Source Test Report for 2022 HCl Compliance Emissions Testing

No. 5 Pickle Line (EG5-PICKLE-LINE)

U.S. Steel Corporation-Great Lakes Works Ecorse, Michigan

Prepared For:

U.S. Steel Corporation-Great Lakes Works
No. 1 Quality Drive
Ecorse, MI 48229

Prepared By:

Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, MI

For Submission To:

Michigan Department of Environment, Great Lakes, & Energy
525 West Allegan Street
Lansing, MI 48933

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MONTROSE AIR QUALITY SERVICES

STAC

ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:	John Nestor	**Date:**	08 / 03 / 2022
Name:	John Nestor	**Title:**	District Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature:	robert j lisy jr	**Date:**	08 / 03 / 2022
Name:	Robert J. Lisy, Jr.	**Title:**	Reporting Hub Manager

EXECUTIVE SUMMARY

Montrose Air Quality Services, LLC (Montrose) was retained by United States Steel Corporation, Great Lakes Works (U.S. Steel) to evaluate Hydrogen Chloride (HCl) from the No. 5 Pickle Line Scrubber inlet and exhaust stacks at the U.S. Steel Corporation-Great Lakes Works facility located at No. 1 Quality Drive in Ecorse, Michigan. The testing program was conducted on June 28, 2022.

The testing consisted of quadruplicate 60-minute test runs at each source. The results of the emission test program are summarized by Table I.

Table I
Executive Summary Table HCl Emission Rates Summary

Parameter/Units	Average Results	Emission Limits
Hydrogen Chloride (HCl) – Pickle Line Scrubber Inlet		
ppmvd	1,127	--
lb/hr	70.1	--
Hydrogen Chloride (HCl) – Pickle Line Scrubber Exhaust		
ppmvd	8.96	18
lb/hr	0.56	1.64
HCl Removal Efficiency		
%	99.2	97

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1.0 Introduction

Montrose Air Quality Services, LLC (Montrose) was retained by U.S. Steel Corporation (U.S. Steel) to conduct an evaluation of the hydrogen chloride (HCl) concentrations and emissions from the No. 5 Pickle Line (EG5-PICKLE-LINE) Scrubber Inlet and Exhaust stack. The scrubber is located at the U.S. Steel-Great Lakes Works facility (State Registration No.: A7809) in Ecorse, Michigan. The evaluation consisted of quadruplicate 60-minute test runs at each sampling location. US EPA Methods 1, 2, 3, 4, 26, and 26A were utilized to perform the study.

All testing was performed in accordance with Montrose test plan PROJ-016626.

EGLE has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (November 2019). The following is a summary of the emissions test report in the format suggested by the Michigan Department of Environment, Great Lakes, & Energy (EGLE) test report format guide.

1.1 Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on June 28, 2022, at the U.S. Steel facility in Ecorse, Michigan. The test program included evaluation of HCl emissions from the EG5-PICKLE-LINE Inlet and Exhaust.

1.2 Purpose of Testing

Renewable Operating Permit (ROP) No. 199600132d, issued by EGLE, governs this process.

The allowable HCl emission rate by permit is:

18 ppm HCl with a maximum emission rate of 1.64 pounds per hour or an overall removal efficiency of 97%.

1.3 Source Description

The EG5-PICKLE-LINE Scrubber captures and removes acid mist and vapors from the process line. All pickle line tubs are completely covered with capture hoods to evacuate the acid mist and fumes. Ductwork carries the fumes to the packed bed scrubber rated at 13,500 ACFM. The fumes are moved through the scrubber by an I.D. fan.

1.4 Test Program Contact

Mr. John Nestor
District Manager
Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, Michigan 48073
Phone: (248) 548-8070

Mr. Nathan Ganhs
U. S. Steel Environmental
United States Steel Corporation
Great Lakes Works
No. 1 Quality Drive
Ecorse, Michigan 48229
Phone: (313) 749-3857

Table 1
Test Personnel and Observers

Name	Affiliation	Telephone Number
Mr. Nathan Ganhs Environmental Coordinator	U.S. Steel Corporation-Great Lakes Works No. 1 Quality Drive Ecorse, MI 48229	(313) 749-3857
Mr. John Nestor District Manager	Montrose 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Todd Wessel Client Project Manager	Montrose 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Mark Nestor Field Technician	Montrose 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Jeff Peitzsch Shop Coordinator	Montrose 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. David Koponen Field Technician	Montrose 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Ms. Regina Angellotti	EGLE Cadillac Place, 3058 W Grand Blvd Suite 2-300 Detroit, MI 48202	313-418-0895

2.0 Plant and Sampling Location Descriptions

2.1 Operating Data

Sections 2.1 through 2.4 summarize the results of the emissions compliance test program.

