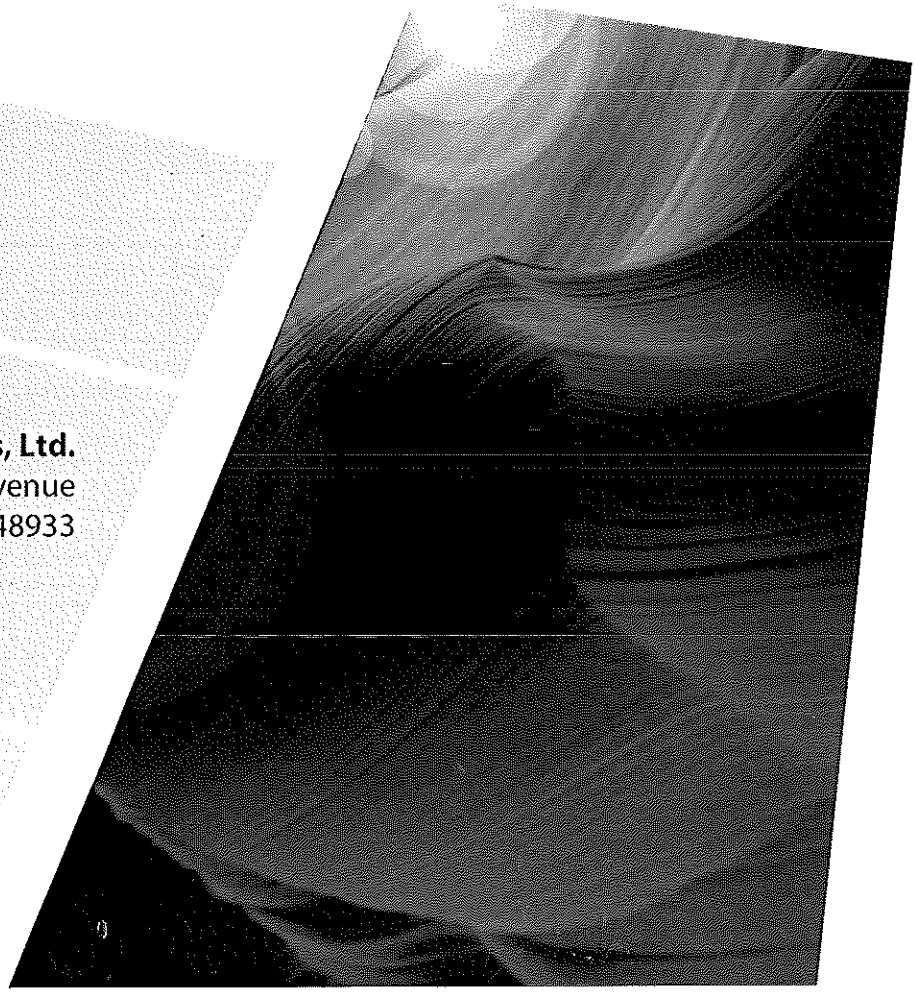
# Report

## *Emissions Test*
## *EUTURBINE2SC*
## *Test Dates: September 16 - 19, 2013*

**Renaissance Power, LLC**
**950 North Division Street**
**Carson City, MI 48811**



**NTH Project No. 73-130145-02**
**October 22, 2013**



**NTH Consultants, Ltd.**
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# 1.0 INTRODUCTION

NTH Consultants, Ltd (NTH) was retained by Renaissance Power, LLC (Renaissance Power) to conduct testing for particulate matter less than 10 microns ($PM_{10}$), volatile organic compounds (VOCs), and formaldehyde emissions on the exhaust of the simple-cycle combustion turbine, designated as EUTURBINE2SC. The test was performed at 75 percent load and 100 percent load. Additionally, NTH performed Method 9 visible emissions (VE) readings at the exhaust of EUTURBINE2SC at 100 percent load. The facility is located in Carson City, Michigan.

## 1.1 Purpose of Test

The testing was performed to satisfy the requirements found in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) No. MI-ROP-N6873-2010.

## 1.2 Test Date Requirement

This test program was performed on September 16-19, 2013.

## 1.3 Project Contact Information

| Location | Address | Contact |
|---|---|---|
| Test Facility | Renaissance Power, LLC<br>950 North Division Street<br>Carson City, MI 48811 | Mr. Matt Kaleyta<br>989-584-2333 ext. 225<br>mkaleyta@renaissance-power.com |
| Company Representative | Renaissance Power, LLC<br>950 North Division Street<br>Carson City, MI 48811 | Mr. Harvey Brophy<br>989-584-2333<br>hbrophy@renaissance-power.com |
| Test Company Representative | NTH Consultants, Ltd.<br>1430 Monroe Avenue NW, Suite 180<br>Grand Rapids, MI 49505 | Mr. Graziano Gozzi<br>616-451-6262<br>ggozzi@nthconsultants.com |
| State Representative | MDEQ<br>525 West Allegan Street<br>Lansing, MI 48909-7973 | Mr. David Patterson<br>517-241-7469<br>pattersond@michigan.gov |
| State Representative | MDEQ<br>350 Ottawa Avenue NW, Unit 10<br>Grand Rapids, MI 49503 | Ms. April Lazzaro<br>616-356-0248<br>lazzaroa@michigan.gov |

This test was performed by Messrs. Graziano Gozzi, Tyler Hanna, Kyle Daneff, Rhiana Dornbos, Chris Occhipinti, Cody Kurzer, Jesse Veenkant, and Robert Williams, from NTH. Operations were coordinated by Messrs. Matt Kaleyta and Harvey Brophy of Renaissance Power.

