Consumers Energy

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Compliance Test Report

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AIR QUALITY DIV.

EUENGINE2-7

Ray Compressor Station
69333 Omo Road
Armada, Michigan 48005
State Registration Number (SRN) B6636

Test Date: July 9-10, 2014

Report Submitted:
September 4, 2014

Report Revision 0

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

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT
REPORT CERTIFICATION

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: Consumers Energy Company - Ray Compressor Station County: Macomb

Source Address: 69333 Omo Road City: Armada

AQD Source ID (SRN): B6636 ROP No.: MI-ROP-B6636-2010 (Minor Mod Submitted on April 18, 2014) 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 _____ To _____

Additional monitoring reports or other applicable documents required by the ROP are attached as described:

Test Report for EUENGINE2-7

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

Ocie Gregory, Jr.	Executive Manager, Gas Compression & Storage	(248) 433-5805
Name of Responsible Official (print or type)	Title	Phone Number

Ocie Gregory Jr 9/02/2014

Signature of Responsible Official Date

* Photocopy this form as needed.

EQP 5736 (Rev 11-04)

1.0 INTRODUCTION

Identification, location and dates of tests

This report summarizes the results of testing conducted on July 9-10, 2014 at Consumers Energy Company's (CEC) Ray Compressor Station. CEC's Regulatory Compliance Testing Section (RCTS) conducted performance tests on Unit 2-7 (natural gas-fired reciprocating engine driven compressor unit) in operation at Consumers Energy's (CEC) Ray Compressor Station, located in Armada, Michigan.

Purpose of testing

The purpose of the testing was to redefine the established operating range for EUENGINE2-7. Pursuant to Renewable Operating Permit (ROP) No. MI-ROP-B6636-2010, the permittee must test for NOx and CO emission to establish those ranges of speed and percentage of maximum torque within which the engine can operate in compliance with its emission limits.

Brief description of source

The Ray 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 in and out of storage reservoirs and along the pipeline system. Unit 2-7 is rated at an output of 6,000 horsepower, a speed of 330 RPM and a heat input of approximately 41 MM Btu/hr. The NO_x and CO emission limits applicable to Unit 2-7 are specified in Conditions I.1 and I.2 of Table FGENGINES, and are summarized in Table 1 below.

Table 1

Summary of Unit 2-7 NO_x and CO Emission Limits

Pollutant	Limit	Time Period/Operating Scenario	Equipment
NO_x	2.0 grams	Per brake horsepower-hour (at 100 percent speed and 100 percent torque)	EUENGINE2-7
	26.5 pounds	Per hour	EUENGINE2-7
	116.0 tons	Per year	EUENGINE2-7
CO	153 tons	Per 12-month rolling time period	EUENGINE2-7

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

The testing was performed by CEC RCTS employees Joe Mason and Brian Miska on July 9-10, 2014. MDEQ representative Mr. Robert Elmouchi observed portions of the test. Ray Field Leader, Mr. Charles Kelly, coordinated the test and collected operating data. The following table contains the test program participant contact information.

Table 2
Test Program Participants
Ray Compressor Station

Responsible Party	Address	Contact
Test Facility	Ray Compressor Station 69333 Omo Road Armada, Michigan 48005	Mr. Charles Kelly 586-784-2096 charles.kelly@cmsenergy.com
Corporate Air Quality Contact	Consumers Energy Company Environmental Services Department 1945 West Parnall Road Jackson, Michigan 49201	Ms. Amy Kapuga 517-788-2201 amy.kapuga@cmsenergy.com
RCTS Representative	Consumers Energy Company Regulatory Compliance Testing Section 17010 Croswell Street West Olive, Michigan 49460	Mr. Joe Mason, QSTI 231-720-4856 joe.mason@cmsenergy.com
MDEQ Representative	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall Lansing, Michigan 48909	Mr. Robert Elmouchi 586-753-3736 elmouchir@michigan.gov

2.0 SUMMARY OF RESULTS

Operating Data

The engine operating conditions consisted of four combinations of engine speed (i.e. revolutions per minute (RPM)) and percentages of maximum torque. Process data collected during each test run included ambient temperature, barometric pressure, engine speed, torque, horsepower, fuel flow, suction pressure and discharge pressure.

