date:
2/22/2017

BT Environmental Consulting,
Inc.
4949 Fernlee
Royal Oak, Michigan