### 1.4 Summary of Results

The emissions test results are summarized in Table 1-1. Detailed results are presented in Tables 1 and 2 located at the end of this report. Calculations can be found in Appendix D.

**Table 1-1**
**EUTURBINE2SC**

| Pollutant | 70% | 100% | Limit |
|---|---|---|---|
| VOC ppm | 0.04 | 1.79 | 2 |
| PM Lb/hr | 6.5 | 7.29 | 9 |
| Formaldehyde Lb/hr | 0.07 | 0.38 | |

## 2.0 PROCESS DESCRIPTION

The Renaissance Power facility located in Carson City, Michigan is a peaking plant that produces electricity from four (4) simple cycle natural gas-fired turbines designated as EUTURBINE1SC - EUTURBINE4SC with a total combined power output of approximately 680 Megawatts (MW). EUTURBINE2SC consists of a compressor, combustion turbine, and generator. Mechanical energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in a four-stage turbine. The mechanical energy is converted to electrical energy through the generator. Each turbine is equipped with dry low-$NO_x$ burners.

## 3.0 REFERENCE METHODOLOGIES

The following U.S. EPA approved test methods and procedures were used, in accordance with specifications stipulated in Appendix A to 40 CFR Part 60.

### 3.1 Traverse Points

The number of traverse points for each source was determined in accordance with U.S. EPA Method 1. A total of thirty-two (32) measurement points were selected for the exhaust flow rate determinations. Four (4) sample ports on both the north and south side of the duct were utilized for the testing, which resulted in the use of four (4) traverse points for each port, as depicted in Figure 1.

### 3.2 Velocity and Temperature

Exhaust gas velocity and temperature measurements were determined using U.S. EPA Method 2. The pressure differential (delta P) was measured at each traverse point using a calibrated Type S Pitot tube connected to an appropriately sized inclined water column manometer. Exhaust gas temperatures were recorded with a calibrated chromel-alumel (Type"K") thermocouple attached directly to the Pitot tube.

### 3.3 Molecular Weight

The exhaust gas compositions were determined using U.S. EPA Reference Method 3A. The oxygen and carbon dioxide concentrations were used to determine exhaust gas composition and molecular weight.

### 3.4 Moisture

The exhaust gas moisture content was determined in accordance with U.S. EPA Method 4 in conjunction with the Method 5 Sampling Train. All impingers were weighed before and after each run to determine the moisture content of the exhaust gas.

### 3.5 Particulate Matter (PM)

Particulate matter (PM) samples were withdrawn isokinetically from the outlet following the guidelines of U.S. EPA Method 5. The sampling train for the Method 5 testing consisted of a nozzle, a heated probe, a heated 83 mm glass fiber filter, four (4) chilled impingers, and a metering console. The particulate samples were collected in the nozzle and filters. At the conclusion of each test run, the filter was removed from the

filter holder, visually inspected and placed into a separate petri dish, with the front half of the filter holder rinsed with acetone into a separate sample bottle. The acetone blank was collected from the acetone stock.

At the laboratory, U.S. EPA Method 5 analytical procedures were used to analyze the samples for PM at the outlet. The acetone rinses were evaporated and desiccated to dryness, and the residue weighed to determine the amount of PM collected. The filters were also desiccated to remove the uncombined water and then weighed to determine the amount of PM collected. A diagram of the Method 5 sampling apparatus is appended in Figure 2.

### 3.6 Opacity

Opacity observations were performed in accordance with the specifications stipulated in U.S. EPA Reference Method 9, and the latest revisions thereof. The VE observations were recorded to the nearest 5 percent (%) at 15-second intervals. Ten (10) sets of 24 observations (four (4) per minute, at 15-second intervals; 6-minute test durations) were conducted. The 6-minute average opacity was calculated by summing each set of 24 observations and dividing by the total number of observations made in that time period.

### 3.7 Volatile Organic Compounds (VOC)

A Flame Ionization Analyzer (FIA) was used to measure concentrations of Volatile Organic Compounds in the sample gas following the guidelines of U.S. EPA Method 25A. The analyzer was calibrated at a minimum of four points: zero gas, low-level gas (25 – 30 percent of calibration span), mid-level gas (45 – 55 percent of calibration span), and high-level gas (90 – 100 percent of span) using propane gas standards.

