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**Air Emissions Test Report
Detroit Water and Sewerage Department
Multiple Hearth Incinerator Nos. 7 and 8
State Registration Number (SRN) B2103
Permit-to-Install Application ID# 61-13
Detroit, Michigan**

Prepared for:

**Mr. CJ Pokorny
Walsh Construction Company**

Prepared by:

**Mr. Leigh A. Gammie, QSTI
Gammie Air Monitoring, LLC**

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GamAir Project No.: 753-1217

1.0 INTRODUCTION

1.1 Summary of Test Program

Gammie Air Monitoring, LLC (GamAir) was retained by Walsh Construction Company (Walsh) to perform an air emissions compliance test program on two multiple hearth incinerators (MHI) Nos. 7 and 8 which are owned and operated by the Detroit Water and Sewerage Department (DWSD). Testing occurred on the scrubber exhaust duct of each MHI. The purpose of this source test program was to quantify the controlled emissions of filterable particulate matter (FPM), multiple metals (cadmium, lead, and mercury), hydrogen chloride (HCl), fluoride (F), sulfuric acid (H₂SO₄), particulate matter less than 10 microns and 2.5 microns (PM_{10/2.5}), polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF), sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, carbon dioxide, and oxygen. The applicable USEPA MACT 129 emission limits are as follows.

Parameter	Units	USEPA MACT 129 Emission Limits
Carbon Monoxide (CO)	ppmvd @ 7% O ₂	3,800
Sulfur Dioxide (SO ₂)	ppmvd @ 7% O ₂	26
Oxides of Nitrogen (NO _x)	ppmvd @ 7% O ₂	220
Filterable Particulate Matter (FPM)	milligrams per dry standard cubic meter @ 7% O ₂	80
Hydrogen Chloride (HCl)	ppmvd @ 7% O ₂	1.2
PCDD/PCDF	nanograms per dry standard cubic meter @ 7% O ₂ (total mass basis) or	5
PCDD/PCDF	nanograms per dry standard cubic meter @ 7% O ₂ (toxic equivalency basis)	0.32
Cadmium	milligrams per dry standard cubic meter @ 7% O ₂	0.095
Lead	milligrams per dry standard cubic meter @ 7% O ₂	0.30
Mercury	milligrams per dry standard cubic meter @ 7% O ₂	0.28
Fugitive Emissions from Ash Handling	% Opacity	5

The applicable Michigan Department of Environmental Quality (MDEQ) emission limits are as follows.

Parameter	Units	MDEQ Emission Limits
PM 10 particulate matter	pounds per hour	1.2
PM 2.5 particulate matter	pounds per hour	1.2
Volatile Organic Compounds (VOC)	pounds per hour	3.2
Fluoride (F)	pounds per hour	1.73
Sulfuric acid (H ₂ SO ₄)	pounds per hour	1.3

Compliance emission tests focused on the parameters listed above. The tests were conducted in accordance with the conditions and monitoring requirements for compliance testing as set forth in the State of Michigan Department of Environmental Quality (MDEQ) and United States Environmental Protection Agency (USEPA) Part 60, Subpart M - Emission Guidelines for Existing Sewage Sludge Incineration Units (Model Rule).

Compliance tests were conducted in accordance with EPA Methods 1-5, 6C, 7E, 8, 10, 13B, 22, 23, 25A, 26A, 29, 201A, and 202 as published in Title 40, Code of Federal Regulations, Parts 51 and 60. The test program for each MHI was conducted over a two day period. Unit No. 7 was tested on 16 & 17 April 2015 and Unit No. 8 was tested on 19 & 21 April 2015. Representatives from Walsh and DWSD were responsible for coordinating the testing with the MDEQ. Mr. Thomas Maza served on the onsite representative from MDEQ. DWSD was responsible for collecting all process data, collecting and analyzing all biosolid samples. Gammie Air Monitoring, LLC (GamAir) was responsible for collecting all air emission samples and the respective analysis of those samples.

Section 2.0 of this report presents a description of each source and describes the sampling locations. Section 3.0 summarizes the test results. Section 4.0 describes the sampling and analysis methodologies. Section 5.0 provides the quality assurance and quality control (QA/QC) procedures specific to this test program.

1.2 Test Program Organization

The following is a list of those individuals responsible for the organization of this test program.

Mr. CJ Pokorny Email: cpokorny@walshgroup.com	Walsh Construction	(313) 363-6570
Mrs. Kashmira Patel Email: kpatel@dwsd.org	DWSD	(313) 297-5938
Mr. Thomas Maza Email: mazat@michigan.gov	MDEQ	(313) 456-4709
Mr. Eugene Waltz Email: ewaltz@earthlink.net	Incinerator Rx	(317) 250-9015

Mr. Leigh Gammie
Email: lag@gamair.com

GamAir

(860) 757-3340

Mr. Clayton Johnson
Email: cjohnson@maxxam.ca

Maxxam Analytics

(905) 817-5769

2.0 SOURCE AND SAMPLE LOCATION DESCRIPTIONS

2.1 Process and Air Pollution Control Description

DWSD operated two identical multiple hearth incinerators (MHI), identified at Nos. 7 and 8, which are 22 foot in diameter and are equipped with 12-hearths. Sludge was dewatered with centrifuges and conveyed to the multiple hearth furnaces with belt conveyors. The sludge conveyors were equipped with nuclear weigh scales for continuous monitoring of the amount of sludge being incinerated. During the compliance test program, each incinerator operated at a minimum 85 percent of rated capacity. The furnace is equipped with auxiliary natural gas burners at hearths 2, 4, 6, 8, 10, and 12. The firing rate of the burners is modulated by a central control system to sustain the desired hearth temperatures. Each air pollution control system is comprised of a double zero hearth afterburner section of Hearths 1 and 2, a quench section, and EnviroCare® Venturi-Pak (venturi throat sections and mist eliminator) scrubber system. Individual process monitoring for each incinerator are shown in Tables 2-1 through 2-4.

2.2 Process Monitoring

2.2.1 Unit No. 7

During the test program MHI No. 7 operated at an optimized feed rate. The following two tables summarize the process conditions during the PCDD/PCDF/metals tests and the FPM/HCl tests, respectively. Sludge feed rate ranged between 2.62 to 3.63 dry tons per hour.

Table 2-1 Summary of Process Data PCDD/PCDF and Metals Tests Detroit Water and Sewerage Department - Incinerator No. 7 Detroit, Michigan 16 April 2015					
Method/Component	Units	Run 1 0930-1141	Run 2 1230-1435	Run 3 1635-1838	Average
Biosolids Feed Rate	wet tons/hour	10.20	10.99	11.17	10.79
Biosolids Cake Solids	%	34	33	31	32.7
Biosolids Feed Rate	dry tons/hour	3.47	3.63	3.46	3.52
Afterburner Exit Temp.	°F	1171	1168	1142	1160
Total Scrubber Water Flow	gallon/minute	1322	1316	1317	1318
Total Scrubber Pressure Drop	inches w.c.	24.8	25.0	24.6	24.8
Scrubber Water Outlet	pH	6.41	6.29	6.34	6.35

% - percent
inches w.c. - inches water column

Table 2-2
Summary of Process Data
FPM and HCl Tests
Detroit Water and Sewerage Department - Incinerator No. 7
Detroit, Michigan
16 April 2015

Method/Component	Units	Run 1 1910-2040	Run 2 2105-2234	Run 3 2300-0028	Average
Biosolids Feed Rate	wet tons/hour	10.67	8.73	11.44	10.28
Biosolids Cake Solids	%	33	30	29	30.7
Biosolids Feed Rate	dry tons/hour	3.52	2.62	3.32	3.15
Afterburner Exit Temp.	°F	1125	1134	1109	1123
Total Scrubber Water Flow	gallon/minute	1314	1325	1353	1331
Total Scrubber Pressure Drop	inches w.c.	28.3	26.9	28.0	27.7
Scrubber Water Outlet	pH	6.38	6.54	6.43	6.45

% - percent
inches w.c. – inches water column

2.2.2 Unit No. 8

During the test program MHI No. 8 operated at an optimized feed rate. Tables 2-3 and 2-4 summarize the process conditions during the PCDD/PCDF/metals tests and the FPM/HCl tests, respectively. Sludge feed rate ranged between 2.05 to 3.00 dry tons per hour. Additional process monitoring data is contained in Appendix D.

