Consumers Energy

Count on Us

# Compliance Test Report

## EUENGINE1

## White Pigeon Compressor Station
## 68536 A Road, Route 1
## White Pigeon, Michigan 49099

**Test Date: July 7, 2016**

**Report Submitted:**
**August 29, 2016**

**Work Order No. 27463277**
**Report Revision 0**

**Test Performed by the Consumers Energy Company**
**Regulatory Compliance Testing Section**
**Laboratory Services Department**

# 1.0 INTRODUCTION

***Identification, location and dates of tests***

This report summarizes the results of testing conducted on July 7, 2016 at Consumers Energy Company's (CEC) White Pigeon Compressor Station. CEC's Regulatory Compliance Testing Section (RCTS) conducted a performance test on one (1) 4-stroke lean burn (4SLB) natural gas-fired, reciprocating internal combustion engines (RICE), identified as EUENGINE1. [This unit was out of service for repairs during the March 2016 test event.] The engine is located and operating at the White Pigeon Compressor Station in White Pigeon, Michigan. Please note that reproducing portions of this test report may omit critical substantiating documentation or cause information to be taken out of context. If any portion of this report is reproduced, please exercise due care in this regard.

***Purpose of testing***

The purpose of the testing was to evaluate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for RICE, 40 CFR Part 63, Subpart ZZZZ, and the Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE), 40 CFR Part 60, Subpart JJJJ, as well as to demonstrate compliance with the facility's current ROP (No. MI-ROP-N5573-2013) emissions limits, as cited in Table I of FGENGINES Flexible Group Conditions. The following table describes the applicable regulations and test parameters:

**Table 1**
**Summary of Test Parameters**

| Source | Test Parameters | Underlying Regulation |
|---|---|---|
| EUENGINE1 | Carbon Monoxide (CO) & diluent gas (Oxygen ($O_2$) or Carbon Dioxide ($CO_2$)) both upstream and downstream from the oxidation catalyst (% reduction) | Subpart ZZZZ |
| | Nitrogen Oxides ($NO_x$), CO[1] & Volatile Organic Compound (VOC) emissions at the engine exhaust (outlet) | Subpart JJJJ |

[1] Please note in 40 CFR Part 60, Subpart JJJJ, Table 1, footnote (b) indicates a new or reconstructed non-emergency lean burn SI ICE greater than or equal to 250 brake horsepower meeting 40 CFR Part 63, Subpart ZZZZ requirements are not required to comply with the CO emission standards in Subpart JJJJ.

***Brief description of source***

The White Pigeon Compressor Station is a natural gas compressor station. The purpose of the facility is to compress and maintain natural gas pipeline system pressure along the pipeline system. EUENGINE1 is a Caterpillar Model G3608 engine, 4SLB design and exclusively fired with pipeline quality natural gas. The engine is equipped with oxidation catalysts to reduce CO and VOC emissions.

***Names, addresses, and telephone numbers of the contacts for information regarding the test and the test report, and names and affiliation of all personnel involved in conducting the testing***

A Test Protocol, dated December 16, 2015, was submitted and subsequently approved by the MDEQ in their letter dated January 27, 2016. RCTS Technical Analysts Joe Mason and Dillon King performed the test on July 7, 2016. CEC Senior Engineer Ms. Amy Kapuga was onsite to coordinate the collection of process data. White Pigeon Field Leader, Mr. Timothy Wolf, coordinated the test and CEC Senior Technician, Craig Jaeger, collected operating data. MDEQ representatives Mr. David Patterson and Ms. Amanda Chapel were on site on July 7, 2016 to witness a portion of this test event.

