Consumers Energy

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Particulate Matter Test Report

B C Cobb Generating Station
Muskegon, Michigan

Unit #4 & #5

Testing Conducted:
July 14 & 15, 2015

Report Submitted:
September 2015

Test Conducted By:
Mr. Brian Miska and Mr. Gregg Kotesky
Consumers Energy Company
Engineering Services Department
Regulatory Compliance Testing Section

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

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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: B.C. Cobb Electric Generating Station | County: Muskegon

Source Address: 151 North Causeway | City: Muskegon

AQD Source ID (SRN): B2836 | ROP No.: MI-ROP-B2386-2011 | ROP Section No.: C

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:

Particulate matter emissions test report for EUBOILER4 and EUBOILER5. Emissions testing was conducted in accordance with permit requirements and approved test protocol.

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

Norman J. Kapala	Site Business Manager	616-738-3200
Name of Responsible Official (print or type)	Title	Phone Number
Norman J. Kapala		9-9-2015
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 emission testing for filterable particulate matter (PM), conducted on Unit #4 and #5 at Consumers Energy's B C Cobb Generation Plant in Muskegon, Michigan on July 14 and 15, 2015. The purpose of the test program was:

1. To satisfy the PM stack testing requirement per the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2836-2011 (i.e., EUBOILER4 and EUBOILER5 special condition V.1). The permit requires testing once every three years to verify PM emission rates for each boiler. PM emission limits for Unit #4 and #5 are presented in Table 1.1 below.

2. To satisfy testing requirements in Consent Decree (CD), Civil Action No.: 14-13580, entered between Consumers Energy, the United States Environmental Protection Agency (EPA), and the United States Department of Justice (DOJ) on November 4, 2014.

The stack test was conducted in accordance with the applicable CD and ROP reference methods and requirements.

Table 1.1 – Summary of Unit #4 and Unit #5 Emission Limits[1]

Source	Pollutant	Limit	Time Period/Operating Scenario
Unit #4	PM	0.18 pounds	Per 1,000 pounds exhaust gas, corrected to 50% excess air
Unit #5	PM	0.18 pounds	Per 1,000 pounds exhaust gas, corrected to 50% excess air

[1]The PM emission limits for Units #4 and #5 are listed in Conditions I.1 of Tables EUBOILER4 and EUBOILER5, respectively.

1.1 Summary of Test Program

The test program was conducted in accordance with the sampling, calibration and quality assurance procedures specified in U.S. EPA CFR Part 60, Appendix A, Reference Methods 1, 2, 3A, 4 and 17, as required by MDEQ Test Protocol approval letter dated June 18, 2015. In addition, equations contained in MDEQ Air Pollution Control Rules, Part 10, § R336.2011, Reference Test Method 5B were utilized to determine the amount of excess air and correct the particulate matter concentration to 50% excess air (Attachment 1).

1.2 Key Personnel

Contact information for the responsible individuals involved in the test program is listed below. Mr. Brian Miska and Mr. Gregg Kotesky, with Consumers Energy, conducted the testing. Mr. David Patterson, with MDEQ, witnessed portions of the testing.

FACILITY

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B C Cobb Plant
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Muskegon, MI 49445

Contact: Ms. Janet Zondlak (231) 727-6243

REGULATORY AGENCY

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Contact: Mr. David Patterson (517) 284-6782

TESTING FIRM

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Regulatory Compliance Testing Section
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ESD Trailer # 4
Essexville, MI 48732

Contact: Mr. Brian Pape (989) 891-3492

ENVIRONMENTAL SERVICES

Consumers Energy Company
Environmental Operations Support - Air Quality
Parnall Complex
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Jackson, MI 49201

Contact: Ms. Kathryn Cunningham (517) 768-3462

2.0 SOURCE DESCRIPTION

2.1 Process Description

The B C Cobb generating facility operates two pulverized coal-fired boilers designated as Unit #4 and #5, as base load units each with a maximum rated capacity of 175 megawatts (MW). Unit #4 and #5 are dry bottom tangential coal-fired boilers with natural gas startup including associated startup guns, pilots, and duct burners. The exhaust ducts for Unit #4 and Unit #5 enter a common exhaust stack after pollution control prior to discharging to atmosphere. The PM sampling was conducted at sampling locations for each individual unit duct upstream of the common exhaust stack..