Applicable Permit Number

The facility (SRN B6636) is operating pursuant to the terms and conditions of MI-ROP-B6636-2010. As described in the introduction above, testing was completed to redefine the established operating range for EUENGINE2-7.

Results

Testing was conducted on EUENGINE2-7 in order to re-establish a range of speeds (i.e. RPM) and % of maximum torque within which the engine can operate in compliance with its respective NO_x and CO emission limits. Furthermore, a low torque operating condition was established in order to establish NO_x and CO emission factors. The NO_x and CO emission limits for Engine 2-7 are as follows:

1. The NO_x emission rate shall not exceed 26.5 pounds per hour (lbs/hr), and 116.0 tons per year (tons/yr).

2. The CO emission rate shall not exceed 153 tons/yr (based on 12-month rolling time period).

Triplicate 20-minute emission test runs were performed at each of four (4) distinct operating conditions (i.e. combination of RPM and % torque) as shown in the table below.

Engine Operating Condition	Engine Speed (RPM)	Engine Torque (Percent)
1	331.6	101.1
2	331.6	89.3
3	291.4	87.2
4	291.7	92.9

The recently established operating range for EUENGINE2-7, based on these operating conditions and associated emission results, is summarized in Figure 1.

Table 3 below illustrates the average NO_x and CO emission results at three RPM and percent (%) maximum torque combinations (Engine Operating Conditions 1, 2 and 4), and one low torque/RPM combination (Engine Operating Condition 3).

TABLE 3
SUMMARY OF NITROGEN OXIDES AND CARBON MONOXIDE EMISSIONS
EUENGINE 2-7
JULY 9-10, 2014

EUENGINE2-7 Percentage of Maximum Torque										
Engine Operating Condition	Torque (%)	Speed, RPM	NO_x Emission Rate						CO Emission Rate	
			gram/ Bhp-Hr	Permit Limit	Lbs/hr	Permit Limit	Tons/ Yr*	Permit Limit	Tons/ Yr*	Permit Limit
1	101.1	331.6	1.9	2.0	26.2	26.5	114.8	116.0	142.8	153
2	89.3	331.6	1.0	NA[1]	12.4	26.5	54.5	116.0	148.5	153
4	92.9	291.7	1.7	NA[1]	17.9	26.5	78.5	116.0	109.6	153

[1] The gram per brake horse power (G/Bhp-Hr) permit limit of 2.0 is based on engine operations at 100 percent engine speed (defined as 330 RPM) and torque.

* Based on 8,760 hrs per year

EUENGINE2-7 Low Torque Operating Condition										
Engine Operating Condition	Low Torque (%)	Speed, RPM	NO_x Emission Rate						CO Emission Rate	
			gram/ Bhp-Hr	Permit Limit	Lbs/hr	Permit Limit	Tons/ Yr*	Permit Limit	Tons/ Yr*	Permit Limit
3	87.2	291.4	1.3	NA[1]	13.3	26.5	58.3	116.0	117.8	153

[1] The gram per brake horse power (G/Bhp-Hr) permit limit of 2.0 is based on engine operations at 100 percent engine speed (defined as 330 RPM) and torque.

* Based on 8,760 hrs per year

3.0 SOURCE DESCRIPTION

Description of Process

The Ray 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 in and out of storage reservoirs and along the pipeline system. The station has eight (8) natural gas fired reciprocating engine driven compressor units, designated as Units 1-2, 1-3, 2-7, 3-1, 3-2, 3-3, 3-4 and 3-5; and two (2) natural gas fired combustion turbine driven compressors, designated as Units 2-5 and 2-6.

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

Engine 2-7 is rated at an output of 6,000 horsepower at a speed of 330 RPM and a heat input of approximately 41 mm Btu/hr.

