

Report of...

# Compliance Emission Sampling

Performed for...

## Cadillac Renewable Energy

Cadillac, Michigan

On the

## Wood Fired Boiler

August 23-24, 2017

138.29

**RECEIVED**

**OCT 25 2017**

**AIR QUALITY DIVISION**

Network Environmental, Inc.  
Grand Rapids, MI

## I. INTRODUCTION

Network Environmental, Inc. was retained by Cadillac Renewable Energy of Cadillac, Michigan to conduct a compliance emission study at their facility. The purpose of the study was to meet the emission testing requirements of Renewable Operating Permit (ROP) No. MI-ROP-N1395-2014a.

ROP No. MI-ROP-N1395-2014a specifies the following emission parameters to be sampled: Particulate Matter, Benzo-A-Pyrene and Volatile Organic Compounds (VOC's). All the testing followed the Michigan Department of Environmental Quality (MDEQ) and U.S. EPA testing protocols.

The following is a list of the applicable emission limits for the boiler exhaust:

Emission Limit(s)
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**Particulate:** 15.7 Lbs/Hr & 0.03 Lbs/MMBTU of Heat Input

**Benzo-A-Pyrene:** 10 ug/M<sup>3</sup> (@ 70 °F & 29.92 in. Hg) & 0.0054 Lbs/Hr

**VOC's:** 22.5 Lbs/Hr & 0.043 Lbs/MMBTU of Heat Input

The following reference test methods were employed to conduct the emission sampling:

- Particulate Matter – U.S. EPA Method 17
- Benzo-A-Pyrene – U.S. EPA Method 23
- VOC's – U.S. EPA Method 25A
- Exhaust Gas Parameters (flow rate, temperature, moisture & density)– U.S. EPA Methods 1- 4

The sampling was performed over the period of August 23-24, 2017 by R. Scott Cargill, Stephan K. Byrd, Richard D. Eerdmans, and David D. Engelhardt of Network Environmental, Inc.. Assisting with the study were Mr. Scott Clark and Mr. Tom Schimd of Cadillac Renewable Energy. Mr. Jeremy Howe of the Michigan Department of Environmental Quality (MDEQ) – Air Quality Division was present to observe portions of the sampling and source operation.

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II. PRESENTATION OF RESULTS

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**II.1 TABLE 1  
PARTICULATE EMISSION RESULTS  
WOOD FIRED BOILER EXHAUST  
CADILLAC RENEWABLE ENERGY  
CADILLAC, MICHIGAN  
AUGUST 23, 2017**

Sample	Time <sup>(1)</sup>	Air Flow Rate DSCFM <sup>(2)</sup>	Particulate Concentration Grains/DSCF <sup>(3)</sup>	Particulate Mass Rates	
				Lbs/Hr <sup>(4)</sup>	Lbs/MMBTU <sup>(5)</sup>
1	07:37-08:47	98,787	0.0044	3.73	0.0072
2	09:09-10:18	97,656	0.0033	2.72	0.0053
3	10:36-11:46	95,767	0.0024	1.94	0.0037
<b>Average</b>		<b>97,403</b>	<b>0.0034</b>	<b>2.80</b>	<b>0.0054</b>

- (1) Times Shown Are The Facility's CEMS Computer Times
- (2) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- (3) Grains/DSCF = Grains Of Particulate Per Dry Standard Cubic Foot Of Exhaust Gas
- (4) Lbs/Hr = Pounds Of Particulate Per Hour
- (5) Lbs/MMBTU = Pounds Of Particulate Per Million BTU of Heat Input. Calculated Using The Formula Found In Section 12.2.1 (Equation 19-1) Of Method 19 For O<sub>2</sub> On A Dry Basis With An F Factor Of 9,240.