2.2 Control Device Description

Each unit utilizes two electrostatic precipitators (ESP) in sequence to control particulate emissions. The original ESP's installed on each unit are two chamber, four field units, with a design efficiency of 99.0 percent, supplied by Joy Manufacturing Company. The second ESP's, which were added in parallel to the first, are single chamber, four field units, designed and manufactured by Environmental Elements Corporation with a design efficiency of 99.93 percent. In addition, each unit utilizes a Wahlco flue gas conditioning system that injects sulfur trioxide into the gas stream (as necessary) to optimize ESP operation. Low NO_x burners are also installed on Unit #5 to reduce NO_x emissions.

3.0 SUMMARY OF TEST RESULTS

During the test program Unit #4 and #5 burned a blend of approximately 20% Eastern bituminous coal and 80% Western sub-bituminous coal. Testing was conducted at normal operating loads for each unit, within 90% of full load (175 MW), with an average gross load of 159 MW for Unit #4 and 163 MW for Unit #5.

3.1 Objectives

The purpose of the test program was:

1. To satisfy the PM stack testing requirement per the MDEQ ROP MI-ROP-B2836-2011 (i.e., EUBOILER4 and EUBOILER5 special condition V.1).

2. To satisfy testing requirements in CD, Civil Action No.: 14-13580, entered between Consumers Energy, the EPA, and the DOJ on November 4, 2014.

The stack test was conducted in accordance with the applicable CD and ROP reference methods and requirements. Table 3.1 presents the specified sampling matrix.

Table 3.1
Test Matrix

Source	Date (2015)	Run	Sampling Time†	Sampling Duration (minutes)	Parameter	Reference Method
Unit #4	July 15	VOID*	9:04-10:31	80	Volumetric Air Flow Molecular Weight Moisture Content Particulate Matter	1 and 2 3A 4 17 and MDEQ 5B
		1	11:11-12:53	96		
		2	14:27-16:09	96		
		3	16:29-18:09	96		
Unit #5	July 14	1	9:14-11:00	100		
		2	11:25-13:22	100		
		3	14:55-16:45	100		

* Did not obtain required sample volume, results excluded from calculations, void run data included in Attachment 2

† Sampling times include port changes

3.2 Test Results and Discussion

As shown in Table 3.2 below, each individual run, as well as the average of the three runs, was below the PM concentration emission limit of 0.18 pounds per 1,000 pounds exhaust gas, corrected to 50% excess air for each unit. Thus, Unit #4 and Unit #5 are in compliance with the ROP particulate matter emission limitations.

Table 3.2
Summary of PM Emission Test Results

Unit	Run	Gas Flowrate (acfm)	Outlet Grain Loading (gr/dscf)	PM Emission Rate (lb/mmBTU)	PM Emission Rate (lb/hr)	PM Concentration (lb/1,000 lbs Gas Flow*)
#4	1	574,030	0.0167	0.0294	47.54	0.0279
#4	2	577,170	0.0148	0.0259	42.76	0.0248
#4	3	577,614	0.0072	0.0126	20.70	0.0120
Average		**576,271**	**0.0129**	**0.0226**	**37.00**	**0.0216**
#5	1	625,962	0.0213	0.0404	66.08	0.0328
#5	2	641,414	0.0168	0.0315	53.39	0.0282
#5	3	645,675	0.0135	0.0249	43.30	0.0227
Average		**637,684**	**0.0172**	**0.0322**	**54.26**	**0.0278**

