

Report of...

Boiler MACT Emission Sampling

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AIR QUALITY DIV.

Performed for the...

Michigan Sugar Company

Sebewaing Michigan

on the

Wet ESP Exhaust

March 16-18, 2016

Project #: 022.40

By...

Network Environmental, Inc.
Grand Rapids, MI

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I. INTRODUCTION

Network Environmental, Inc. was retained by the Michigan Sugar Company of Bay City, Michigan, to perform emission sampling at their Sebewaing, Michigan facility. The purpose of the sampling was to determine compliance with the National Emission Standard for Hazardous Air Pollutants (NESHAP) 40CFR Part 63 Subpart DDDDD (MACT for Industrial, Commercial, Institutional Boilers and Process Heaters). The following is a list of the compounds sampled and corresponding emission limits:

Compounds Sampled	Emission Limit
Carbon Monoxide (CO)	160 PPM @ 3% O ₂ or 0.14 Lbs/MMBTU of Steam Output
Particulate	4.0 E-02 Lbs/MMBTU of Heat Input or 4.2 E-02 Lbs/MMBTU of Steam Output
Mercury (Hg)	5.7 E-06 Lbs/MMBTU of Heat Input or 6.4 E-06 Lbs/MMBTU of Steam Output
Hydrochloric Acid (HCl)	2.2 E-02 Lbs/MMBTU of Heat Input or 2.5 E-02 Lbs/MMBTU of Steam Output

The test methods used were as follows:

- Carbon Monoxide (CO) – U.S. EPA Method 10
- Particulate & Mercury (Hg) – U.S. EPA Method 29 (combined with U.S. EPA Method 5)
- Hydrochloric Acid (HCl) – U.S. EPA Method 26A
- Oxygen (O₂) & Carbon Dioxide (CO₂) – 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 March 16-18, 2016 by Stephan K. Byrd, R. Scott Cargill, Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc.. Assisting with the sampling were Mr. Steven Smock and the operating staff of the facility. Ms. Sharon LeBlanc of the Michigan Department of Environmental Quality (MDEQ) - Air Quality Division was present to observe the sampling and source operation.

II. PRESENTATION OF RESULTS

**II.1 TABLE 1
PARTICULATE
EMISSION RESULTS SUMMARY
WET ESP EXHAUST
MICHIGAN SUGAR COMPANY
SEBEWAING, MICHIGAN
MARCH 16-17, 2016**

Sample	Date	Time	Air Flow Rate DSCFM ⁽¹⁾	Particulate Mass Emission Rate		
				Lbs/Hr ⁽²⁾	Lbs/MMBTU Heat Input ⁽³⁾	Lbs/MMBTU Steam Output ⁽⁴⁾
1	3/16/16	15:45-18:26	45,161	2.22	2.18E-02	1.62E-02
2	3/17/16	09:19-11:56	43,798	3.90	3.13E-02	2.72E-02
4	3/17/16	15:35-18:11	44,322	5.81	4.47E-02	3.88E-02
Average			44,427	3.98	3.26E-02	2.74E-02

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

(2) Lbs/Hr = Pounds of Particulate Per Hour

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

(4) Lbs/MMBTU Steam Output = Pounds Per Million BTU of Steam Output (Calculated Using 137.34 MMBTU/Hr Of Steam Production For Sample One, 143.35 MMBTU Of Steam Production For Sample Two and 149.72 MMBTU Of Steam Production For Sample Three.)

(5) Particulate Emission Limit From Part 63 Subpart DDDDD = 4.0E-02 Lbs/MMBTU Of Heat Input OR 4.2E-02 Lbs/MMBTU Of Steam Output

**II.2 TABLE 2
CARBON MONOXIDE (CO)
EMISSION RESULTS SUMMARY
WET ESP EXHAUST
MICHIGAN SUGAR COMPANY
SEBEWAING, MICHIGAN
MARCH 18, 2016**