**II.2 TABLE 2  
VOC EMISSION RESULTS  
WOOD FIRED BOILER EXHAUST  
CADILLAC RENEWABLE ENERGY  
CADILLAC, MICHIGAN  
AUGUST 23, 2017**

Sample	Time <sup>(1)</sup>	Air Flow Rate SCFM <sup>(2)</sup>	VOC Concentration PPM <sup>(3)</sup>	VOC Mass Emission Rates	
				Lbs/Hr <sup>(4)</sup>	Lbs/MMBTU <sup>(5)</sup>
1	07:53-08:53	130,676	0.4	0.36	0.00069
2	09:06-10:06	130,061	0.3	0.27	0.00052
3	10:34-11:34	128,414	1.0	0.88	0.00169
<b>Average</b>		<b>129,717</b>	<b>0.6</b>	<b>0.50</b>	<b>0.00097</b>

- (1) Times Shown Are The Facility's CEMS Computer Times  
(2) SCFM = Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)  
(3) PPM = Parts Per Million (v/v) On A Wet (Actual) Basis As Propane  
(4) Lbs/Hr = Pounds Of VOC Per Hour As Propane  
(5) Lbs/MMBTU = Pounds Of VOC Per Million BTU Of Heat Input. Calculated Using The Formula Found In Section 12.2.1 (Equation 19-1) Of Method 19 For O<sub>2</sub> On A Dry Basis With An F Factor Of 9,240.

**II.3 TABLE 3  
 BENZO-A-PYRENE EMISSION RESULTS  
 WOOD FIRED BOILER EXHAUST  
 CADILLAC RENEWABLE ENERGY  
 CADILLAC, MICHIGAN  
 AUGUST 23-24, 2017**

Sample	Date	Time <sup>(1)</sup>	Air Flow Rate DSCFM <sup>(2)</sup>	Benzo-A-Pyrene Concentration ug/M <sup>3</sup> <sup>(3)</sup>	Benzo-A-Pyrene Mass Rate Lbs/Hr <sup>(4)</sup>
1	8/23/17	14:02-15:19	91,045	0.0056	1.92E-06
2	8/24/17	07:56-09:13	95,979	0.0050	1.79E-06
3	8/24/17	10:10-11:24	97,390	0.0033	1.19E-06
<b>Average</b>			<b>94,805</b>	<b>0.0046</b>	<b>1.63E-06</b>

- (1) Times Shown Are The Facility's CEMS Computer Times
- (2) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 70 °F & 29.92 in. Hg)
- (3) ug/M<sup>3</sup> = Micrograms Per Dry Standard Cubic Meter (STP = 70 °F & 29.92 in. Hg)
- (4) Lbs/Hr = Pounds of Benzo-A-Pyrene Per Hour

### **III. DISCUSSION OF RESULTS**

The results of the emission sampling are summarized in Tables 1 through 3 (Sections II.1 through II.3). It should be noted that all sample times shown are times from the facility's CEMS system. The results are presented as follows:

#### **III.1 Particulate Emission Results (Table 1)**

Table 1 summarizes the particulate emission results as follows:

- Sample
- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Particulate Concentration (Grains/DSCF) – Grains of Particulate Per Dry Standard Cubic Foot of Exhaust Gas
- Particulate Mass Emission Rate (Lbs/Hr) – Pounds of Particulate Per Hour
- Particulate Mass Emission Rate (Lbs/MMBTU) – Pounds of Particulate Per Million BTU of Heat Input

The Lbs/MMBTU results were calculated using U.S. EPA Method 19 for oxygen on a dry basis with an F Factor of 9,240.

#### **III.2 VOC Emission Results (Table 2)**

Table 2 summarizes the VOC emission results as follows:

- Sample
- Time
- Air Flow Rate (SCFM) – Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- VOC Concentration (PPM) – Parts Per Million (v/v) On An Actual (Wet) Basis As Propane
- VOC Mass Emission Rates
  - ◊ Lbs/Hr – Pounds of VOC Per Hour as Propane
  - ◊ Lbs/MMBTU – Pounds of VOC Per Million BTU of Heat Input

The Lbs/MMBTU results were calculated using U.S. EPA Method 19 for oxygen on a dry basis with an F Factor of 9,240

#### **III.3 Benzo-A-Pyrene Results (Table 3)**

Table 3 summarizes the benzo-a-pyrene results as follows:

- Sample

- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 70 °F & 29.92 in. Hg)
- Benzo-A-Pyrene Concentration (ug/M<sup>3</sup>) – Micrograms Per Dry Standard Cubic Meter (STP = 70 °F & 29.92 in. Hg)
- Benzo-A-Pyrene Mass Emission Rate (Lbs/Hr) – Pounds of Benzo-A-Pyrene Per Hour

#### **IV. SOURCE DESCRIPTION**

The source sampled is the exhaust of the wood fired boiler. Emission control on the boiler consists of a selective non-catalytic reduction (SNCR) system, a multi-clone dust collector and an electrostatic precipitator (ESP). The boiler has a spreader-stoker design and burns wood in the presence of air to generate heat. NO<sub>x</sub> removal from the exhaust gases is accomplished by the SNCR system. After the SNCR system, the exhaust gases pass through the multi-clone dust collector for removal of material which can be re-injected into the boiler for higher efficiency. After this pre-treatment, further particulate removal is achieved when the exhaust gases pass through the ESP. The treated exhaust gases are vented to the atmosphere through a 96 inch I.D. exhaust stack.

Operating data during the testing can be found in Appendix B.

#### **V. SAMPLING AND ANALYTICAL PROTOCOL**

The sampling location for the boiler exhaust was on the 96 inch diameter exhaust at a location that meets the 8 duct diameter downstream and 2 duct diameter upstream requirement of U.S. EPA Method 1. There are 4 sample ports. Twelve (12) sampling points (3 per port) were used for the isokinetic sampling. The sampling point dimensions were as follows:

<u>Sample Point</u>	<u>Dimension (Inches)</u>
1	4.22
2	14.02
3	28.42

**V.1 Particulate** – The particulate emission sampling was conducted in accordance with U.S. EPA Reference Method 17. Method 17 is an in-stack filtration method. Three (3) samples were collected. Each sample was sixty (60) minutes in duration, and had a minimum sample volume of thirty (30) dry standard cubic feet. The samples were collected isokinetically and analyzed for total particulate by gravimetric analysis. All the quality assurance and quality control procedures listed in the method were incorporated in the sampling and analysis. Figure 1 is a diagram of the Method 17 particulate sampling train.

**V.2 Benzo-A-Pyrene** - The determination for benzo-a-pyrene was performed in accordance with U.S. EPA Method 23 modified for PAH's. A Modified Method 5 (MM5) sampling train, as described in Method 23, was used to collect the PAH samples. The sampling train consisted of a heated glass lined probe followed by a heated pre-cleaned quartz filter. A condenser coil followed by an XAD sorbent trap followed the heated filter. An impinger train containing HPLC water followed the XAD trap. All sampling train components were pre-cleaned in accordance with the method.

Three (3) samples were collected. Each sample was sixty (60) minutes in duration, and had a minimum sample volume of thirty (30) dry standard cubic feet. The sampling system operation was consistent with U.S. EPA Method 5. The three samples and the blank train were recovered in pre-cleaned sample bottles with Teflon lined caps. The probe rinse and filter rinse were combined with the XAD extract for analysis. The back-half impinger condensate was also analyzed. The benzo-a-pyrene analysis was performed in accordance with California Air Resources Board (CARB) Method 429, which is separation by high-resolution gas chromatography and measurement by high-resolution mass spectrometry. All quality assurance requirements specified in the method were incorporated in the sampling and analysis. Figure 2 is a diagram of the Method 23 Benzo-A-Pyrene sampling train.

**V.3 VOC** – The VOC emission sampling was conducted in accordance with U.S. EPA Reference Method 25A. A J.U.M. Model 3-500 flame ionization detector (FID) analyzer was used to monitor the source sampled. Sample gas was extracted through a heated probe. A heated teflon sample line was used to transport the exhaust gases to the analyzer. The analyzer produces instantaneous readouts of the VOC concentrations (PPM).

