I. INTRODUCTION

Network Environmental, Inc. was retained by the Grayling Generating Station of Grayling, 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-N2388-2014a.

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

Pollutant	Permit Limit	Units	Result	
Particulate (PM)	0.03	Lbs/MMBTU	0.0028	Compliant
	12.0	Lbs/Hr	1.51	Compliant
VOC's	0.017	Lbs/MMBTU	0.010	Compliant
	8.9	Lbs/Hr	4.9	Compliant
Arsenic (As)	0.02	Lbs/Hr	<0.000059 (N.D.)	Compliant
Cadmium (Cd)	0.012	Lbs/Hr	0.00023	Compliant
Total Chromium (Cr)	0.012	Lbs/Hr	0.0022	Compliant
Lead (Pb)	0.02	Lbs/Hr	0.0025	Compliant
Manganese (Mn)	0.061	Lbs/Hr	0.0027	Compliant
Zinc (Zn)	9.5	Lbs/Hr	0.041	Compliant
Benzo-A-Pyrene	0.005	Lbs/Hr	1.27E-06	Compliant
H_2SO_4	0.003	Lbs/MMBTU	0.002	Compliant
	1.5	Lbs/Hr	1.2	Compliant

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

- Particulate Matter – U.S. EPA Method 5 (combined with Method 29)
- VOC's – U.S. EPA Method 25A
- Metals – U.S. EPA Method 29 (combined with Method 5)
- Benzo-A-Pyrene – U.S. EPA Method 23
- H_2SO_4 – U.S. EPA Method 8
- Exhaust Gas Parameters (air flow rate, temperature, moisture & density) – U.S. EPA Methods 1- 4

During the sampling the boiler was firing a combination of wood waste and tire derived fuel (TDF).

The sampling was performed over the period of November 10-12, 2020 by Stephan K. Byrd, R. Scott Cargill, Richard D. Eerdmans, and David D. Engelhardt of Network Environmental, Inc.. Assisting with the study were Mr. Richard Laur of the Grayling Generating Station, Ms. Chloe Palajac of NTH Consultants, Ltd. and the operating staff of the facility. Mr. Jeremy Howe and Ms. Sharon LeBlanc of the Michigan Department of Environmental, Great Lakes and Energy (EGLE) - Air Quality Division were present to observe the sampling and source operation.

II. PRESENTATION OF RESULTS

II.1 TABLE 1
PARTICULATE EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Filterable Particulate Emissions	
				Lbs/Hr (2)	Lbs/MMBTU (3)
1	11/11/20	09:30-10:45	103,007	1.41	0.0026
2	11/11/20	11:40-12:55	103,828	1.79	0.0035
3	11/11/20	13:55-15:10	105,514	1.33	0.0025
Average			**104,116**	**1.51**	**0.0028**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Lbs/Hr = Pounds Per Hour
(3) Lbs/MMBTU = Pounds Per Million BTU Of Heat Input (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU)

II.2 TABLE 2
TOTAL HYDROCARBON (VOC) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	VOC Emissions		
				PPM (2)	Lbs/Hr (3)	Lbs/MMBTU (4)
1	11/10/20	11:30-12:30	89,380	8.44	5.16	0.0107
2	11/10/20	15:45-16:45	88,943	8.96	5.45	0.0113
3	11/10/20	17:05-18:05	88,200	6.71	4.04	0.0084
Average			**88,841**	**8.04**	**4.88**	**0.0102**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) PPM = Parts Per Million (v/v) On A Dry Basis As Propane
(3) Lbs/Hr = Pounds Per Hour As Propane
(4) Lbs/MMBTU = Pounds Per Million BTU Of Heat Input (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU)

II.3 TABLE 3
ARSENIC (As) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Arsenic (As) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	N.D. (4)	N.D. (4)
2	11/11/20	11:40-12:55	103,828	N.D. (4)	N.D. (4)
3	11/11/20	13:55-15:10	105,514	N.D. (4)	N.D. (4)
Average			**104,116**	**----**	**----**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour
(4) N.D. = Non Detected at a detection limit 0.00015 Mg/M^3 & 0.000059 Lbs/Hr (Average detection limit for the 3 samples)