**Table 2**
**Test Program Participants**

| Responsible Party | Address | Contact |
|---|---|---|
| Test Facility | White Pigeon Compressor Station<br>68536 A Road<br>White Pigeon, Michigan 49099 | Mr. Timothy Wolf<br>269-483-2902<br>timothy.wolf@cmsenergy.com |
| Corporate Air Quality Contact | Consumers Energy Company<br>Environmental Services Department<br>1945 West Parnall Road<br>Jackson, Michigan 49201 | Ms. Amy Kapuga<br>517-788-2201<br>amy.kapuga@cmsenergy.com |
| Test Representative | Consumers Energy Company<br>Regulatory Compliance Testing Section<br>17010 Croswell Street<br>West Olive, Michigan 49460 | Mr. Joe Mason, QSTI<br>231-720-4856<br>joe.mason@cmsenergy.com |
| State Representative | Michigan Department of Environmental Quality<br>525 West Allegan St.<br>Lansing, Michigan 48909 | Mr. David Patterson<br>517-284-6782<br>pattersond2@michigan.gov |
| State Representative | Michigan Department of Environmental Quality<br>7953 Adobe Rd.<br>Kalamazoo, Michigan 49009 | Ms. Amanda Chapel<br>269-567-3551<br>chapel@michigan.gov |

RECEIVED

AUG 3 0 2016

AIR QUALITY DIV.

## 2.0 SUMMARY OF RESULTS

***Operating Data***

Operating data collected during each test run included catalyst inlet temperature, pressure drop across catalyst, engine load, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure, discharge pressure, and horsepower. The purpose of documenting engine horsepower is to verify engine load during the performance test, as Subpart ZZZZ § 63.6620 (b) states *the test must be conducted at any load condition within plus or minus 10 percent of 100 percent load.* Engine load was obtained by dividing the recorded horsepower value observed during each test run by the rated engine horse power.

***Applicable Permit Number***

The White Pigeon Compressor Station is currently operating pursuant to the terms and conditions of Renewable Operating Permit (ROP) No. MI-ROP- N5573-2013. A performance test was conducted, as required, on one (1) 4SLB natural gas-fired RICE, identified as EUENGINE1.

***Results***

The purpose of the testing was to evaluate compliance with both (a) the National Emission Standards for Hazardous Air Pollutants (NESHAP) for RICE, 40 CFR Part 63, Subpart ZZZZ, and (b) Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE), 40 CFR Part 60, Subpart JJJJ. A summary of the test results are presented below.

**Table 3**
**Summary of 40 CFR 63 Subpart ZZZZ Results**

| Source | CO Reduction Efficiency (%) [ZZZZ Limit = ≥93%] | Catalyst Inlet Temperature (°F) [ZZZZ Limit = ≥450°F and ≤1350°F] | Catalyst Pressure Drop (Inches Water Gauge) [ZZZZ Limit = ±2" from Initial Test] | Initial Catalyst Pressure Drop (Inches Water Gauge) |
|---|---|---|---|---|
| EUENGINE1 | 99.3 | 793.6 | 2.26 | 3.45 |

Based on the dry CO concentrations measured at the oxidation catalyst inlet and outlet corrected to 15% $O_2$, the above results indicate the oxidation catalysts are operating at a CO reduction efficiency greater than the 93 percentage requirement in Subpart ZZZZ. The associated oxidation catalyst also meets the operating requirements for catalyst inlet temperature and pressure drop across the catalyst.

In addition, $NO_x$, CO and VOC emission rates were verified for the natural gas-fired RICE pursuant to MI-ROP-N5573-2013, FGENGINES, Conditions I.1, I.2 and IX.2.

**Table 4**
**Summary of 40 CFR 60 Subpart JJJJ Results**

| Source | $NO_x$ Emission Rate (g/hp-hr) [ROP Limit = 0.5; JJJJ Limit = 2.0] | CO Emission Rate (g/hp-hr) [ROP Limit = 0.2[1]; JJJJ Limit = 4.0] | VOC Emission Rate, Expressed as NMOC (g/hp-hr) [JJJJ Limit = 1.0] |
|---|---|---|---|
| EUENGINE1 | 0.47 | 0.004 | 0.339 |

The NOx, CO and VOC engine emission rates shown above all fall within the permit requirements, as well as the applicable emission limits within 40 CFR Part 60, Subpart JJJJ in cases where the permit does not contain an explicit emission limit (i.e., VOCs).

## 3.0 SOURCE DESCRIPTION

***Description of Process***

The White Pigeon Compressor Station is a natural gas compressor station. The purpose of the facility is to maintain pressure of natural gas in order to move it along the pipeline system. Four (4) natural gas-fired reciprocating engine driven compressor units, designated at EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4, were installed in 2010 to maintain station reliability, working in conjunction with several other grandfathered RICE located at the facility.