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

It should be noted that the first run conducted on Unit #4, conducted from 9:04 a.m. to 10:31 a.m., did not obtain the minimum sample volume as required by the Consent Decree Paragraph 155 (i.e., the test run did not collect a minimum of 30 dry standard cubic feet of exhaust gas), and thus the results from that test run were excluded from the calculations to determine the average PM emission rate of the unit. Three additional test runs were conducted for Unit #4 which satisfied the minimum sample volume requirements. The data collected during the initial test run is included in this report, as required, and may be found in Attachment 2. Example calculations and calculation data sheets are presented in Attachments 1 and 2. Field and laboratory data sheets are presented in Attachment 3.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Triplicate PM test runs were performed on Unit #5 on July 14, 2015 and on Unit #4 on July [illegible], 2015. Each boiler was operating at greater than 90% load during the testing under routine operating conditions. Operating data required to be collected during the test runs, per the approved stack test protocol, included unit load in megawatts and stack opacity readings; this data is presented in Attachment 4.

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 Reference 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 #4 and #5 exhaust duct breechings and test port locations is shown in Figures 1 and 2.

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. Exhaust gas temperatures were also measured in conjunction with delta P determinations using a chromel/alumel "Type E" thermocouple and a temperature indicator.

Attachment 2 of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at the Unit #4 and #5 sample locations. 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 of Unit #4 measured in September 2006 was observed to be 1.4°, 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 Unit #4 PM test. A cyclonic flow verification was performed prior to the PM tests at the Unit #5 sample location on July 14, 2015, resulting in an average null angle of 1.5°, which also meets the less than 20° requirement, verifying the absence of cyclonic flow.

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 Reference 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, an in-stack alundum thimble filter and 47 mm glass fiber filter (back-up), a stainless 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 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 particulate was rinsed from the sampling nozzle 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 in units of: grains per dry standard cubic foot (Gr/dscf), pounds per hour (lb/hr) and pounds per thousand pounds of exhaust gas (lb/1000 lbs), corrected to 50% excess air, as required by ROP MI-ROP-B2836-2011. The Method 5B/17 sampling train is shown in Figure 3. The Method 17 nozzle configuration is presented in Figure 4.

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 impingers and nozzle/filter particulate catch 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 5.

6.0 CERTIFICATION

I hereby certify that the statements and information in this test report and supporting enclosures are true, accurate, and complete, and that the test program was performed in accordance with test methods specified in this report.

Brian C. Pape, QSTI
Senior Engineering Technical Analyst Lead
ESD/Laboratory Services – Regulatory Compliance Testing Section

Report prepared by:

Dillon A. King, QSTI
General Engineering Technical Analyst
ESD/Laboratory Services – Regulatory Compliance Testing Section

Report reviewed by:

Kathryn R. Ross
Senior Environmental Planner
Environmental Services – Air Quality Section

B C COBB UNITS #4 & #5

PARTICULATE EMISSION TEST

SUMMARY TABLE

Date	Unit	Gross MW	Gas Volume (acfm)	Outlet Grain Loading (gr/dscf)	Particulate Emission Rate (lb/mmBtu)	Particulate Emission Rate lb/hr	lb/1000 lbs Gas Flow*	Average Stack Opacity (%)	Flue Gas Temp (°F)	Flue Gas Velocity (fps)	Excess Air (%)	Flue Gas Moisture (%)	Isokinetic Variation (%)
7/15/2015	4	159	574,030	0.0167	0.0294	47.54	0.0279	11.4	326.9	53.5	30.7	11.7	101.1
7/15/2015	4	159	577,170	0.0148	0.0259	42.76	0.0248	12.2	328.0	53.8	29.1	10.6	99.4
7/15/2015	4	159	577,614	0.0072	0.0126	20.70	0.0120	11.4	329.3	53.8	30.2	10.7	98.7
	Average	159.0	576,271	0.0129	0.0226	37.00	0.0216	11.7	328.1	53.7	30.0	11.0	99.7
7/14/2015	5	162	625,962	0.0213	0.0404	66.08	0.0326	11.6	317.1	58.3	37.3	11.7	101.6
7/14/2015	5	163	641,414	0.0168	0.0315	53.39	0.0262	10.7	318.7	59.8	37.3	11.7	101.3
7/14/2015	5	163	645,675	0.0135	0.0249	43.30	0.0227	12.5	319.6	60.2	36.1	11.3	101.4
	Average	162.7	637,684	0.0172	0.0322	54.26	0.0278	11.6	318.5	59.4	36.9	11.6	101.5