II.4 TABLE 4
CADMIUM (Cd) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Cadmium (Cd) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	0.00079	0.00031
2	11/11/20	11:40-12:55	103,828	0.00059	0.00023
3	11/11/20	13:55-15:10	105,514	0.00037	0.00015
Average			**104,116**	**0.00059**	**0.00023**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour

II.5 TABLE 5
TOTAL CHROMIUM (Cr) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Total Chromium (Cr) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	0.0114	0.0044
2	11/11/20	11:40-12:55	103,828	0.0024	0.0009
3	11/11/20	13:55-15:10	105,514	0.0031	0.0012
Average			**104,116**	**0.0056**	**0.0022**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour

II.6 TABLE 6
MANGANESE (Mn) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Manganese (Mn) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	0.0088	0.0034
2	11/11/20	11:40-12:55	103,828	0.0070	0.0027
3	11/11/20	13:55-15:10	105,514	0.0052	0.0021
Average			**104,116**	**0.0070**	**0.0027**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour

II.7 TABLE 7
LEAD (Pb) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Lead (Pb) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	0.0057	0.0022
2	11/11/20	11:40-12:55	103,828	0.0078	0.0030
3	11/11/20	13:55-15:10	105,514	0.0056	0.0022
Average			**104,116**	**0.0064**	**0.0025**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour

II.8 TABLE 8
ZINC (Zn) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Zinc (Zn) Emissions	
				Mg/M^3 (2)	Lbs/Hr (3)
1	11/11/20	09:30-10:45	103,007	0.118	0.046
2	11/11/20	11:40-12:55	103,828	0.094	0.036
3	11/11/20	13:55-15:10	105,514	0.107	0.042
Average			**104,116**	**0.106**	**0.041**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds Per Hour

II.9 TABLE 9
BENZO-A-PYRENE EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Benzo-A-Pyrene Emissions	
				ug/M^3 (2)	Lbs/Hr (3)
1	11/11/20	17:05-18:20	103,837	2.16E-03	8.41E-07
2	11/12/20	08:13-09:28	106,292	4.50E-03	1.79E-06
3	11/12/20	10:17-11:30	104,250	3.02E-03	1.18E-06
Average			**104,793**	**3.23E-03**	**1.27E-06**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) ug/M^3 = Micrograms Per Dry Standard Cubic Meter (STP = 68 °F and 29.92 in. Hg)
(3) Lbs/Hr = Pounds Per Hour

II.10 TABLE 10
SULFURIC ACID (H_2SO_4) EMISSION RESULTS
WOOD FIRED BOILER EXHAUST
GRAYLING GENERATING STATION
GRAYLING, MI

Sample	Date	Time	Air Flow Rate DSCFM (1)	Sulfuric Acid (H_2SO_4) Emissions		
				Mg/M^3 (2)	Lbs/Hr (3)	Lbs/MMBTU (4)
1	11/12/20	12:25-13:37	107,661	2.87	1.16	0.0021
2	11/12/20	14:10-15:22	108,038	3.13	1.27	0.0023
3	11/12/20	15:52-17:04	108,148	2.78	1.12	0.0021
Average			**107,949**	**2.93**	**1.18**	**0.0022**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F and 29.92 in. Hg)
(2) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter (STP = 68 °F and 29.92 in. Hg)
(3) Lbs/Hr = Pounds Per Hour
(4) Lbs/MMBTU = Pounds Per Million BTU Of Heat Input (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU.

III. DISCUSSION OF RESULTS

The results of the emission sampling are summarized in Tables 1 through 10 (Sections II.1 through II.10). The results are presented as follows:

III.1 Particulate Emission Results (Table 1)

Table 1 summarizes the particulate emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Particulate Mass Emission Rates:
  - ✧ Lbs/Hr - Pounds of Particulate Per Hour
  - ✧ Lbs/MMBTU - Pounds of Particulate Per Million BTU of Heat Input (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU)

III.2 VOC Emission Results (Table 2)

Table 2 summarizes the total hydrocarbon (VOC) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (SCFM) - Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- VOC Concentrations (PPM) - Parts Per Million (v/v) On A Dry 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 (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU)

III.3 Arsenic (As) Emission Results (Table 3)

Table 3 summarizes the arsenic (As) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Arsenic (As) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter

- Arsenic (As) Mass Emission Rates (Lbs/Hr) - Pounds of Arsenic Per Hour

Arsenic was below the detection limit for each of the three samples. The average detection limit was 0.00015 Mg/M^3 & 0.000059 Lbs/Hr.