Table 2-3
Summary of Process Data
PCDD/PCDF and Metals Tests
Detroit Water and Sewerage Department - Incinerator No. 8
Detroit, Michigan
19 April 2015

Method/Component	Units	Run 1	Run 2	Run 3	Average
		1225-1428	1522-1724	1747-1950	
Biosolids Feed Rate	wet tons/hour	10.2	10.82	8.63	9.88
Biosolids Cake Solids	%	25	19	25	23.0
Biosolids Feed Rate	dry tons/hour	3.00	2.42	2.54	2.65
Afterburner Exit Temp.	°F	1107	1142	1218	1156
Total Scrubber Water Flow	gallon/minute	1322	1319	1309	1317
Total Scrubber Pressure Drop	inches w.c.	29.7	28.7	30.3	29.6
Scrubber Water Outlet	pH	6.20	6.20	6.13	6.18

Table 2-4
Summary of Process Data
FPM and HCl Tests
Detroit Water and Sewerage Department - Incinerator No. 8
Detroit, Michigan
21 April 2015

Method/Component	Units	Run 1	Run 2	Run 3	Average
		0800-0924	0953-1123	1145-1314	
Biosolids Feed Rate	wet tons/hour	8.71	9.33	10.79	9.61
Biosolids Cake Solids	%	26	22	22	23.3
Biosolids Feed Rate	dry tons/hour	2.27	2.05	2.37	2.23
Afterburner Exit Temp.	°F	1129	1095	1119	1114
Total Scrubber Water Flow	gallon/minute	1288	1252	1338	1293
Total Scrubber Pressure Drop	inches w.c.	27.4	27.0	27.3	27.2
Scrubber Water Outlet*	pH	6.16	6.26	6.18	6.20

% - percent

inches w.c. – inches water column

2.3 Outlet Flue Gas Sampling Locations

MHI Nos. 7 and 8 sampling locations were identical. Outlet flue gas sampling occurred at a location that is between the scrubber exhaust and induced draft fan. The inside diameter of the exhaust duct is 54 inches. Two test ports, spaced 90° apart, were located 120 inches (2.2 duct diameters) to the nearest upstream disturbance and 108 inches (2.0 duct diameters) to the nearest downstream disturbance. In accordance with EPA Method 1, twenty four (24) traverse points (12 per port) were used for isokinetic sampling and volumetric flowrate determinations. Continuous emissions monitoring (CEM) took place through a single port that was located adjacent to the DWSD total hydrocarbons (THC) sampling probe (same elevation). All continuous emissions monitoring (CEM) took place at the following three traverse points 9", 26", and 44". The EPA Method 1 traverse points are shown in Appendix A.

3.0 SUMMARY AND DISCUSSION OF RESULTS

3.1 Objectives and Test Matrix

The purpose of this test program was to measure air emissions from two MHI specifically Nos.7 and 8. Emissions testing was conducted in accordance with EPA approved test procedures. Three emissions tests were conducted on each MHI for each parameter, with the average result of the three tests reported. Table 3-1 lists the compliance parameters measured, the EPA reference methods used, and the sampling times for each test. The specific objectives for each MHI were to:

- Measure fluoride emissions from the outlet stack in accordance with EPA Method 13B.
- Measure multiple metals (cadmium, lead, and mercury) emissions from the outlet stack in accordance with EPA Method 29.
- Measure PCDD/PCDF emissions from the outlet stack in accordance with EPA Method 23.
- Measure filterable particulate matter (PM) emissions from the outlet stack in accordance with EPA Method 5 and measure PM10/2.5 emissions in accordance with EPA Methods 201A and 202.
- Measure fugitive emissions (VE) from the ash handling system in accordance with EPA Method 22.
- Measure hydrogen chloride (HCl) emissions from the outlet stack in accordance with EPA Methods 5 and 26A.
- Measure O₂, CO₂, SO₂, NO_x, CO, and VOC from the outlet stack in accordance with EPA Methods 3A, 6C, 7E, 10, and 25A.
- Measure sulfuric acid emissions from the outlet stack in accordance with EPA Method 8
- Determine percent solids from collected sludge samples in accordance with Method SM2540B (Standard Methods) and ASTM Method D3684-01, respectively.
- Monitor and record scrubber pressure drop, auxiliary fuel consumption use, hearth operating temperatures, scrubber water pH, and sludge feed rate.

3.2 Test Matrix

Table 3-1 presents the sampling and analytical matrix used at each of the scrubber outlet sampling locations.

**TABLE 3-1
Test Matrix
Compliance Test Program
Detroit Water and Sewerage Department
Two Multiple Hearth Incinerators - Nos. 7 & 8
Detroit, Michigan**

Sampling Location	No. of Runs ^a	Pollutant Type ^b	Sampling Method ^c	Sampling Organization	Sample Run Time (min.)	Analytical Method ^d	Analytical Laboratory
Outlet Stack	3	O ₂ /CO ₂ & SO ₂	EPA M3A & 6C	GamAir	60	CEM	GamAir
CEMS Port		NO _x , CO, VOC	7E,10, 25A				
Outlet EPA Ports ^e	3	Metals	EPA M29	GamAir	120	ICP/MS	Maxxam
Outlet EPA Ports	3	PCDD/PCDF	EPA M23	GamAir	120	HRGC/ HRMS	Maxxam
Outlet EPA Ports	3	HCl	EPA M26A	GamAir	84	IC	Maxxam
		FPM	EPA M1-5	GamAir	84	Gravimetric	Maxxam
Outlet EPA Ports	3	H ₂ SO ₄	EPA M8	GamAir	84	Titration	Maxxam
Outlet EPA Ports	3	PM10/2.5	EPA 201A/202	GamAir	84	Gravimetric	Maxxam
Outlet EPA Ports	3	Fluoride	EPA 13B	GamAir	84	IC	Maxxam
Ash Handling	3	Visible Emissions	EPA M22	GamAir	60	NA	GamAir
Process Feed	3	Percent Solids	Grab	BWSD	Grab	Gravimetric	Maxxam

^a number of test runs ^b HCl and FPM tests will be conducted using the same M1-5/26A sampling train. ^c M – EPA Method.

^d CEM – continuous emissions monitoring; ICP/MS – inductively coupled plasma/mass spectrometry; IC – ion chromatography
EPA Ports – two ports spaced 90° apart.

3.2 Field Test Changes

One test for fluoride and PM10/2.5 were performed on Unit No. 7. It was determined by the MDEQ that one test, instead of the normal three tests, would suffice as long as three tests for the above mentioned parameters were performed on Unit No. 8. The carbon monoxide analyzer span had to be increased from 919 parts per million (ppm) to 4721 ppm during the testing of Unit Nos. 7 and 8. A 4721 ppm CO calibration gas was obtained from a local supplier as the highest CO calibration gas brought to the job site was 919 ppm. At the end of each CEMS test day the 4721 ppm gas was introduced to the CEMS system to prove linearity over the entire span. This was successfully accomplished for both units and met the approval of Mr. Thomas Maza the onsite MDEQ representative. Please note at no time did either unit exceed the 3800 ppm corrected to 7% oxygen CO emission limit.

3.3 Summary of Results

3.3.1 Unit No. 7

All Unit No. 7 test results are summarized in Table 3-2. The average FPM concentration was 12.79 milligrams per dry standard cubic meter corrected to 7% oxygen (mg/dscm at 7% O₂). The FPM concentration is below the EPA limit of 80.0 mg/dscm at 7% O₂ and represents 16 percent of the limit. HCl emissions averaged 0.15 parts per million corrected to 7% oxygen (ppm at 7% O₂). The HCl emissions are below the EPA limit of 1.2 ppm at 7% O₂ and represent 13 percent of the limit. PCDD/PCDF emissions were below both EPA limits of 5.0 nanograms per dry standard cubic meter corrected to 7% oxygen (ng/dscm at 7% O₂), total weight basis and 0.32 nanograms per dry standard cubic meter corrected to 7% oxygen (ng/dscm at 7% O₂), toxic equivalency factor basis. The average PCDD/PCDF concentration of 1.61 ng/dscm at 7% O₂ (total weight basis) represents 32.2 percent of the limit and the TEF concentration represents 13 percent of the limit. The average cadmium concentration of 0.017 mg/dscm at 7% O₂ is below the limit of 0.095 mg/dscm at 7% O₂ and is 18 percent of the limit. The average lead concentration of 0.098 mg/dscm at 7% O₂ is below the limit of 0.30 mg/dscm at 7% O₂ and is 33 percent of the limit. The average mercury concentration of 0.062 mg/dscm at 7% O₂ is below the limit of 0.28 mg/dscm at 7% O₂ and is 22 percent of the limit. All sulfur dioxide, oxides of nitrogen, and carbon monoxide gaseous pollutants were below their respective EPA limits as shown in Table 3-2.