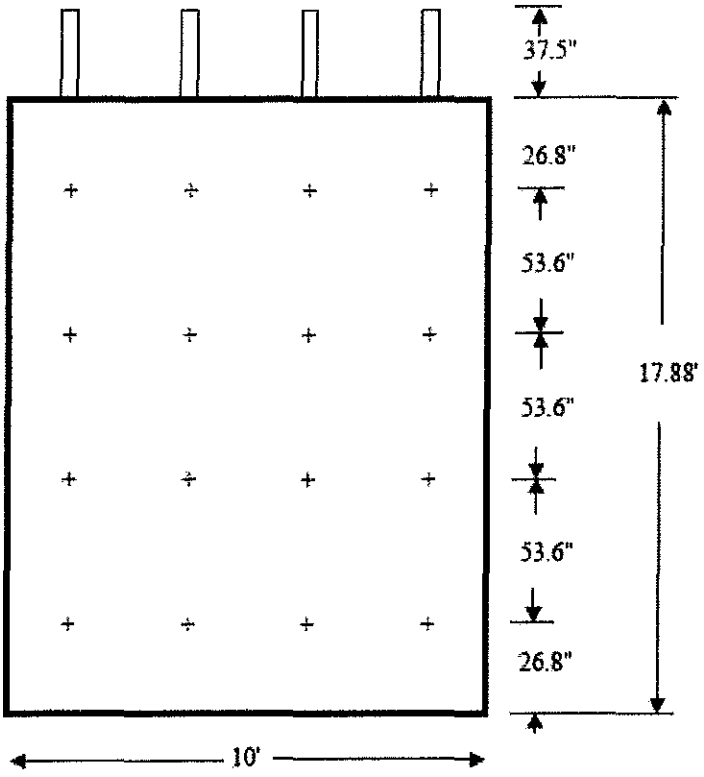
* Emissions in pounds of particulate per 1000 pounds gas flow corrected to 50 % excess air.

Notes: 1. The particulate emission limit is 0.18 lbs/1,000 lbs gas flow at 50% excess air for Units 4 and 5.
2. Oxygen and carbon dioxide are measured at the point of particulate sampling.
3. Flue gas moisture is determined by the condensate method.
4. Flue gas temperature is the average temperature at the point of particulate sampling.