The $NO_x$ emissions from each of the engines are minimized through the use of lean-burn combustion technology. Lean-burn combustion refers to a high level of excess air (generally 50% to 100% relative to the stoichiometric amount) in the combustion chamber. The excess air absorbs heat during the combustion process, thereby reducing the combustion temperature and pressure and resulting in lower $NO_x$ emissions.

Each of the engines is also equipped with oxidation catalysts. The catalysts are designed in a modular manner, and each Caterpillar Model G3616 engine is equipped with four catalyst modules, while the Caterpillar Model G3608 engine is equipped with two catalyst modules. The catalysts use proprietary materials in order to lower the temperature at which the oxidation process occurs for CO and other organic compounds. As a result, the oxidation process will occur at the exhaust gas temperatures generated by the engines. The catalyst vendor has guaranteed a minimum CO destruction efficiency of 93%. The estimated formaldehyde and non-methane, non-ethane hydrocarbon (NMNEHC) destruction efficiencies are 85% and 75%, respectively.

***Process Flow Sheet or Diagram***

NA

***Type and Quantity of Raw Material Processed During the Tests***

NA

***Maximum and Normal Rated Capacity of the Process***

The White Pigeon Compressor Station operates four natural gas fired, 4SLB Caterpillar engines equipped with oxidation catalysts for CO and formaldehyde reduction. The three Model 3616's and one Model 3608 are operated to maintain natural gas main pipeline transport pressure to various storage facilities located in Michigan and/or local distribution companies. The following table contains the pertinent tested engine specifications.

**Table 5**
**Summary of Specifications for EUENGINE1**

| Parameter [1] | EUENGINE1 |
|---|---|
| Make | Caterpillar |
| Model | G3608 |
| Output (brake-horsepower) | 2,370 |
| Heat Input, LHV (mmBtu/hour) | 16.1 |
| Exhaust Gas Temp. (ºF) | 857 |

[1] All engine specifications are based upon vendor data for operation at 100% of rated engine capacity.

***Description of Process Instrumentation Monitored During the Test***

Engine process data collected included catalyst inlet temperature, pressure drop across the catalyst, engine load, horsepower, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure and discharge pressure. The preceding operating data was logged at least once every clock minute and then averaged to determine the per-test run values. Ambient temperature, barometric pressure, and humidity were collected and recorded every twenty minutes during test runs and averaged to determine ambient weather conditions for each test run performed.

## 4.0 SAMPLING AND ANALYTICAL PROCEDURES

***Description of sampling train(s) and field procedures***

Triplicate one-hour runs were performed on EUENGINE1 to determine CO reduction efficiency by concurrently measuring $O_2$ and CO concentrations at the oxidation catalyst inlet and outlet (engine exhaust). $NO_x$ and VOC concentrations were also measured at the engine exhaust. Exhaust gas moisture content was calculated via the results of the natural gas analysis (F-factors) performed on the day of the testing in conjunction with ambient weather conditions as per U.S. EPA Reference Method 4, Alternative Procedure 16.4. The U.S. EPA Test Methods described within the test protocol were used throughout the test, without deviation. The CO reduction efficiency test methods and calculations were consistent with those specified in 40 CFR Part 63, Subpart ZZZZ §63.6620 Equation 1 and Table 4. The $NO_x$, CO and VOC emission rates were measured and calculated using Equations 1-3 in 40 CFR Part 60, Subpart JJJJ §60.4244 and Table 2.

RCTS measured $O_2$ concentrations in order to satisfy Subpart ZZZZ requirements for correcting CO concentrations to 15% $O_2$ prior to determining percent CO reduction. The $F_c$ and $F_d$ fuel factors used to derive the $CO_2$ correction factors were based on the daily natural gas fuel samples and analyses.

The catalyst inlet and engine exhaust traverse points were typical from a U.S. EPA Method 1 perspective. Traverse points on the engine exhaust stack were located at 16.7, 50.0, and 83.3% of the stack diameter in a line through the centroidal area as described in Method 7E.

