

Report of...

# Boiler Area Source Emission Sampling

Performed for...

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**AIR QUALITY DIV.**

## Morton Salt

Manistee, Michigan

on the

## #6 Boiler Exhaust

October 1-8, 2015

Project #: 203.09

By...

Network Environmental, Inc.  
Grand Rapids, MI

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**I. INTRODUCTION**

Network Environmental, Inc. was retained by Morton Salt of Manistee, Michigan, to perform emission sampling at their facility. The purpose of the sampling was to determine compliance with the Boiler Area Source National Emission Standard for Hazardous Air Pollutants (NESHAP)(40CFR Part 63 Subpart JJJJJ). The following emission sampling was performed on the #6 Boiler exhaust:

Operating Condition	Compounds To Be Sampled
100% Coal Burning w/No Lime Injection In Baghouse	Hydrochloric Acid (HCl), Mercury (Hg) & Carbon Monoxide (CO)
100% Coal Burning w/1.0 Lb/Min Lime Injection In Baghouse	HCl
100% Coal Burning w/2.0 Lbs/Min Lime Injection In Baghouse	HCl
100% Coal Burning w/4.0 Lbs/Min Lime Injection In Baghouse	HCl

The test methods used were as follows:

- Carbon Monoxide (CO) – U.S. EPA Method 10
- Mercury (Hg) – U.S. EPA Method 29
- Hydrochloric Acid (HCl) – U.S. EPA Method 26A
- Oxygen (O<sub>2</sub>) & Carbon Dioxide (CO<sub>2</sub>) – U.S. EPA Methods 3 & 3A
- Exhaust Gas Parameters (air flow rate, temperature, moisture & density) – U.S. EPA Methods 1-4

The sampling was performed over the period of October 1-8, 2015 by R. Scott Cargill, Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc.. Assisting with the sampling was Mr. Donald E. Kuk of Morton Salt and the operating staff of the facility. Mr. Robert Dickman and Mr. David Patterson of the Michigan Department of Environmental Quality (MDEQ) - Air Quality Division were present to observe the sampling and source operation.

**II. PRESENTATION OF RESULTS**

**II.1 TABLE 1  
CARBON MONOXIDE (CO)  
EMISSION RESULTS SUMMARY  
#6 BOILER EXHAUST  
MORTON SALT  
MANISTEE, MICHIGAN  
OCTOBER 1, 2015**

Sample	Time	Air Flow Rate DSCFM <sup>(1)</sup>	% O <sub>2</sub> <sup>(2)</sup>	CO Concentration		Mass Emission Rate
				PPM <sup>(3)</sup>	PPM@3%O <sub>2</sub> <sup>(4)</sup>	Lbs/Hr <sup>(5)</sup>
1	14:38-15:38	42,331	8.0	184.1	255.46	33.89
2	16:09-17:09	45,496	8.9	117.9	175.87	23.32
3	18:24-19:24	46,112	9.3	140.3	216.50	28.13
<b>Average</b>		<b>44,646</b>	<b>8.7</b>	<b>147.4</b>	<b>215.94</b>	<b>28.45</b>

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- (2) % O<sub>2</sub> = Percent Oxygen (v/v) On A Dry Basis
- (3) PPM = Parts Per Million (v/v) On A Dry Basis
- (4) PPM@3%O<sub>2</sub> = Parts Per Million (v/v) On A Dry Basis Corrected To 3 Percent Oxygen
- (5) Lbs/Hr = Pounds of CO Per Hour
- (6) **40 CFR Part 63 Subpart JJJJJ Table 1 has established a CO emission limit of 420 PPM @ 3%O<sub>2</sub> for this source.**

**II.2 TABLE 2  
HYDROCHLORIC ACID (HCl)  
EMISSION RESULTS SUMMARY  
#6 BOILER EXHAUST  
MORTON SALT  
MANISTEE, MICHIGAN**