III.4 Cadmium (Cd) Emission Results (Table 4)

Table 4 summarizes the cadmium (Cd) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Cadmium (Cd) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Cadmium (Cd) Mass Emission Rates (Lbs/Hr) - Pounds of Cadmium Per Hour

III.5 Total Chromium (Cr) Emission Results (Table 5)

Table 5 summarizes the total chromium (Cr) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Total Chromium (Cr) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Total Chromium (Cr) Mass Emission Rates (Lbs/Hr) - Pounds of Total Chromium Per Hour

III.6 Manganese (Mn) Emission Results (Table 6)

Table 6 summarizes the manganese (Mn) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Manganese (Mn) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Manganese (Mn) Mass Emission Rates (Lbs/Hr) - Pounds of Manganese Per Hour

III.7 Lead (Pb) Emission Results (Table 7)

Table 7 summarizes the lead (Pb) emission results as follows:

- Sample

- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Lead (Pb) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Lead (Pb) Mass Emission Rates (Lbs/Hr) - Pounds of Lead Per Hour

III.8 Zinc (Zn) Emission Results (Table 8)

Table 8 summarizes the Zinc (Zn) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Zinc (Zn) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Zinc (Zn) Mass Emission Rates (Lbs/Hr) - Pounds of Zinc Per Hour

III.9 Benzo-A-Pyrene Emission Results (Table 9)

Table 9 summarizes the benzo-a-pyrene emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Benzo-A-Pyrene Concentration (ug/M^3) - Micrograms Per Dry Standard Cubic Meter
- Benzo-A-Pyrene Mass Emission Rate (Lbs/Hr) - Pounds of Benzo-A-Pyrene Per Hour

III.10 Sulfuric Acid (H_2SO_4) Emission Results (Table 10)

Table 10 summarizes the sulfuric acid (H_2SO_4) emission results as follows:

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Sulfuric Acid (H_2SO_4) Concentrations (Mg/M^3) - Milligrams Per Dry Standard Cubic Meter
- Sulfuric Acid (H_2SO_4) Mass Emission Rates:
  - ✧ Lbs/Hr - Pounds of Sulfuric Acid Per Hour
  - ✧ Lbs/MMBTU - Pounds of Sulfuric Acid Per Million BTU of Heat Input (Calculated Using Equation 19-6 From U.S. EPA Method 19 With An F-Factor of 1,830 DSCF/MMBTU)

IV. SAMPLING AND ANALYTICAL PROTOCOL

The sampling location for the boiler exhaust was on the 92 inch diameter exhaust at a location approximately 6 duct diameters downstream and 20 duct diameters upstream from the nearest disturbances. 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:

Sample Point	Dimension (Inches)
1	4.04
2	13.43
3	27.23

IV.1 Particulate & Metals – The particulate and metals sampling was conducted by employing U.S. EPA Method 29 (combined with Method 5). This is an out of stack filtration method, where the sampling probe and filter are heated at 250 °F (plus or minus 25 °F).

Three (3) samples were collected from the boiler exhaust stack. Each sample was sixty (60) minutes in duration. Each sample had a minimum sample volume of thirty (30) dry standard cubic feet. The samples were collected isokinetically on quartz filters and in a nitric acid/hydrogen peroxide solution.

The filters and nozzle/probe rinses (front half) were analyzed gravimetrically for particulates in accordance with U.S. EPA Method 5. The nozzle/probe rinses, filters and nitric acid/hydrogen peroxide solutions were analyzed for all the above listed metals by inductively coupled argon plasma/mass spectrophotometry (ICAP/MS) analysis in accordance with Method 29. 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 sampling train.