All Michigan DEQ targeted pollutants were below their respective emission limits. The average sulfuric acid emission rate of 0.048 pounds per hour is below the emission limit of 1.3 pounds per hour. The average fluoride emission rate of less than (<) 0.0034 pounds per hour is below the emission limit of 1.73 pounds per hour. The average VOC emission rate of 0.46 pounds per hour is below the emission limit of 3.2 pounds per hour. Both the PM10 and PM2.5 average emission rates of 0.97 and 0.94, respectively were below the emission limit of 1.2 pounds per hour.

Test results are further detailed in Appendix B. An example calculation is also contained in Appendix B. Copies of field data sheets are shown in Appendix C. Process monitoring data is contained in Appendix. D. Appendix E contains all laboratory analytical reports and

Appendix F displays all equipment calibration data.

TABLE 3-2 Summary of Emissions Data Compliance Test Program Detroit Water and Sewerage Department - Incinerator No. 7 Detroit, Michigan 16-17 April 2015			
Parameter	Average Test Concentration* or Emission Rate	USEPA MACT 129 or MDEQ Emission Limit*	Compliance Status
USEPA MACT 129 Pollutants			
Sulfur Dioxide	1.3 ppmvd	26 ppmvd	Yes
Oxides of Nitrogen	90.8 ppmvd	220 ppmvd	Yes
Carbon Monoxide	1210.3 ppmvd	3800 ppmvd	Yes
Filterable Particulate Matter	12.79 mg/dscm	80.0 mg/dscm	Yes
Hydrochloric Acid	0.15 ppmvd		Yes
Cadmium	0.017 mg/dscm	0.095 mg/dscm	Yes
Lead	0.098 mg/dscm	0.30 mg/dscm	Yes
Mercury	0.062 mg/dscm	0.28 mg/dscm	Yes
PCDD/PCDF	1.61 ng/dscm	5.0 ng/dscm	Yes
	0.042 ng/dscm TEF	0.32 ng/dscm TEF	Yes
Fugitive Emission	1.2%	5%	Yes
Michigan DEQ Pollutants			
PM2.5 and CPM	0.94 pounds/hour	1.2 pounds/hour	Yes
PM10 and CPM	0.97 pounds/hour	1.2 pounds/hour	Yes
Sulfuric Acid	0.048 pounds/hour	1.3 pounds/hour	Yes
Fluoride	<0.0034 pounds/hour	1.73 pounds/hour	Yes
VOC	0.46 pounds/hour	3.2 pounds/hour	Yes

*All MACT 129 concentrations are corrected to 7 percent oxygen (@ 7% O₂).

ppmvd – parts per million, volume dry basis.

mg/dscm – milligrams per dry standard cubic meter.

ng/dscm – nanograms per dry standard cubic meter.

ng/dscm TEF – with toxic equivalency factor.

3.3.1 Unit No. 8

All Unit No. 8 test results are summarized in Table 3-2. The average FPM concentration was 7.58 milligrams per dry standard cubic meter corrected to 7% oxygen (mg/dscm at 7% O₂).

The FPM concentration is below the EPA limit of 80.0 mg/dscm at 7% O₂ and represents 9.5 percent of the limit. HCl emissions averaged < 0.18 parts per million corrected to 7% oxygen (ppm at 7% O₂). The HCl emissions are below the EPA limit of 1.2 ppm at 7% O₂ and represent 15 percent of the limit. PCDD/PCDF emissions were below both EPA limits of 5.0

nanograms per dry standard cubic meter corrected to 7% oxygen (ng/dscm at 7% O₂), total weight basis and 0.32 nanograms per dry standard cubic meter corrected to 7% oxygen (ng/dscm at 7% O₂), toxic equivalency factor basis. The average PCDD/PCDF concentration of 2.55 ng/dscm at 7% O₂ (total weight basis) represents 51.0 percent of the limit and the TEF concentration represents 19.4 percent of the limit. The average cadmium concentration of 0.015 mg/dscm at 7% O₂ is below the limit of 0.095 mg/dscm at 7% O₂ and is 16 percent of the limit. The average lead concentration of 0.053 mg/dscm at 7% O₂ is below the limit of 0.30 mg/dscm at 7% O₂ and is 18 percent of the limit. The average mercury concentration of 0.034 mg/dscm at 7% O₂ is below the limit of 0.28 mg/dscm at 7% O₂ and is 12 percent of the limit. All sulfur dioxide, oxides of nitrogen, and carbon monoxide gaseous pollutants were below their respective EPA limits as shown in Table 3-2.

All Michigan DEQ targeted pollutants were below their respective emission limits. The average sulfuric acid emission rate of 0.29 pounds per hour is below the emission limit of 1.3 pounds per hour. The average fluoride emission rate of less than (<) 0.0038 pounds per hour is below the emission limit of 1.73 pounds per hour. The average VOC emission rate of 0.95 pounds per hour is below the emission limit of 3.2 pounds per hour. Both the PM10 and PM2.5 average emission rates of 0.65 and 0.56, respectively were below the emission limit of 1.2 pounds per hour.

TABLE 3-3
Summary of Emission Data
Compliance Test Program
Detroit Water and Sewerage Department - Incinerator No. 8
Detroit, Michigan
19 & 21 April 2015

Parameter	Average Test Concentration* or Emission Rate	USEPA MACT 129 or MDEQ Emission Limit*	Compliance Status
USEPA MACT 129 Pollutants			
Sulfur Dioxide	2.8 ppmvd	26 ppmvd	Yes
Oxides of Nitrogen	96.2 ppmvd	220 ppmvd	Yes
Carbon Monoxide	2194.7 ppmvd	3800 ppmvd	Yes
Filterable Particulate Matter	7.58 mg/dscm	80.0 mg/dscm	Yes
Hydrochloric Acid	<0.18 ppmvd		Yes
Cadmium	0.015 mg/dscm	0.095 mg/dscm	Yes
Lead	0.053 mg/dscm	0.30 mg/dscm	Yes
Mercury	0.034 mg/dscm	0.28 mg/dscm	Yes
PCDD/PCDF	2.55 ng/dscm	5.0 ng/dscm	Yes
	0.062 ng/dscm TEF	0.32 ng/dscm TEF	Yes
Fugitive Emissions	0%	5%	Yes
MDEQ Pollutants			
PM2.5 and CPM	0.56 pounds/hour	1.2 pounds/hour	Yes
PM10 and CPM	0.65 pounds/hour	1.2 pounds/hour	Yes
Sulfuric Acid	0.29 pounds/hour	1.3 pounds/hour	Yes
Fluoride	<0.0038 pounds/hour	1.73 pounds/hour	Yes
VOC	0.95 pounds/hour	3.2 pounds/hour	Yes

*All MACT 129 concentrations are corrected to 7 percent oxygen (@ 7% O₂).

ppmvd – parts per million, volume dry basis.

mg/dscm – milligrams per dry standard cubic meter.

ng/dscm – nanograms per dry standard cubic meter.

ng/dscm TEF – with toxic equivalency factor

4.0 SAMPLING AND ANALYTICAL METHODOLOGY

The following EPA test methods were utilized during this emissions test program:

EPA Method 1	Sample and velocity traverses for stationary sources
EPA Method 2	Determination of stack gas velocity and volumetric flow rate (type S Pitot tube)
EPA Method 3A	Determination of oxygen and carbon dioxide concentrations in emissions from stationary sources (Instrumental analyzer procedure)
EPA Method 4	Determination of moisture content in stack gases
EPA Method 5	Determination of particulate emissions from stationary sources
EPA Method 6C	Determination of sulfur dioxide emissions from stationary sources (instrumental analyzer procedure)
EPA Method 7E	Determination of oxides of nitrogen emissions from stationary sources (instrumental analyzer procedure)
EPA Method 8	Determination of sulfuric acid from stationary sources
EPA Method 10	Determination of carbon monoxide emissions from stationary sources (instrumental analyzer procedure)
EPA Method 13B	Determination of total fluoride emissions from stationary sources
EPA Method 22	Visual determination of fugitive emissions from material sources
EPA Method 23	Determination of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) emissions from stationary sources
EPA Method 25A	Determination of total gaseous organic concentration using a flame ionization analyzer
EPA Method 26A	Determination of hydrogen chloride emissions from stationary sources
EPA Method 29	Determination of metals emissions from stationary sources
EPA Method 201A	Determination of PM10 and PM2.5 emissions from stationary sources
EPA Method 202	Dry impinger method for determining condensable particulate emissions from stationary sources

The following sections describe the sampling and analytical procedures utilized during this emissions test program. All tests were performed in triplicate unless otherwise noted. All sampling and analytical procedures followed those outlined in Title 40, CFR, Part 60; any deviations for this test program are addressed in the following sections.