2.2 Applicable Permit

The applicable permit for this emissions test program is ROP No. 199600132d.

2.3 Results

The overall results of the emission test program are summarized by Table 2 (See Section 5.1). Detailed results for each run can be found in Tables 3 and 4.

2.4 Emission Regulation Comparison

The results are summarized in Table 2 (Section 5.1).

3.0 Source Descriptions

3.1 Process Description

The Pickling process uses a mineral acid (hydrochloric acid) to remove metal oxides formed when steel is hot rolled and cooled in the presence of oxygen. It is necessary to remove these oxides to provide a smooth clean surface for use as hot roll steel and/or to perform subsequent cold forming operations.

The No. 5 Pickle Line (EG5-PICKLE-LINE) at U.S Steel consists of three pickle tubs in series. The fresh acid solution is introduced in the 3rd pickle tank. The acid solution then cascades from the 3rd tank to the 1st tank in a direction counter to the direction of the metal strip. By this countercurrent arrangement, the cleanest strip near the process exit is treated by the freshest acid, ensuring that the steel strip is as free of oxide scale as possible.

The EG5-PICKLE-LINE Scrubber captures and removes acid mist and vapors from the process line. All pickle line tubs are completely covered with capture hoods to evacuate the acid mist and fumes. Ductwork carries the fumes to the packed bed scrubber rated at 13,500 ACFM. The fumes are moved through the scrubber by an I.D. fan.

3.2 Raw and Finished Materials

Raw Material used is hydrochloric acid.

3.3 Process Capacity

On a typical processing day, U.S Steel's EG5-PICKLE-LINE will process approximately 300 coils of steel which is approximately 9,000 tons of steel.

3.4 Process Instrumentation

There is no process instrumentation relevant to the testing that was performed. U.S. Steel documented the start and end times of each production cycle and weights of coiled steel processed.

4.0 Sampling and Analytical Procedures

4.1 Sampling Train and Field Procedures

Measurement of exhaust gas velocity, molecular weight, and moisture content was conducted using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- EPA Method 1 - "Location of the Sampling Site and Sampling Points"
- EPA Method 2 - "Determination of Stack Gas Velocity and Volumetric Flowrate"
- EPA Method 3 - "Determination of Molecular Weight of Dry Stack Gas"
- EPA Method 4 - "Determination of Moisture Content in Stack Gases"
- EPA Method 26 - "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources (Non-Isokinetic Method)"
- EPA Method 26A - "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources (Isokinetic Method)"

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. Figure 1 presents the test port and traverse/sampling point locations used. A cyclonic flow evaluation was conducted at the outlet sampling location during the January 2022 testing event. An S-type pitot tube and thermocouple assembly calibrated in accordance with Method 2, Section 4.1.1 was used to measure exhaust gas velocity pressures and temperatures during testing. Because the pitot tube dimensions were within the specified limits, the baseline pitot tube coefficient of 0.84 (dimensionless) was assigned for this testing. Flow rates were not determined at the scrubber inlet. The inlet flow rate was assumed to be equal to the exhaust.

Molecular weight determinations were conducted according to Method 3. The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Moisture content was determined from the condensate collected in the Method 26 and 26A sampling trains according to Method 4.

The Exhaust gas was measured using Method 26A (isokinetic sampling), and the inlet gas was measured using Method 26 (non-isokinetic sampling).

Method 26A was used to measure HCl concentrations and calculate emission rates from the exhaust stack (see Figure 2 for sampling train schematic diagram) MAQS Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a Teflon coated stainless steel nozzle; (2) a heated borosilicate or quartz probe liner; (3) a heated borosilicate or quartz glass filter holder containing a pre-weighed 90-mm diameter washed Teflon filter with Teflon filter support; (4) a set of two Greensburg-Smith (GS) impingers each of which contained 100 ml of 0.1 Normal Sulfuric Acid (0.1 N H_2SO_4), (5) a modified GS impinger that was empty as a knock out impinger, (6) a modified GS impinger containing a known weight of silica gel desiccant; (7) a length of sample line, and (8) a Nutech control case equipped with a pump, dry gas meter, and calibrated orifice.