All components of the $CO_2$, $O_2$, $NO_x$, CO and VOC extractive sample systems in contact with flue gas were constructed of Type 316 stainless steel and/or Teflon. The $CO_2$, $O_2$, $NO_x$ and CO samples were routed to a sample conditioner to remove moisture from the gas prior to injection into the respective analyzer, while the VOC sample was injected directly into the analyzer from the heated sample line as the VOC instrument measures gas on a wet basis. The output signal from each analyzer was connected to a computerized data acquisition system (DAS).

The $CO_2$, $O_2$, $NO_x$, and CO analyzers were calibrated with U.S. EPA Protocol calibration gases at a minimum of three points: low (0-20% of calibration span), mid-level (40-60% of calibration span) and high-level gas (equal to the calibration span) following specifications in U.S. EPA Method 7E. The VOC instrument was calibrated with four propane in nitrogen gases following U.S. EPA Method 25A specifications at the zero level, low (25 to 35 percent of calibration span), mid (45 to 55 percent of calibration span and high (equivalent to instrument span). All instruments were operated thereafter to insure that zero drift, calibration gas drift, bias and calibration error met the specified method requirements. The extractive sample system apparatus diagram is shown in Figure 1.

The data measured from the pollutant and diluent analyzers was averaged for each run and corrected for drift and bias. The inlet and outlet CO concentrations in part per million by volume (ppmv) used for determining CO reduction efficiency were also corrected to 15 percent $O_2$ using the $CO_2$ correction factor ratio equation in 40 CFR Part 63, Subpart ZZZZ, § 63.6620 (e)(2)(ii). Both $CO_2$ and $O_2$, concentrations were measured as percent by volume, dry basis, while $NO_x$ concentrations were measured as ppmv, dry basis.

$O_2$ concentrations were monitored using a paramagnetic analyzer, respectively, following the guidelines of U.S. EPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from a Stationary Source (Instrumental Analyzer Procedure).*

$NO_x$ concentrations were monitored using a chemiluminescence analyzer following the guidelines of U.S. EPA Method 7E, *Determination of Nitrogen Oxides from Stationary Sources (Instrumental Analyzer Procedure).*

The CO concentrations were measured using an NDIR analyzer following the guidelines of U.S. EPA Reference Method 10, *Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure).*

VOC concentrations were monitored using a Thermo Model 55i Direct Methane and Non-methane Analyzer following the guidelines of U.S. EPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer (FIA)* using the drift and bias corrections specified in U.S. EPA Method 7E, *Determination of Nitrogen Oxides from Stationary Sources (Instrumental Analyzer Procedure).* This instrument is similar to a Method 25A analyzer with methane cutter in that it employs a flame ionization detector (FID) analytical principal and is capable of providing a total hydrocarbon concentration, minus methane. However, with the Thermo 55i analyzer, the method of determining the methane and non-methane organic concentrations is slightly different. Specifically, while the Thermo 55i does rely upon a FID to determine the concentration of organic compounds, it also contains a gas chromatographic column which is used to separate methane from the other organic compounds. It works by first injecting the sample gas into the column, after which the methane fraction of the sample gas moves through the column more quickly than the other organic compounds (due to its low molecular weight and high volatility). The methane then exits the column and is analyzed in the FID. After the methane has been analyzed, the column is flushed with inert carrier gas and the remaining non-methane organic compounds are then analyzed in the FID. The preceding analytical technique results in separate measurements for methane and non-methane organic compounds via the use of a single FID, and these measurements are recorded by a data acquisition system. Compared to more conventional Method 25A analyzers with methane cutters, the Thermo 55i is believed to yield more accurate low-level non-methane hydrocarbon measurements, even in the presence of high levels of methane. It should be noted that for purposes of this test program, RCTS did not quality assure the methane channel on the Thermo Model 55i analyzer.

<u>Quality Assurance Procedures</u>

Each U.S. EPA reference method performed during this test contains specific language stating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each method. To that end, CEC RCTS attempts to minimize any factors which could cause sampling errors by implementing a quality assurance (QA) program into every component of field testing, including the following information.