IV.2 VOC – The total hydrocarbon (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 boiler exhaust. 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 94.9 PPM was used to establish the initial instrument calibration. Calibration gases of 30.2 PPM and 50.6 PPM were used to determine the calibration error of the analyzer. After each sample, a system zero and system injection of 30.2 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 2 is a diagram of the Method 25A VOC sampling train.

IV.3 Benzo-A-Pyrene – The benzo-a-pyrene emission sampling was performed in accordance with U.S. EPA Method 23. A Modified Method 5 (MM5) sampling train, as described in Method 23, was used to collect the 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 analytes were extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry. The analysis followed the procedures of SW-846 Method 8290. All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis. Figure 3 is a diagram of the Method 23 sampling train.

IV.4 Sulfuric Acid – The sulfuric acid determinations were conducted in accordance with U.S. EPA Method 8. The exhaust gas was extracted through a heated probe which lead to an impinger train. The first impinger contained 80% isopropyl alcohol (IPA), which is where the sulfuric acid was collected. The samples were collected isokinetically as described in the method. Immediately following each sample, a twenty (20) minute purge (at approximately the average sampling rate) using ambient air was

performed on the impinger train. The purge is designed to remove any SO_2 that might remain in the first impinger. The sulfuric acid content in the samples was determined by the analytical procedure in EPA ALT-133 (EPA Method 8A) which is ion chromatography. 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. All the quality assurance and quality control requirements of the method were incorporated in the sampling and analysis. The sulfuric acid sampling train is shown in Figure 4.

IV.5 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, moistures and densities were determined using the isokinetic sampling trains. All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis.

This report was prepared by:

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This report was reviewed by:

Stephan K. Byrd
President

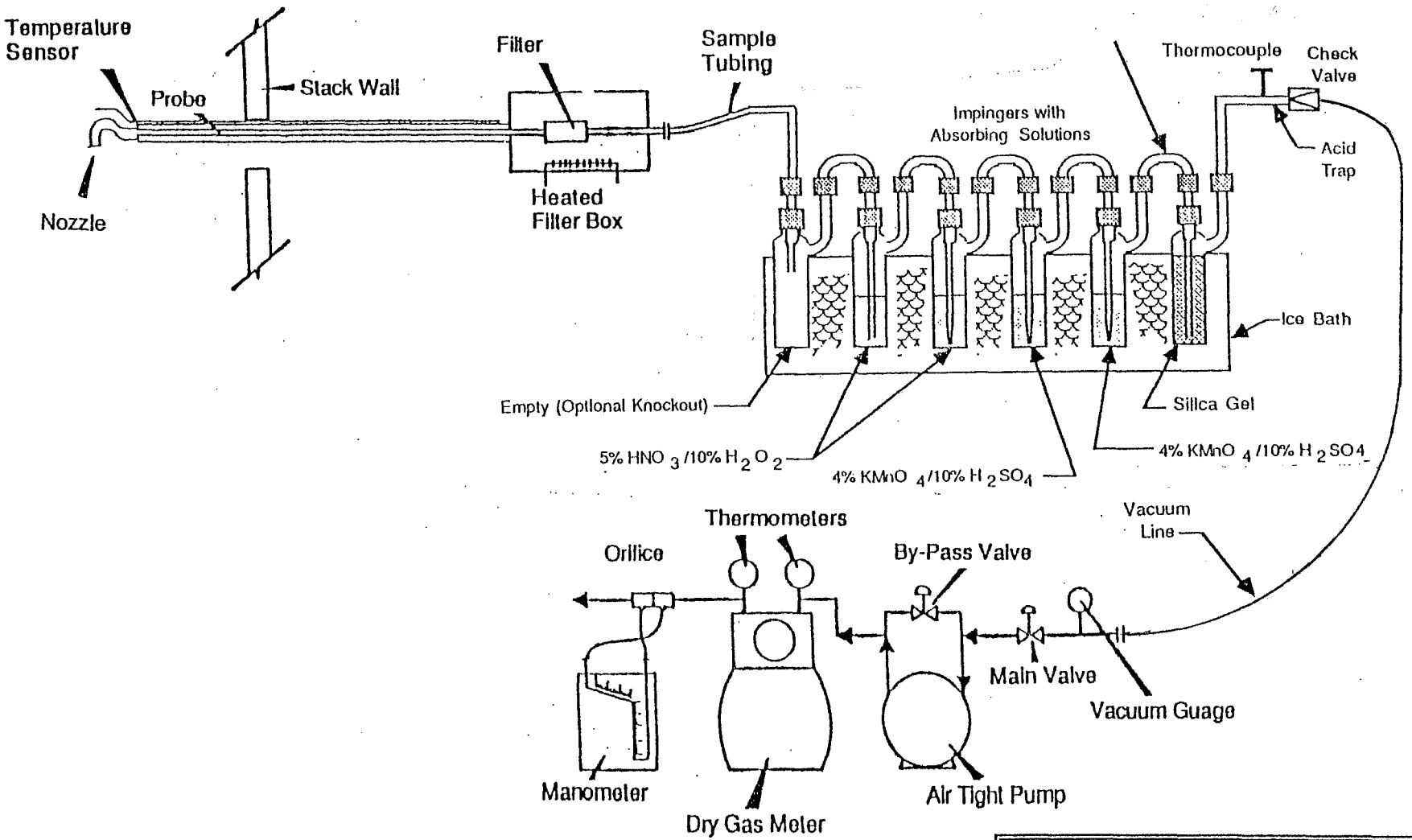

Figure 1

Particulate & Metals Sampling Train

