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Particulate Matter Test
Final Report
JH Campbell Generating Station West Olive, Michigan
EUBOILER1 & 2

Consumers Energy Company
J.H. Campbell Generating Station
17000 Croswell
West Olive, MI 49460

Protocol Submitted September 19, 2014
Test Date: October 21, 2014

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
Engineering Services Department
Work Order No. 16500297

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, J.H. Campbell Plant — County: Ottawa

Source Address: 17000 Croswell — City: West Olive

AQD Source ID (SRN): B2835 — ROP No.: MI-ROP-2835-2013 — ROP Section No.: 1

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 N/A To N/A

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

Units 1 and 2 Particulate Matter Test Report

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

Thomas J. Gesinski	Site Business Manager	(616) 738-3200
Name of Responsible Official (print or type)	Title	Phone Number
Thomas J Gesinski		12/16/2014
Signature of Responsible Official		Date

* Photocopy this form as needed.

EQP 5736 (Rev 11-04)

1.0 Introduction

This report summarizes the results of the Particulate Matter (PM) Emissions Test Consumers Energy Company (CEC) Regulatory Compliance Testing Section (RCTS) performed at the common exhaust gas location associated with coal-fired boilers EUBOILER1 & EUBOILER2 (Unit 1 & 2) in operation at the CEC J.H. Campbell Generating Station located in West Olive, Michigan. The PM compliance demonstration was scheduled in accordance with the J. H. Campbell facility renewable operating permit (ROP) No. MI-ROP-B2835-2013.

1.1 Summary of Test Program

The test program followed the requirements described in ROP No. MI-ROP-B2835-2013, using the sampling, calibration and quality assurance procedures specified in U.S. EPA CFR Part 60, Appendix A, Reference Methods (RM) Methods 1, 2, 3, 4 and 17, in conjunction with Michigan Department of Environmental Quality (MDEQ) Air Pollution Control Rules, Part 10, § R336.2011, Reference Test Method 5B.

1.2 Test Program Roles

Table 1-1 below contains the test program responsible individual names, addresses and contact information.

TABLE 1-1

Program Role	Contact	Address
Test Facility	Mr. Joseph Firlit 616-738-3260 Sr Engineering Technical Analyst joseph.firlit@cmsenergy.com	J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Facility	Mr. Michael T. Rabideau 616-738-3273 Senior Technician michael.rabideau@cmsenergy.com	J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Test Team Representative	Mr. Joe Mason, QSTI 616-738-3385 Technical Analyst joe.mason@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460
Regulatory Agency Representative	Ms. Karen Kajiya-Mills Technical Programs Unit Manager 517-335-4874 kajiya-millsk@michigan.gov	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall, 3rd Floor N Lansing, Michigan 48909

2.0 Summary of Results

2.1 Fuel Consumption

During the testing period, Unit 1 burned 100% Western coal at an average rate of 116 tons per hour. Unit 2 burned a blend of 63.17% Western coal, with a balance of Eastern coal, at a cumulative rate averaging 139 tons per hour. Testing was conducted at as close to full load as possible with Unit 1 operating at an average of 272 MW for each of the three tests, and Unit 2 operating at an average of 338 MW for each of the three tests.

2.2 PM Emission Limit

Testing was conducted on Units 1 and 2 in order to demonstrate compliance with the facility's current ROP (No. MI-ROP-B2835-2013) particulate matter emission limit. The particulate matter emission limits for Unit 1 and 2 are specified in Condition I.1 of Table EUBOILER1 and EUBOILER2 respectively. The permitted limit for each unit is summarized in Table 2-1 below.