Sample	Time	Air Flow Rate DSCFM ⁽¹⁾	CO Concentration		CO Mass Emission Rate		
			PPM ⁽²⁾	PPM @ 3 %O ₂ ⁽³⁾	Lbs/Hr ⁽⁴⁾	Lbs/MMBTU Heat Input ⁽⁵⁾	Lbs/MMBTU Steam Output ⁽⁶⁾
1	11:25-12:25	47,955	72.6	213.0	15.14	0.177	0.106
2	12:32-13:32	48,343	51.0	160.2	10.72	0.133	0.076
3	13:40-14:40	49,753	67.7	212.6	14.65	0.176	0.101
Average		48,684	63.8	195.3	13.50	0.162	0.094

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
(2) PPM = Parts Per Million (v/v) On A Dry Basis
(3) PPM @ 3 %O₂ = Parts Per Million (v/v) On A Dry Basis Corrected To 3 Percent Oxygen
(4) Lbs/Hr = Pounds of CO Per Hour
(5) Lbs/MMBTU Heat Input = Pounds Per Million BTU of Heat Input (Calculated Using U.S. EPA Method 19 With An F-Factor of 9,780 DSCF/MMBTU)
(6) Lbs/MMBTU Steam Output = Pounds Per Million BTU of Steam Output (Calculated Using 142.16 MMBTU/Hr Of Steam Production For Sample One, 141.50 MMBTU Of Steam Production For Sample Two and 145.02 MMBTU Of Steam Production For Sample Three.)
(7) CO Emission Limit From Part 63 Subpart DDDDD = 160 PPM @ 3 %O₂ OR 0.14 Lbs/MMBTU Of Steam Output

**II.3 TABLE 3
MERCURY (Hg)
EMISSION RESULTS SUMMARY
WET ESP EXHAUST
MICHIGAN SUGAR COMPANY
SEBEWAING, MICHIGAN
MARCH 16-17, 2016**

Sample	Date	Time	Air Flow Rate DSCFM ⁽¹⁾	Hg Mass Emission Rate		
				Lbs/Hr ⁽²⁾	Lbs/MMBTU Heat Input ⁽³⁾	Lbs/MMBTU Steam Output ⁽⁴⁾
1	3/16/16	15:45-18:26	45,161	4.73E-05	4.64E-07	3.45E-07
2	3/17/16	09:19-11:56	43,798	3.11E-05	2.49E-07	2.17E-07
4	3/17/16	15:35-18:11	44,322	2.11E-05	1.62E-07	1.41E-07
Average			44,427	3.32E-05	2.92E-07	2.34E-07

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)r
- (2) Lbs/Hr = Pounds of Particulate Per Hour
- (3) Lbs/MMBTU Heat Input = Pounds Per Million BTU of Heat Input (Calculated Using U.S. EPA Method 19 With An F-Factor of 9,780 DSCF/MMBTU)
- (4) Lbs/MMBTU Steam Output = Pounds Per Million BTU of Steam Output (Calculated Using 137.34 MMBTU/Hr Of Steam Production For Sample One, 143.35 MMBTU Of Steam Production For Sample Two and 149.72 MMBTU Of Steam Production For Sample Three.)
- (5) **Hg Emission Limit From Part 63 Subpart DDDDD = 5.7E-06 Lbs/MMBTU Of Heat Input OR 6.4E-06 Lbs/MMBTU Of Steam Output**

**II.4 TABLE 4
HYDROCHLORIC ACID (HCl)
EMISSION RESULTS SUMMARY
WET ESP EXHAUST
MICHIGAN SUGAR COMPANY
SEBEWAING, MICHIGAN
MARCH 18, 2016**

Sample	Time	Air Flow Rate DSCFM ⁽¹⁾	HCl Concentration Mg/M ³ ⁽²⁾	HCl Mass Emission Rate		
				Lbs/Hr ⁽³⁾	Lbs/MMBTU Heat Input ⁽⁴⁾	Lbs/MMBTU Steam Output ⁽⁵⁾
1	08:20-09:27	47,955	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾
2	09:52-11:03	48,343	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾	N.D. ⁽⁶⁾
3	11:28-12:35	49,753	2.879	0.536	6.02E-03	3.79E-03
Average		48,684	0.983	0.183	2.05E-03	1.29E-03