U.S. EPA Protocol gas standards certified according to the U.S. EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997 or May, 2012 version and certified to have a total relative uncertainty of ±1 percent were used to calibrate the analyzers during the test program. Although not required in the context of this Parts 60 and 63 test program, the vendors providing the calibration gases also participate in the Protocol Gas Verification Program (PGVP), an EPA audited program developed for 40 CFR Part 75.

The extractive sample system instruments were calibrated and operated following the appropriate method guidelines, based on specifications contained in Method 7E (as referenced in Methods 3A and 10). Before daily testing began, an Analyzer Calibration Error (ACE) test was conducted by introducing the calibration gases directly into each analyzer. If the measured response didn't meet the ±2 percent of instrument span specification, or within 0.5 ppmv absolute difference to pass the ACE check, appropriate action was taken and the ACE was repeated. Prior to beginning the first run, an initial system bias check was conducted by introducing the low and upscale calibration gases into the sampling system at the probe outlet and drawing them through the sample conditioning system in the same manner as the exhaust gas sample, while measuring the instrument response. Each instrument response must meet a specification of ≤ 5.0 percent of instrument span.

Low and upscale bias calibrations were performed after each run thereafter to quantify system calibration drift and bias. During the initial system bias tests, system response time was measured and the sample flow rate throughout the remainder of the test was monitored to maintain the sample flow rate within 10 percent of the average flow rate observed during the response time test. Sampling for each run was started after twice the system response time had elapsed.

***Description of recovery and analytical procedures***
NA

***Dimensioned sketch showing all sampling ports in relation to breeching and to upstream and downstream disturbances or obstructions of gas flow and a sketch of cross-sectional view of stack indicating traverse point locations and exact stack dimensions***
The exhaust stack configuration for the Caterpillar Model G3608 engine (i.e., EUENGINE1) is shown in Figure 2.

## 5.0 TEST RESULTS AND DISCUSSION

***Detailed tabulation of results, including process operating conditions and exhaust gas conditions***

Table 6 contains a summary of the CO percent reductions and emission rates, NOx emissions rates, and VOC emissions rates, observed for during testing conducted July 7, 2016. Comprehensive RICE operating data, individual run concentrations and emissions, calculation spreadsheets, field data sheets, calibration information, fuel analyses and analytical data are contained in Attachments 1 - 6.

***Discussion of significance of results relative to operating parameters and emission regulations***

40 CFR 63 Subpart ZZZZ

The average percent reduction of CO for EUENGINE1 was greater than the minimum required destruction efficiency. Thus, EUENGINE1 is in compliance with the CO percent reduction across the catalyst.

40 CFR 60 Subpart JJJJ

The $NO_x$, CO and VOC emission rates are within the MDEQ ROP and 40 CFR 60 Subpart JJJJ emission limits for EUENGINE1.

***Discussion of any variations from normal sampling procedures or operating conditions, which could have affected the results***

NA

***Documentation of any process or control equipment upset condition which occurred during the testing***

NA

***Description of any major maintenance performed on the air pollution control device(s) during the three month period prior to testing***

NA

***In the event of a re-test, a description of any changes made to the process or air pollution control device(s)***

NA

***Results of any quality assurance audit sample analyses required by the reference method***

NA

***Calibration sheets for the dry gas meter, orifice meter, pitot tube, and any other equipment or analytical procedures which require calibration***

Attachment 4 contains the analyzer calibration data, response time test results, $NO_2$ to NO converter efficiency check and calibration gas Certificates of Analysis.

***Sample calculations of all the formulas used to calculate the results***

Sample calculations for all formulas used in the test report are contained in Attachment 6.

***Copies of all field data sheets, including any pre-testing, aborted tests, and/or repeat attempts***

Please refer to Attachment 1 for process data collected during the test runs; Attachment 2 for calculation spreadsheets for each of the test runs; and Attachment 3 for data sheets with the measured concentrations for each test run.

***Copies of all laboratory data including QA/QC***

For this testing event, laboratory data includes the results of the natural gas fuel analyses which are presented in Attachment 5. The information in Attachment 5 also includes a calculation spreadsheet for purposes of calculating the $F_d$, $F_c$ and $F_w$ fuel factors.

RECEIVED
AUG 3 0 2016
AIR QUALITY DIV.

