# SOURCE TEST REPORT
# 2021 HYDROGEN CHLORIDE COMPLIANCE TESTING
# UNITED STATES STEEL CORPORATION
# GREAT LAKES WORKS
# No. 5 PICKLE LINE
# ECORSE, MICHIGAN



Prepared For:

**UNITES STATES STEEL CORPORATION**
GREAT LAKES WORKS
No. 1 QUALITY DRIVE
ECORSE, MICHIGAN 48229

For Submittal To:

**EGLE**
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Prepared By:

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| | |
|---|---|
| Document Number: | **M049AS-003571-RT-624** |
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STAC STACK TESTING ACCREDITATION COUNCIL

A2LA ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

MONTROSE AIR QUALITY SERVICES

## 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: _____ Date: 03 / 01 / 2021

Name: Steven Smith Title: Client Project 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: _____ Date: 03 / 01 / 2021

Name: Matthew Young Title: District Manager

## EXECUTIVE SUMMARY

Montrose Air Quality Services, LLC (MAQS) 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 facility located at No. 1 Quality Drive in Ecorse, Michigan. The testing program was conducted on February 16, 2021.

The testing consisted of triplicate 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 Rate Summary**

| Unit | Emission Rate | | Permit Limit | |
|---|---|---|---|---|
| | HCl (lb/hr) | HCl (PPMV, Dry) | HCl (lb/hr) | HCl (PPMV, Dry) |
| Pickle Line - Inlet | 24.2 | 479.3 | | |
| Pickle Line - Outlet | 1.96 | 38.7 | 1.64 | 18 |

## TABLE OF CONTENTS

## TABLES



## FIGURES



## APPENDIX

# 1.0 INTRODUCTION

Montrose Air Quality Services, LLC (MAQS) was retained by United States Steel Corporation (U.S. Steel) to conduct an evaluation of the hydrogen chloride (HCl) concentrations and emissions from the No. 5 Pickle Line Scrubber inlet and exhaust stacks. The scrubber is located at the U. S. Steel facility in Ecorse, Michigan. The evaluation consisted of triplicate 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 MAQS test plan PROJ-003571.

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 EGLE test report format guide.

## 1.a IDENTIFICATION, LOCATION, AND DATES OF TEST

Sampling and analysis for the emission test program was conducted on February 16, 2021 at the U.S. Steel facility in Ecorse, Michigan. The test program included evaluation of HCl emissions from the No. 5 Pickle Line inlet and exhaust stacks.

## 1.b PURPOSE OF TESTING

Permit No. ROP 199600132d, issued by State of Michigan Division of Environmental Quality, 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.c SOURCE DESCRIPTION

The No. 5 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 16,950 ACFM. The fumes are moved through the scrubber by an I.D. fan.

## 1.d TEST PROGRAM CONTACT

Mr. Todd Wessel
Client Project Manager
Montrose Air Quality Services
4949 Fernlee Avenue
Royal Oak, Michigan 48073
Phone (616) 885-4013

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

**Table 1**
**Testing Personnel Summary**

| Name and Title | Affiliation | Telephone |
|---|---|---|
| Mr. Nathan Ganhs<br>Environmental Department | U.S. Steel<br>No. 1 Quality Drive<br>Ecorse, Michigan 48229 | (313) 749-3857 |
| Mr. Matthew Young<br>District Manager | MAQS<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (586) 744-9133 |
| Mr. Steven Smith<br>Client Project Manager | MAQS<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (248) 548-8072 |
| Mr. Dave Trahan<br>Field Project Manager | MAQS<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (248) 548-8072 |
| Mr. David Koponen<br>Field Technician | MAQS<br>4949 Fernlee Avenue<br>Royal Oak, MI 48073 | (248) 548-8072 |

## 2.0 SUMMARY OF RESULTS

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

### 2.a OPERATING DATA

Operating data monitored included the start and end times of each production cycle and the weights of coiled steel processed.

### 2.b APPLICABLE PERMIT

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

### 2.c RESULTS

The overall results of the emission test program are summarized by Table 2 (see Section 5.a). Detailed results for each run can be found in Tables 3 and 4.

### 2.d EMISSION REGULATION COMPARISON

The results are summarized in Table 2 (Section 5.a).