Figure 1

B C Cobb Generating Facility
Unit #4

Equal Area Traverse for Rectangular Ducts

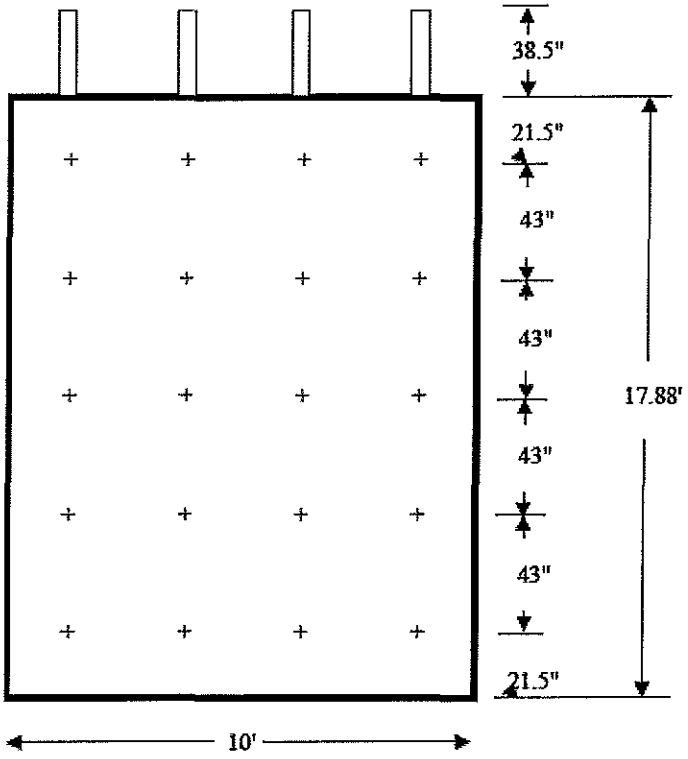


Duct Length:	17.884'
Duct Width:	10'
Number of Ports:	4
Test Points per Port:	4
Distance between Ports:	2.5'
Distance between Points:	4.5'

Figure 2

B C Cobb Generating Facility
Unit #5

Equal Area Traverse for Rectangular Ducts



Duct Length:	17.884'
Duct Width:	10'
Number of Ports:	4
Test Points per Port:	5
Distance between Ports:	2.5'
Distance between Points:	3.6'