4.1 Volumetric Flow Rate Tests

The volumetric flowrate of the exhaust gases, at the scrubber outlet test locations, were determined using EPA Methods 1-4. In accordance with EPA Method 1 twenty four (24) traverse points were utilized for flue gas velocity measurements during the isokinetic tests. The locations of the traverse points, as determined by EPA Method 1, are listed in Appendix A. Flue gas velocity measurements were taken at each traverse point during each test run using an S-type Pitot tube and an inclined water manometer in accordance with EPA Method 2. Stack temperature measurements was taken at each traverse point using a Type-K thermocouple and digital temperature readout. The stack static pressure was measured during

each test run using the Pitot tube and manometer setup. Pitot tube leak checks were performed before and after each test run in accordance with EPA Method 2.

The molecular weight of the outlet exhaust gases was determined by measuring the oxygen (O₂) and carbon dioxide (CO₂) concentrations using EPA Method 3A in conjunction with collected an integrated gas sample in 25 liter Tedlar bags. When applicable carbon dioxide and oxygen concentrations were determined from integrated gaseous samples collected during each test run using the sample train described in EPA Method 3B. The flue gas moisture content was determined from the moisture catch of each isokinetic sampling train during the emissions testing in accordance with EPA Method 4. A minimum sample volume of 35 cubic feet was collected during each moisture test run. The moisture content of the flue gas was calculated as the ratio of the moisture catch corrected to standard conditions to the sum of the dry sample volume and the moisture catch, both corrected to standard conditions.

4.2 Hydrogen Chloride and Filterable Particulate Matter Tests

The hydrogen chloride (HCl) and filterable particulate matter (FPM) emissions were sampled and analyzed in accordance with EPA Methods 5 and 26A. Three 84 minute tests were performed for compliance determination on each MHI. This sampling train is shown in Appendix A. The Method 5/26A sampling train consists of a Pyrex® glass nozzle, a heated glass lined sample probe, a heated Teflon filter (tared), a set of four tared glass impingers connected in series in an ice bath, a control module consisting of a leak free sampling pump, a calibrated critical orifice, an inclined manometer, and a calibrated dry gas meter.

The first two impingers each contained 100 ml of 0.1 N sulfuric acid (H₂SO₄) while the third impinger contained 100 ml of sodium hydroxide (NaOH). The fourth impinger contained a known quantity of silica gel. The sampling train glassware was cleaned prior to testing with soap and water and rinsed thoroughly with water. The sample probe and oven box were maintained at a temperature of 248±25°F during sampling to prevent moisture condensation. The impinger outlet temperature was maintained below 68°F during sampling by adding ice to the cold box. A vacuum line is connected from the outlet of the fourth impinger to the control module.

Before each test, the sampling train was leak checked to ensure no leakage greater than 0.02 cubic feet per minute at 10" Hg vacuum. The probe was then placed in the stack and stack gas was withdrawn isokinetically for an equal period of time at each traverse point with a sampling rate not exceeding 1.0 cfm.

The velocity differential pressure, critical orifice differential pressure, dry gas meter volume, dry gas meter outlet temperatures, probe temperature, stack temperature, oven box temperature, impinger outlet temperature, and sample vacuum were recorded at each traverse point during sampling. At the end of each test, the sampling train was leak checked to ensure no leakage greater than 0.02 cubic feet per minute at the highest recorded test vacuum.

Sample recovery consisted of rinsing the nozzle, probe, and filter holder front half three times with acetone. These acetone rinses were collected in Container 2. The tared Teflon filter was recovered in a clean laboratory area and placed in Container 1. Both the acetone and filter were desiccated and weighed (constant weight) in accordance with EPA Method 5. The contents of the four impingers was measured gravimetrically for moisture gain then

transferred to sample Container 3. Impingers 1 and 2 and their connecting glassware were rinsed with deionized distilled (DI) water twice. These rinses will be added to Container 3. The third impinger contents were discarded. The sample containers were sealed and the liquid levels marked. The HCl samples were shipped to Maxxam Analytics, Inc. for analysis. The HCl analysis was performed by ion chromatography (IC) as described in EPA Method 26A.

4.3 Multiple Metals Tests

Multiple metals (cadmium, lead, and mercury) were sampled and analyzed in accordance with EPA Method 29. These metals tests were performed in triplicate on each MHI at the exhaust stack location during 120-minute test runs. A schematic of the multiple metals sampling train is shown in Appendix A. The following is a description of the metals sampling train and the procedures used to quantify multiple-metals during the test program. The multiple-metals sampling train consisted of a glass nozzle, a heated glass lined probe, a quartz filter/holder in a heated box, a set of six glass impingers connected in series, a control module consisting of a leak free sampling pump, a calibrated critical orifice, an inclined manometer, and a calibrated dry gas meter. A Teflon fitting connected the nozzle to the probe liner. All of the sampling train glassware underwent the cleaning and nitric acid soaking procedure described in EPA Method 29 prior to testing. The sample probe and oven box were maintained at a temperature of $248 \pm 25^{\circ}\text{F}$ during sampling to prevent moisture condensation. The first and second impingers each contained 100 ml of 5% nitric acid/10% hydrogen peroxide ($5\%\text{HNO}_3/10\%\text{H}_2\text{O}_2$). The third impinger was empty. The fourth and fifth impingers contained 100 ml of 4% potassium permanganate/10% sulfuric acid ($4\%\text{KMnO}_4/10\%\text{H}_2\text{SO}_4$). The acidic permanganate solution was prepared fresh on-site daily. The sixth impinger contained a known quantity of silica gel. The second impinger was a Greenburg-Smith impinger with a standard tip, while the other impingers had modified tips. The temperature at the outlet of the sixth impinger was maintained below 68°F during sampling by adding ice to the water bath. A vacuum line connected the outlet of the sixth impinger to the control module.

Before each test and after each test run, the sampling train was leak checked to ensure no leakage greater than 0.02 cubic feet per minute at 15" Hg vacuum. The probe was then placed in the stack and stack gas was withdrawn isokinetically for an equal period of time at each traverse point. The velocity differential pressure, critical orifice differential pressure, dry gas meter volume, dry gas meter inlet and outlet temperatures, probe temperature, stack temperature, oven box temperature, impinger outlet temperature, and sample vacuum were recorded at each traverse point during sampling. At the completion of each test, the sampling train was leak checked to ensure no leakage greater than 0.02 cubic feet per minute at the highest recorded test vacuum. After the post-test leak check, the sampling train was disassembled, all open ends were sealed, and the sampling train components were moved to the cleanup area for recovery. The recovery procedure for the multiple-metals sampling train is described as follows. The filter was carefully removed from the filter holder with Teflon coated forceps and placed in a labeled plastic Petri dish (Container 1). Any particulate matter or filter fragments that adhered to the filter holder gasket were transferred to the Petri dish using a dry, acid cleaned nylon bristle brush. The Petri dish was sealed for transport to the

laboratory.

The nozzle, probe liner, and filter holder front half were rinsed and brushed thoroughly with 100 ml of 0.1 N nitric acid (HNO_3) using a Teflon coated brush. These rinses were collected in a labeled glass sample jar (Container 3). The sample jars were sealed and the liquid level marked. The nozzle, probe liner, and filter holder front half were then rinsed with deionized water followed by acetone. These rinses were discarded. The moisture gain in the first two impingers was measured gravimetrically and their contents transferred to a labeled glass sample jar (Container 4). The first two impingers, the filter support, the back half of the filter holder, and the connecting glassware between the back half of the filter holder and the second impinger were rinsed with 100 ml of 0.1 N HNO_3 . These rinses were combined with the impinger contents and the sample jar was sealed and the liquid level marked.

The moisture gain in the third impinger was measured gravimetrically and its contents transferred to a labeled glass sample jar (Container 5A). This impinger was then rinsed with 100 ml of 0.1 N HNO_3 . The rinses were combined with the impinger contents and the sample jar was sealed and the liquid level marked.