## 3.0 SOURCE DESCRIPTION

Sections 3.a through 3.e provide a detailed description of the process.

### 3.a 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 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 No. 5 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 16,950 ACFM. The fumes are moved through the scrubber by an I.D. fan.

### 3.b RAW AND FINISHED MATERIALS

Raw Material used is hydrochloric acid.

### 3.c PROCESS CAPACITY

On a typical processing day, U.S Steels Pickle Line will process approximately 300 coils of steel which is approximately 9,000 tons of steel.

### 3.d 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

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

## 4.a 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):

- Method 1 - "Location of the Sampling Site and Sampling Points"
- Method 2 - "Determination of Stack Gas Velocity and Volumetric Flowrate"
- Method 3 - "Determination of Molecular Weight of Dry Stack Gas"
- Method 4 - "Determination of Moisture Content in Stack Gases"
- Method 26 - "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources (Non-Isokinetic Method)"
- 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. 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 outlined in Sections 2.6 through 2.8 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 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.b RECOVERY AND ANALYTICAL PROCEDURES

Recovery and analytical procedures were described in Section 4.a.

### 4.c SAMPLING PORTS

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

### 4.d TRAVERSE POINTS

Sampling port and traverse point locations for the No. 5 Pickle Line exhaust stack are illustrated by Figure 1.

## 5.0 TEST RESULTS AND DISCUSSION

Sections 5.a through 5.k provide a summary of the test results.

### 5.a RESULTS TABULATION

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

**TABLE 2**
**Test Program HCl Emission Rates Summary**

| Unit | Emission Rate | | Permit Limit | |
|---|---|---|---|---|
| | HCl (lb/hr) | HCl (PPMV, Dry) | HCl (lb/hr) | HCl (PPMV, Dry) |
| Pickle Line - Inlet | 24.2 | 479.3 | | |
| Pickle Line - Outlet | 1.96 | 38.7 | 1.64 | 18 |

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

### 5.b DISCUSSION OF RESULTS

Emission limitations for Permit No. 199600132d are summarized by section 1b. The results of the emissions test program are summarized by Table 2 (see section 5.a). Detailed results for each run are summarized by Tables 3 and 4.

### 5.c SAMPLING PROCEDURE VARIATIONS

There were no sampling procedure variations during the test program.

### 5.d PROCESS OR CONTROL DEVICE UPSETS

No upset conditions occurred during testing.

### 5.e CONTROL DEVICE MAINTENANCE

No maintenance was performed during the test program.

### 5.f AUDIT SAMPLE ANALYSIS

No audit samples were required.

### 5.g CALIBRATION SHEETS

Relevant equipment calibration documents are provided as Appendix B.

### 5.h SAMPLE CALCULATIONS

Sample Calculations are provided in Appendix C.

### 5.i FIELD DATA SHEETS

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

### 5.j LABORATORY DATA

Laboratory results are presented in Appendix D.

# Tables

**TABLE 3**
**HCl EMISSIONS RESULTS -**
**SCRUBBER INLET**

| Run Number | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| **Date** | 2/16/2021 | 2/16/2021 | 2/16/2021 | -- |
| **Time** | 10:42-12:10 | 12:25-13:25 | 13:38-14:57 | -- |
| **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 |
| moisture content, % volume | 15.81 | 16.56 | 15.63 | 16.00 |
| volumetric flow rate, dscfm | 8,834 | 8,897 | 8,972 | 8,901 |
| **HCl** | | | | |
| ppmvd | 517.3 | 469.0 | 451.6 | 479.3 |
| lb/hr | 25.9 | 23.7 | 23.0 | 24.2 |

**TABLE 4**
**HCl EMISSIONS AND RE RESULTS -**
**SCRUBBER EXHAUST**

| Run Number | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| **Date** | 2/16/2021 | 2/16/2021 | 2/16/2021 | -- |
| **Time** | 10:42-12:16 | 12:25-13:30 | 13:38-14:59 | -- |
| **Process Data*** | | | | |
| charged steel, tons | 175 | 204 | 202 | 194 |
| **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 | 102.8 | 105.1 | 102.2 | 103.3 |
| moisture content, % volume | 6.91 | 7.71 | 6.43 | 7.02 |
| volumetric flow rate, dscfm | 8,834 | 8,897 | 8,972 | 8,901 |
| **HCl** | | | | |
| ppmvd | 34.9 | 34.8 | 46.3 | 38.7 |
| lb/hr | 1.75 | 1.76 | 2.36 | 1.96 |
| **HCl Removal Efficiency (RE)** | | | | |
| % | 93.3 | 92.6 | 89.7 | 91.9 |

* Process data was provided by US Steel Corporation - Great Lakes Works personnel
† Displayed Run 2 moisture content values are saturated for the respective stack gas temperature and pressure.