Description of Process Instrumentation Monitored During the Test

Process data collected during each test run included ambient temperature, barometric pressure, engine speed, torque, horsepower, fuel flow, suction pressure and discharge pressure. With the exception of the ambient data (collected once per day of testing), the preceding data was logged at least once every clock minute and then averaged to determine the per-test run values.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Description of sampling train(s) and field procedures

Triplicate 20-minute test runs were performed to determine NO_x and CO concentrations. The U.S. EPA Test Methods were used exclusively, as described within the test protocol. All components of the CO_2, NO_x and CO extractive sample systems in contact with flue gas were constructed of Type 316 stainless steel and/or Teflon. The exhaust gases were analyzed by extracting exhaust gas through a heated probe and particulate filter, heated sample lines, a moisture removal trap, a secondary particulate filter and a sample pump. The sample was then passed through a distribution header to the various instrumental analyzers (NOx, CO, and CO_2). Additional components of the sampling apparatus included a calibration valve assembly, sample flow rate control and sample gas manifold. All monitors in use were calibrated with U.S. EPA Protocol No. 1 calibration gases and operated to insure that zero drift, calibration gas drift, and calibration error met the specified method requirements. The output signal from each analyzer was connected to a computerized data acquisition system (DAS). A simplistic diagram for the sampling apparatus is presented as Figure 2.

The CO_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. All instruments were operated thereafter to insure that zero drift, calibration gas drift, bias and calibration error met the specified method requirements.

The data measured from the pollutant and diluent analyzers was averaged for each run and corrected for drift and bias. CO_2 concentrations were measured as percent by volume, dry basis, while NO_x and CO concentrations were measured as ppmv, dry basis.

CO_2 diluent concentrations were monitored using a non-dispersive infrared (NDIR) and 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).*

Quality Assurance Procedures

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 recently 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 and sample port diagram for EUENGINE2-7 is shown in Figures 3 and 4.

5.0 TEST RESULTS AND DISCUSSION

Detailed tabulation of results, including process operating conditions and flue gas conditions
Table 3 contains a summary of the NO_x and CO emission rates observed for EUENGINE2-7 during testing conducted July 9-10, 2014. Engine operating data, calculation spreadsheets, field data sheets and calibration information are contained in Attachments 1 - 4.

Discussion of significance of results relative to operating parameters/emission regulations
The average NO_x and CO emission rates at all tested combination of RPM and % torque were below the emission limits. Thus, EUENGINE2-7 is in compliance with the ROP NO_x and CO emission limits.

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

Documentation of process/control equipment upset condition that occurred during 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 5.