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
(2) Mg/M³ = Milligrams Per Dry Standard Cubic Meter
(3) Lbs/Hr = Pounds of HCl Per Hour
(4) Lbs/MMBTU Heat Input = Pounds Per Million BTU of Heat Input (Calculated Using U.S. EPA Method 19 With An F-Factor of 9,780 DSCF/MMBTU)
(5) Lbs/MMBTU Steam Output = Pounds Per Million BTU of Steam Output (Calculated Using 134.7 MMBTU/Hr Of Steam Production For Sample One, 142.3 MMBTU Of Steam Production For Sample Two and 135.6 MMBTU Of Steam Production For Sample Three.)
(6) N.D. = Non Detected at detection limits of 0.035 Mg/M³, 0.0063 Lbs/Hr, 6.25E-05 Lbs/MMBTU of Heat Input & 4.26E-05 Lbs/MMBTU of Steam Output. The detection limit values were used in calculating the averages.
(7) **HCl Emission Limit From Part 63 Subpart DDDDD) = 2.2E-02 Lbs/MMBTU Of Heat Input OR 2.5E-02 Lbs/MMBTU Of Steam Output**

III. DISCUSSION OF RESULTS

The results of the emission sampling are summarized in Tables 1 through 4 (Sections II.1 through II.4). The results are presented as follows:

III.1 Particulate

Table 1 – Particulate Emission Results Summary

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- Particulate Mass Emission Rate (Lbs/Hr) – Pounds of Particulate Per Hour
- Particulate Mass Emission Rate (Lbs/MMBTU Heat Input) – Pounds of Particulate Per Million BTU of Heat Input (Calculated using Equation 19-1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)
- Particulate Mass Emission Rate (Lbs/MMBTU Steam Output) – Pounds of Particulate Per Million BTU of Steam Output. The BTU/Lb of steam value used (1201 BTU/Lb of Steam) in these calculations was obtained from a Steam Table using steam operating data supplied by Michigan Sugar. The steam table used can be found in Appendix F. Boiler operating data during the testing can be found in Appendix H.

A more detailed breakdown of each individual Particulate sample can be found in Appendix A. It should be noted that the particulate samples are labeled 1, 2 and 4. During sample 3, it was noticed that there was particulate breakthrough occurring at the filter. At the half way mark of the sample (port change), the third sample was aborted and discarded. The fourth sample (actual official third sample) was assembled and completed. It was later determined that there was a small tear in the third filter (aborted test 3) that was causing some particulate to escape and enter the back half.

III.2 CO

Table 2 – 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)
- CO Concentration (PPM) - Parts Per Million (v/v) on a Dry Basis

- CO Concentration (PPM @ 3 %O₂) - 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
- CO Mass Emission Rate (Lbs/MMBTU Heat Input) – Pounds of CO Per Million BTU of Heat Input (Calculated using Equation 19-1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)
- CO Mass Emission Rate (Lbs/MMBTU Steam Output) – Pounds of CO Per Million BTU of Steam Output. The BTU/Lb of steam value used (1201 BTU/Lb of Steam) in these calculations was obtained from a Steam Table using steam operating data supplied by Michigan Sugar. The steam table used can be found in Appendix F. Boiler operating data during the testing can be found in Appendix H.

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

III.3 Hg

Table 3 – Mercury (Hg) Emission Results Summary

- Sample
- Date
- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- 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 19-1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)
- Hg Mass Emission Rate (Lbs/MMBTU Steam Output) – Pounds of Hg Per Million BTU of Steam Output. The BTU/Lb of steam value used (1201 BTU/Lb of Steam) in these calculations was obtained from a Steam Table using steam operating data supplied by Michigan Sugar. The steam table used can be found in Appendix F. Boiler operating data during the testing can be found in Appendix H.