### 3.8 Condensable Particulate Matter (CPM)

The condensable particulate matter concentrations were determined by U.S. EPA Reference Method 202. The exhaust gases were extracted from the sample stream isokinetically through a titanium nozzle, a heated titanium probe, a glass coil type condenser, a dropout impinger and a modified Greenburg-Smith impinger with an open tube tip, a condensable particulate matter filter holder containing a Teflonc membrane filter, one impinger containing 100 mL of water and one impinger containing silica gel for moisture collection. All glassware used in the Method 202 sampling train was cleaned prior to testing according to method specifications. During the testing, the condensable particulate matter filter temperatures were monitored

and maintained at the method appropriate temperatures through the use of a recirculation pump attached to the condenser, and chilled water surrounded the impinger apparatus. Figure 2 shows the Method 202 apparatus.

### 3.9 Aldehyde and Ketone

Aldehyde samples were withdrawn at a constant rate from the emission source and were collected in aqueous acidic 2,4-dinitrophenylhydrazine. Formaldehyde present in the emissions reacts with the 2,4-dinitrophenylhydrazine to form the formaldehyde dinitrophenylhydrazone derivative. The dinitrophenylhydrazone derivative is extracted, solvent-exchanged, concentrated, and then analyzed by high performance liquid chromatography (HPLC) according to Method 8315 or other appropriate techniques.

## 4.0 QUALITY ASSURANCE

Each promulgated U.S. EPA reference method described above is accompanied by a statement indicating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each. To that end, NTH attempts to minimize any factors in the field that could increase error by implementing a quality assurance program into every testing activity segment.

All test apparatus will be calibrated and checked for leaks according to appropriate U.S. EPA QA/QC standards. All samples were clearly identified, marked, and sealed with Teflon tape for transport to NTH's laboratory. All field data was recorded onto appropriate data sheets and calculated results will be reviewed prior to release.

The pitot tubes and thermocouples used to measure the exhaust gas during this test program were calibrated according to the procedures outlined in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods,* Method 2, *Type S Pitot Tube Inspection,* and Calibration Procedure 2E *Temperature Sensor.*

U.S. EPA Protocol No. 1 gas standards were used to calibrate the VOC, $O_2$, and $CO_2$ analyzers during the test program. These gases are certified according to the *U.S. EPA Traceability Protocol for Assay & Certification*

*of Gaseous Calibration Standards; Procedure G-1; September, 1997*, and are certified to have a total relative uncertainty of ±1 percent.

The DAS software used during the testing is programmed to the specifications described in the applicable U.S. EPA Method in use during the test, and operates based on each pre-programmed analyzer span value.

## 5.0 SUMMARY OF RESULTS

No operational problems were encountered during the test program, except during run #2. Post leak check on the south side exhibited higher values than method allows. An additional run, #4, was performed in order to have a three run average, at the 100 percent load. Test results are tabulated and can be found in Tables 1-4 at the end of this section. Laboratory sample analysis data can be found in Appendix B, electronic data in Appendix C, process data in Appendix E, handwritten data in Appendix F, and quality assurance/quality control information in Appendix G.

# TABLES

# TABLE 1

**Renaissance Power LLC**

**Summary of Emissions for PM, VOC, and Formaldehyde**

**CT Unit # 2**
**100 % Load**
**9/17-18/13**

| Run No. | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| Date | September 17, 2013 | September 17, 2013 | September 18, 2013 | |
| Run Time | 1408-1548 | 1723-1945 | 1211-1351 | |
| Sample Duration (Minutes) | 100 | 100 | 100 | |
| Sample Volume (dscf) | 72.8 | 72.5 | 72.4 | 72.6 |
| **Method 0011 Test Fixed Gases** | | | | |
| Oxygen, % by volume, dry | 13.9 | 13.7 | 13.7 | 13.8 |
| Carbon dioxide, % by volume, dry | 3.80 | 3.80 | 3.80 | 3.8 |
| Moisture, % by volume | 7.4 | 7.2 | 6.7 | 7.1 |
| **North PM Test Volumetric Flow Rates** | | | | |
| Actual Cubic Feet Minute | 1,379,341 | 1,346,119 | 1,270,094 | |
| Standard Cubic Feet Minute | 465,037 | 447,256 | 419,337 | |
| Dry Standard Cubic Feet Minute | 448,894 | 415,091 | 395,898 | |
| **South PM Test Volumetric Flow Rates** | | | | |
| Actual Cubic Feet Minute | 1,587,886 | 1,566,029 | 1,532,634 | |
| Standard Cubic Feet Minute | 532,805 | 515,662 | 502,798 | |
| Dry Standard Cubic Feet Minute | 493,038 | 478,767 | 446,512 | |
| **Total Stack Volumetric Flow Rates (From North and South PM Testing)** | | | | |
| Actual Cubic Feet Minute | 2,967,226 | 2,912,148 | 2,802,728 | |
| Standard Cubic Feet Minute | 997,842 | 962,917 | 922,135 | |
| Dry Standard Cubic Feet Minute | 941,933 | 893,858 | 842,409 | |