The Method 26 inlet sampling train utilized an unheated Teflon line in place of a heated filter, heated glass probe and nozzle. The sampling train was identical to the Method 26A train from the filter holder on back.

A sampling train and pitot tube leak test was conducted before and after each test run. Upon completion of the final leak check for each test run, the impinger train was carefully disassembled. The liquid volume of each impinger was measured gravimetrically and any volume increase was noted on field sheets. The impinger catch solution was then transferred to a pre-cleaned sample container. The impingers were then triple rinsed with deionized water (DI H_2O), and the rinses added to the sample container. The container was labeled with the test number, test location, test date and the level of liquid was marked on the outside of each container. The samples were then placed in a sealed cooler for storage. In addition, blank samples of the 0.1N H_2SO_4 and DI were collected. MAQS personnel shipped the samples to Bureau Veritas in Mississauga, Ontario for analysis. All appropriate QA/QC measures were strictly adhered to. Results of the laboratory tests are included in Appendix D.

4.2 Recovery and Analytical Procedures

Recovery and analytical procedures were described in Section 4.1.

4.3 Sample Ports

Sampling ports are located on the stack and meet EPA Method 1 criteria.

4.4 Traverse Points

Sampling port and traverse point locations for the EG5-PICKLE-LINE Exhaust are illustrated by Figure 1.

5.0 Test Discussion and Results

Sections 5.1 through 5.11 provide a summary of the test results.

5.1 Recovery and Analytical Procedures

The results of the emissions test program are summarized by Table 2.

Table 2
Test Program HCl Emission Rates Summary

Parameter/Units	Average Results	Emission Limits
Hydrogen Chloride (HCl) – EG5-PICKLE-LINE Scrubber Inlet		
ppmvd	1,127	--
lb/hr	70.1	--
Hydrogen Chloride (HCl) – EG5-PICKLE-LINE Scrubber Exhaust		
ppmvd	8.96	18
lb/hr	0.56	1.64
HCl Removal Efficiency		
%	99.2	97

Detailed data for each test run can be found in Tables 3 and 4.

5.2 Discussion of Results

Emission limitations for Permit No. 199600132d are summarized by Section 1.2. The results of the emissions test program are summarized by Table 2 (See Section 5.1). Detailed results for each run are summarized by Tables 3 and 4.

5.3 Sampling Procedure Variations

During Run 3 at the EG5-PICKLE-LINE Scrubber Exhaust, it was determined that the EPA Method 26A Train's isokinetic sampling rate was outside of the acceptable range of 100±10% as specified by EPA Method 5, Section 8.5. Run 3 was voided, and an additional run was performed. The data sheets for Run 3 are included in the Appendix.

An additional run was also performed due a suspected problem with Run 2. However, Run 2 was determined to be acceptable. As a result, four compliance runs are shown for this testing event.

EPA Method 3 was not performed during Run 2 at either location. For Run 2, a dry molecular weight value of 29.0 g/g-mole was utilized as per EPA Method 2, section 8.6

The EG5-PICKLE-LINE Scrubber Inlet moisture content displayed in Table 3 reflects the saturated moisture content value determined for the given stack gas temperature and pressure as per Section 4.0, of EPA Method 4. The measured flue gas percent by volume moisture content was higher than the calculated saturated value. Therefore, EPA Method 26A should have been utilized since it is suitable for sources that emit acid particulate matter (PM) (i.e., halides dissolved in water droplets). It is the opinion of Montrose that the use of EPA Method 26 at the inlet had an undeterminable effect on the emission results.

5.4 Process or Control Device Upsets

No upset conditions occurred during testing.

5.5 Control Device Maintenance

No maintenance was performed during the test program.

5.6 Audit Sample Analysis

No audit samples were required.

5.7 Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.8 Sample Calculations

Sample Calculations are provided in Appendix C.

5.9 Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix A.

5.10 Laboratory Data

Laboratory results are presented in Appendix D.

5.11 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

Results Tables

Table 3
HCl Emissions Results -
EG5-PICKLE-LINE Scrubber Inlet

Parameter/Units	Run 1	Run 2*	Run 4	Run 5	Average
Date	6/28/2022	6/28/2022	6/28/2022	6/28/2022	--
Time	8:30-9:30	9:50-10:56	12:40-13:40	14:05-15:05	--
Sampling & Flue Gas Parameters					
O_2, % volume dry	21.0	--	21.0	21.0	21.0
CO_2, % volume dry	0.0	--	0.0	0.0	0.0
flue gas temperature, °F	127.1	126.8	128.9	130.3	128.3
moisture content, % volume†	13.9	14.2	15.0	15.6	14.7
moisture content (measured), % volume	15.0	15.7	15.8	17.3	16.0
volumetric flow rate, dscfm‡	11,021	11,137	10,697	10,980	10,959
HCl					
ppmvd	940	1,101	1,102	1,366	1,127
lb/hr	58.8	69.6	66.9	85.2	70.1

* EPA Method 3 was not performed during Run 2. See Section 5.3 for further details.