TABLE 2-1 Summary of EUBOILER1 and EUBOILER2 PM Emission Limit

Pollutant	Limit	Equipment
PM	0.16 pound per 1,000 pounds exhaust gas, corrected to 50% excess air	EUBOILER1
PM	0.15 pound per 1,000 pounds exhaust gas, corrected to 50% excess air	EUBOILER2

2.3 Summary of PM Emission Test Results

As shown in Table 2-2 (following page), each individual run, as well as the average particulate emission rate, was below the PM limit for Unit 2 of 0.15 pound per 1,000 pounds exhaust gas, corrected to 50% excess air. In the test protocol submitted by CEC on September 22, 2014, and approved by Mr. Rob Dickman of the DEQ, AQD on October 1, 2014; it was understood and agreed upon that if the combined PM results of both Unit 1 and Unit 2 collected from the common stack were below 0.15 pound per 1,000 pounds exhaust gas, corrected to 50% excess air, then compliance of the individual emission rates of each unit would be demonstrated. Soot blowing events occurred in both units during each of the three test runs, as required.

TABLE 2-2 Summary of EUBOILER1 and EUBOILER2 Common Stack PM Test Results

Run Number	Unit	Unit #1 Steam Flow (Klbs/hr)	Unit #2 Steam Flow (Klbs/hr)	Gas Volume (acfm)	Particulate Concentration (lb/MMBtu)	Particulate Concentration lbs/hr	lb/1000 lbs Gas Flow *	Average Stack Opacity (%)
1	1&2	1,800	2,421	2,261,285	0.0084	51.50	0.007	13
2	1&2	1,799	2,406	2,235,947	0.0016	9.63	0.001	13
3	1&2	1,801	2,401	2,217,504	0.0123	73.96	0.010	14
Average		1,800	2,410	2,238,245	0.0074	45.03	0.006	13

* Emissions in pounds of particulate, per 1,000 pounds gas flow, corrected to 50% excess air.

3.0 Source Description

3.1 Process Description

EUBOILER1 is a pulverized coal-fired 2490 mmBtu per hour dry bottom, tangential fired boiler with fuel oil startup capabilities and a full load rating of 1,750,000 lbs/hr steam flow at 274 MW gross (260 MW net) load. EUBOILER2 is a 3560 mmBtu per hour wall-fired (converted from cell burner) boiler also with fuel oil startup capability. The full load rating is 2,550,000 lbs/hr steam flow at 378 MW gross (358 MW net) load. Basic operating parameters used to regulate boiler operations consist of temperature, unit load, fuel blend and usage rate, and electrical or steam output. The individual Unit 1 & 2 exhausts are ducted to a common exhaust stack where the effluent mixes upstream of the PM sample location.

3.2 Control Device Description

Unit 1 emissions are currently controlled by low-NOx burners and two electrostatic precipitators (ESPs) in series. Unit 1 permitted controls to be installed include dry sorbent injection for acid gases control, carbon injection (for mercury control), and fabric filter baghouse. Unit 2 emissions are controlled by low-NOx burners, selective catalytic reduction and a fabric filter baghouse. Permitted controls to be installed include dry sorbent injection (DSI), carbon injection (for mercury control).

4.0 Sampling and Analytical Procedures

Triplicate PM test runs approximately 80 minutes in duration were performed while both Units 1 and 2 were in operation. The resulting PM values therefore represent a combined concentration and subsequent emission rate. Each boiler was operating as close to full load as possible under routine operating conditions. Soot-blowing occurred in both units during each of the three tests.

4.1 Sampling Location

The number and location of traverse points for determining exhaust gas velocity and volumetric air-flow were determined in accordance with U.S. EPA Method 1, *Sample and Velocity Traverses for Stationary Sources.* The area of the exhaust duct was determined and the cross-section divided into a number of equal areas based on existing air flow disturbances. A schematic depicting the Unit 1 and 2 exhaust duct breechings and test port locations is shown in Figure 1.

4.2 Velocity and Temperature

The exhaust gas velocity and temperature were determined using U.S. EPA Reference Method 2, *Determination of Stack Gas Temperature and Velocity (Type S Pitot Tube).* The exhaust gas pressure differential (delta P) was measured at each traverse point during PM testing using an "S Type" Pitot tube connected to an appropriately sized magnehelic or oil manometer. Exhaust gas temperatures were also be measured in conjunction with delta P determinations using a chromel/alumel "Type K" thermocouple and a temperature indicator.