| Emission Rate | 1 | 2 | 3 | |
|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | |
| Total VOC (ppmv) | 1.240 | 2.870 | 1.270 | 1.79 |
| Total VOC (lb/MMBtu) | 3.91E-03 | 8.95E-03 | 4.02E-03 | 5.63E-03 |
| | | | | |
| **Formaldehyde** | | | | |
| Total Formaldehyde (lb/MMBtu) | 3.64E-05 | 4.69E-04 | 3.55E-05 | 1.80E-04 |
| Total Formaldehyde (lb/hr) | 0.08 | 0.99 | 0.07 | 0.38 |
| | | | | |
| **North Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 1.58 | 0.85 | 0.45 | 0.96 |
| Filterable PM (lb/MMBtu) | 1.5E-03 | 8.9E-04 | 5.0E-04 | 9.7E-04 |
| Condensable PM (lb/hr) | 14.32 | 6.59 | 2.79 | 7.90 |
| Condensable PM (lb/MMBtu) | 1.4E-02 | 6.9E-03 | 3.1E-03 | 7.9E-03 |
| $PM_{10}$ (lb/hr) | 15.90 | 7.44 | 3.24 | 8.86 |
| $PM_{10}$ (lb/MMBtu) | 1.5E-02 | 7.8E-03 | 3.5E-03 | 8.9E-03 |
| | | | | |
| **South Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 1.18 | 4.10 | 0.86 | 2.05 |
| Filterable PM (lb/MMBtu) | 1.0E-03 | 3.7E-03 | 8.4E-04 | 1.9E-03 |
| Condensable PM (lb/hr) | 6.95 | 3.25 | 1.23 | 3.81 |
| Condensable PM (lb/MMBtu) | 6.1E-03 | 2.9E-03 | 1.2E-03 | 3.4E-03 |
| $PM_{10}$ (lb/hr) | 8.13 | 7.35 | 2.10 | 5.86 |
| $PM_{10}$ (lb/MMBtu) | 7.1E-03 | 6.7E-03 | 2.0E-03 | 5.3E-03 |
| | | | | |
| **Combined Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 1.37 | 2.59 | 0.67 | 1.54 |
| Filterable PM (lb/MMBtu) | 1.3E-03 | 2.4E-03 | 6.8E-04 | 1.4E-03 |
| Condensable PM (lb/hr) | 10.46 | 4.80 | 1.96 | 5.74 |
| Condensable PM (lb/MMBtu) | 9.8E-03 | 4.8E-03 | 2.1E-03 | 5.5E-03 |
| $PM_{10}$ (lb/hr) | 11.83 | 7.39 | 2.64 | 7.29 |
| $PM_{10}$ (lb/MMBtu) | 1.1E-02 | 7.2E-03 | 2.7E-03 | 7.0E-03 |

| | |
|---|---|
| dscf: | dry standard cubic feet |
| lb/hr: | pounds per hour |
| lb/ton of MMBtu: | pounds per ton of MMBtu |