† Displayed moisture content values are saturated for their respective stack gas temperatures and pressures. See Section 5.2 for further details.

‡ Volumetric flow rates for each run measured at the EG5-PICKLE-LINE Scrubber Exhaust are utilized at the EG5-PICKLE-LINE.

Table 4
HCl Emissions and RE Results -
EG5-PICKLE-LINE Scrubber Exhaust

Parameter/Units	Run 1	Run 2†	Run 4	Run 5	Average
Date	6/28/2022	6/28/2022	6/28/2022	6/28/2022	--
Time	8:30-9:33	9:50-11:02	12:40-13:44	14:05-15:08	--
Process Data*					
Charged Steel, tons	193	304	296	233	257
Sampling & Flue Gas Parameters					
O_2, % volume dry	21.0	--	21.0	21.0	21.0
CO_2, % volume dry	0.0	--	0.0	0.0	0.0
flue gas temperature, °F	111.0	108.8	106.7	109.7	109.0
moisture content, % volume	8.16	7.62	7.30	8.41	7.87
volumetric flow rate, dscfm	11,021	11,137	10,698	10,980	10,959
HCl					
ppmvd	10.05	10.00	7.26	8.55	8.96
lb/hr	0.63	0.63	0.44	0.53	0.56
HCl Removal Efficiency (RE)					
%	98.9	99.1	99.3	99.4	99.2

* Process data was provided by U.S. Steel-Great Lakes Works personnel.

† EPA Method 3 was not performed during Run 2. See Section 5.3 for further details.