A more detailed breakdown of each individual Hg sample can be found in Appendix A. It should be noted that the Hg samples are labeled 1, 2 and 4. During sample 3, it was noticed that there was particulate breakthrough occurring at the filter. At the half way mark of the sample (port change), the third sample was aborted and discarded. The fourth sample (actual official third sample) was assembled

and completed. It was later determined that there was a small tear in the third filter (aborted test) that was causing some particulate to escape and enter the back half.

III.4 HCl

Table 4 – Hydrochloric Acid (HCl) Emission Results Summary

- Sample
- Time
- Air Flow Rate (DSCFM) - Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in. Hg)
- HCl Concentration (Mg/M³) - 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 19-1 from U.S. EPA Method 19. The F Factor used for the Lbs/MMBTU calculations was 9,780 DSCF/MMBTU.)
- HCl Mass Emission Rate (Lbs/MMBTU Steam Output) – Pounds of HCl Per Million BTU of Steam Output. The BTU/Lb of steam value used (1201 BTU/Lb of Steam) in these calculations was obtained from a Steam Table using steam operating data supplied by Michigan Sugar. The steam table used can be found in Appendix F. Boiler operating data during the testing can be found in Appendix H.

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

III.5 Emission Limits

National Emission Standard for Hazardous Air Pollutants (NESHAP) 40CFR Part 63 Subpart DDDDD (MACT for Industrial, Commercial, Institutional Boilers and Process Heaters) has established the following emission limits for this source:

Compound	Emission Limit
Carbon Monoxide (CO)	160 PPM @ 3% O ₂ or 0.14 Lbs/MMBTU of Steam Output
Particulate	4.0 E-02 Lbs/MMBTU of Heat Input or 4.2 E-02 Lbs/MMBTU of Steam Output
Mercury (Hg)	5.7 E-06 Lbs/MMBTU of Heat Input or 6.4 E-06 Lbs/MMBTU of Steam Output
Hydrochloric Acid (HCl)	2.2 E-02 Lbs/MMBTU of Heat Input or 2.5 E-02 Lbs/MMBTU of Steam Output

IV. SOURCE DESCRIPTION

There are two (2) boilers at the Sebewaing facility. Both boilers are Wicks "A" frame coal fired stokers. These boilers are as follows:

- Boiler #2 (EUICKESEASTBOIL) - Built in 1940. Designed heat input of approximately 87 MMBTU/Hr
- Boiler #3 (EUICKESWESTBOIL) - Built in 1939. Designed heat input of approximately 87 MMBTU/Hr

These boilers are used for generating process steam. The exhaust gases from these boilers have a common exhaust duct that leads to a wet scrubber followed by a Wet ESP before being emitted to atmosphere. Source operating data during the sampling can be found in Appendix H.

V. SAMPLING AND ANALYTICAL PROTOCOL

The sampling location was on the 60 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 of U.S. EPA Method 1. Twelve (12) sampling points were used for this source.

V.1 Particulate & Mercury (Hg) - The Particulate & Hg emission sampling was conducted by employing U.S. EPA Method 29 (combined with U.S. EPA 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. The samples were one hundred fifty (150) minutes in duration and each had a minimum sample volume of three (3) 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 nozzle/probe rinses and filters (front half) were analyzed for particulate by gravimetric analysis in accordance with Method 5. 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 Particulate & 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 Wet ESP 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 249.4 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 249.4 PPM gas to determine the system bias. After each sample, a system zero and system injection of 249.4 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 Wet ESP exhaust. Each sample was sixty (60) minutes in duration.

The analyzer was initially spanned with a 169.2 PPM gas. Calibration gases of 49.66 PPM and 92.97 PPM were used to complete the initial calibration. After monitoring the source for a little while, it was noticed that there were CO spikes that were exceeding the 169.2 PPM gas. The analyzer was taken off line and then re-calibrated using the 985.3 PPM span. The initial CO calibration is also included in Appendix B.

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 (3/18/16) - The O₂ & CO₂ sampling was conducted in accordance with U.S. EPA Reference Method 3A. Servomex Model 1400M portable stack gas analyzers were used to monitor the Wet ESP 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 O₂ & CO₂ concentrations (%).