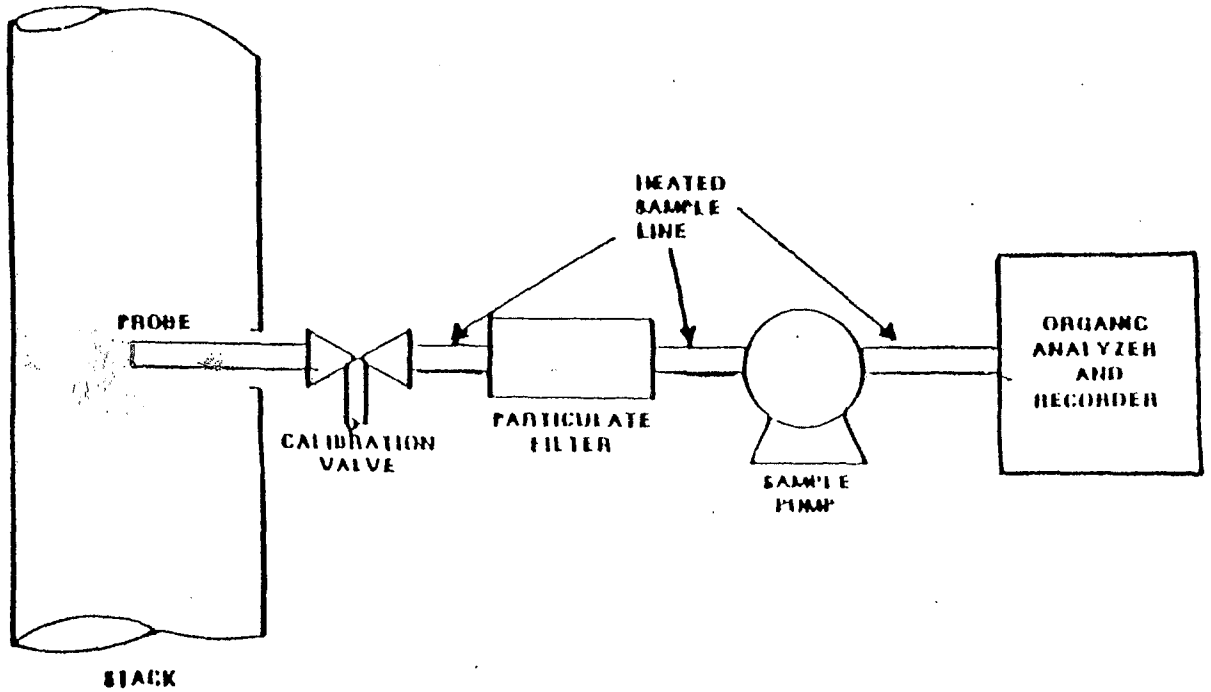

Figure 2

VOC
Sampling Train

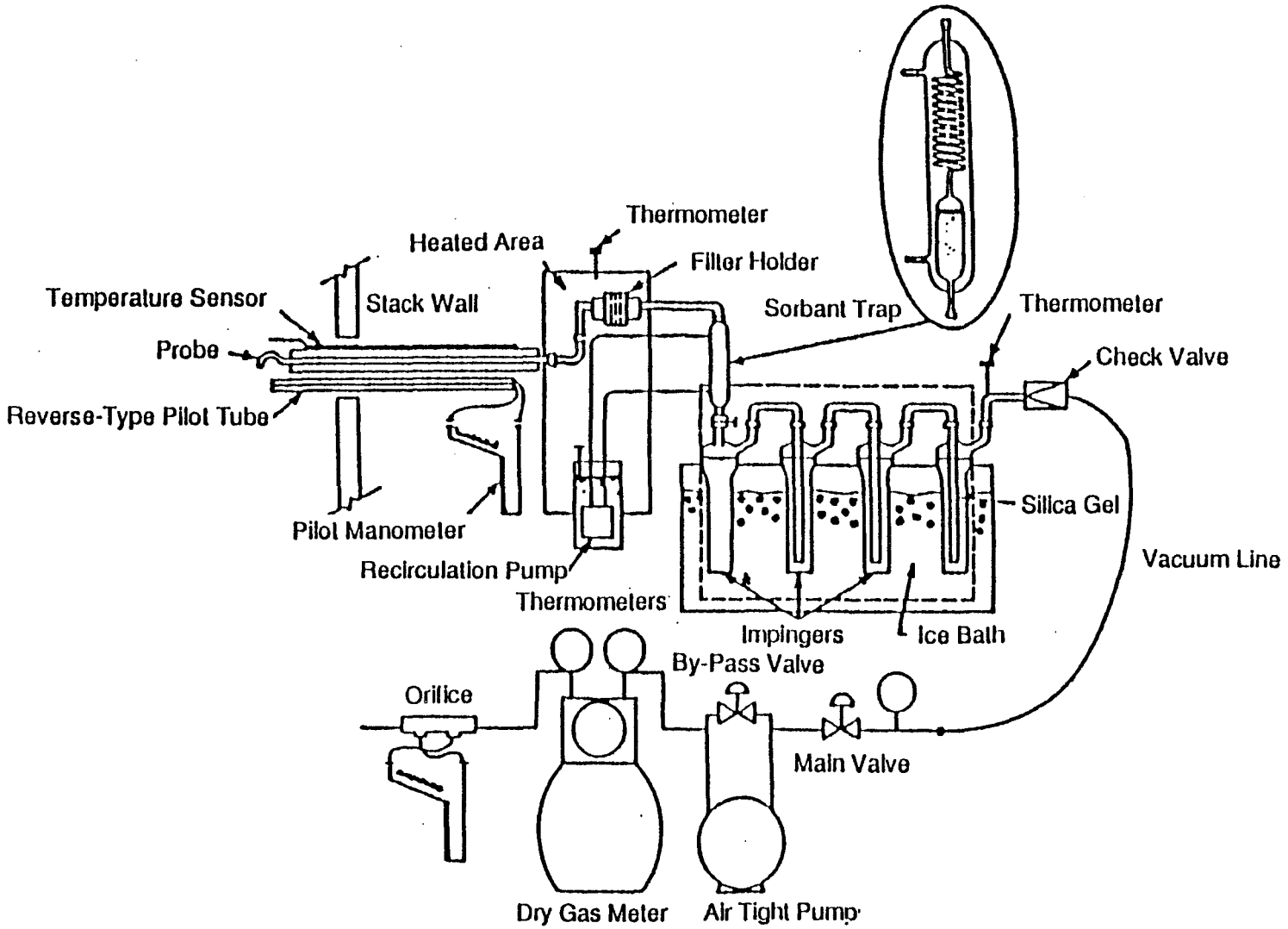