Operating Condition	Sample	Date	Time	Air Flow Rate DSCFM <sup>(1)</sup>	Concentration Mg/M <sup>3</sup> <sup>(2)</sup>	Mass Emission Rate	
						Lbs/Hr <sup>(3)</sup>	Lbs/MMBTU <sup>(4)</sup>
No Lime Injection	1	10/1/15	15:18-16:26	45,496	5.24	0.893	0.00539
	2	10/1/15	17:03-18:11	43,294	5.85	0.948	0.00632
	3	10/1/15	18:48-19:53	46,112	5.56	0.961	0.00602
<b>Average</b>				<b>44,967</b>	<b>5.55</b>	<b>0.934</b>	<b>0.00591</b>
<b>The potential HCl emissions are 4.09 Tons/Year using the Lbs/Hr results and 5.59 Tons/Year using the Lbs/MMBTU results <sup>(6)</sup></b>							
1.0 Lbs/Min Lime Injection	4	10/6/15	09:21-10:26	39,905	1.15	0.171	0.00112
	5	10/6/15	10:45-11:48	39,022	0.41	0.059	0.00039
	6	10/6/15	12:10-13:14	39,515	0.34	0.051	0.00034
<b>Average</b>				<b>39,481</b>	<b>0.63</b>	<b>0.094</b>	<b>0.00062</b>
2.0 Lbs/Min Lime Injection	7	10/7/15	08:50-09:54	39,730	0.238	0.035	0.000237
	8	10/7/15	10:19-11:23	39,923	0.088	0.013	0.000085
	9	10/7/15	11:45-12:48	40,696	0.066	0.010	0.000068
<b>Average</b>				<b>40,116</b>	<b>0.131</b>	<b>0.020</b>	<b>0.000130</b>
4.0 Lbs/Min Lime Injection	10	10/8/15	08:40-09:42	38,359	0.045	0.0064	0.000044
	11	10/8/15	10:05-11:09	38,186	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>
	12	10/8/15	12:16-13:19	38,145	0.092	0.0131	0.000089
<b>Average</b>				<b>38,230</b>	<b>0.059</b>	<b>0.0084</b>	<b>0.000057</b>

(1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)

(2) Mg/M<sup>3</sup> = Milligrams Per Dry Standard Cubic Meter

(3) Lbs/Hr = Pounds of HCl Per Hour

(4) Lbs/MMBTU = Pounds Per Million BTU of Heat Input (Calculated Using U.S. EPA Method 19 With An F-Factor of 9,780 DSCF/MMBTU)

(5) Sample 11 was non detected at a detection limit of 0.040 Mg/M<sup>3</sup>, 0.0057 Lbs/Hr & 0.000038 Lbs/MMBTU. The detection limit values were used for sample 11 when calculating the averages for this condition.

(6) The potential emissions were calculated based on 8,760 Hours/Year of operation, a maximum design rate of 216 MMBTU/Hr and using the emission results averages from the No Lime Injection operating condition.

**II.3 TABLE 3  
MERCURY (Hg)  
EMISSION RESULTS SUMMARY  
#6 BOILER EXHAUST  
MORTON SALT  
MANISTEE, MICHIGAN  
OCTOBER 1, 2015**

Sample	Time	Air Flow Rate DSCFM <sup>(1)</sup>	Concentration Mg/M <sup>3</sup> <sup>(2)</sup>	Mass Emission Rate	
				Lbs/Hr <sup>(3)</sup>	Lbs/MMBTU <sup>(4)</sup>
1	14:44-16:56	42,331	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>
2	17:42-19:48	43,224	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>
3	20:32-22:35	39,137	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>	N.D. <sup>(5)</sup>
<b>Average</b>		<b>41,564</b>	----	----	----

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)  
(2) Mg/M<sup>3</sup> = Milligrams Per Dry Standard Cubic Meter  
(3) Lbs/Hr = Pounds of Hg Per Hour  
(4) Lbs/MMBTU = Pounds Per Million BTU of Heat Input (Calculated Using U.S. EPA Method 19 With An F-Factor of 9,780 DSCF/MMBTU)  
(5) N.D. = Not Detected At Detection Limits Of 2.17E-04 Mg/M<sup>3</sup>, 3.38E-05 Lbs/Hr & 2.24E-07 Lbs/MMBTU  
(6) **40 CFR Part 63 Subpart JJJJJ Table 1 has established a Hg emission limit of 2.2E-05 Lbs/MMBTU for this source.**

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

The results of the emission sampling are summarized in Tables 1 through 3 (Sections II.1 through II.3).