The analyzers were calibrated by direct injection prior to the testing. Span gases of 20.96% O₂ and 20.42% CO₂ were used to establish the initial instrument calibrations. Calibration gases of 5.942% O₂/12.01% CO₂ and 11.99% O₂/6.028% CO₂ 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 11.99% O₂/6.028% CO₂ gas to determine the system bias. After each sample, a system zero and system injection

of 11.99% O₂/6.028% CO₂ were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzers 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.

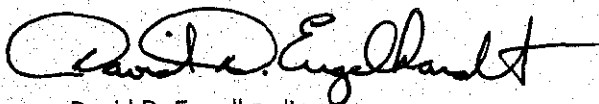
V.4 Oxygen & Carbon Dioxide (3/16-17/16) - The O₂ & CO₂ sampling during the sampling over the period of 3/16-17/16 was performed by employing U.S. EPA Method 3. Bag samples were collected from the back of the isokinetic sampling trains and analyzed by Orsat analysis. All the quality assurance and quality 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 each. 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 Wet ESP exhaust. 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.

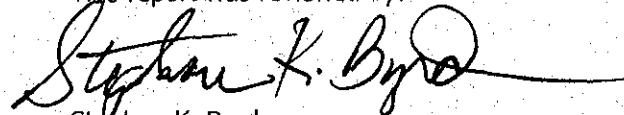
V.6 Exhaust Gas Parameters – The exhaust gas parameters (air flow rate, temperature, moisture and density) were determined in conjunction with the other sampling by employing U.S. EPA Methods 1 through 4. Air flow rates, temperatures and moistures were determined using the isokinetic sampling trains.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

This report was prepared by:

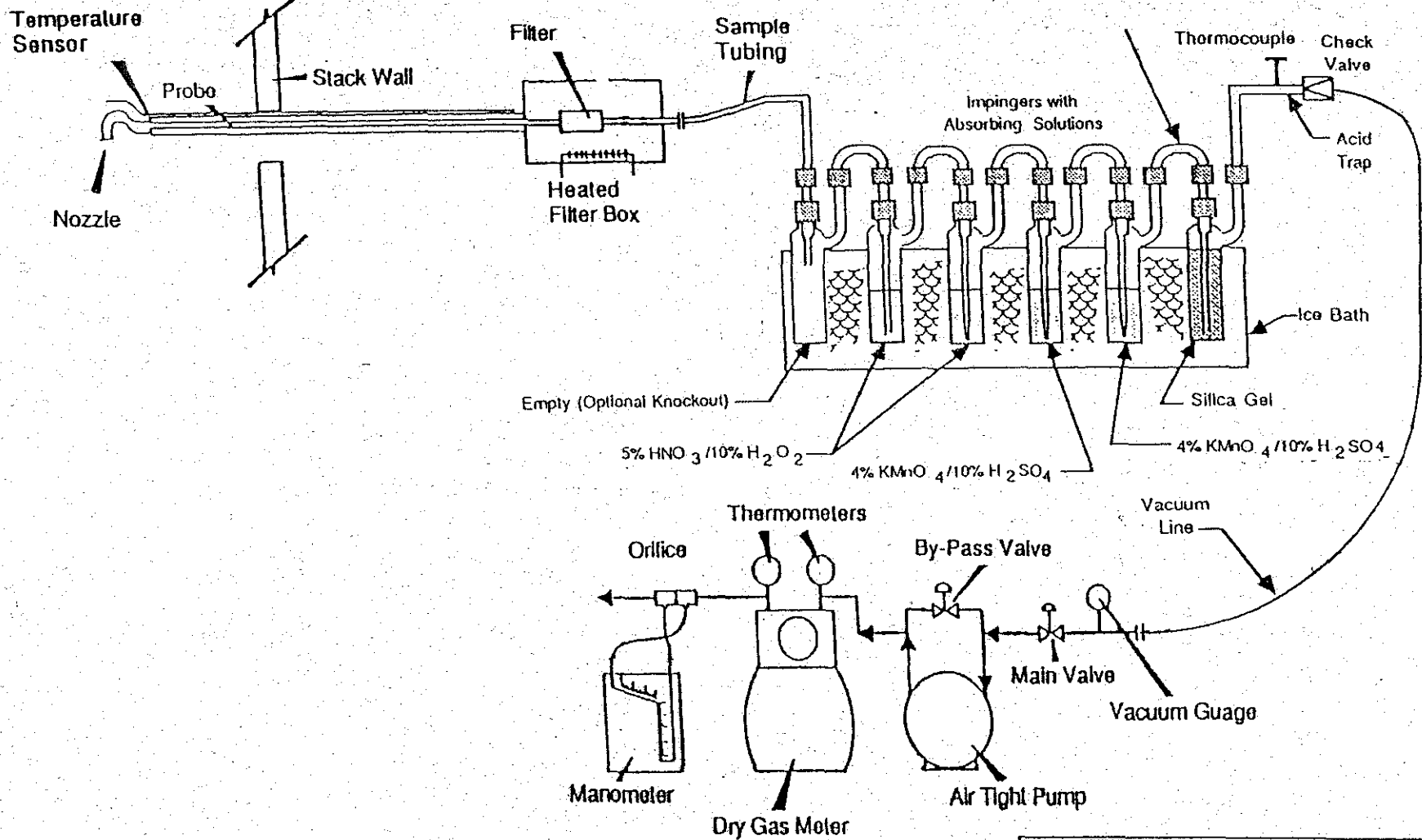


David D. Engelhardt
Vice President

This report was reviewed by:



Stephan K. Byrd
President



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Figure 1
Particulate & Hg Sampling Train