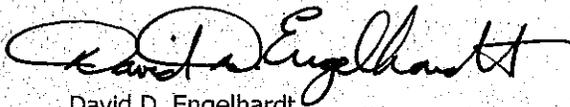
The analyzer was calibrated by system injection (from the back of the stack probe to the analyzer) prior to the testing. A span gas of 96.49 PPM was used to establish the initial instrument calibration. Calibration gases of 29.17 PPM and 50.19 PPM were used to determine the calibration error of the analyzer. After each sample, a system zero and system injection of 29.17 PPM were performed to establish system drift and

system bias during the test period. All calibration gases used were EPA Protocol Propane Calibration Gases. Three (3) samples were collected from the boiler exhaust. Each sample was sixty (60) minutes in duration.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler exhaust. All reference method data was corrected using Equation 7E-5 from U.S. EPA Method 7E. Figure 3 is a diagram of the Method 25A VOC sampling train.

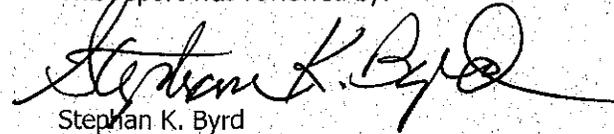
**V.4 Exhaust Gas Parameters** – The exhaust gas parameters (air flow rate, temperature, moisture and density) were determined in conjunction with the other sampling by employing U.S. EPA Methods 1 through 4. Air flow rates, temperatures and moistures were determined using the Method 17 & 23 sampling trains. Bag samples were collected from the Method 17 & 23 sampling trains and analyzed for oxygen and carbon dioxide by Orsat. All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis.

This report was prepared by:

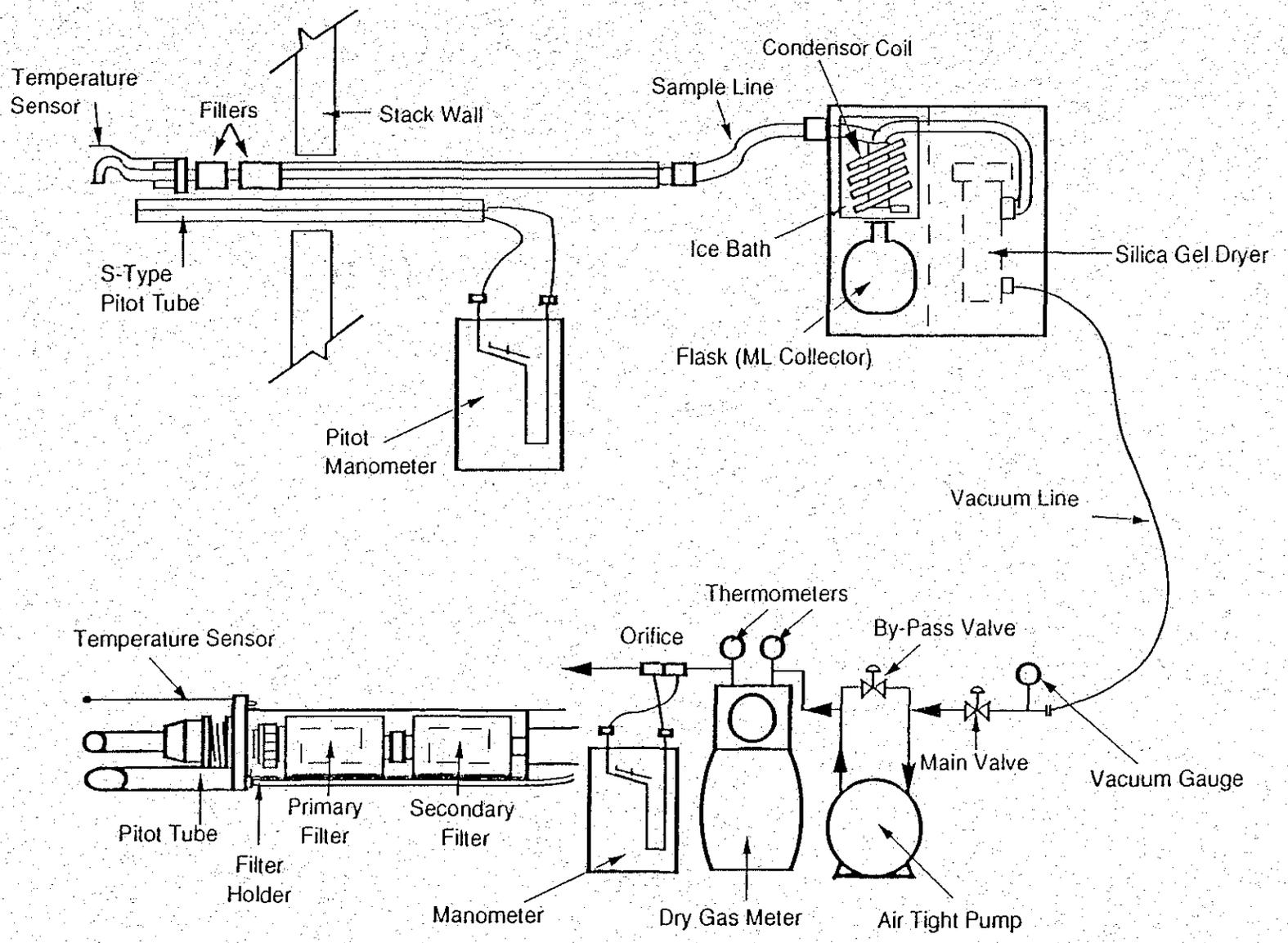


David D. Engelhardt  
Vice President

This report was reviewed by:

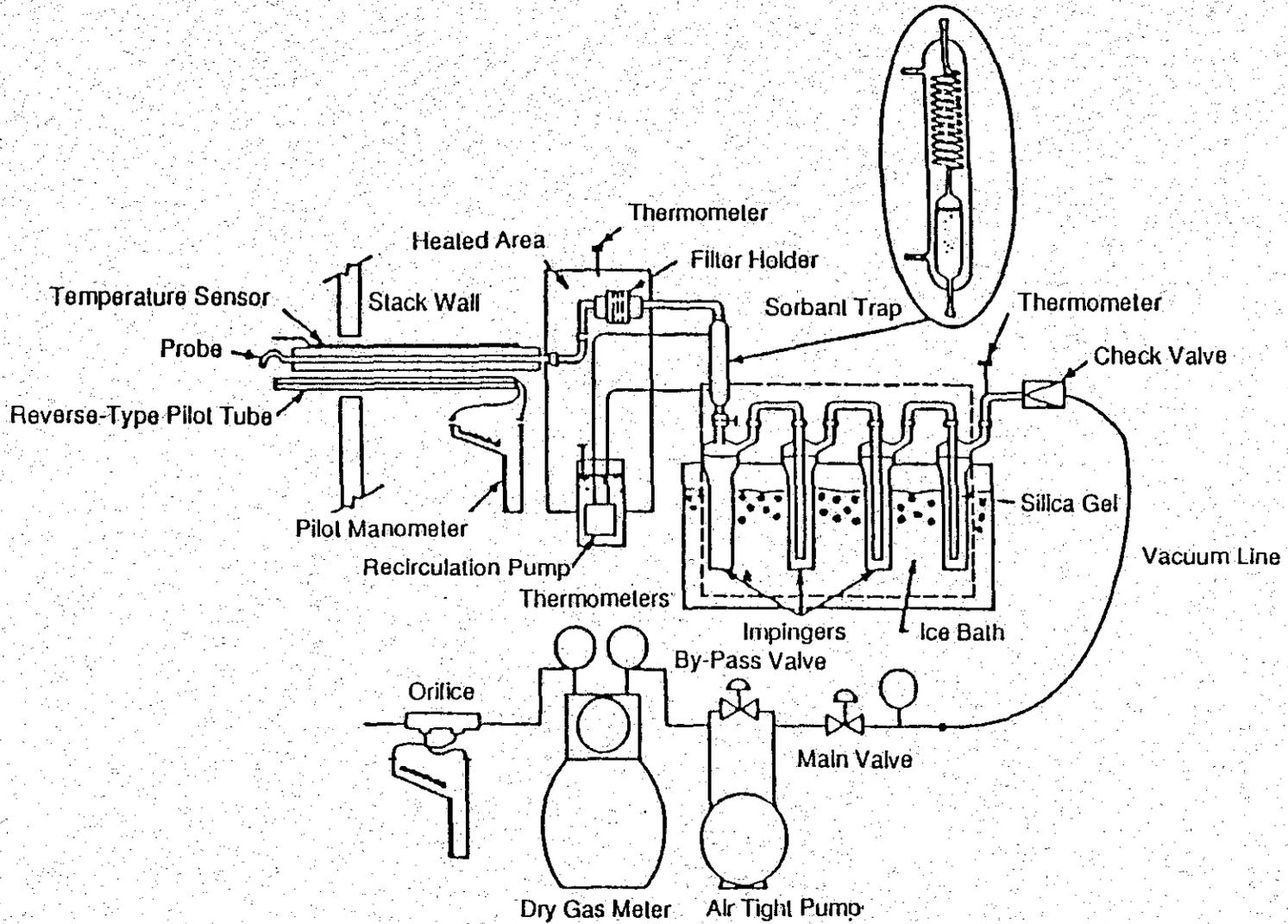


Stephan K. Byrd  
President



**Figure 1**

**Method 17  
Particulate Sampling Train**



**Figure 2**  
**Method 23**  
**Benzo-A-Pyrene Sampling Train**

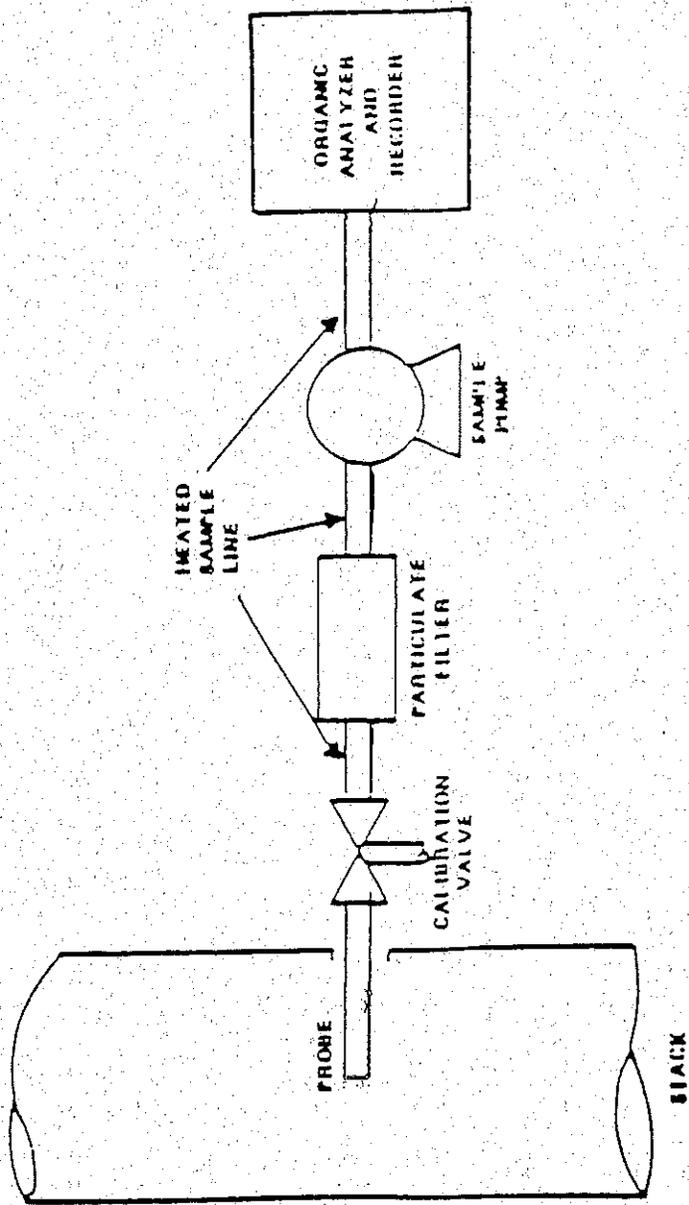


Figure 3

Method 25A  
VOC Sampling Train