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
NA

FIGURE 1

Allowed Operating Range for EUENGINE2-7

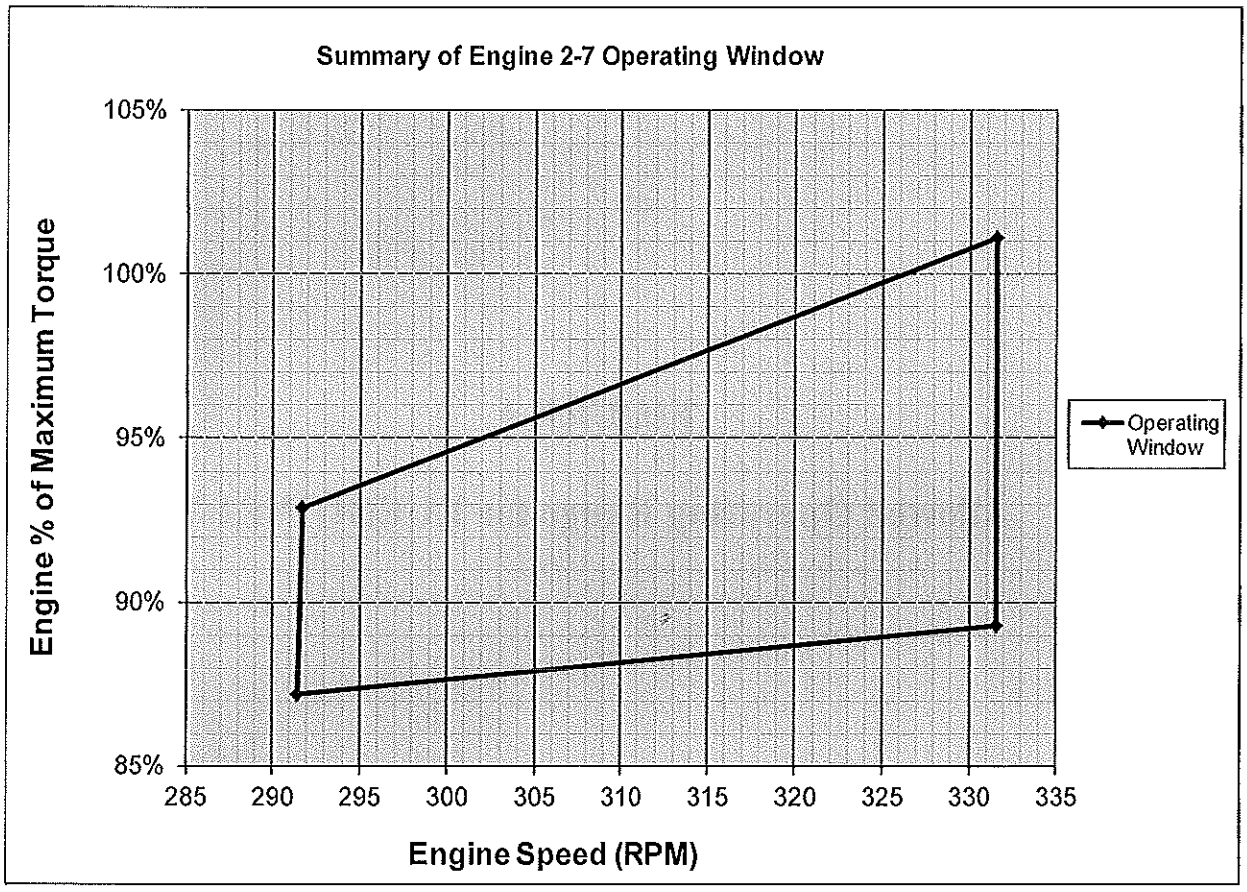

Summary of Engine 2-7 Operating Window
105%
100%
95%
90%
85%
Engine % of Maximum Torque
285
290
295
300
305
310
315
320
325
330
335
Engine Speed (RPM)
Operating Window