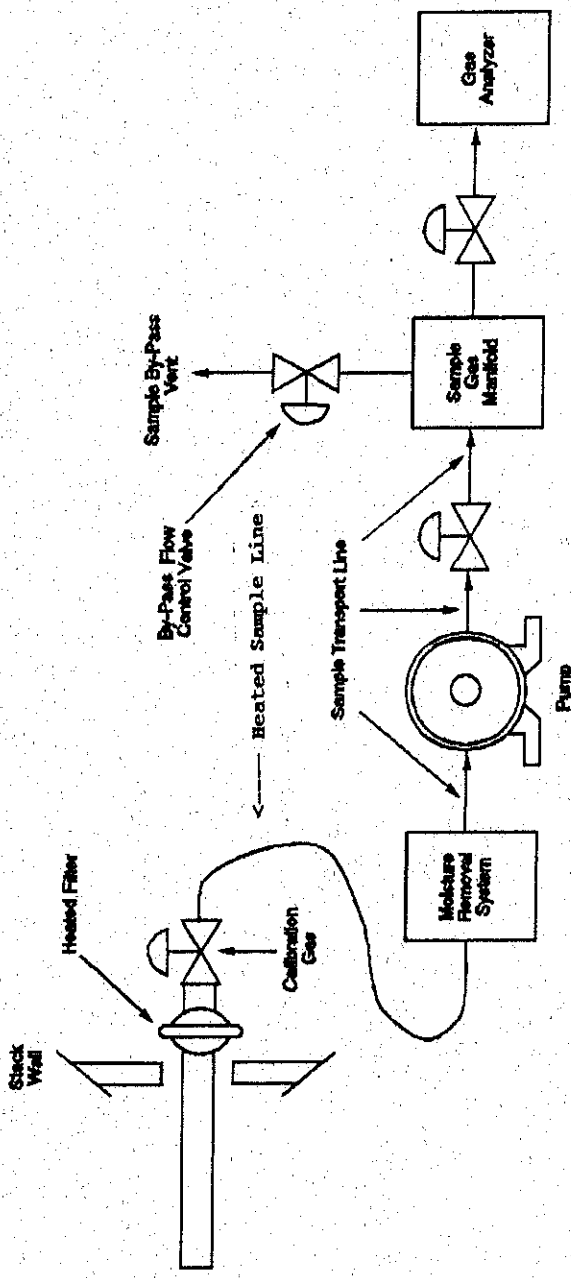


Figure 2
CO, O₂ & CO₂ Sampling Train

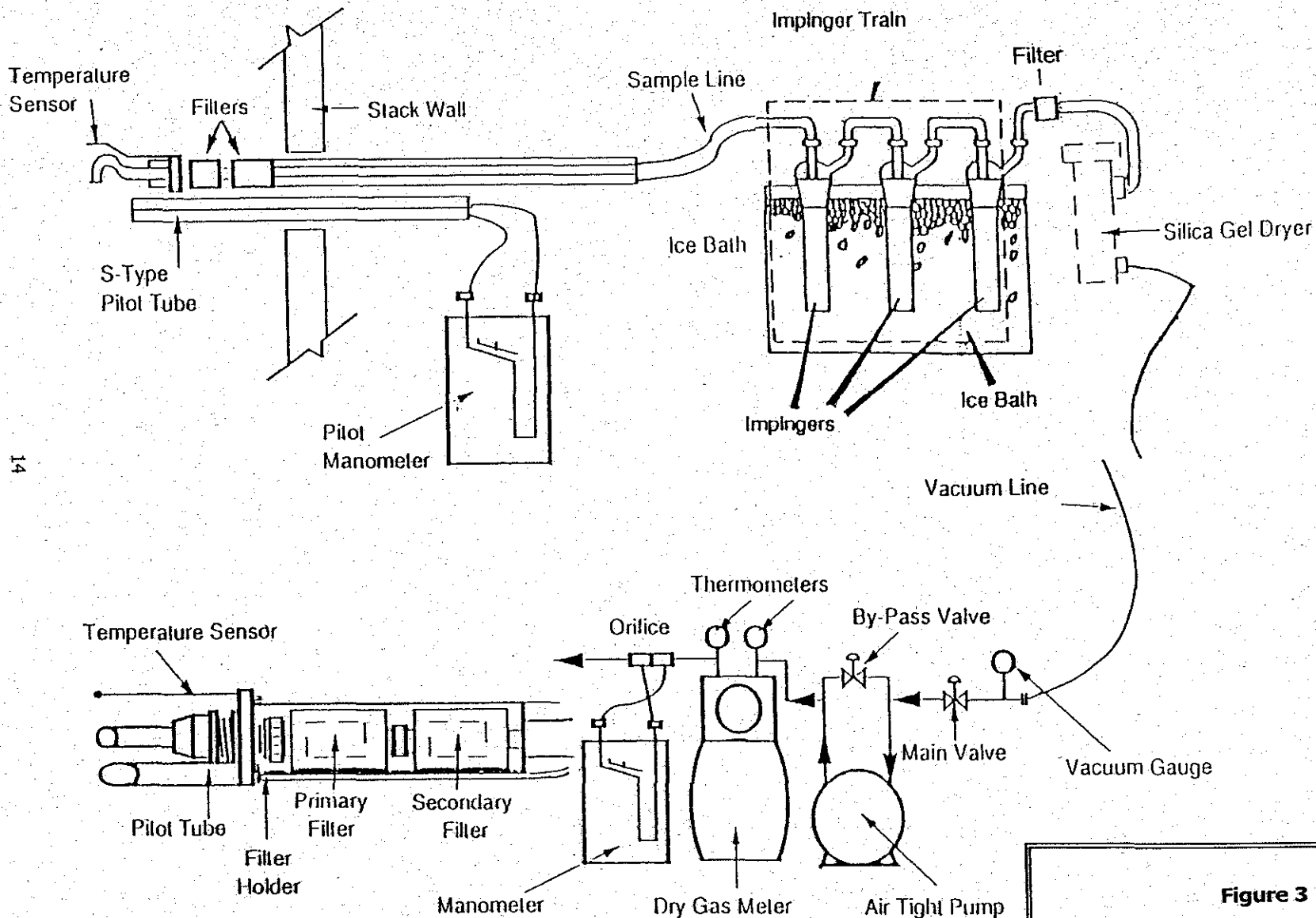


Figure 3
HCl Sampling Train