Attachment 2 of this test report includes cyclonic flow test data measured in September, 2005 as verification of the absence of cyclonic flow at the sample location of the Unit 1 and 2 Common Stack. Method 1, § 11.4.2 indicates *if the average* (null angle) *is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology...must be used.* The average null yaw angle measured in September, 2005 was observed to be 5°, thus meeting the less than 20° requirement and in the absence of ductwork and/or stack configuration changes, this null angle information is considered to be valid and additional cyclonic flow verification was not performed prior to the PM tests.

4.3 Molecular Weight

The exhaust gas composition was determined using U.S. EPA Reference Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure).* Integrated oxygen and carbon dioxide concentrations were obtained on a real-time basis at each traverse point for determining flue gas molecular weight. The reference monitor used was calibrated with certified gas standards at three levels and operated following the guidelines of Method 3A.

4.4 Moisture

The exhaust gas moisture content was determined using U.S. EPA Reference Method 4, *Determination of Moisture in Stack Gases* in conjunction with the Method 5B/17 sample apparatus. Exhaust gas was drawn through a series of three impingers; the first containing water,

the second empty and the third containing indicating silica gel. The impingers were immersed in an ice bath to ensure condensation of exhaust gas moisture and the amount of water vapor collected was determined gravimetrically to calculate exhaust gas percent moisture.

4.5 Particulate Matter

Filterable PM samples were withdrawn isokinetically from the source following the guidelines of U.S. EPA Method 17, *Determination of Particulate Emissions from Stationary Sources (In-Stack Filtration Method)* using the testing principles, applicability and test criteria described in MDEQ Air Pollution Control Rules, Part 10, § R336.2011, Reference Test Method 5B (MDEQ Method 5B).

The PM sample apparatus consisted of a stainless steel nozzle, two in-stack 47 mm glass fiber filters (primary and back-up), a steel probe and flexible umbilical, three chilled impingers and a metering console. Particulate matter was collected in the nozzle and upon the in-stack filters. Upon successful conclusion of each test, the nozzle/filter apparatus and impinger set was carefully sealed and transported to the laboratory. At the laboratory, following the requirements in MDEQ Method 5B, the filters were removed from the holders, visually inspected and placed into a desiccator. Any remaining filter residue was rinsed from the filter holders into appropriately labeled pre-weighed sample beakers using deionized water. The water rinses were evaporated and desiccated to dryness, as were the filters, with the residue weighed to determine the amount of particulate collected. The filter catch and water rinses were reported as filterable particulate, grains per dry standard cubic foot (Gr/dscf), pound per hour (lb/hr) and lb/1000 lbs of exhaust gas, corrected to 50% excess air, as required by ROP MI-ROP-B2835-2013. The Method 5B/17 sampling train is shown in Figure 2.

5.0 Quality Assurance Procedures

Each U.S. EPA reference method performed contains specific language stating reliable results are obtained by persons equipped with a thorough knowledge of the techniques associated with each method. To that end, factors which potentially caused sampling errors were minimized by implementing quality assurance (QA) programs into every applicable component of field testing possible. The following QA components were included in this test program.

While not directly required, each PM sample apparatus was leak-checked before each test run as well as immediately after. Extreme care was exercised to minimize effects of stray or ambient particulate at the sampling site, such as ensuring the sample ports are cleaned thoroughly, maintaining enough distance from duct walls and/or other sources of PM so that bias was not introduced artificially. Time, meter box temperature, sample rate, barometric pressure,

source temperature and total sample volume was documented for each run. Isokinetic variation was verified to be within Method requirements. Field recovery of the impinger and nozzle/filter fractions were carefully performed in an enclosed laboratory area, prior to analysis.