# Figures

## EG5-PICKLE-LINE SAMPLING LOCATION SCHEMATIC

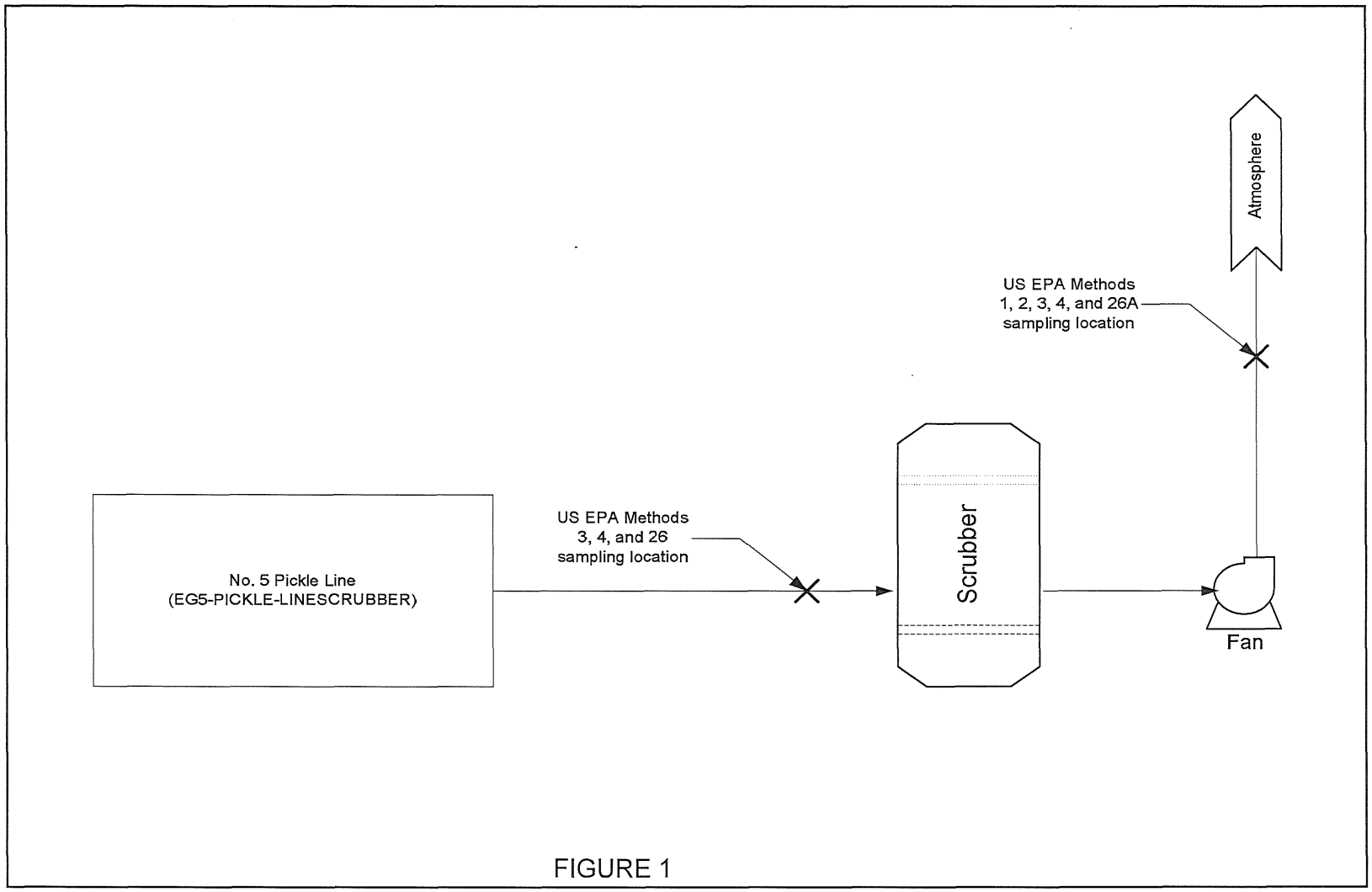
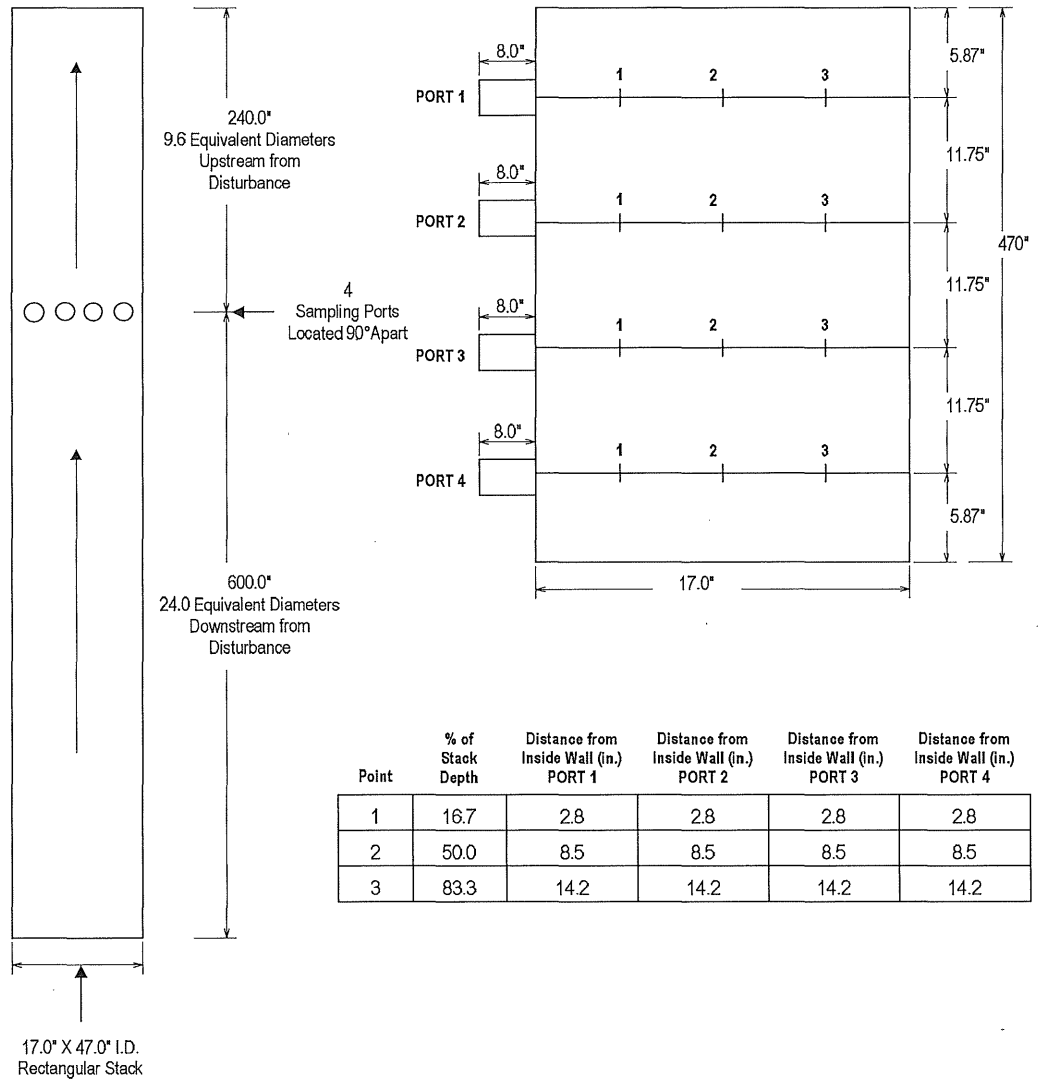