The moisture gain in the permanganate impingers was measured gravimetrically and the contents transferred to a labeled glass sample jar (Container 5B). The impinger and connecting glassware was then rinsed with 100 ml of fresh 4% KMnO_4 /10% H_2SO_4 followed by a rinse with 100 ml of deionized water. The permanganate and deionized water rinses were combined with the impinger contents and the sample jar was sealed and the liquid level marked. This sample jar was not completely filled and was vented to relieve excess pressure. The permanganate impingers were rinsed with a total of 25 ml of 8N HCl. The walls and stem of the permanganate impingers were rinsed and collected in a labeled sample jar containing 200 ml of deionized water (Container 5C). The sample jar was sealed and the liquid level marked. The silica gel impinger was weighed for moisture gain. The silica gel was then returned to its original storage container to be dried for reuse. The following is a list of the sample recovery containers.

- | | |
|--------------|--|
| Container 1 | filter is removed from filter holder and stored in sealed Petri dish |
| Container 2 | not used in this procedure, used for FPM procedure |
| Container 3 | nozzle, sample probe, and front half of filter housing are brushed and rinsed three times with 100 ml of 0.1N HNO_3 and save |
| Container 4 | measure contents of impingers 1 and 2 and save; filter support, back half of filter housing, and flexible Teflon line are rinsed three times with 100 ml of 0.1N HNO_3 and save |
| Container 5A | measure contents of impinger 3 then rinse three times with 100 ml of 0.1N HNO_3 and save |
| Container 5B | measure contents of impingers 4&5 then rinse three times with 100 ml of acidified KMnO_4 and 100 ml of deionized distilled water and save. |
| Container 5C | rinse impingers 4&5 with 25 ml of 8N HCl solution followed by 100 ml of deionized distilled water and save |
| Container 6 | weigh contents of impinger 6 for moisture gain |

- Container 7 not used in this procedure
- Container 8A 0.1N HNO₃ reagent blank (300 ml)
- Container 8B deionized distilled water blank (100 ml)
- Container 9 HNO₃/H₂O₂ reagent blank (200 ml)
- Container 10 acidified KMnO₄ reagent blank (100 ml)
- Container 11 8N HCl reagent blank (200 ml)
- Container 12 filter blanks (3)

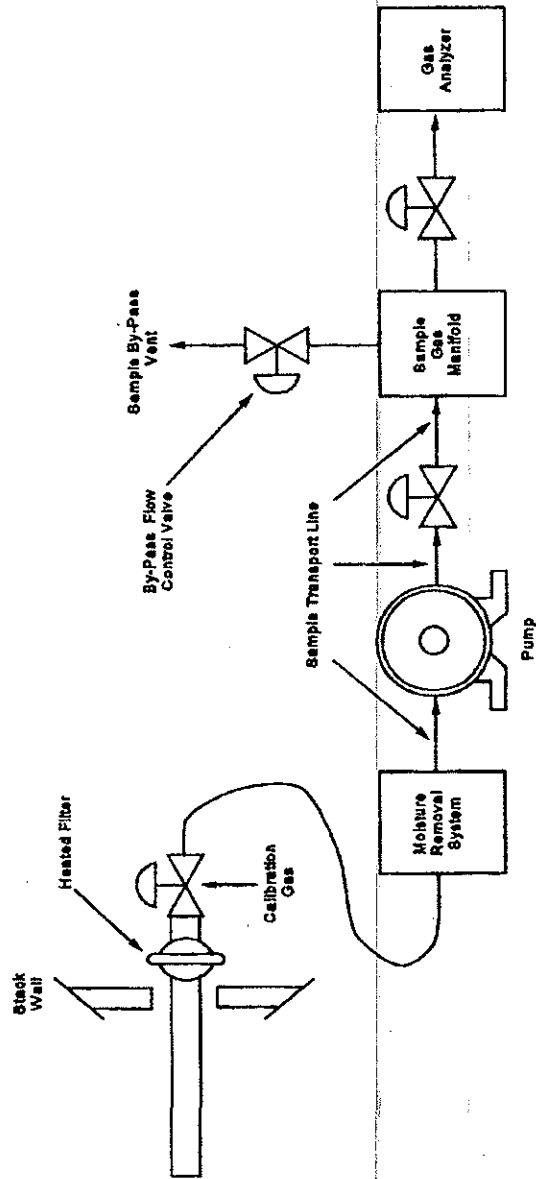
Two unused filter and aliquots of each of the impinger and rinse solutions, in the volumes specified in Method 29, were collected and submitted with the field samples as reagent blanks. Metals results were not reagent blank corrected. Front half and back half fractions were combined before analysis. Containers 1 through 4 were digested in concentrated acid before being analyzed for the target metals (except mercury) by inductively coupled plasma-mass spectrometry (ICP/MS). The mercury analysis (Containers 1-4, 5A, B, and C) were conducted on each of the sample fractions following digestion with acid and permanganate by cold vapor atomic absorption spectroscopy (CVAAS). All collected reagent blanks were analyzed using the same methodologies as the collected samples.

4.4 Polychlorinated Dibenzo-p-dioxins and Dibenzofurans Tests

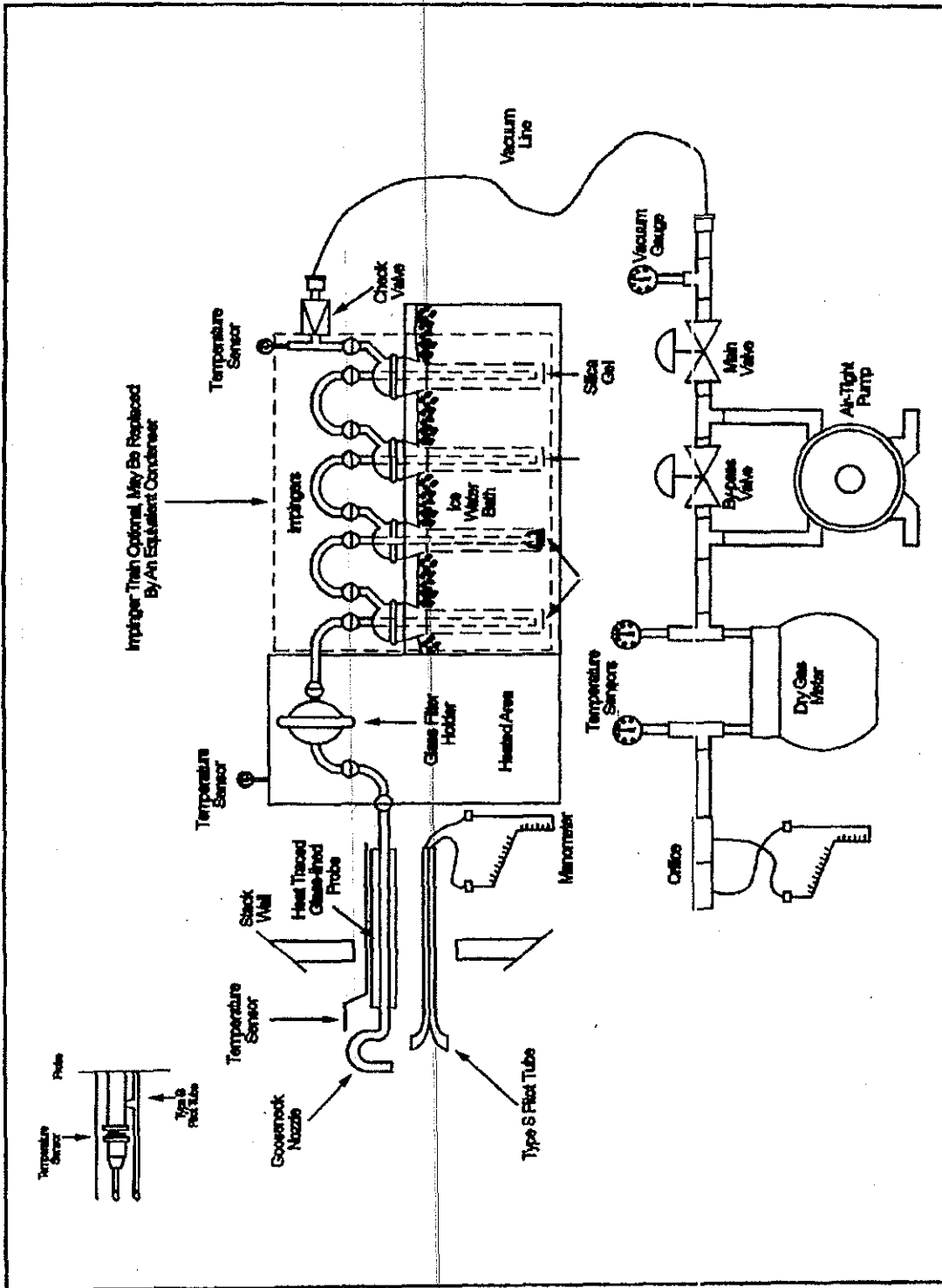
Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) sampling was conducted in accordance with EPA Method 23. Three PCDD/PCDF tests were performed on each MHI with each test being 120-minutes in duration. The Method 23 sampling train is shown in Appendix A. The following is a description of the sampling train and the procedures used to quantify PCDD and PCDF.