All manual test equipment was calibrated before the test program in accordance with appropriate U.S. EPA procedures. Pitot tubes and thermocouples used to measure the exhaust gas were calibrated following the handbook requirements outlined in *Stationary Source-Specific Methods,* Method 2, *Type S Pitot Tube Inspection*, and in ALT – 011, *Alternative Method 2 Thermocouple Calibration Procedure Calibration Procedure*. Dry test meters used for moisture determination were calibrated using ALT – 009 as described in Method 5, § 16.1, using the procedures in Method 5, § 10.3.2. All applicable equipment calibration documents are included in this report in Attachment 6.

6.0 Test Results and Discussion

Each of the three particulate test runs, along with the average of these three runs, resulted in a measured particulate emission rate which was below the particulate matter emission limit of 0.15 pound per 1,000 pounds exhaust gas, corrected to 50% excess air (the PM limit for EUBOILER2). Being that the particulate test was performed in the common stack of Unit 1 and 2, while soot blowing events occurred, and the PM emission rate measured was below the limit for Unit 2, it is understood that each of the individual units are operating within compliance of the limitations established by the ROP.

Sample calculations for all formulas used in this test report are contained in Attachment 1 of this report. Detailed results of the test, including calculation sheets and field / laboratory datasheets are included in Attachments 2 and 3 respectively. Plant operating conditions such as megawatts (MW), opacity, and soot blowing activities, as well as flue gas conditions are included in Attachment 4. Fuel analysis results of the coal sample collected during the test and information pertaining to the representative blend ratios of fuel burned during the test are included in Attachment 5. Documentation of equipment calibration is provided in Attachment 6.

J H CAMPBELL UNITS 1 AND 2

PARTICULATE EMISSION TEST

SUMMARY TABLE

Date	Unit	Unit #1 Gross Load (MW)	Unit #2 Gross Load (MW)	Unit #1 Steam Flow (Klbs/hr)	Unit #2 Steam Flow (Klbs/hr)	Gas Volume (acfm)	Outlet Grain Loading (gr/dscf)	Particulate Concentration (lb/MMBtu)	Particulate Concentration lbs/hr	lb/1000 lbs Gas Flow *	Average Stack Opacity (%)	Flue Gas Temp (°F)	Flue Gas Velocity (fps)	Excess Air (%)	Flue Gas Moisture (%)	Isokinetic Variation (%)
10/21/2014	1&2	272	338	1,800	2,421	2,261,285	0.0044	0.0084	51.50	0.007	13.0	303.1	132.9	37.8	9.5	105.3
10/21/2014	1&2	272	338	1,799	2,406	2,235,947	0.0008	0.0016	9.63	0.001	13.0	302.4	131.4	38.5	9.9	98.7
10/21/2014	1&2	272	338	1,801	2,401	2,217,504	0.0064	0.0123	73.96	0.010	14.0	300.3	130.4	38.6	9.9	97.5
Average		272	338	1,800	2,410	2,238,245	0.0038	0.0074	45.03	0.006	13.3	301.9	131.6	38.3	9.8	100.5

* Emissions in pounds of particulate per 1000 pounds gas flow corrected to 50 % excess air.

Notes:
1. Units 1&2 share a common stack. All stack data and particulate emission rate data are for Units 1&2 combined.
2. The particulate emission limits for Units 1 and 2 are 0.16 and 0.15 lbs/1,000 lbs gas flow at 50% excess air, respectively.
3. Oxygen and carbon dioxide are measured at the point of particulate sampling.
4. Flue gas moisture is determined by the condensate method.
5. Flue gas temperature is the average temperature at the point of particulate sampling.

