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**HCl EMISSION MEASUREMENT PROGRAM  
PICKLING LINE SCRUBBER EXHAUST  
AK STEEL CORPORATION  
DEARBORN WORKS  
DEARBORN, MICHIGAN**

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Prepared for:



AK Steel, Inc.  
14661 Rotunda Drive  
Dearborn, MI 48120

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**OCT 16 2017**

**AIR QUALITY DIVISION**

Prepared by:



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EQM PN: 050074.0185

September 2017

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## 1. INTRODUCTION

On August 23, 2017, Environmental Quality Management, Inc. (EQM) conducted a compliance evaluation of hydrochloric acid (HCl) emissions from the acid pickling line scrubber exhaust at the AK Steel Corporation Dearborn Works (AK Steel) facility in Dearborn, Michigan. The testing was conducted to satisfy the requirements of Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Permit to Install (PTI) No. 120-16 as well as the Steel HCl Pickling MACT, NESHAP Subpart CCC.

EPA Reference Methods 1 through 4 were used to determine stack gas velocity and temperature, volumetric flow rate, dry molecular weight, and moisture content. EPA Method 26A was used to determine HCl emissions.

Mr. David Pate of AK Steel coordinated process operations for testing purposes. Messrs. Chris Janzen, Gary Drexler, and Nick Pharo of EQM conducted the sampling efforts. Messrs. Tom Gasloli and Jonathan Lamb of the Michigan Department of Environmental Quality (MDEQ) witnessed process operations and sampling efforts.

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2. SUMMARY OF TEST RESULTS

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The HCl concentrations were measured at the scrubber outlet of the pickling line. Sampling was conducted on August 23, 2017. Three 60-minute sampling runs were completed. Stack gas velocity and temperature, volumetric flow rate, molecular weight, moisture content, and HCl emissions were measured during each test run.

Table 2-1 summarizes the stack gas conditions and HCl emissions measured at the scrubber outlet during each test run.

Table 2-1. Stack Gas Conditions and HCl Emissions Pickle Line Scrubber Exhaust

August 23, 2017

AK Steel, Dearborn Works

Run No.	Velocity, fps <sup>a</sup>	Volumetric Flow Rate		Stack Temperature, °F	Moisture, %	HCl, ppm (dry) <sup>d</sup>	Permit Limit, ppm	HCl, lbs/hr <sup>e</sup>
		acfm <sup>b</sup>	dscfm <sup>c</sup>					
PL-1	43.9	12,942	9,890	129	14.7	0.49	6	0.03
PL-2	43.9	12,932	9,712	132	15.7	0.53	6	0.03
PL-3	43.7	12,872	9,645	132	16.0	0.60	6	0.03
<b>Average</b>	<b>43.9</b>	<b>12,915</b>	<b>9,749</b>	<b>131</b>	<b>15.5</b>	<b>0.54</b>	<b>6</b>	<b>0.03</b>

<sup>a</sup>Feet per second.

<sup>b</sup>Actual cubic feet per minute.

<sup>c</sup>Dry standard cubic feet per minute.

<sup>d</sup>Parts per million.

<sup>e</sup>Pounds per hour.

Note: Oxygen and Carbon Dioxide % by volume were measured using a Fyrite Analyzer during testing. Oxygen was recorded at 21.0% by volume, and Carbon Dioxide was recorded at 0.0% by volume for each test run.

### **3. SAMPLING AND ANALYTICAL PROCEDURES**

The sampling and analytical procedures used in this test program followed EPA Methods 1 through 4 and 26A. A brief description of each method follows.

#### **3.1 Location of Measurement Sites**

EPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to select a representative measurement site. The sampling location is discussed in detail in Section 4, "Process Descriptions/Sampling Locations."

#### **3.2 Stack Gas Volumetric Flow Rate**

EPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate," was used to determine volumetric flow rate. A Type "S" pitot tube with an assigned coefficient of 0.84 and an inclined manometer were used to measure velocity pressure. A calibrated Type "K" thermocouple attached directly to the pitot tube was used to measure stack gas temperature. The average stack gas velocity was calculated from the average velocity pressure, average stack gas temperature, stack gas molecular weight, and absolute static pressure. The volumetric flow rate is the product of velocity and the stack cross-sectional area.

#### **3.3 Stack Gas Dry Molecular Weight**

EPA Method 3, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight," was used to determine stack gas dry molecular weight. Grab samples were collected during each measurement run and were analyzed by using a Fyrite combustion gas analyzer that read percent concentrations of CO<sub>2</sub> and O<sub>2</sub>.