Figures

Figure 1
EG5-PICKLE-LINE Scrubber Sampling Location

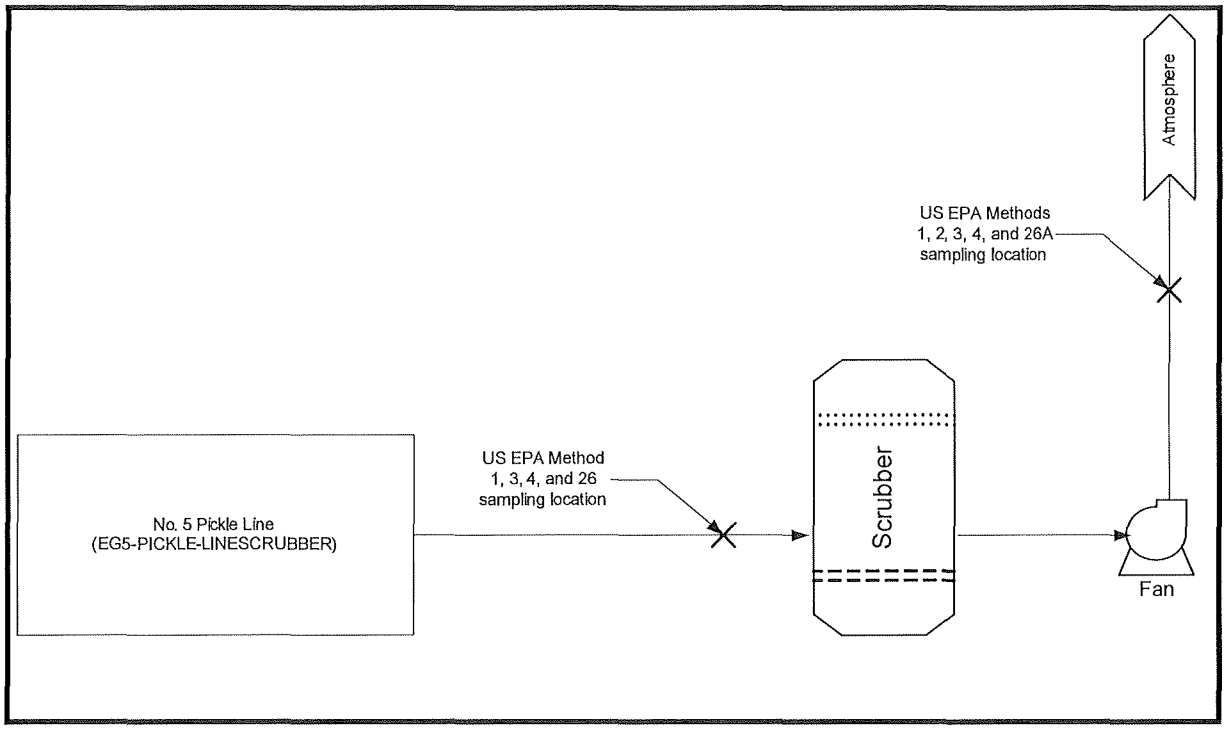
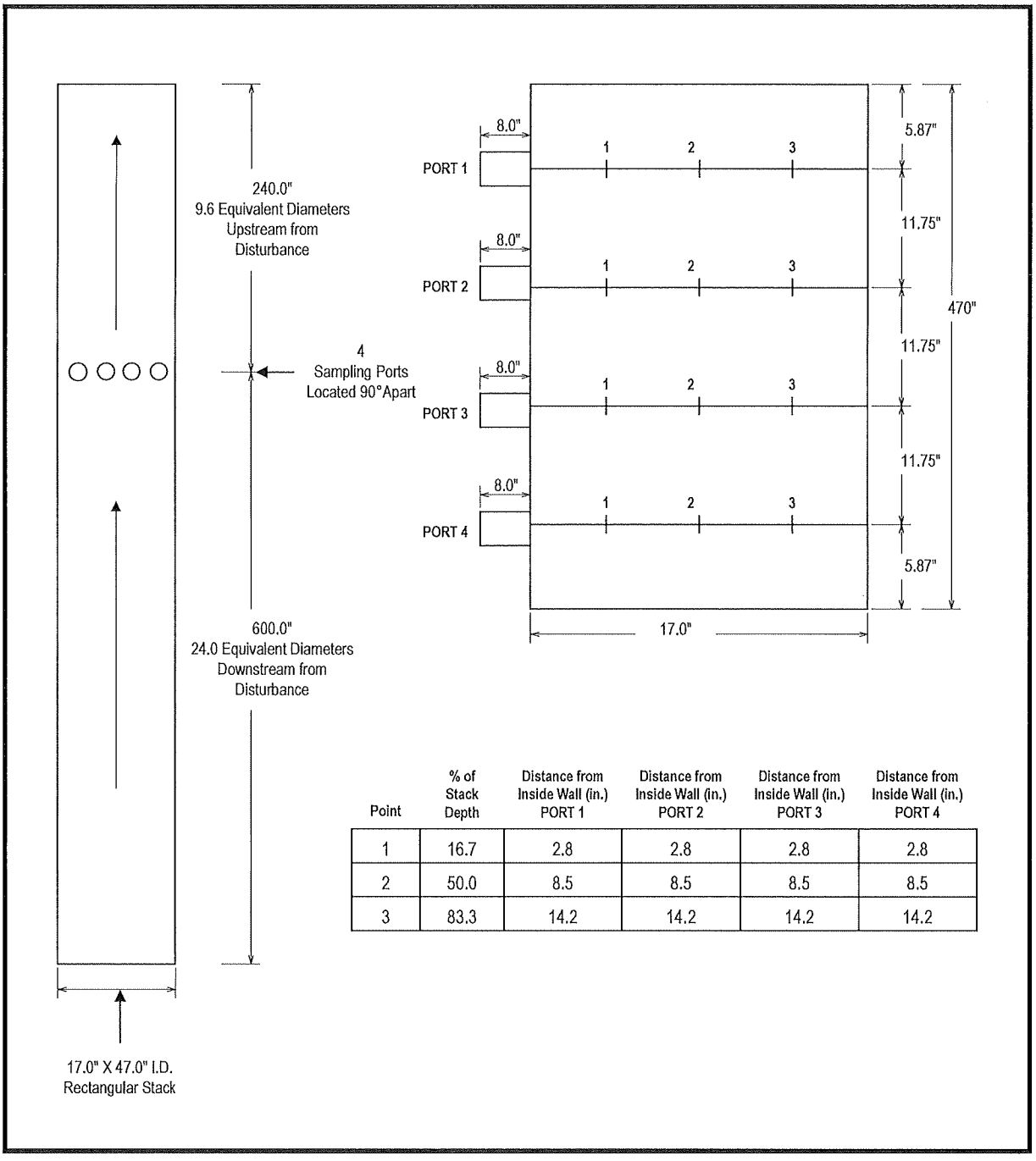