COAL ANALYSIS
(on dry basis)

Unit #	Test #	Date	% Moisture	% Ash	% Sulfur	Btu
1	1	10/21/2014	24.12	6.39	0.3	12,125
1	2	10/21/2014	24.12	6.39	0.3	12,125
1	3	10/21/2014	24.12	6.39	0.3	12,125
2	1	10/21/2014	16.72	10.25	0.56	12,360
2	2	10/21/2014	16.72	10.25	0.56	12,360
2	3	10/21/2014	16.72	10.25	0.56	12,360

Figure 1
In-Stack Test Ports and Traverse Position Detail

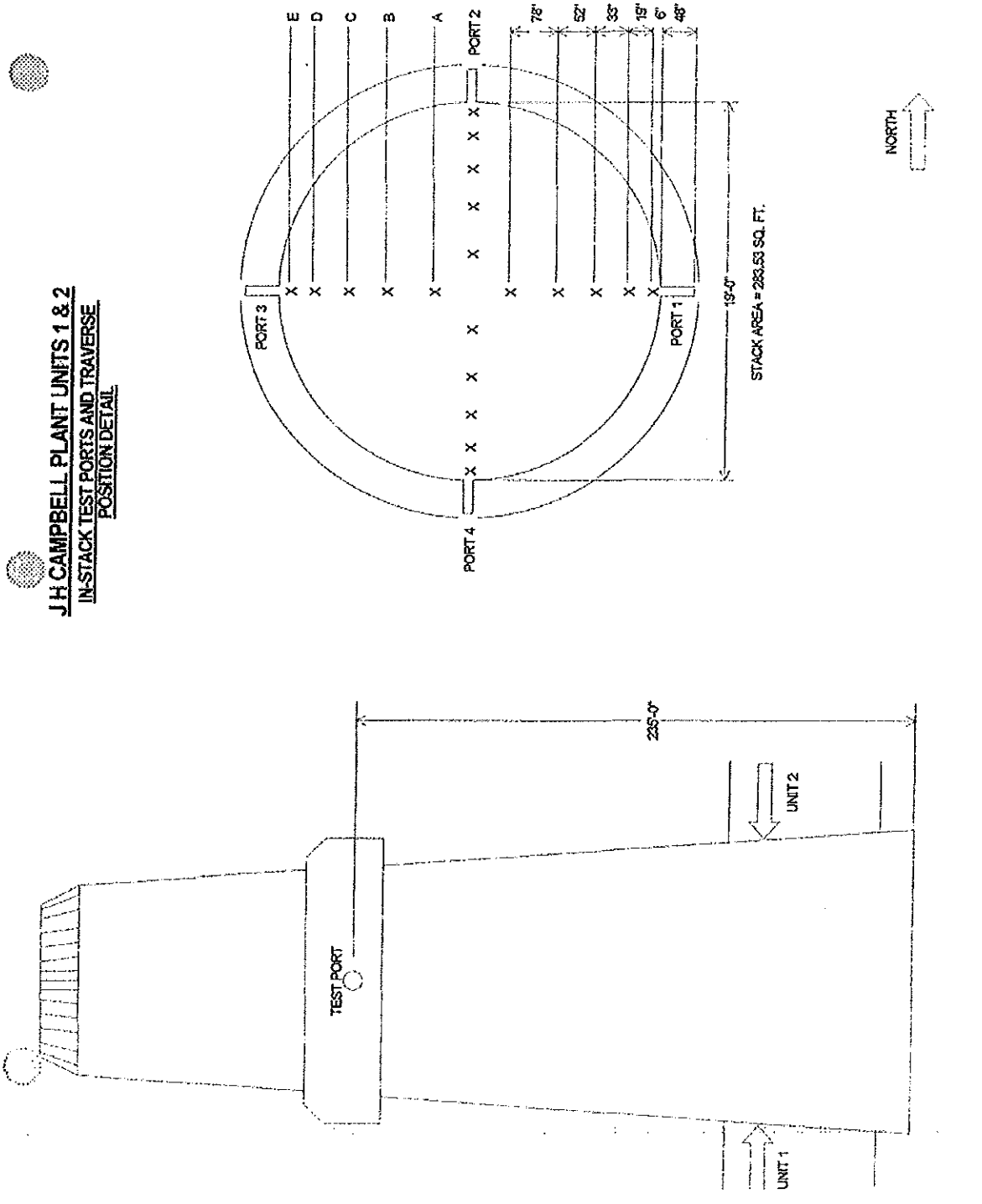

J H CAMPBELL PLANT UNITS 1 & 2
IN-STACK TEST PORTS AND TRAVERSE
POSITION DETAIL
E
D
C
B
A
PORT 2
78"
52"
33"
19"
6"
48"
PORT 3
PORT 1
PORT 4
19'-0"
STACK AREA = 283.53 SQ. FT.
NORTH
235'-0"
UNIT 2
TEST PORT
UNIT 1