The results are presented as follows:

#### **III.1 CO**

Table 1 – Carbon Monoxide (CO) Emission Results Summary

- Sample
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Oxygen (O<sub>2</sub>) Concentration (%) - Percent on a Dry Basis
- CO Concentration (PPM) - Parts Per Million (v/v) on a Dry Basis
- CO Concentration (PPM @ 3 %O<sub>2</sub>) - Parts Per Million (v/v) on a Dry Basis Corrected To 3 Percent Oxygen
- CO Mass Emission Rate (Lbs/Hr) - Pounds of CO Per Hour

All the CO sample data was calibration corrected using Equation 7E-5 from U.S. EPA Method 7E.

#### **III.2 HCl**

Table 2 – Hydrochloric Acid (HCl) Emission Results Summary

- Operating Condition
- Sample
- Date
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- HCl Concentration (Mg/M<sup>3</sup>) - Milligrams Per Dry Standard Cubic Meter
- HCl Mass Emission Rate (Lbs/Hr) - Pounds of HCl Per Hour
- HCl Mass Emission Rate (Lbs/MMBTU Heat Input) - Pounds of HCl Per Million BTU of Heat Input (Calculated using Equation 2.1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)

A more detailed breakdown of each individual HCl sample can be found in Appendix A.

#### **III.3 Hg**

Table 3 – Mercury (Hg) Emission Results Summary

- Sample

- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Hg Concentration (Mg/M<sup>3</sup>) – Milligrams Per Dry Standard Cubic Meter
- Hg Mass Emission Rate (Lbs/Hr) – Pounds of Hg Per Hour
- Hg Mass Emission Rate (Lbs/MMBTU Heat Input) – Pounds of Hg Per Million BTU of Heat Input (Calculated using Equation 2.1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)

A more detailed breakdown of each individual Hg sample can be found in Appendix A.

### III.4 Emission Limits

40CFR Part 63 Subpart JJJJJ (Boiler Area Source NESHAP) and the source Renewable Operating Permit (MI-ROP-B1824-2015) have established the following emission limits for the #6 Boiler:

- Mercury (Hg): 2.2E-05 Lbs/MMBTU
  - All three (3) test run emission levels were not detected at detection limits of 2.24E-07 Lbs/MMBTU.
- Carbon Monoxide (CO): 420 PPM @ 3% O<sub>2</sub>
  - All three (3) test run emission levels were under the 420 PPM corrected to 3 percent oxygen.
- Hydrochloric Acid (HCl): 9.9 Tons/Year (approximately a daily emission level of 0.015 Lbs/MMBTU)
  - While there is no emission limit under the area source NESHAP rule, the source must demonstrate that potential to emit (PTE) is less than Clean Air Act (CAA) major source thresholds (10 tons per year of a single HAP or 25 tons per year of total HAPs). As Hg levels from the boiler are negligible and no other non - de minimus sources of HAPs are at the facility, HCl is the HAP of concern. Morton Salt has installed a lime injection system to neutralize the acid gases and control HCl emissions from the boiler. PTE when not injecting lime to control HCl, was under 9.9 tons per year at worst case conditions of 8760 hours per year and a maximum design rate of 216 MMBtu/hr for the boiler. Since the chlorine content of the coal burned in the boiler will vary and therefore HCl emissions from the boiler will vary, additional test runs were conducted to measure HCl emission levels at varying lime injection feed rates based upon stoichiometric calculations. During the tests, chlorine content and coal feed rates were monitored. This data will be utilized to develop the mathematical curves necessary to determine the amount of lime needed to adequately

control and maintain the HCl emissions under the CAA major source and thresholds and ROP limits. These charts will be incorporated into the site Malfunction Abatement Plan (MAP).

In Summary, these performance tests demonstrate compliance with the CO and Hg emission limits contained in Subpart JJJJJ Table 1 for existing coal fired boilers. Potential HCl emission levels during the runs while not injecting lime demonstrate that the site is an area source of HAPs. Data from the additional test runs will ensure that lime is injected when needed in rates sufficient to ensure HCl emissions levels remain under CAA major source thresholds as required by the ROP.

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

The #6 Boiler is a Wickes spreader stoker coal and natural gas co-fired boiler. It's maximum rating is 180,000 pounds of steam per hour (216 MMBTU/Hr). The particulate matter is controlled by a baghouse equipped with a Lime injection system. This boiler is used for generating process steam and electricity. Source operating data during the sampling can be found in Appendix H.