## TABLE 6
## SUMMARY OF RICE EFFICIENCY AND EMISSIONS
## WHITE PIGEON COMPRESSOR STATION
## EUENGINE1
## July 7, 2016

| Time Period | Run 1<br>855-955 | Run 2<br>1056-1156 | Run 3<br>1215-1315 | Averages |
|---|---|---|---|---|
| **Process Conditions** | | | | |
| Engine Speed, Revolutions Per Minute: | 999.30 | 999.36 | 999.26 | **999.31** |
| Brake Horsepower: | 2280.31 | 2256.88 | 2221.78 | **2252.99** |
| Torque, Percent: | 96.21 | 95.26 | 93.79 | **95.09** |
| Fuel Flow, SCFM | 283.33 | 280.24 | 276.51 | **280.03** |
| Suction Pressure, PSIG: | 432.0 | 415.7 | 413.9 | **420.53** |
| Discharge Pressure, PSIG | 645.3 | 640.2 | 634.3 | **639.9** |
| Catalyst Delta P, Inches of Water: (operating limit = 1.45-5.45) | 2.87 | 1.98 | 1.92 | **2.26** |
| Catalyst Inlet Temperature, degrees F: | 792.9 | 793.4 | 794.6 | **793.6** |
| **Inlet Gas Conditions** | | | | |
| Drift Corrected Oxygen Concentration, Dry (Percent): | 11.51 | 11.47 | 11.45 | **11.46** |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv): | 436.7 | 443.1 | 432.63 | **437.37** |
| Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2): | 274.06 | 227.19 | 270.06 | **273.77** |
| **Outlet Gas Conditions** | | | | |
| Drift Corrected Oxygen Concentration, Dry (Percent): | 11.43 | 11.39 | 11.44 | **11.42** |
| Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv): | 2.86 | 3.22 | 3.34 | **3.14** |
| Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2): | 1.78 | 1.99 | 2.09 | **1.96** |
| CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ): | 99.35 | 99.28 | 99.23 | **99.29** |
| Emission Rate, Grams Per Brake Horsepower: | 0.004 | 0.004 | 0.005 | **0.004** |
| ROP Emission Limit, Grams Per Brake Horsepower[2]: | | | | **0.2** |
| | | | | |
| Drift Corrected Nitrogen Oxides Concentration, Dry (ppmdv): | 56.83 | 57.76 | 65.19 | **59.96** |
| Emission Rate, Grams Per Brake Horsepower: | 0.450 | 0.455 | 0.517 | **0.474** |
| ROP Emission Limit, Grams Per Brake Horsepower[1]: | | | | **0.5** |
| | | | | |
| Drift Corrected Volatile Organic Compounds (as NMOC) Concentration, Dry (ppmdv): | 51.11 | 44.29 | 39.01 | **44.80** |
| VOC (as NMOC) Emission Rate, Grams Per Brake Horsepower (<1.0 Grams per Brake Horsepower Per 40 CFR Part 60, Subpart JJJJ): | 0.387 | 0.334 | 0.297 | **0.339** |
| 40 CFR Part 60, Subpart JJJJ VOC (as NMOC) Emission Limit, Grams Per Brake Horsepower | | | | **1.0** |

[1] The ROP CO and $NO_x$ emission limits are more stringent than the applicable limits in 40 CFR Part 60, Subpart JJJJ, which are as follows: CO = 4.0 grams/HP-hour; NOx = 2.0 grams/HP-hour.