### **3.4 Stack Gas Moisture Content**

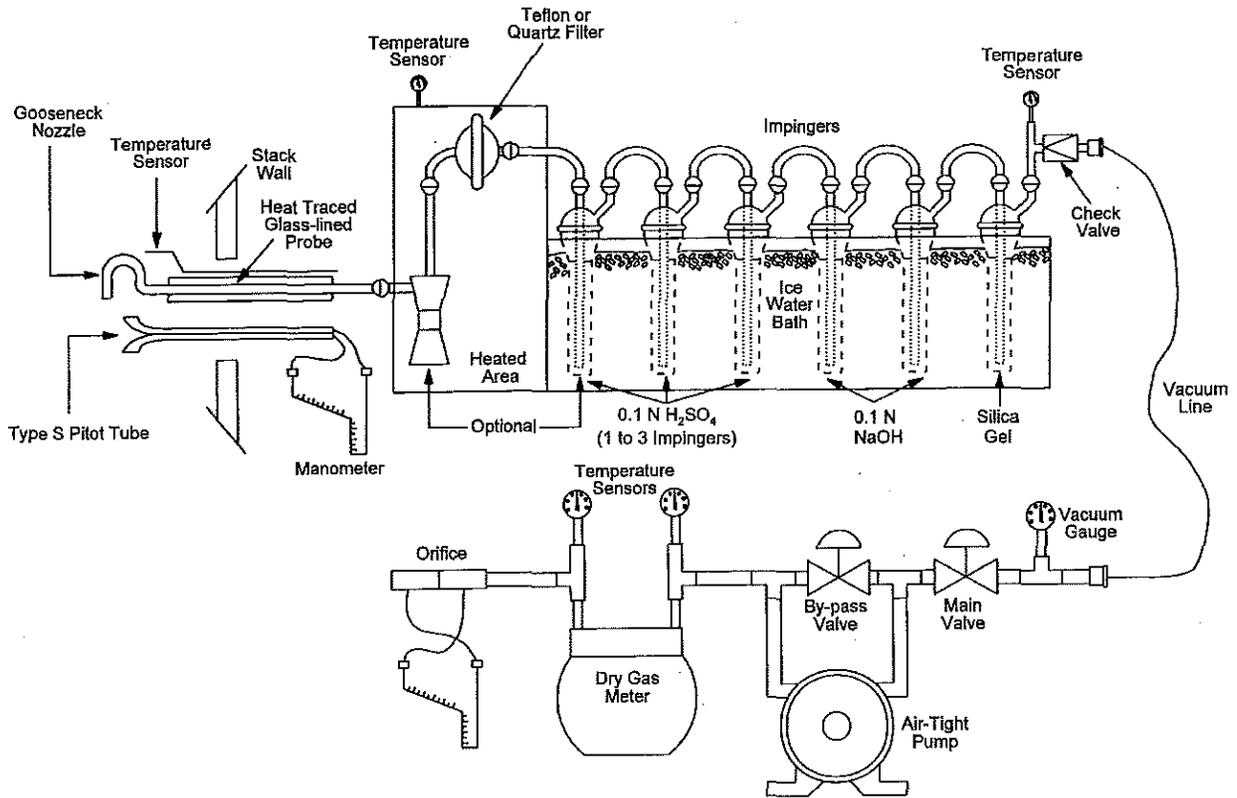
EPA Method 4, "Determination of Moisture Content in Stack Gases," was used to determine stack gas moisture content. The initial and final contents of all impingers were gravimetrically measured to the nearest tenth of a gram.

### **3.5 HCl Emission Measurements**

EPA Method 26A, "Determination of Hydrogen Chloride Emissions from Stationary Sources," was used to determine hydrochloric acid emissions. The sampling train consisted of a glass nozzle, heated glass-lined probe, heated filter, and a series of impingers followed by a vacuum pump, dry gas meter, and calibrated orifice. The probe and filter temperatures were maintained above 248°F. Thermocouples were used to monitor temperatures of the stack gas, sampling probe, filter, and impinger exit gas. Testing was conducted isokinetically. A schematic of the sampling train is shown in Figure 3-1.

### **3.6 Test Comments**

1. Because halogens were not measured, the sodium hydroxide impingers referenced in Method 26A were omitted from the sampling train. This was approved by MDEQ prior to testing.
2. An audit sample was submitted for analysis along with the run samples. The audit sample showed the analysis was acceptable. Audit sample results are shown in Appendix C.
3. The results for each run were below the detection limit. The detection limit was used for all runs.



**Figure 3-1. EPA Method 26A Sampling Train**

Note: The 0.1 N NaOH impingers were omitted from the sampling train.