FIGURE 1

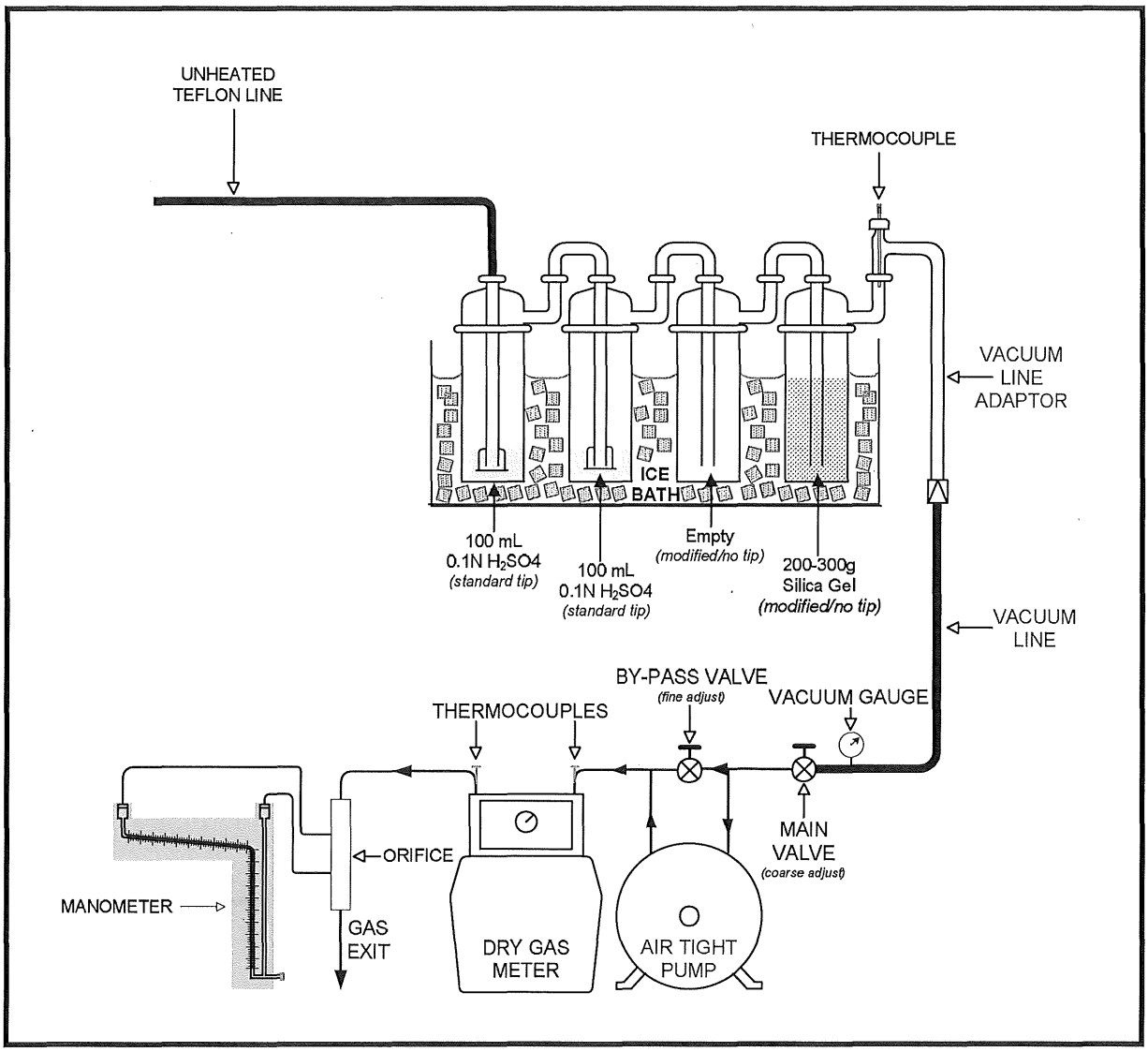
## EG5-PICKLE-LINE SCRUBBER EXHAUST TRAVERSE POINT LOCATION DRAWING




| 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 2

**FIGURE 3**
**US EPA METHOD 26 SAMPLING TRAIN**



## FIGURE 4
## US EPA METHOD 26A (HALIDES) SAMPLING TRAIN