Figure 2
Method 5B/17 Sample Apparatus

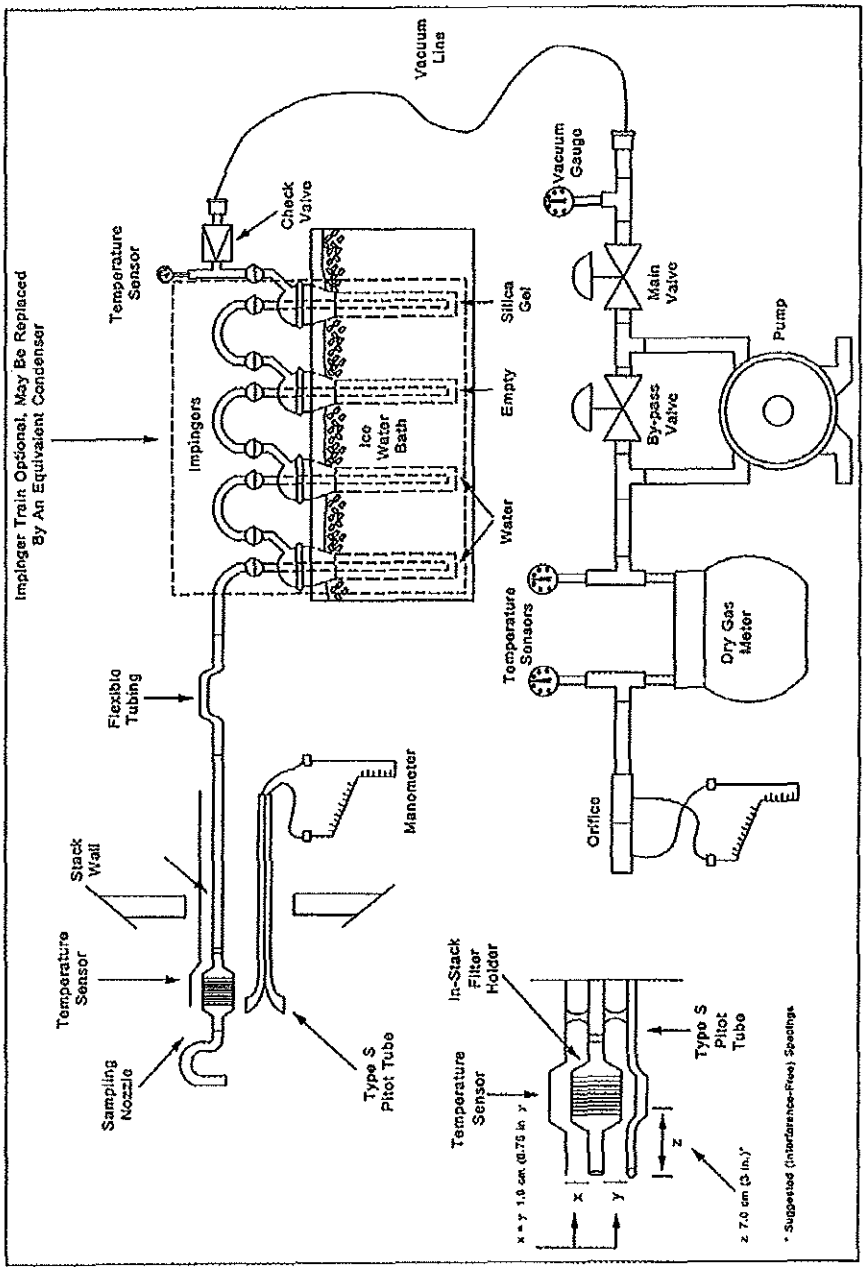
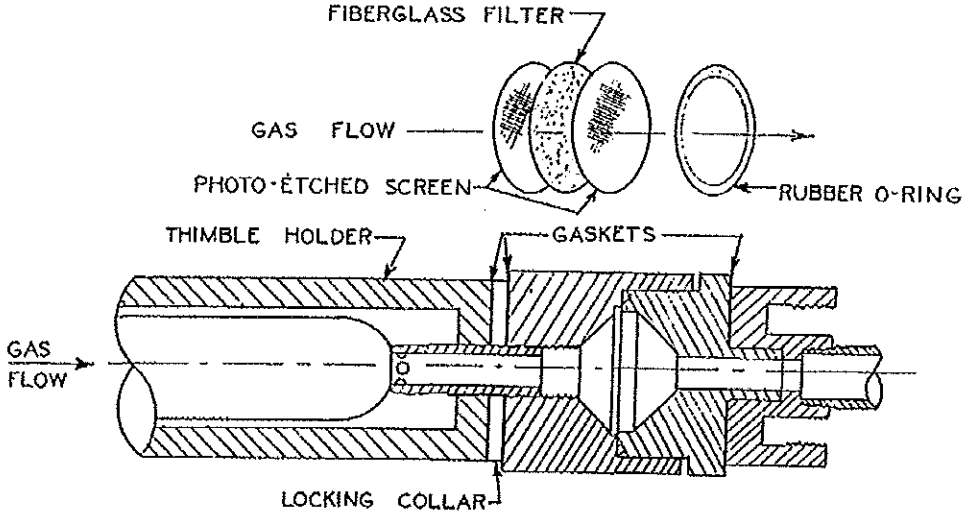
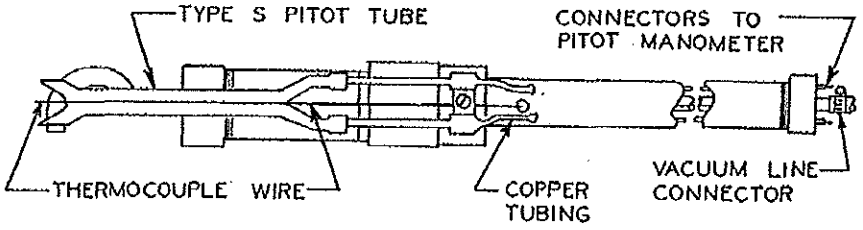