Figure 3

Method 17 Sample Train Flow Diagram

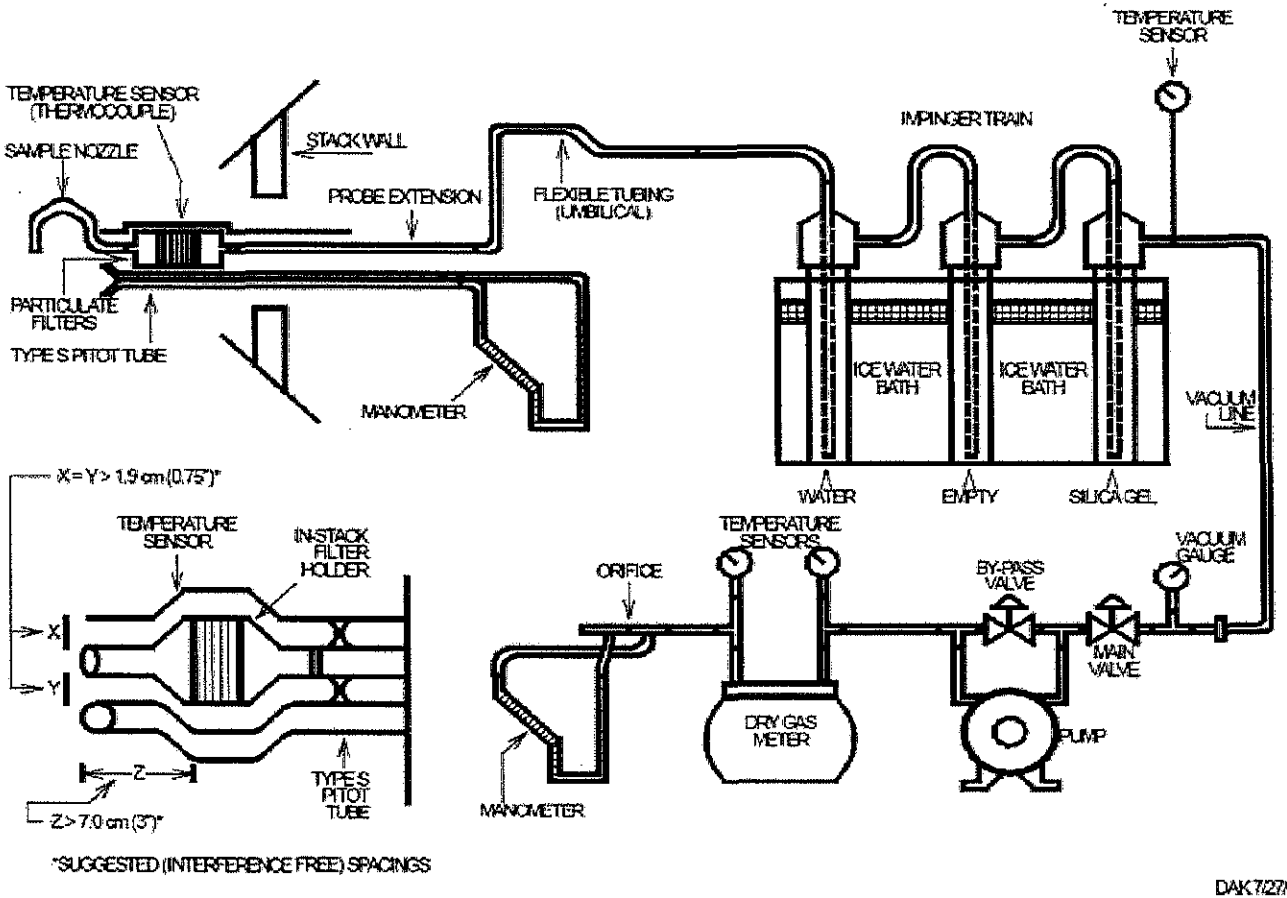
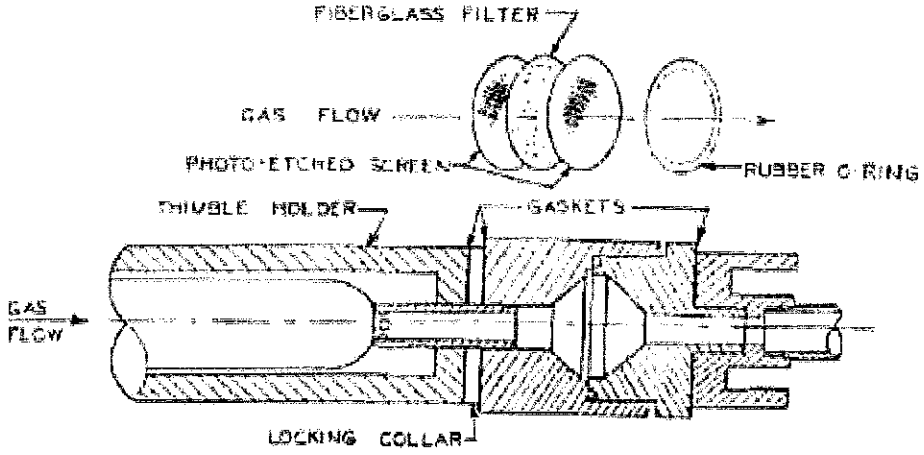
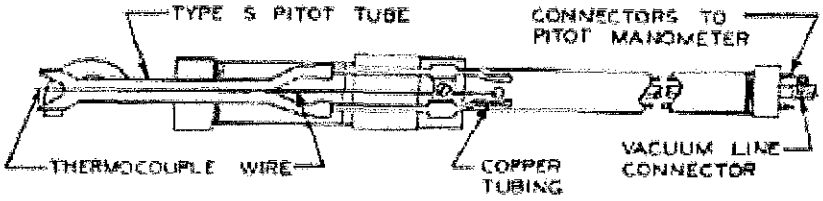


Figure 4

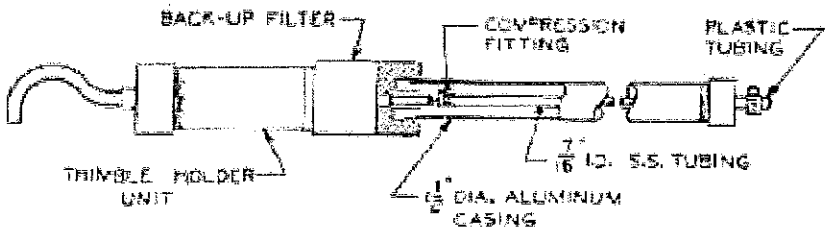
Method 17 Probe Assembly Diagram



IN-LINE FIBERGLASS FILTER HOLDER



PARTICULATE - SAMPLING PROBE ASSEMBLY



PROBE ASSEMBLY