# TABLE 2

**Renaissance Power LLC**

**Summary of Emissions for PM, VOC, and Formaldehyde**

**CT Unit # 2**
**75% Load**
**9/19/2013**

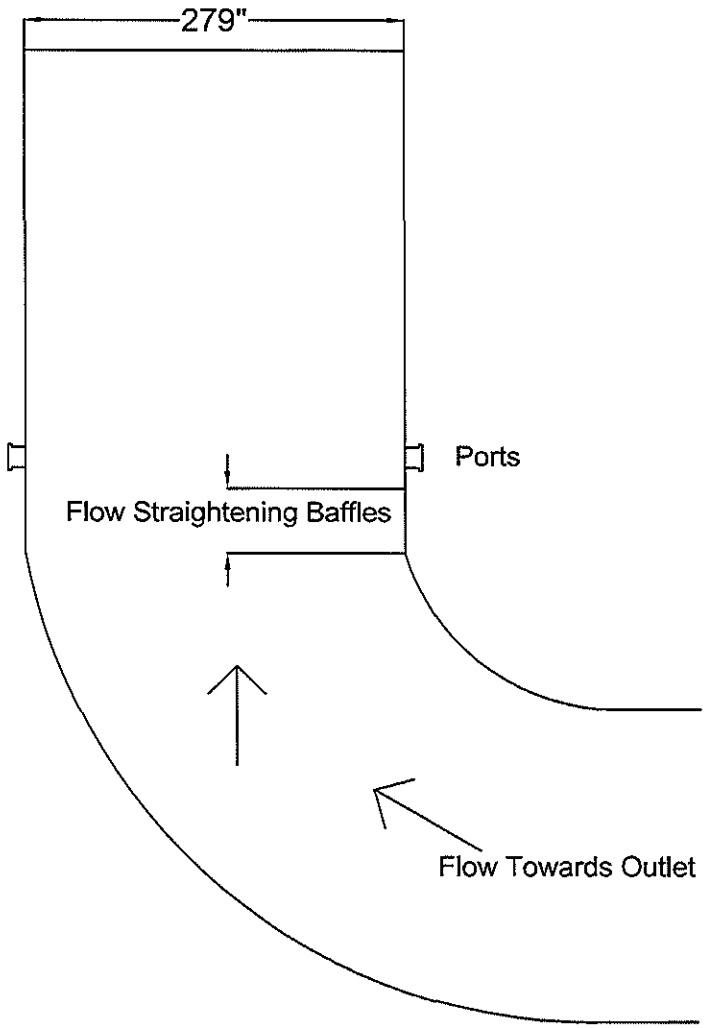
| Run No. | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| Date | September 19, 2013 | September 19, 2013 | September 19, 2013 | |
| Run Time | 1029-1209 | 1416-1556 | 1802-1942 | |
| Sample Duration (Minutes) | 100 | 100 | 100 | |
| Sample Volume (dscf) | 72.4 | 71.9 | 72.4 | 72.2 |
| **Volumetric Flow Rates** | | | | |
| Actual Cubic Feet Minute | 2,184,637 | 2,285,496 | 2,359,227 | 2,276,453 |
| Standard Cubic Feet Minute | 709,197 | 741,457 | 765,286 | 738,646 |
| Dry Standard Cubic Feet Minute | 655,551 | 677,424 | 698,991 | 677,322 |
| **Fixed Gases** | | | | |
| Oxygen, % by volume, dry | 13.7 | 13.7 | 13.7 | 13.7 |
| Carbon dioxide, % by volume, dry | 3.80 | 3.80 | 3.80 | 3.8 |
| Moisture, % by volume | 7.6 | 8.6 | 8.7 | 8.3 |
| **North PM Test Volumetric Flow Rates** | | | | |
| Actual Cubic Feet Minute | 1,080,019 | 1,127,098 | 1,182,378 | |
| Standard Cubic Feet Minute | 351,089 | 366,437 | 384,485 | |
| Dry Standard Cubic Feet Minute | 323,183 | 337,385 | 346,822 | |
| **South PM Test Volumetric Flow Rates** | | | | |
| Actual Cubic Feet Minute | 1,098,551 | 1,139,868 | 1,143,894 | |
| Standard Cubic Feet Minute | 356,131 | 369,003 | 370,146 | |
| Dry Standard Cubic Feet Minute | 340,585 | 365,124 | 358,982 | |
| **Total Stack Volumetric Flow Rates (From North and South PM Testing)** | | | | |
| Actual Cubic Feet Minute | 2,178,569 | 2,266,966 | 2,326,272 | |
| Standard Cubic Feet Minute | 707,220 | 735,440 | 754,631 | |
| Dry Standard Cubic Feet Minute | 663,768 | 702,509 | 705,803 | |

| Emission Rate: | | | | |
|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | |
| Total VOC (ppmv) | 0 | 0.130 | 0 | 0.04 |
| Total VOC (lb/MMBtu) | 0 | 3.97E-04 | 0 | 1.32E-04 |
| | | | | |
| **Formaldehyde** | | | | |
| Total Formaldehyde (lb/MMBtu) | 4.38E-05 | 4.43E-05 | 4.60E-05 | 4.47E-05 |
| Total Formaldehyde (lb/hr) | 0.07 | 0.07 | 0.08 | 0.07 |
| | | | | |
| **North Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 0.88 | 1.26 | 1.25 | 1.13 |
| Filterable PM (lb/MMBtu) | 1.2E-03 | 1.6E-03 | 1.5E-03 | 1.4E-03 |
| Condensable PM (lb/hr) | 1.51 | 2.97 | 17.30 | 7.26 |
| Condensable PM (lb/MMBtu) | 2.0E-03 | 3.7E-03 | 2.1E-02 | 8.9E-03 |
| $PM_{10}$ (lb/hr) | 2.40 | 4.23 | 18.56 | 8.39 |
| $PM_{10}$ (lb/MMBtu) | 8.6E-06 | 1.4E-05 | 5.8E-05 | 2.7E-05 |
| | | | | |
| **South Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 1.63 | 4.24 | 4.40 | 3.42 |
| Filterable PM (lb/MMBtu) | 2.0E-03 | 4.9E-03 | 2.2E-03 | 3.0E-03 |
| Condensable PM (lb/hr) | 1.70 | 0.74 | 1.28 | 1.24 |
| Condensable PM (lb/MMBtu) | 2.1E-03 | 8.5E-04 | 6.3E-04 | 1.2E-03 |
| $PM_{10}$ (lb/hr) | 3.32 | 4.98 | 5.67 | 4.66 |
| $PM_{10}$ (lb/MMBtu) | 4.1E-03 | 5.7E-03 | 2.8E-03 | 4.2E-03 |
| | | | | |
| **Combined Particulate Matter** | | | | |
| Filterable PM (lb/hr) | 1.27 | 2.81 | 2.85 | 2.31 |
| Filterable PM (lb/MMBtu) | 1.6E-03 | 3.3E-03 | 1.9E-03 | 2.3E-03 |
| Condensable PM (lb/hr) | 1.61 | 1.81 | 9.15 | 4.19 |
| Condensable PM (lb/MMBtu) | 2.0E-03 | 2.2E-03 | 1.1E-02 | 5.0E-03 |
| $PM_{10}$ (lb/hr) | 2.87 | 4.62 | 12.00 | 6.50 |
| $PM_{10}$ (lb/MMBtu) | 2.1E-03 | 3.0E-03 | 1.5E-03 | 2.2E-03 |