FIGURE 2

Sampling Apparatus Schematic

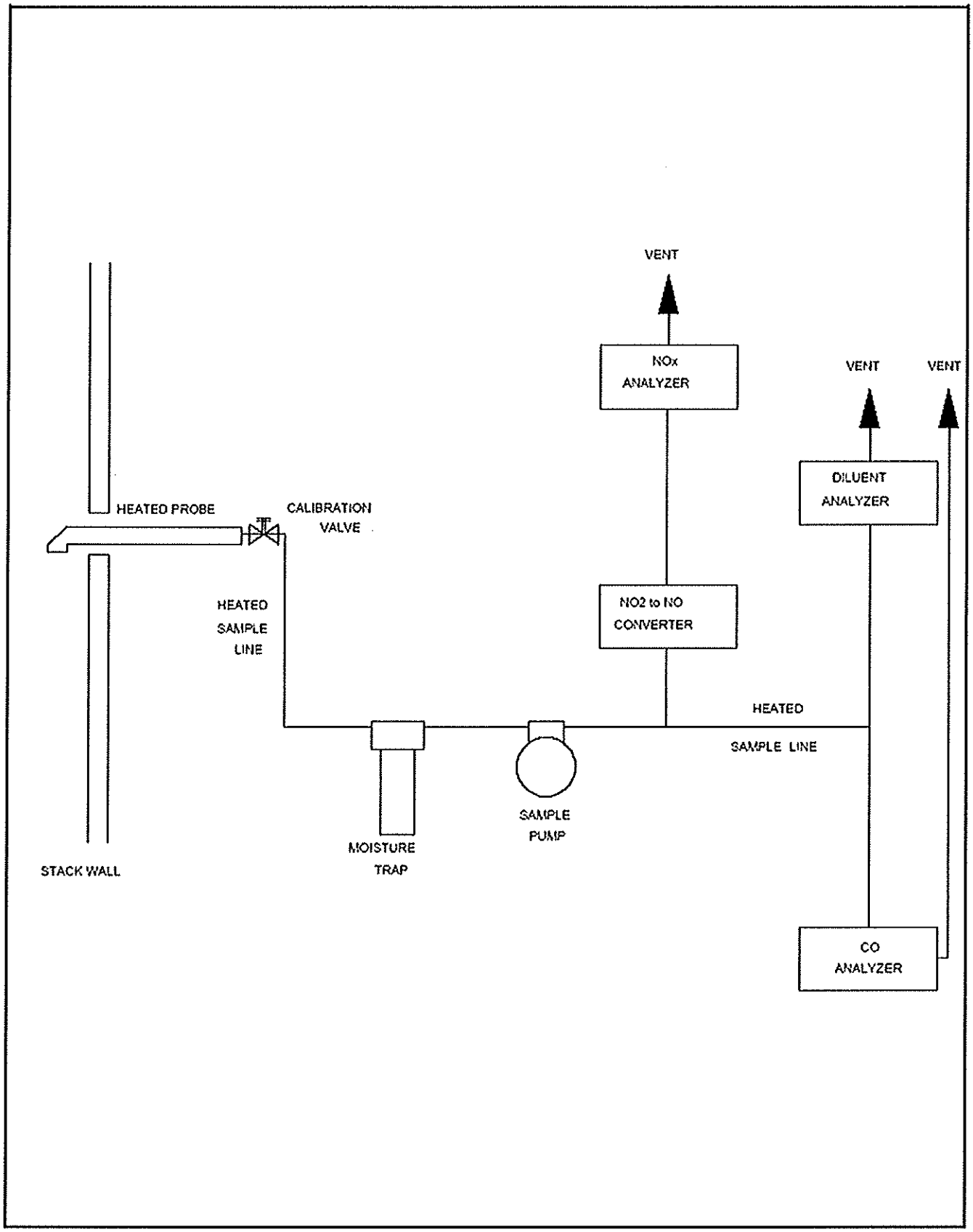
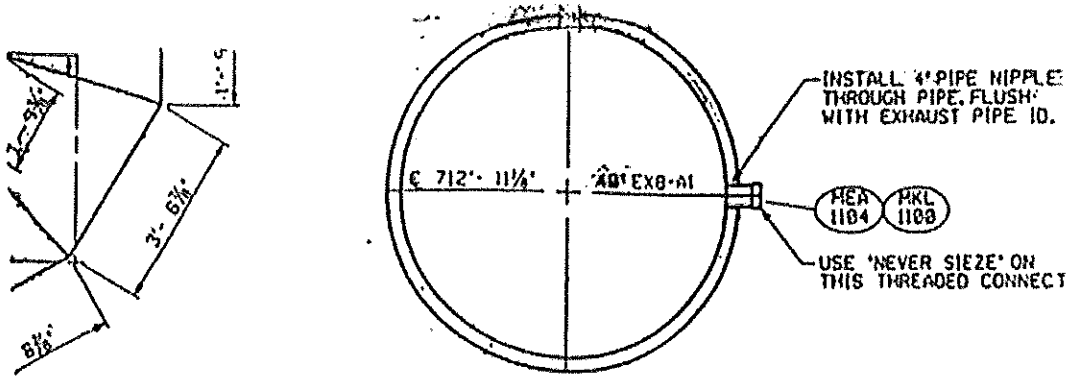

VENT
NOx
ANALYZER
VENT
VENT
DILUENT
ANALYZER
HEATED PROBE
CALIBRATION
VALVE
HEATED
SAMPLE
LINE
NO2 to NO
CONVERTER
HEATED
SAMPLE LINE
SAMPLE
PUMP
MOISTURE
TRAP
STACK WALL
CO
ANALYZER