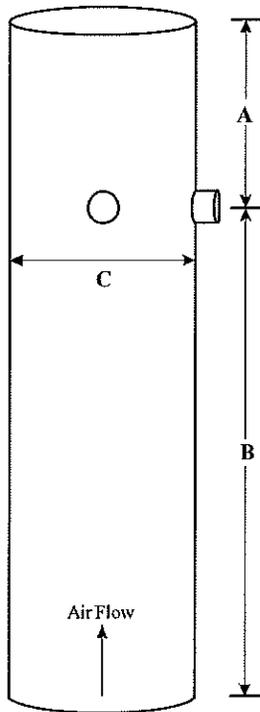
## **4. PROCESS DESCRIPTION/SAMPLING LOCATIONS**

### **4.1 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. These oxides must be removed to provide a smooth, clean surface for use as hot roll steel and/or to perform subsequent cold forming operations. AK Steel Dearborn's pickling line consists of four pickling tubs in series. The fresh acid solution is introduced in the fourth pickling tank. The liquor then cascades from the fourth tank to the first tank in a direction counter to the direction of the steel strip. By this countercurrent arrangement, the cleanest strip near the process exit is treated by the freshest acid, thus ensuring that the steel strip is as free of oxide scale as possible. The pickling line process scrubber captures and removes acid mist and vapors from the line. All pickling line tubs are completely covered with capture hoods to evacuate the acid mist and fumes. Ductwork carries the fumes to a packed bed water scrubber rated at 14,125 acfm. The fumes are moved through the scrubber by an induced draft (ID) fan. Scrubber efficiency is designed to meet an outlet concentration of 6 ppm HCl or less.

### **4.2 Sampling Location**

Sampling was conducted at the HCl Pickle Line scrubber outlet. The scrubber exhaust was sampled in a circular, vertical section of 30-inch inside-diameter ductwork, with two ports at 296 inches, 9.9 duct diameters (dd) downstream of a bend and 360 inches (12 dd) upstream of a disturbance. Twelve points (6 per port) were used to traverse the duct during each test run. Figure 4-1 is a schematic of the sampling location.



Sampling Location	Dimension* A	Dimension* B	Dimension* C
Pickling Line	360 in.	296 in.	30 in.

*Dimension A = Upstream distance*  
*Dimension B = Downstream distance*  
*Dimension C = Cross-sectional dimensions of duct*

Traverse Point	Fraction of Length	Traverse Point Location
1	0.044	7.8 in.
2	0.146	10.9 in.
3	0.296	15.4 in.
4	0.704	27.6 in.
5	0.854	32.1 in.
6	0.956	35.2 in.

\*Accounts for port length of 6.5 inches.

**Figure 4-1. Scrubber Outlet Sampling Location**

## 5. QUALITY ASSURANCE AND QUALITY CONTROL

Field sampling quality assurance for this project included the use of calibrated source sampling equipment, reference test methods, and traceability protocols for recording and calculating data. Analytical quality assurance included use of validated analytical procedures, calibration of analytical instruments, and analysis of audit (control) samples and blanks. Calibration and quality control procedures used for this test program are described below.

All manual stack gas sampling equipment was calibrated before the test program in accordance with the procedures outlined in the *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III*, EPA-600/4-72-027b. Table 5-1 summarizes stack gas sampling equipment calibrations performed for this project. The meter boxes were calibrated after the test.

Table 5-2 lists additional calibration checks performed on the sampling equipment just prior to testing to ensure that equipment was not damaged during transport.

**Table 5-1. Field Equipment Calibration Summary<sup>a</sup>**

<b>Equipment</b>	<b>Calibrated Against</b>	<b>Allowable Error</b>
Method 5 meter box	Reference test meter	Y ±0.02 ΔH ±0.20 post-test Y ±0.05
Fyrite	Certified cylinder gas	±0.5%
Pitot tube	Geometric specifications	See EPA Method 2
Stack Thermocouple	ASTM-3F thermometer	±1.5%
Impinger (or condenser thermocouple)	ASTM-3F	±2°F
Dry gas meter thermocouple	ASTM-3F	±5°F
Probe nozzles	Caliper	High-low 0.004 in.
Barometer	NBS traceable barometer	±0.1 in. Hg

<sup>a</sup>As recommended in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Source-Specific Methods*. EPA-600/4-77-027b, August 1977.

**Table 5-2. Field Checks of Sampling Equipment**

<b>Equipment</b>	<b>Checked Against</b>	<b>Allowable Difference</b>
Pitot tube	Inspection	No visible damage
Thermocouples	ASTM 2F or 3F	±1.5%
Probe nozzles	Caliper	High-low 0.004 in.