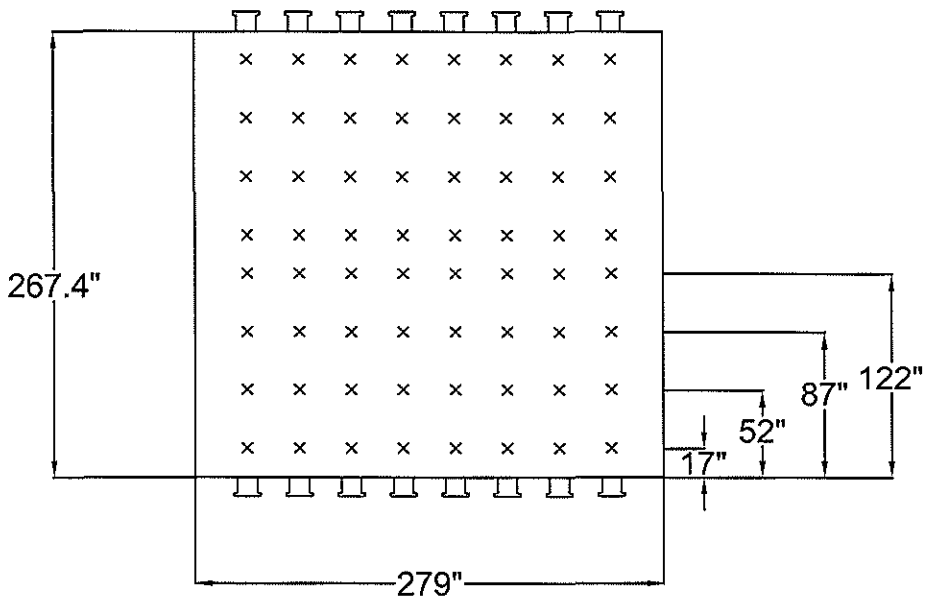
| | |
|---|---|
| dscf: | dry standard cubic feet |
| lb/hr: | pounds per hour |
| lb/ton of MMBtu: | pounds per ton of MMBtu |

# FIGURES

## Profile View




## Plan View




Traverse Points

## Notes

1. Traverse points mirrored for both ports
2. X denotes a traverse point
3. Traverse point locations shown to the nearest inch

| | | | |
|---|---|---|---|
| NTH | Drafted by: TH | Job Number: 73-130145 | Client: Renaissance Power, LLC |
| | NTH Consultants, Ltd. | Figure 1: Sample of Testing Locations | |