FIGURE 3

EUENGINE2-7 Exhaust Stack Diagram



EXHAUST · TEST PORT DETAIL

SCALE: 1" = 1'- 0"

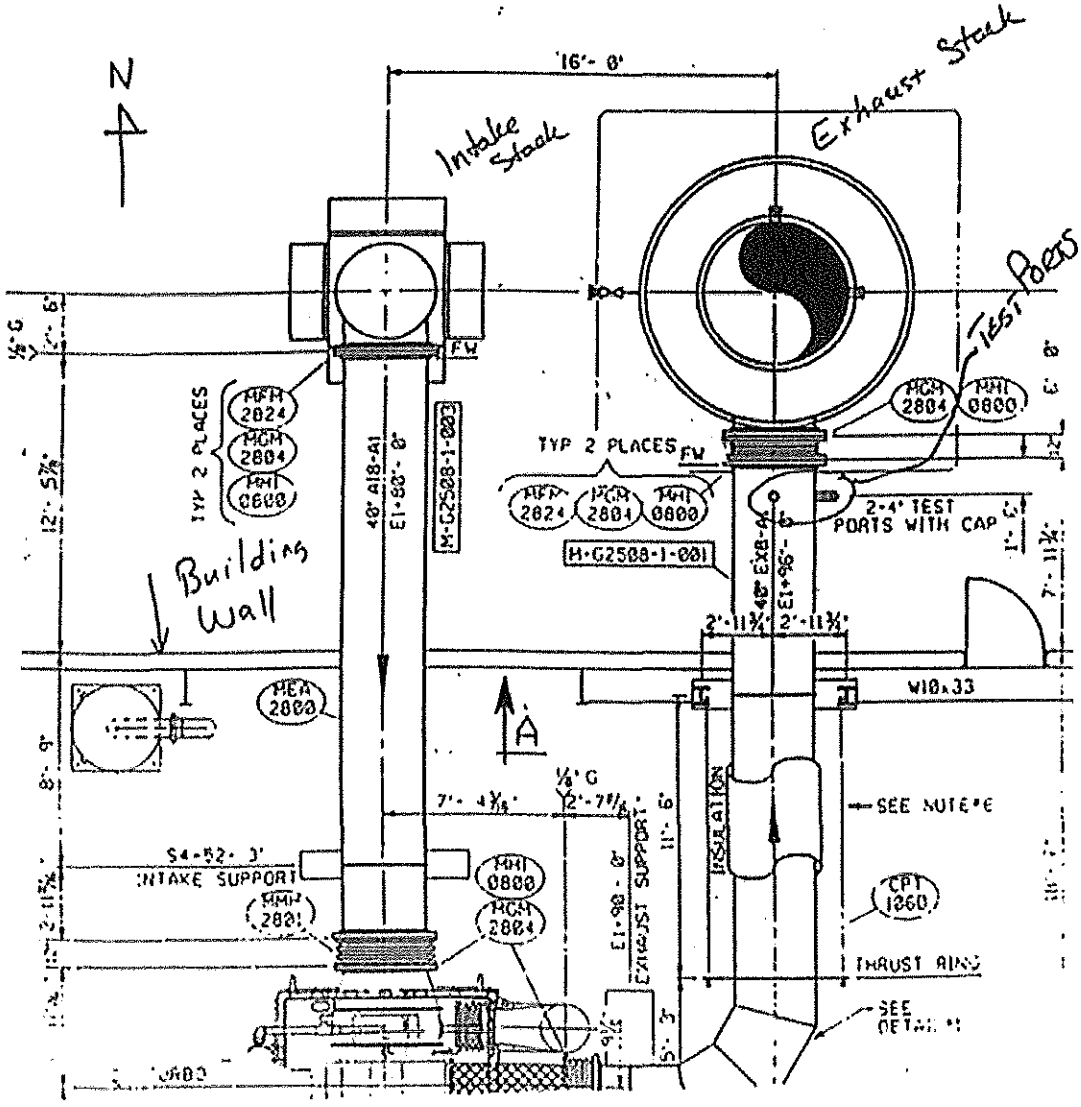