The sampling train consisted of precleaned acid soaked, DI water soaked, and tap water rinsed glassware, a Pyrex® glass button hook nozzle, a heated glass lined sample probe, a heated filter in a glass filter holder, a water cooled glass coil condenser, a water cooled adsorbent module (spiked pre-weighed XAD-2 trap), a set of four glass impingers connected in series in an ice bath, and a control module consisting of a leak free sampling pump, a calibrated critical orifice, an inclined manometer, and a calibrated dry gas meter. A Teflon fitting connected the nozzle to the probe liner. The probe and oven box were maintained at a temperature of 248±25°F during sampling to prevent moisture condensation. The first impinger was empty with the next two impingers each containing 100 ml of deionized water. The fourth impinger contained a known quantity of silica gel. The second impinger used a standard Greenburg-Smith tip, while the other impingers have modified straight tips. The glass components of the sampling train including the adsorbent module were cleaned in strict accordance with the procedures of EPA Method 23. Silicone grease is not used on any GamAir sampling trains. The spiked adsorbent traps were loaded with XAD resin by the subcontracted analytical laboratory prior to being shipped to the test site. The fourth impinger outlet temperature was maintained below 68°F during sampling by adding ice. The coil condenser was cooled by circulating water to and from the cold box using a peristaltic pump. The adsorbent module was also maintained at a temperature less than 68°F during sampling.

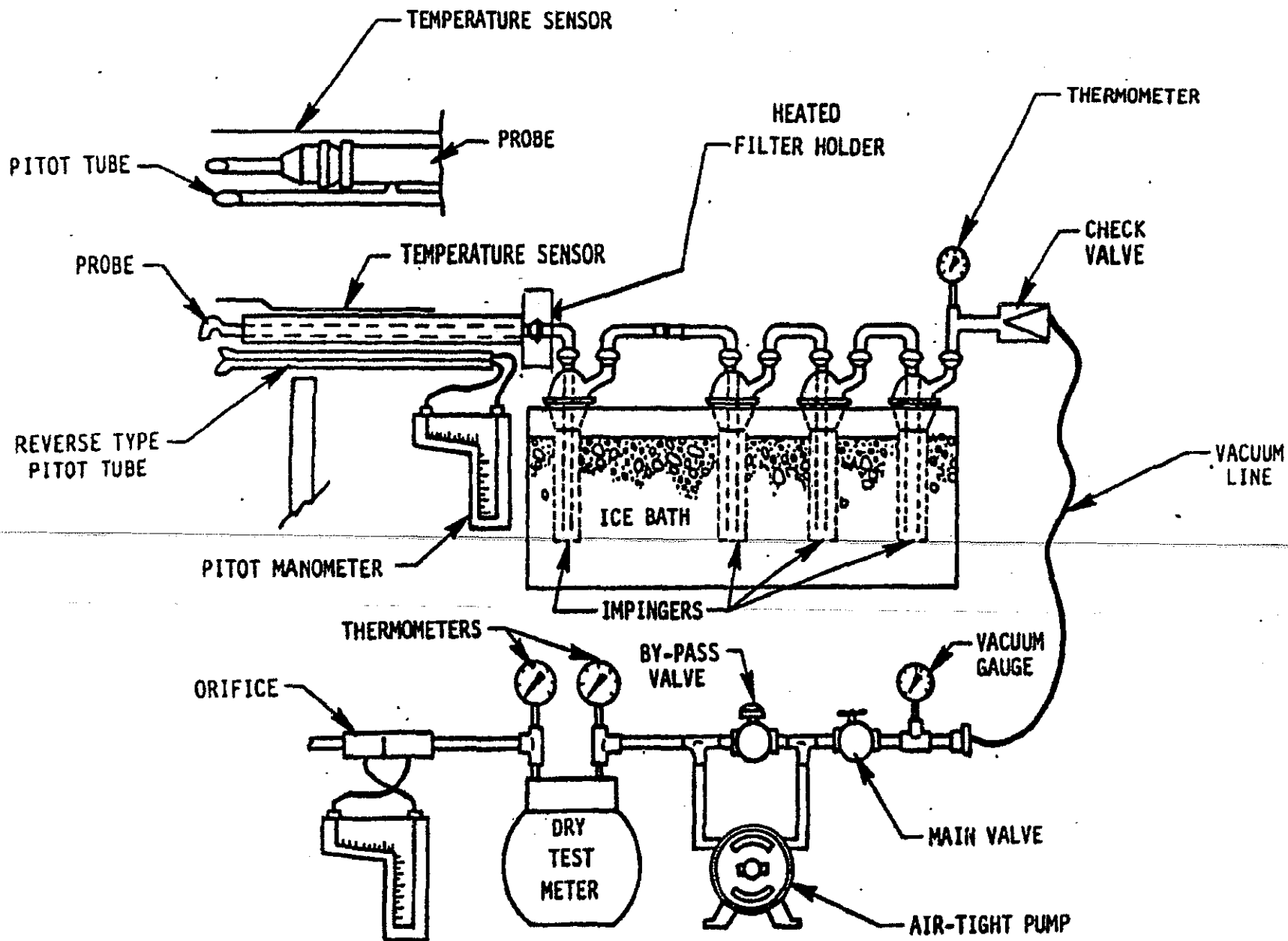
Before each test the sampling train was leak checked to ensure no leakage greater than 0.02 cubic feet per minute at 10" Hg vacuum. The probe was placed in the stack and stack gas was



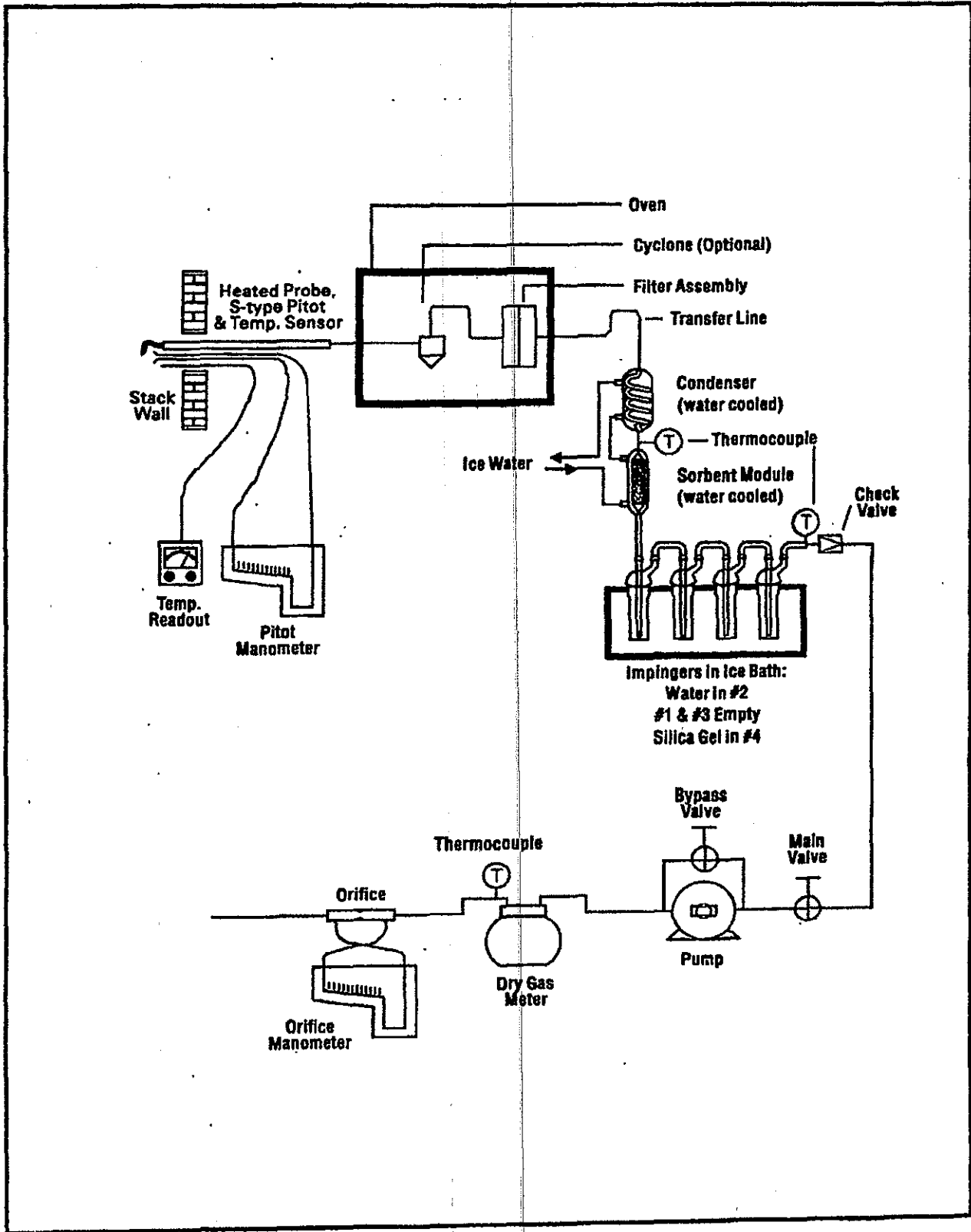
**EPA Methods 3A, 6C, 7E, and 10
Continuous Emissions Monitoring Sampling Train**