Figure 2. U.S. EPA Method 202

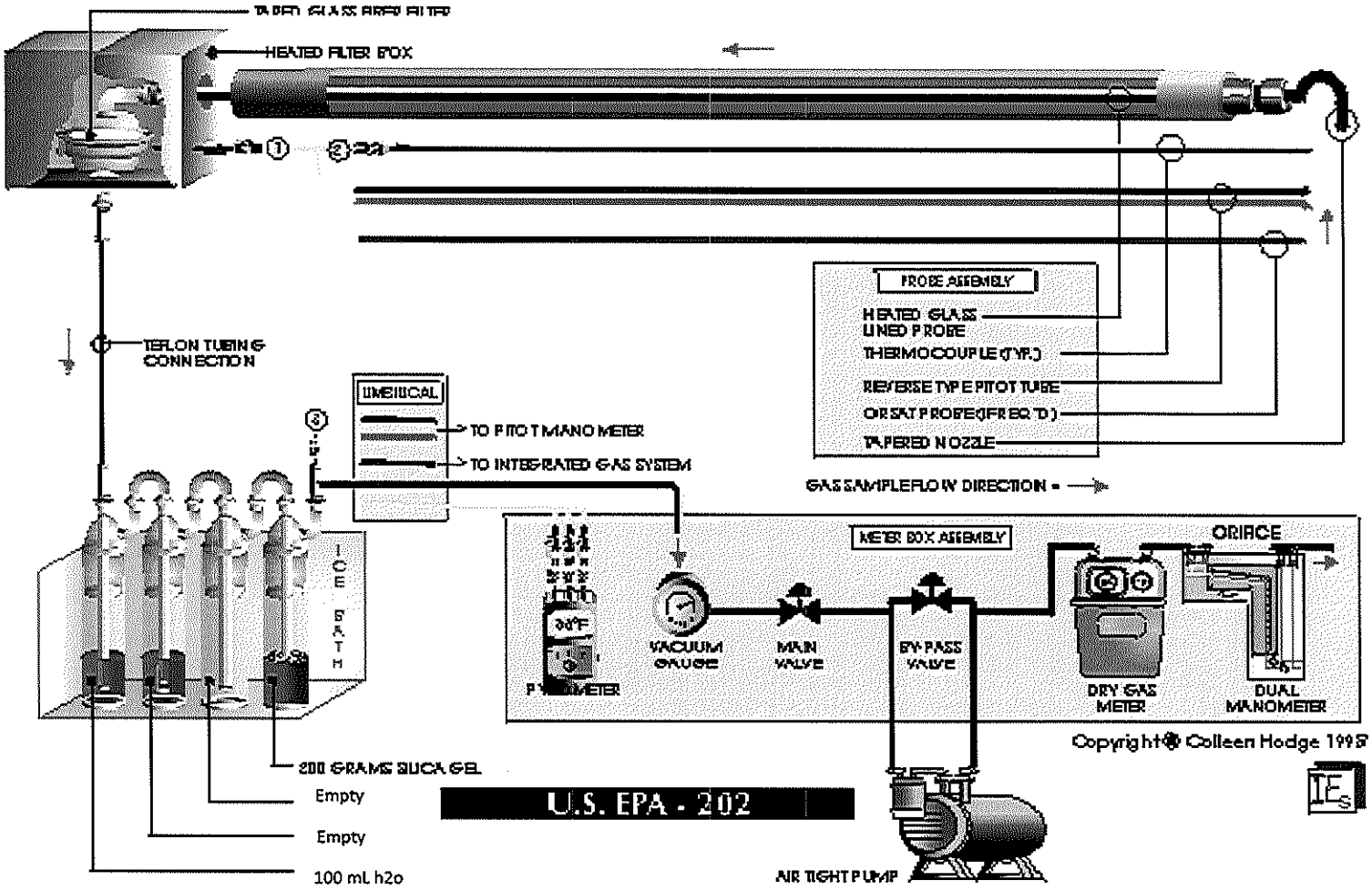
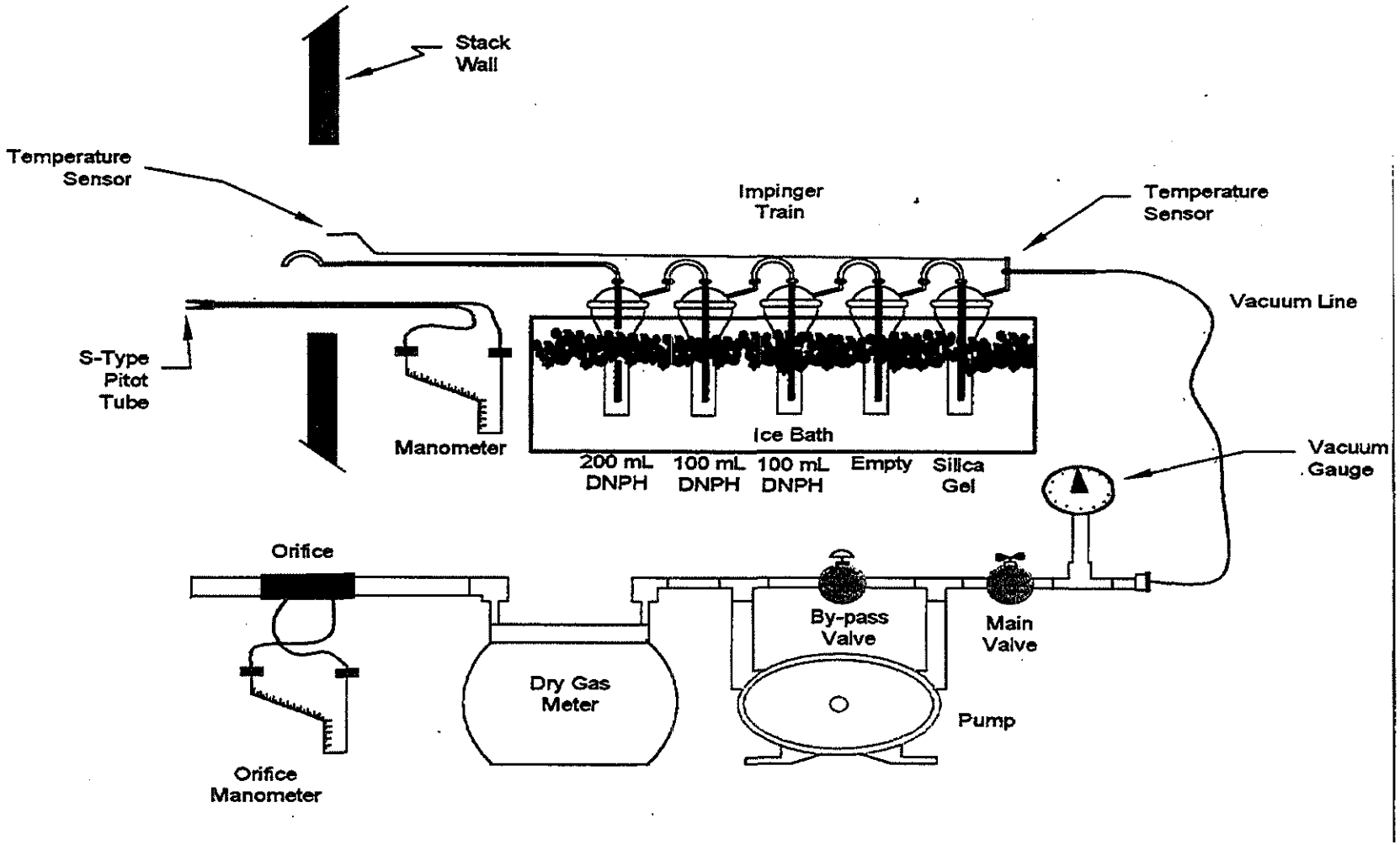