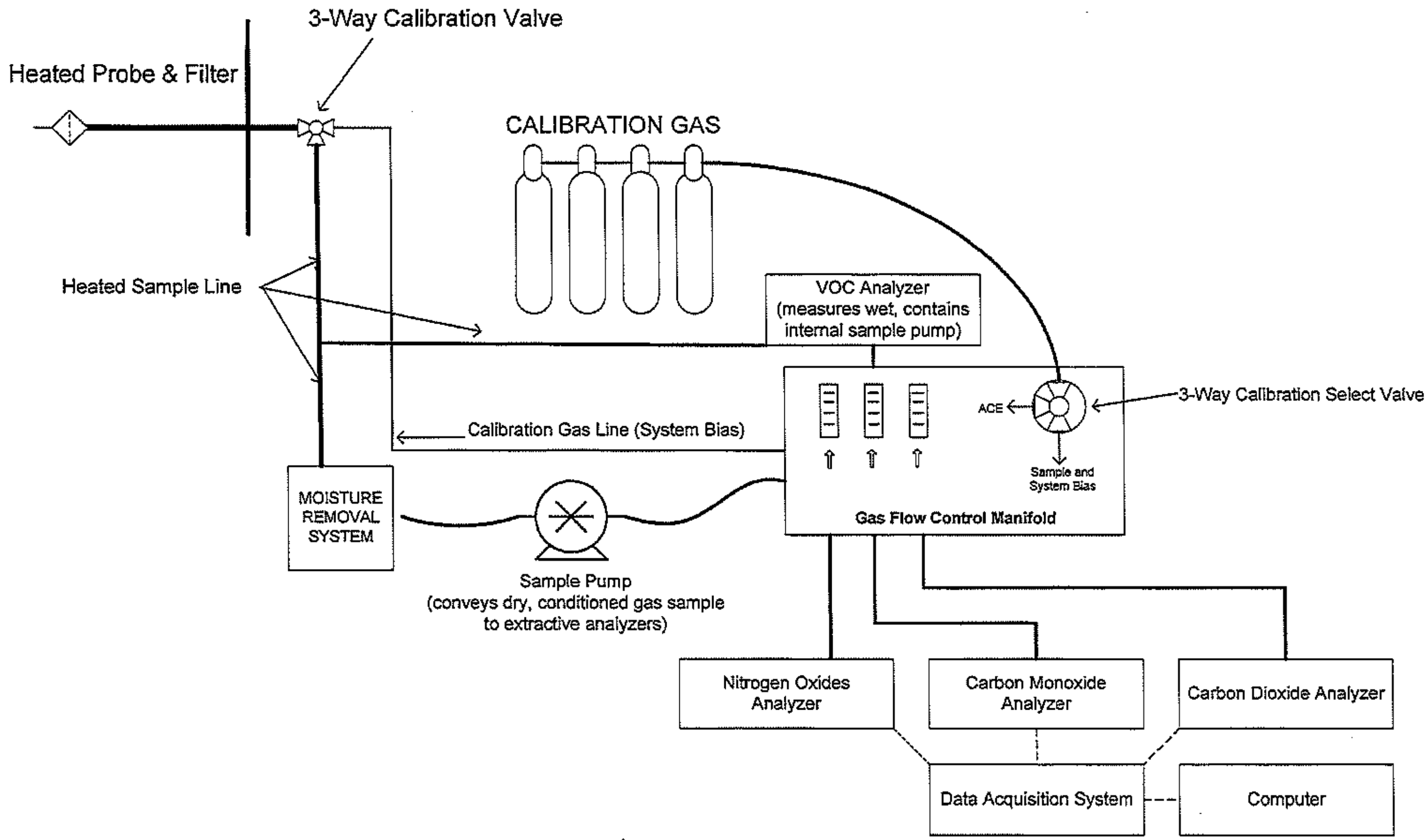
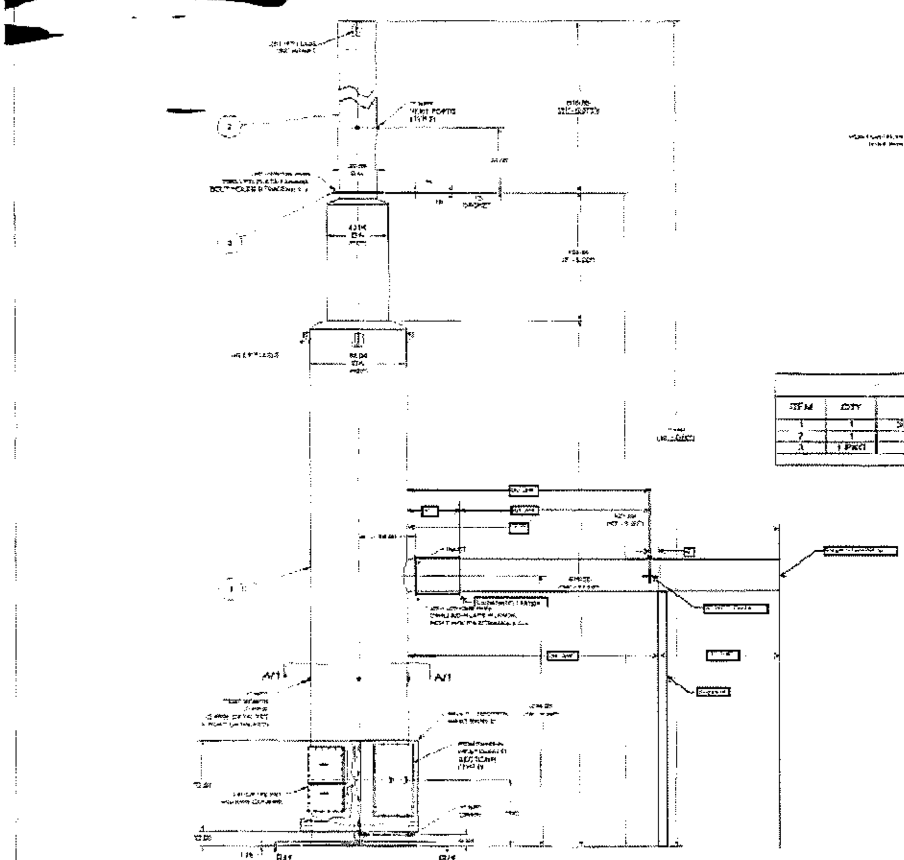
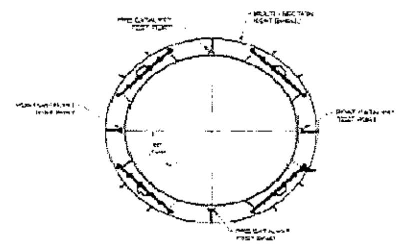