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

The sampling location was as follows:

- #6 Boiler - On the 78 inch I.D. stack with 2 sample ports in a location that exceeded the 8 duct diameters downstream and 2 duct diameters upstream from the nearest disturbances requirement. Twelve (12) sampling points were used for this source.

**V.1 Mercury (Hg)** - The Hg emission sampling was determined by employing U.S. EPA Method 29. Three (3) samples were collected. The samples were one hundred twenty (120) minutes in duration and each had a minimum sample volume of two (2) dry standard cubic meters (DSCM). The samples were collected isokinetically on quartz filters, in a nitric acid/hydrogen peroxide solution and in a acidic potassium permanganate solution.

The front half, the nitric acid/hydrogen peroxide solutions and the acidic potassium permanganate solutions were analyzed for mercury by cold vapor atomic absorption spectrophotometry (CVAAS). All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis. A diagram of the Hg sampling train is shown in Figure 1.

**V.2 Carbon Monoxide** - The CO sampling was conducted in accordance with U.S. EPA Reference Method 10. A Thermo Environmental Model 48C gas analyzer was used to monitor the boiler exhaust. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the CO concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 985.3 PPM was used to establish the initial instrument calibration. Calibration gases of 250.2 PPM and 492.5 PPM were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 250.2 PPM gas to determine the system bias. After each sample, a system zero and system injection of 250.2 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified. 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. The analyzer averages were corrected for calibration error and drift using formula EQ.7E-5 from 40 CFR Part 60, Appendix A, Method 7E. A diagram of the sampling train is shown in Figure 2.

**V.3 Oxygen & Carbon Dioxide (10/1/15)** - The O<sub>2</sub> & CO<sub>2</sub> sampling was conducted in accordance with U.S. EPA Reference Method 3A. Servomex Model 1400M portable stack gas analyzers were used to monitor the boiler exhaust. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzers. The analyzers produce instantaneous readouts of the O<sub>2</sub> & CO<sub>2</sub> concentrations (%).

The analyzers were calibrated by direct injection prior to the testing. Span gases of 21.03% and 20.42% CO<sub>2</sub> were used to establish the initial instrument calibrations. Calibration gases of 5.942% O<sub>2</sub>/12.01% CO<sub>2</sub> and 11.99% O<sub>2</sub>/6.028% CO<sub>2</sub> were used to determine the calibration error of the analyzers. The sampling system (from the back of the stack probe to the analyzers) was injected using the 5.942% O<sub>2</sub>/12.01% CO<sub>2</sub> gas to determine the system bias. After each sample, a system zero and system injection of 5.942%

O<sub>2</sub>/12.01% CO<sub>2</sub> were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer's were calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler. The analyzer averages were corrected for calibration error and drift using formula EQ.7E-5 from 40 CFR Part 60, Appendix A, Method 7E. A diagram of the sampling train is shown in Figure 2.

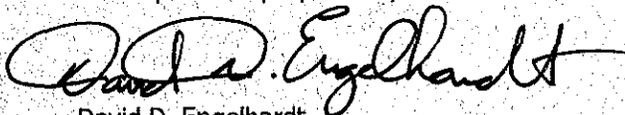
**V.4 Oxygen & Carbon Dioxide (10/6-8/15)** - The O<sub>2</sub> & CO<sub>2</sub> sampling during the HCl sampling over the period of 10/6-8/15 was performed by employing U.S. EPA Method 3. Bag samples were collected from the back of the isokinetic HCl sampling train and analyzed by Orsat analysis. All the quality assurance and quality control requirements specified in the method were incorporated in the sampling and analysis.

**V.5 Hydrochloric Acid** - The HCl emission sampling was conducted in accordance with U.S. EPA Method 26A. The sampling was performed isokinetically in accordance with the method. The HCl was collected in the first two impingers of the sampling train, which contained 100 mls of 0.1 normal sulfuric acid. The probe rinse and the impinger catch from the impingers were combined and analyzed for HCl using Ion-chromatography as described in the method.

Three (3) samples were collected from the boiler exhaust during each operating condition. Each sample was sixty (60) minutes in duration and had a minimum sample volume of one (1) dry standard cubic meter (DSCM). All the quality assurance and quality control requirements specified in the method were incorporated in the sampling and analysis. A diagram of the sampling train is shown in Figure 3.