**Figure 3**
**OSW Method 0011**



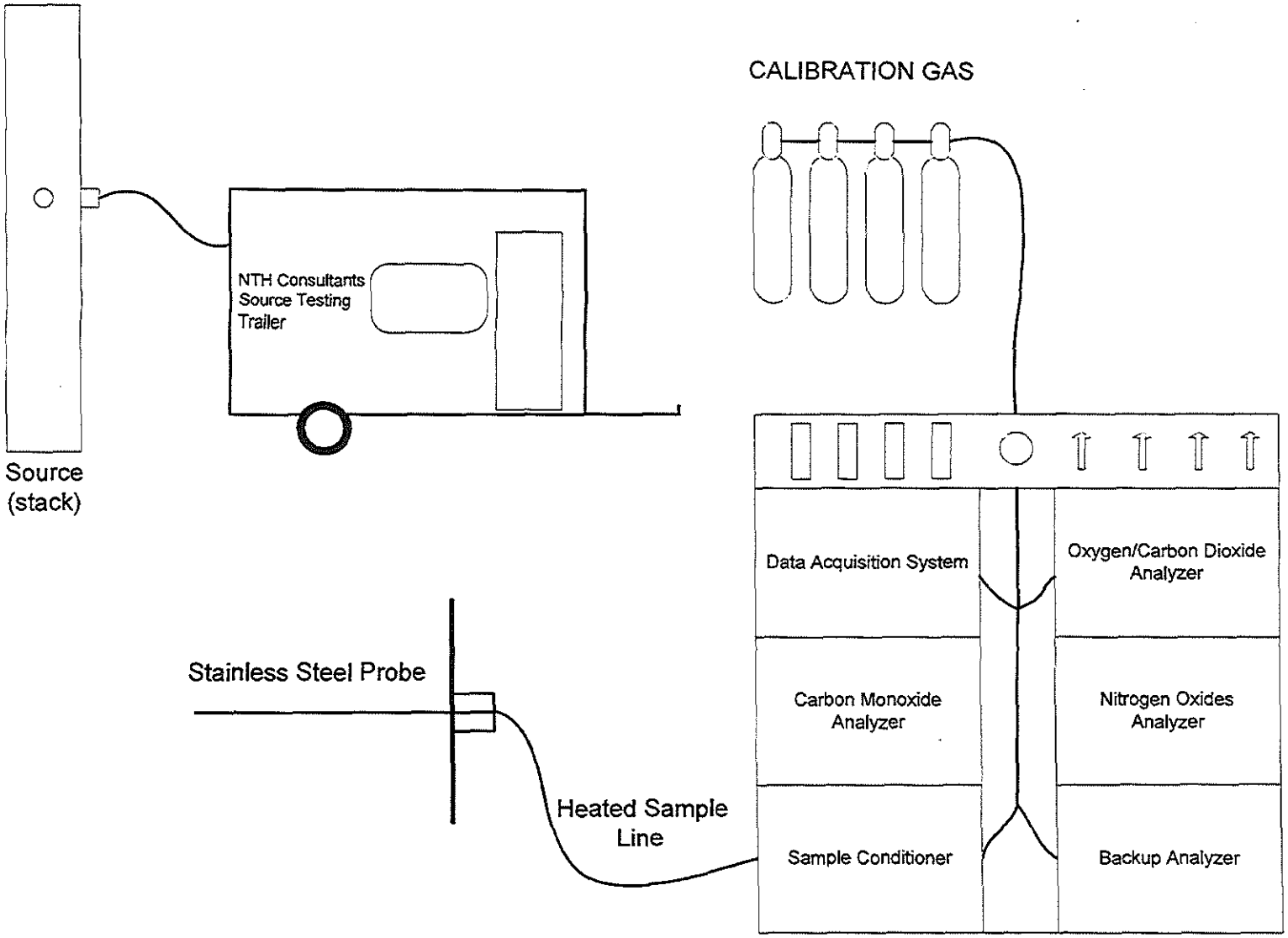



FIGURE 4
NTH Consultants, Ltd.

NTH CEMS/Reference Method
Analyzers