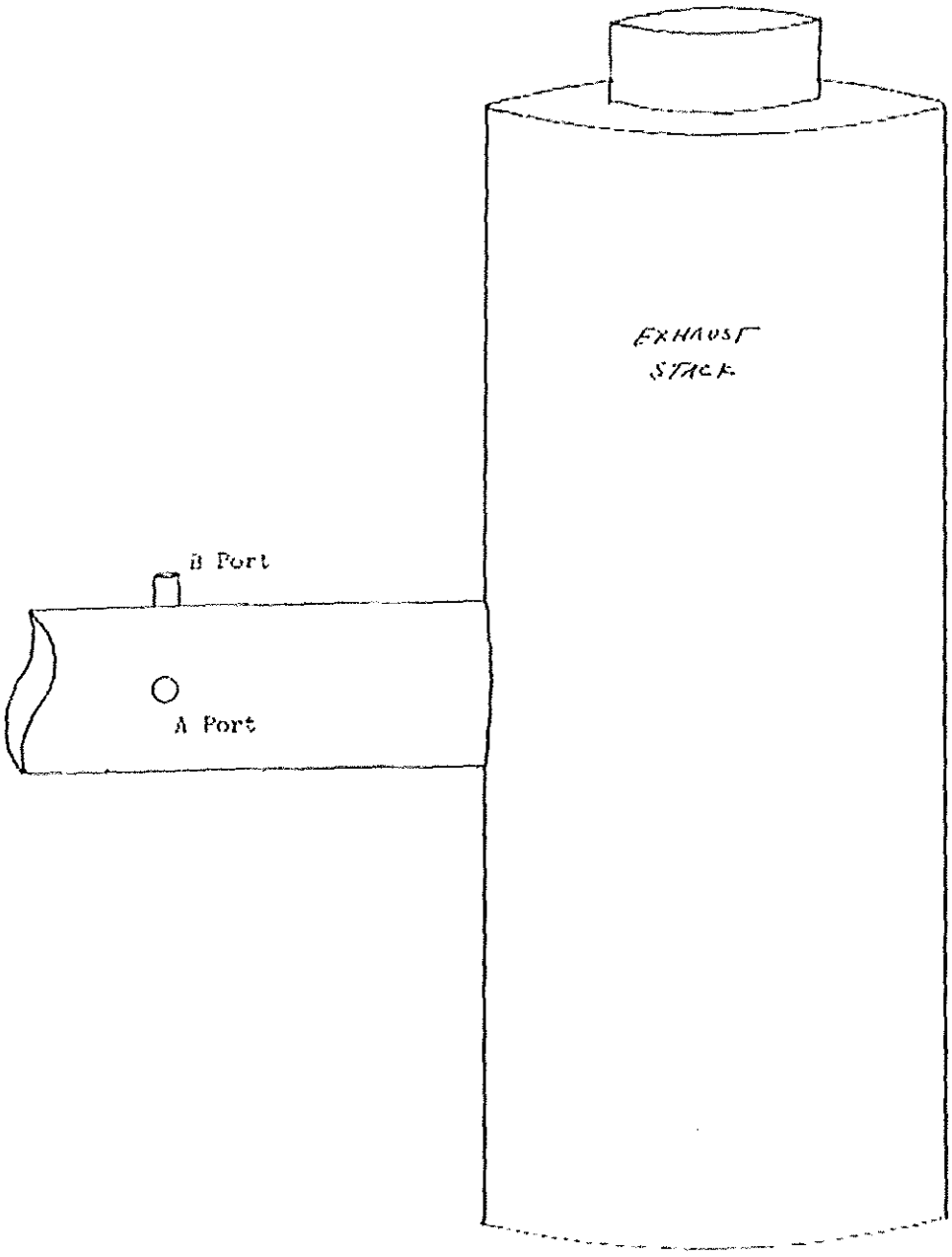


FIGURE 4

EUENGINE2-7 Sampling Port Diagram


EXHAUST
STACK
B Port
A Port