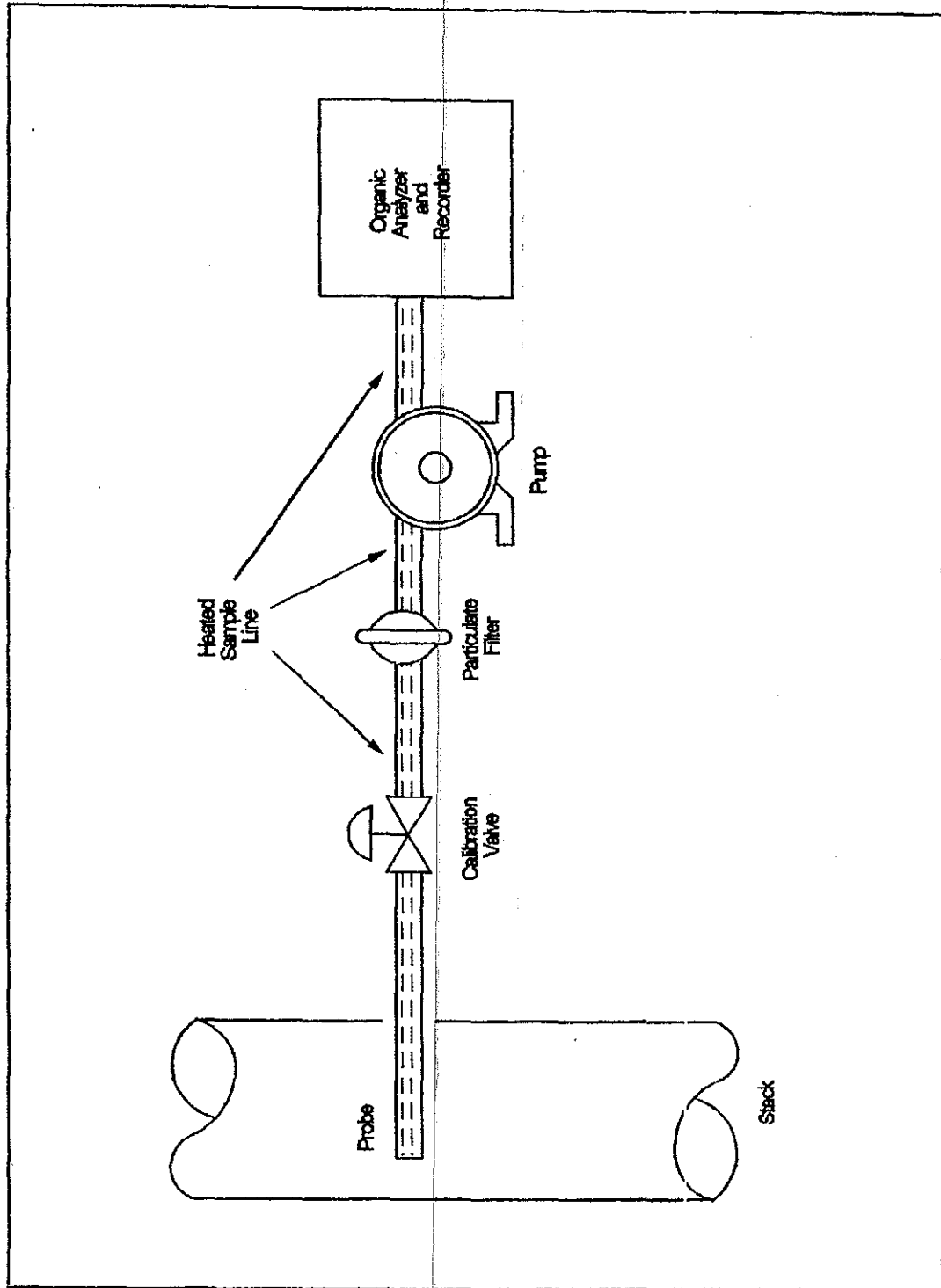
EPA Method 5
Conventional Sampling Train