Figure 2
EG5-PICKLE-LINE Scrubber Exhaust Stack Traverse Point Location Drawing



Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2	Distance from Inside Wall (in.) PORT 3	Distance from Inside Wall (in.) PORT 4
1	16.7	2.8	2.8	2.8	2.8
2	50.0	8.5	8.5	8.5	8.5
3	83.3	14.2	14.2	14.2	14.2

Figure 3
US Method 26 Sampling Train

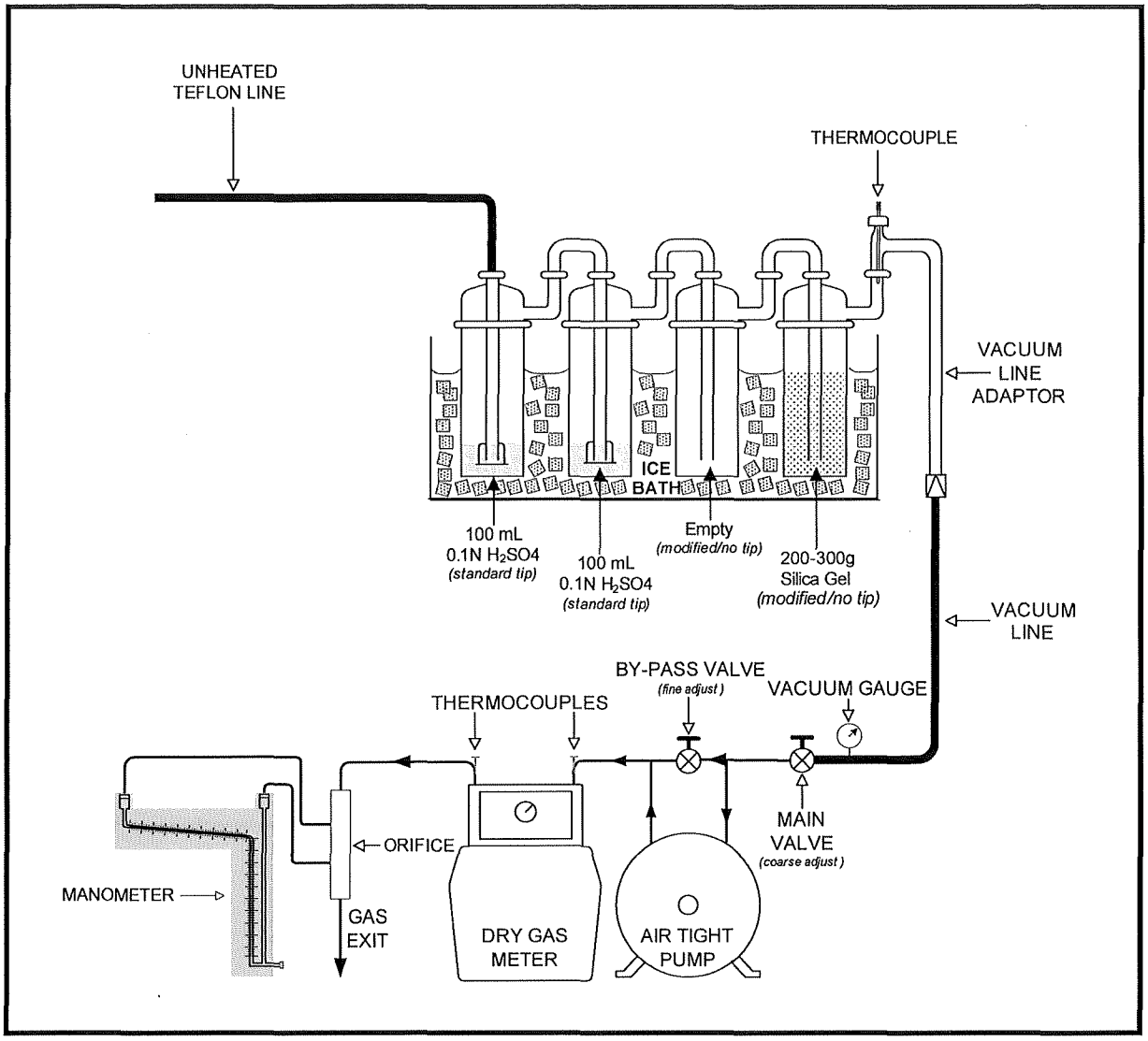


Figure 4
US Method 26A (Halides) Sampling Train