Vacuum Line
Vacuum Gauge
Check Valve
Temperature Sensor
Main Valve
Pump
Silica Gel
Empty
Impingers
Ice Water Bath
By-pass Valve
Water
Impinger Train Optional, May Be Replaced By An Equivalent Condenser
Temperature Sensors
Dry Gas Meter
Flexible Tubing
Manometer
Orifice
Stack Wall
Temperature Sensor
In-Stack Filter Holder
Type S Pitot Tube
Sampling Nozzle
Type S Pitot Tube
Temperature Sensor
x
y
z

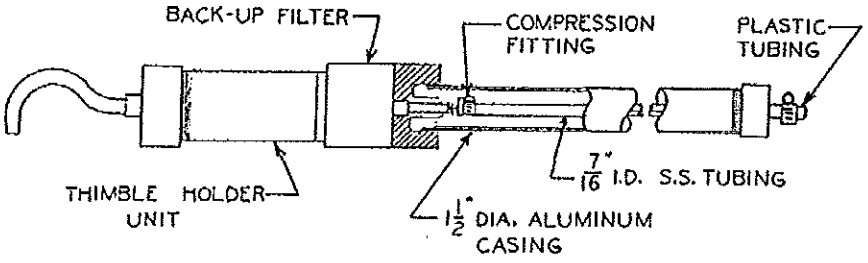
Figure 3
Probe Assembly Diagram



IN-LINE FIBERGLASS FILTER HOLDER



PARTICULATE - SAMPLING PROBE ASSEMBLY



PROBE ASSEMBLY