EPA Method 8/Sulfuric Acid Sampling Train

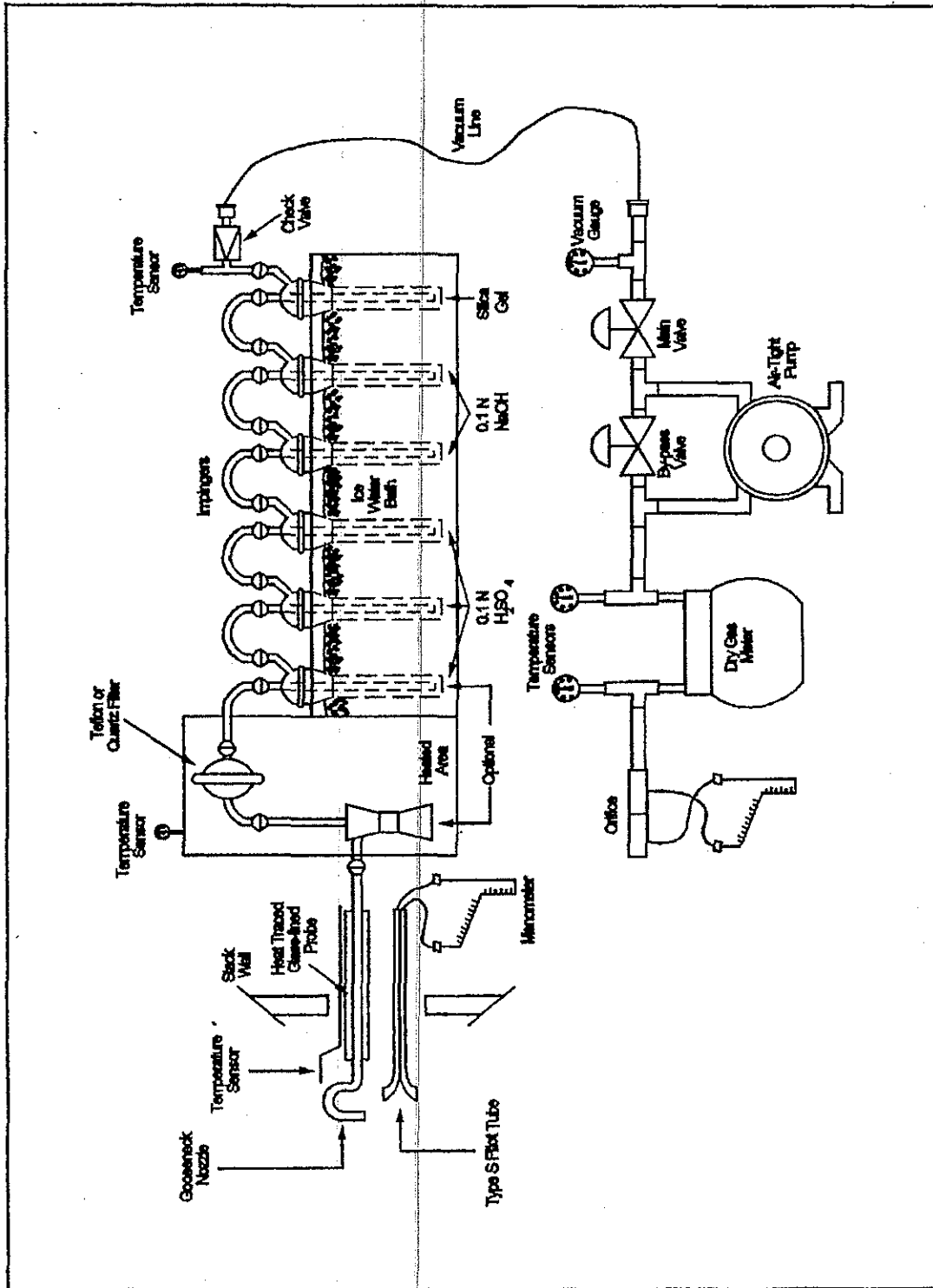


**EPA Method 23
PCDD/PCDF Sampling Train**

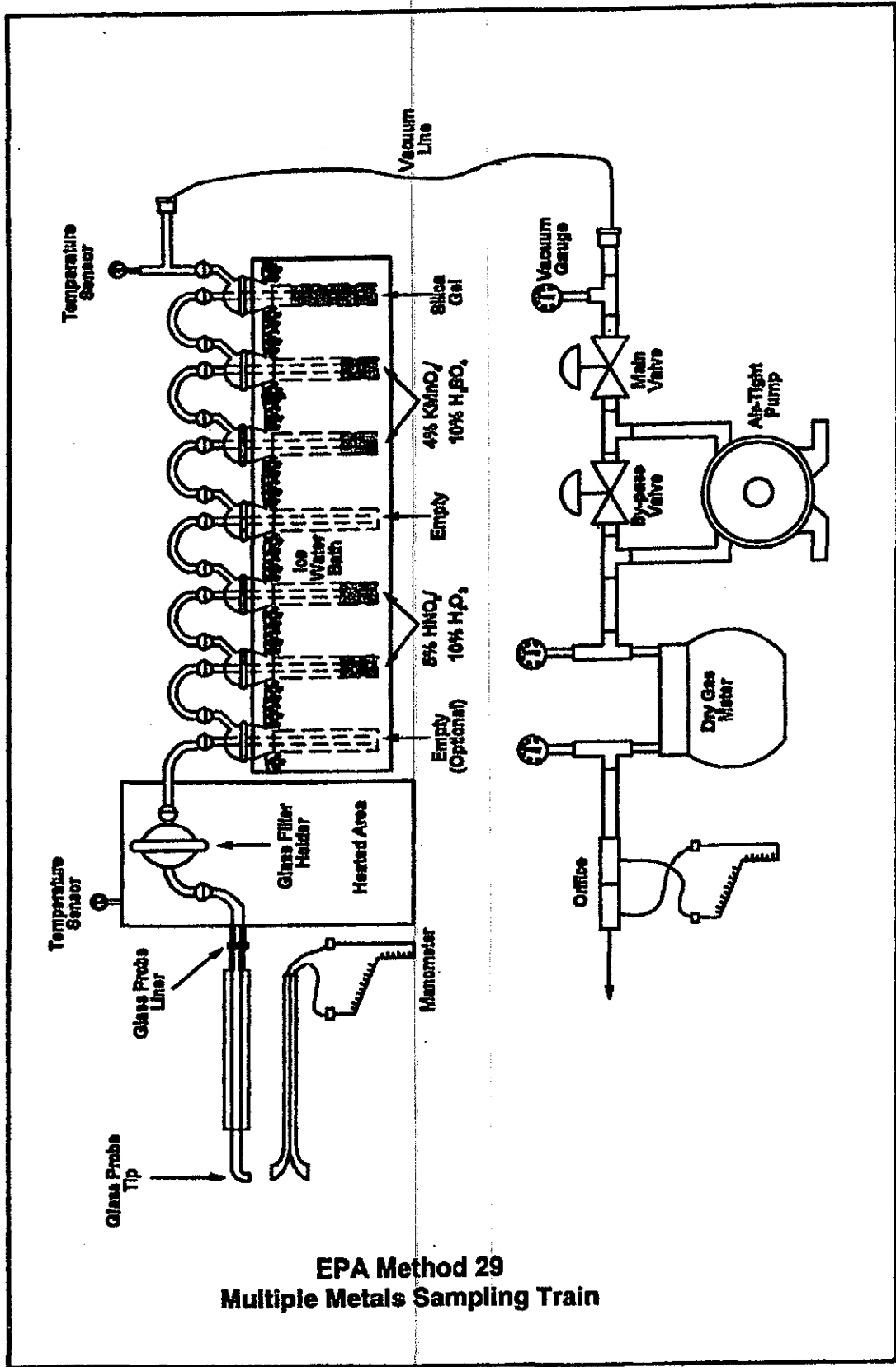


Organic Concentration Measurement System

**EPA Method 25A
Total Gaseous Organics Sampling Train**

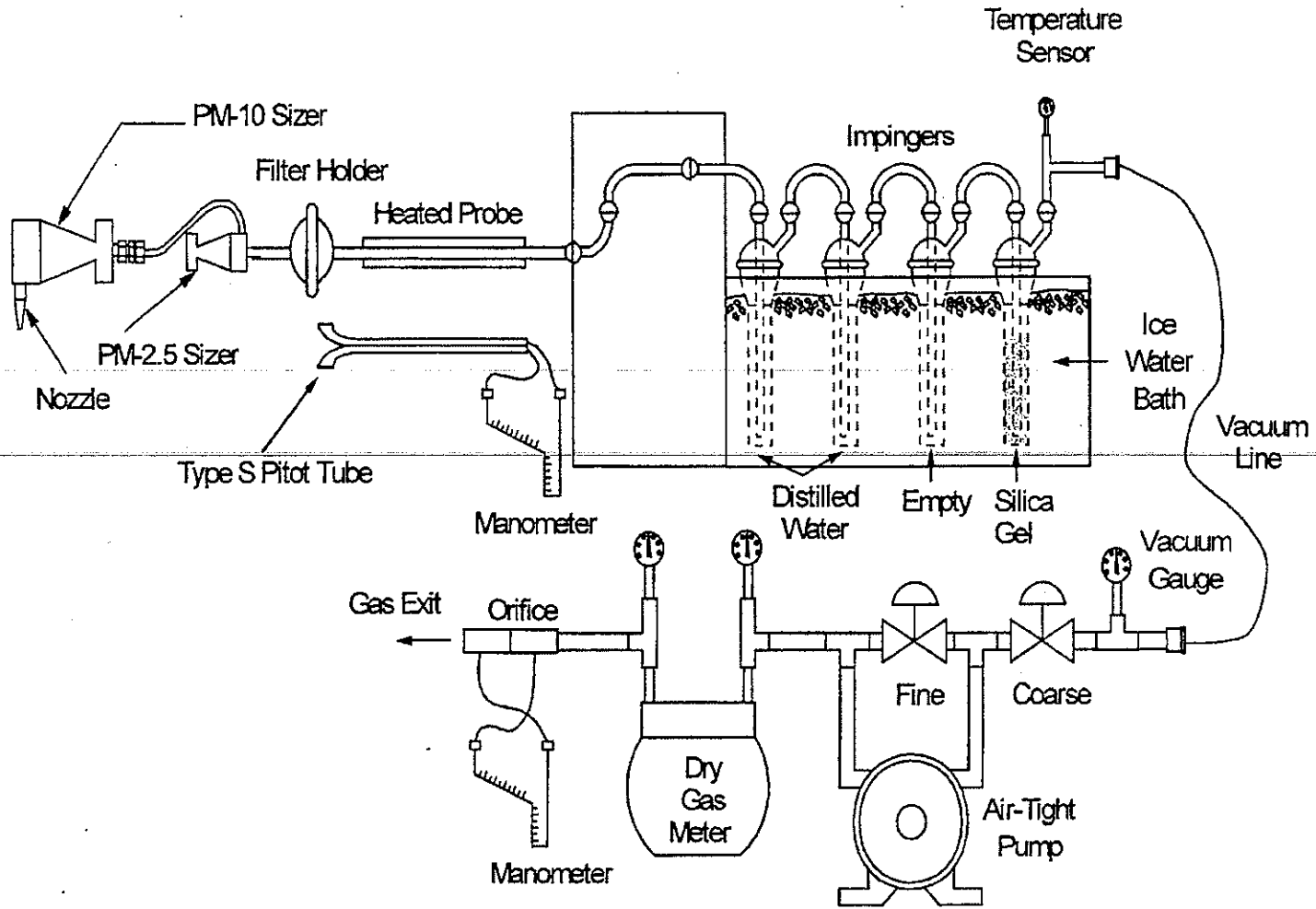


**EPA Method 26A
Hydrochloric Acid Sampling Train**



**EPA Method 29
Multiple Metals Sampling Train**

EPA Other Test Method 027
PM10 and PM2.5 Sampling Train



EPA Method 202
Condensable Particulate Sampling Train