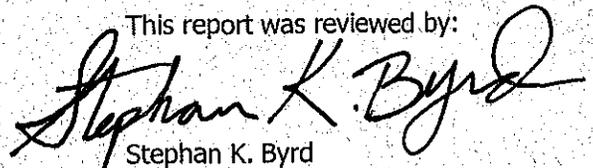
**V.6 Exhaust Gas Parameters** - The exhaust gas parameters (air flow rate, temperature, moisture and density) were determined in conjunction with the other sampling by employing U.S. EPA Methods 1 through 4. Air flow rates, temperatures and moistures were determined using the isokinetic sampling trains. All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis.

This report was prepared by:



David D. Engelhardt  
Vice President

This report was reviewed by:



Stephan K. Byrd  
President

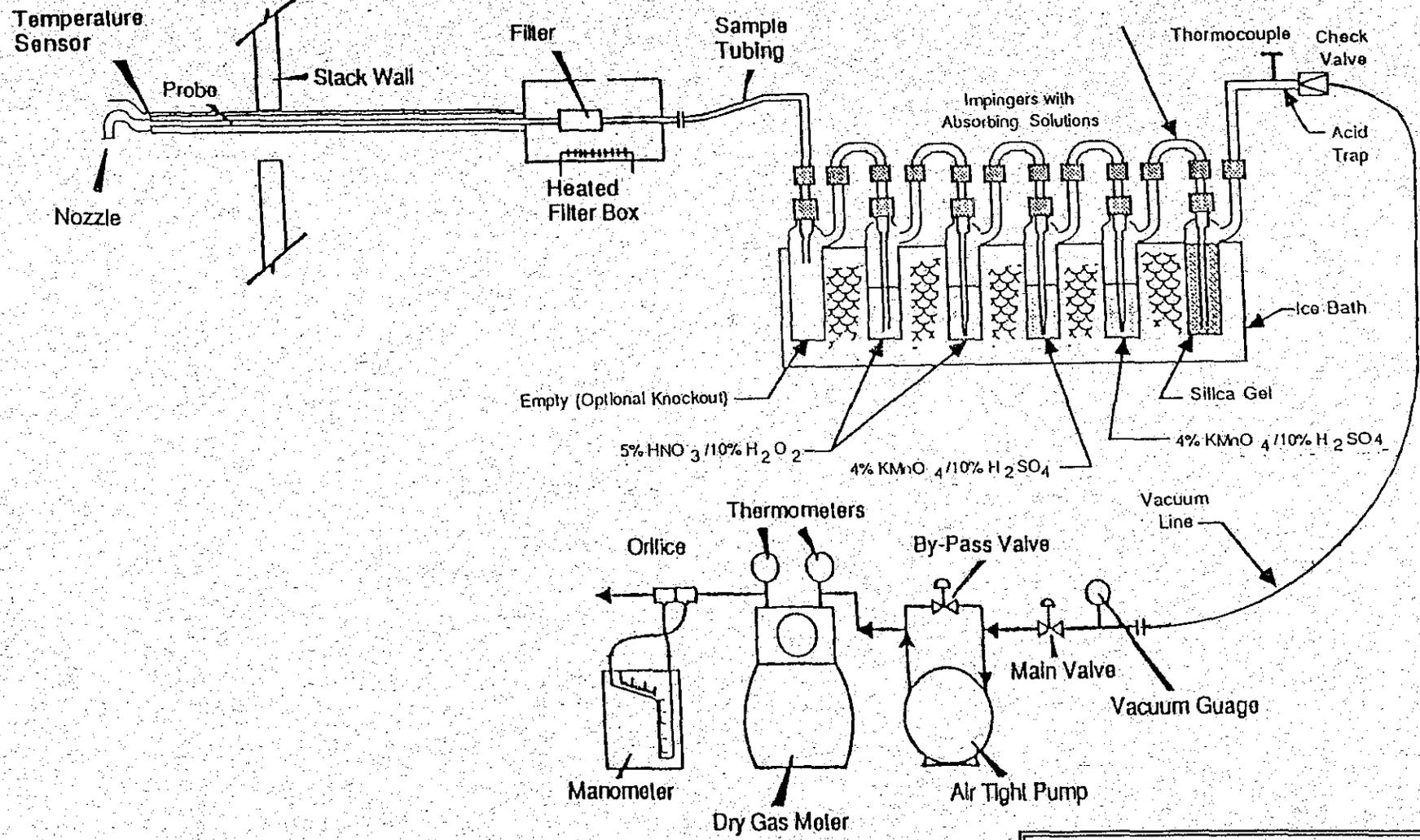


Figure 1  
Hg Sampling Train

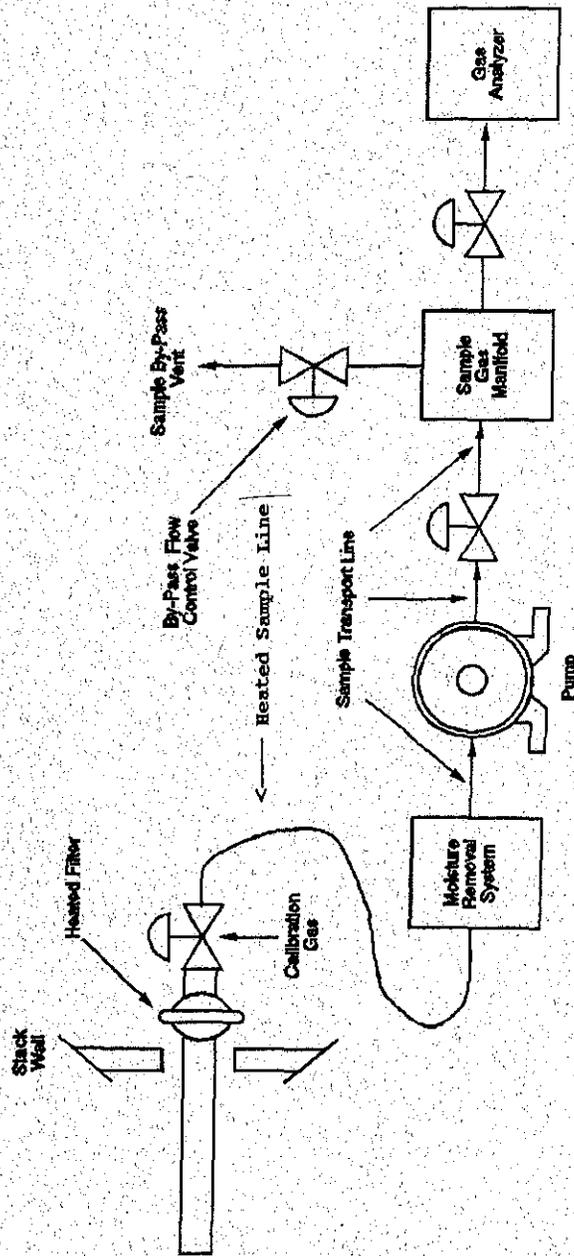
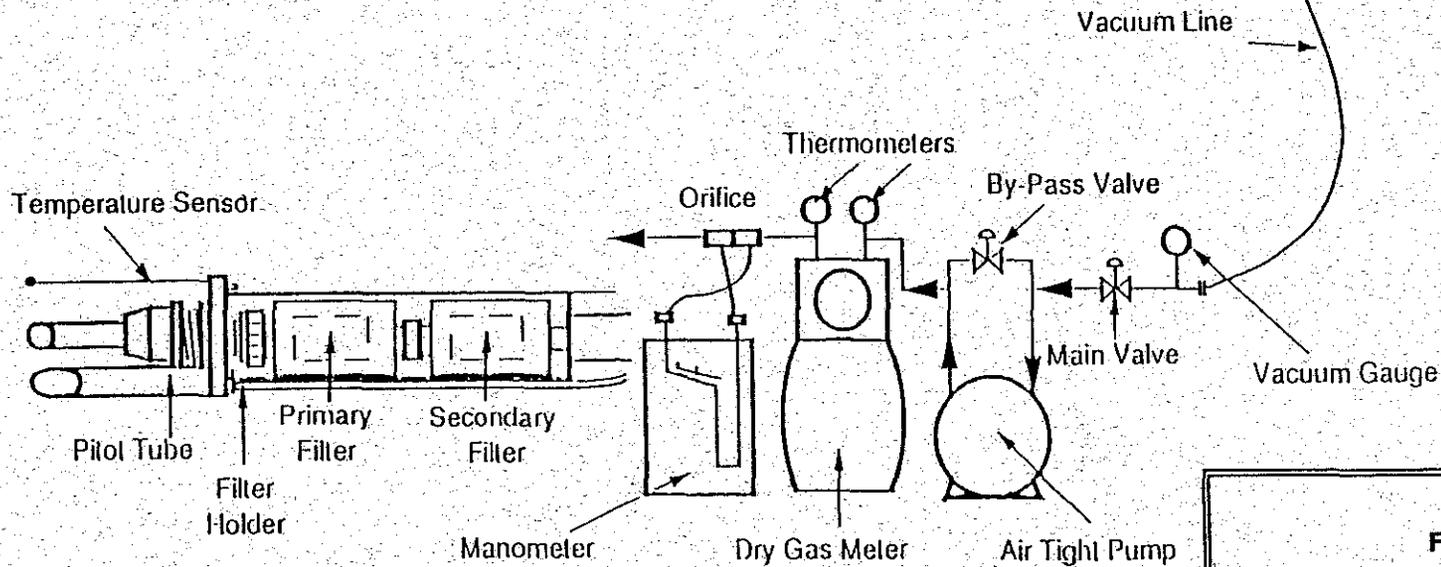
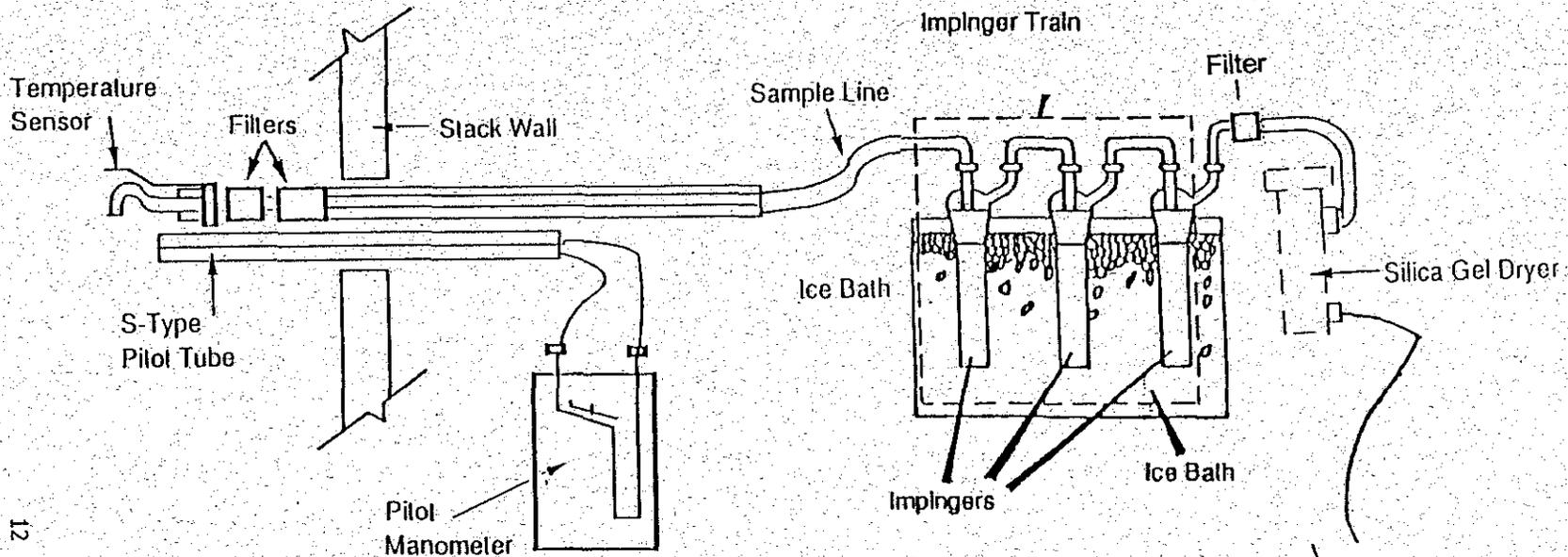


Figure 2

CO, O<sub>2</sub> & CO<sub>2</sub> Sampling Train



**Figure 3**  
**HCl Sampling Train**