Figure 3

Benzo-A-Pyrene Sampling Train

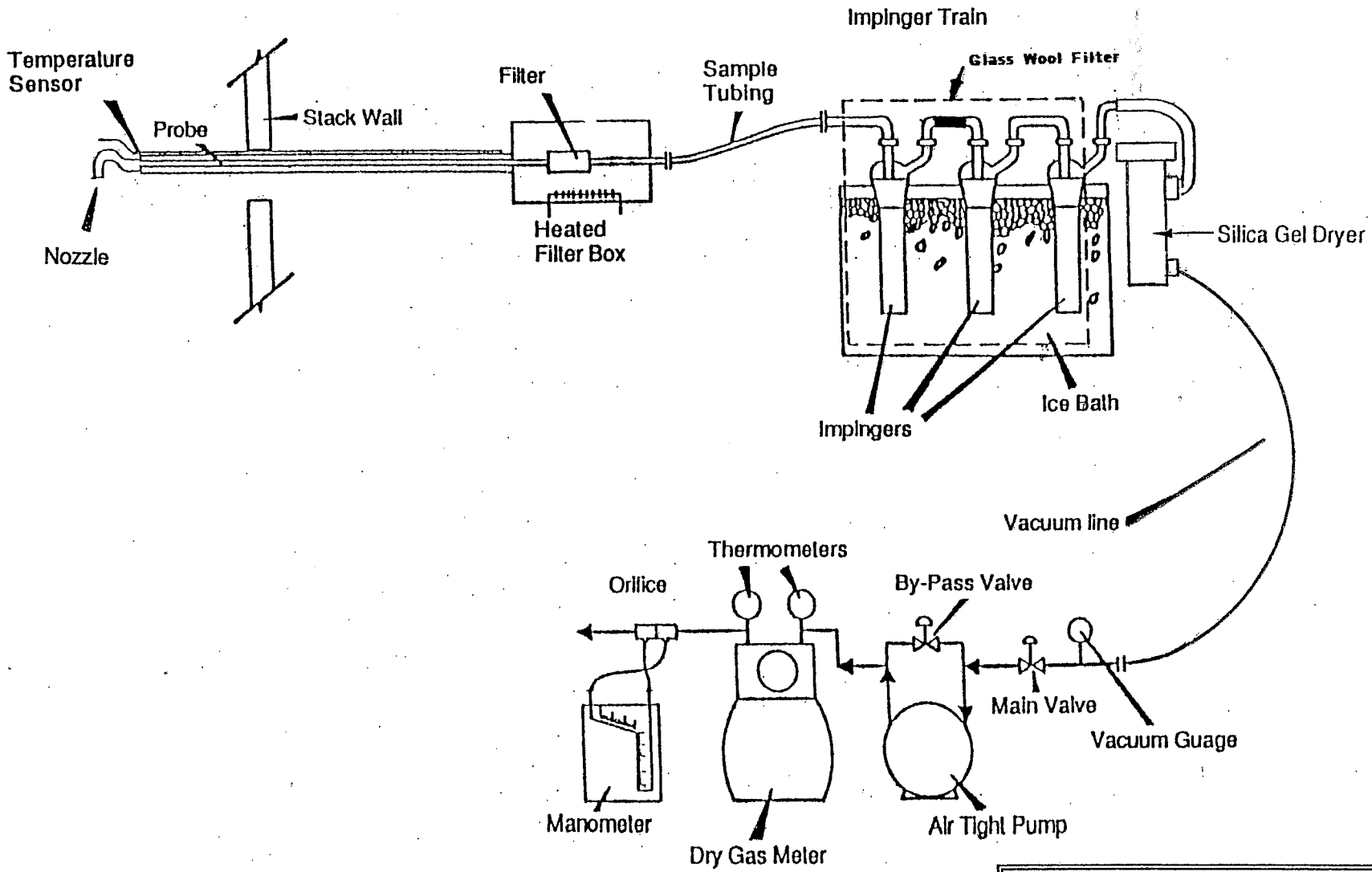

Figure 4

Sulfuric Acid Sampling Train