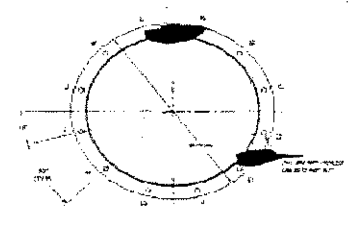

**FIGURE 1**

**DRY AND WET EXTRACTIVE GASEOUS SAMPLE APPARATUS**





VIEW A-A/1



VIEW B-B/1
FOUNDATION PLAN

TABLE #1

| ITEM | QTY | DESCRIPTION | U.S. PART # | WEIGHT (LBS) |
|---|---|---|---|---|
| 1 | 1 | SILENCER / CATALYST | TBD | 22,000 |
| 2 | 1 | OUTLET STACK | TBD | [illegible] |
| 3 | 1 PKG | LOOSE PARTS | TBD | [illegible] |
| | | | TOTAL SYSTEM WEIGHT = | [illegible] |

| SUPPORT | DEAD LOAD | FORCE DIRECTION | WIND LOAD X | WIND LOAD Y | WIND LOAD Z | SEISMIC LOAD X | SEISMIC LOAD Y | SEISMIC LOAD Z |
|---|---|---|---|---|---|---|---|---|
| A | -2.4 | X | 1.2 | – | 34.6 | [illegible] | – | [illegible] |
| | | Y | – | 1.2 | 34.6 | – | [illegible] | [illegible] |
| B | -2.4 | X | 1.2 | – | 34.6 | [illegible] | [illegible] | [illegible] |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| C | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| D | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| E | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| F | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| G | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | | 1.2 | 34.6 | | 0.6 | 15.3 |
| H | -2.4 | X | 1.2 | | 34.6 | 0.6 | | 15.3 |
| | | Y | | 1.2 | 34.6 | | 0.6 | 15.3 |
| I | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | [illegible] |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| J | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | [illegible] |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| K | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |
| L | -2.4 | X | 1.2 | – | 34.6 | 0.6 | – | 15.3 |
| | | Y | – | 1.2 | 34.6 | – | 0.6 | 15.3 |

System overturning moment = [illegible] kip ft
Horizontal shear force = [illegible] kips

COMMENTS

UNIVERSAL SILENCER

16-6000005 | 0 | 1 of 1