Regulatory Information

Permit No.	Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit-to-Install (PTI) No. 120-16
Regulatory Citation	Steel Pickling National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 63. Subpart CCC

Source Information

Source Name	*Source ID*	*Target Parameter*
Steel Pickling Process Line Scrubber	PLTCM	HCl

Contact Information

Test Location
Cleveland-Cliffs
Dearborn Works
4001 Miller Road
Dearborn, MI 48120

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Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

Adam Robinson

Adam Robinson
Alliance Technical Group, LLC

9/20/2022

Date

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Introduction

1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Cleveland-Cliffs Dearborn Works Inc. (Dearborn Works) to conduct compliance testing at the Dearborn, Michigan facility. Portions of the facility are subject to provisions of the Steel Pickling National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 63. Subpart CCC and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit-to-Install (PTI) No. 120-16. Testing was conducted to determine the concentration and emission rate of hydrogen chloride (HCl) from the exhaust of the PLTCM Scrubber.

1.1 Facility Description

The steel pickling process line (EUNPKLLINE) uses hydrochloric acid to remove metal oxides from the steel in order to provide a smooth, clean surface for use as hot roll steel and/or to perform subsequent cold forming operations. The Pickle line consists of four acid tubs in series. Fresh acid is added to the fourth tub and cascades from the fourth tank to the first tank, countercurrent to the direction of travel of the steel. The Pickle line emissions are controlled by a packed bed water scrubber with a rating of 14,125 acfm.

1.2 Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	David Pate
Regulatory Personnel	Regina Angellotti Andrew Riley
Alliance Personnel	Matt McDivitt John Wilson

1.3 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP) submitted to EGLE.

Summary of Results

2.0 Summary of Results

Alliance conducted compliance testing at the Cleveland-Cliffs Dearborn Works facility in Dearborn, MI on August 16, 2022. Testing consisted of determining the concentration and emission rate of HCl at the exhaust of the PLTCM Scrubber.

Table 2-1 provides a summary of the emission testing results with comparisons to the applicable EGLE permit limits. Any difference between the summary results listed in the following table and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of Results

Run Number	Run 1	Run 2	Run 3	Average
Date	**8/16/22**	**8/16/22**	**8/16/22**	**--**
Hydrogen Chloride Data				
Concentration, ppmvd	0.37	2.9	2.8	2.0
Permit Limit, ppmvd	--	--	--	6
Percent of Limit, %	--	--	--	**34**
Emission Rate, lb/hr	0.017	0.12	0.13	0.088

Testing Methodology

3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix D.

Table 3-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 & 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3	Fyrite Analysis
Moisture Content	4	Gravimetric Analysis
Hydrogen Chloride	26A	Isokinetic Sampling

3.1 U.S. EPA Reference Test Methods 1 and 2 – Sampling/Traverse Points and Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-1 in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded during each test run. The data collected was utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

3.2 U.S. EPA Reference Test Method 3 – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3. One (1) integrated Tedlar bag sample was collected during each test run. The bag samples were analyzed on site with a Fyrite O_2/CO_2 analyzer. The Fyrite solutions were verified by conducting a calibration check with EPA Protocol 1 O_2/CO_2 gas. The remaining stack gas constituent was assumed to be nitrogen for the stack gas molecular weight determination.

3.3 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

3.4 U.S. EPA Reference Test Method 26A – Hydrogen Chloride

The hydrogen chloride (HCl) testing was conducted in accordance with U.S. EPA Reference Test Method 26A. The complete sampling system consisted of a teflon nozzle, heated glass-lined probe, heated Teflon filter, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning train consisted of four (4) chilled impingers. The first and second impingers contained 100 mL of 0.1 N H_2SO_4, the third was initially empty and the fourth contained 200-300

grams of silica gel. The probe liner and filter heating systems were maintained at 248-273°F, and the impinger temperature was maintained at 20°C (68°F) or less throughout the testing.

Following the completion of each test run, the sampling train was leak checked at a vacuum pressure greater than or equal to the highest vacuum pressure observed during the run and the contents of the impingers were measured for moisture gain. The absorbing solution (0.1 N H_2SO_4) from the first and second impingers was placed into sample container 3. The back-half of the filter holder, first, second and third impingers and all glassware leading to the outlet of the third impinger were rinsed with de-ionized (DI) water. These rinses were also placed in container 3. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory for analysis.

Appendix A

Alliance SOURCE TESTING

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Run No.: 1
Parameter: HCl

Meter Pressure (Pm), in. Hg

$$Pm = Pb + \frac{\Delta H}{13.6}$$

where,

Pb	30.08	= barometric pressure, in. Hg
ΔH	1.654	= pressure differential of orifice, in H_2O
Pm	30.20	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

$$Ps = Pb + \frac{Pg}{13.6}$$

where,

Pb	30.08	= barometric pressure, in. Hg
Pg	-0.50	= static pressure, in. H_2O
Ps	30.04	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.636 \times Y \times Vm \times Pm}{Tm}$$

where,

Y	1.019	= meter correction factor
Vm	44.017	= meter volume, cf
Pm	30.20	= absolute meter pressure, in. Hg
Tm	537.2	= absolute meter temperature, °R
Vmstd	44.475	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	126	= volume of H_2O collected, ml
Vwstd	5.942	= scf

Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)

$$BWSsat = \frac{10^{6.37-\left(\frac{2,827}{Ts+365}\right)}}{Ps}$$

where,

Ts	122.0	= stack temperature, °F
Ps	30.04	= absolute stack gas pressure, in. Hg
BWSsat	0.121	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

$$BWS = \frac{Vwstd}{(Vwstd + Vmstd)}$$

where,

Vwstd	5.942	= standard wet volume, scf
Vmstd	44.475	= standard meter volume, dscf
BWS	0.118	= dimensionless

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Run No.: 1
Parameter: HCl

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \text{ unless } BWSsat < BWSmsd$$

where,

BWSsat	0.121	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.118	= moisture fraction (measured)
BWS	0.118	

Molecular Weight (DRY) (Md), lb/lb-mole

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O2) + (0.28\,(100 - \%CO_2 - \%O2))$$

where,

CO_2	0.0	= carbon dioxide concentration, %
O_2	20.5	= oxygen concentration, %
Md	28.82	= lb/lb mol

Molecular Weight (WET) (Ms), lb/lb-mole

$$Ms = Md\ (1 - BWS) + 18.015\ (BWS)$$

where,

Md	28.82	= molecular weight (DRY), lb/lb mol
BWS	0.118	= moisture fraction, dimensionless
Ms	27.55	= lb/lb mol

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2})\,avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.840	= pitot tube coefficient
$\Delta P^{1/2}$	0.585	= velocity head of stack gas, $(in.\ H_2O)^{1/2}$
Ts	581.7	= absolute stack temperature, °R
Ps	30.04	= absolute stack gas pressure, in. Hg
Ms	27.55	= molecular weight of stack gas, lb/lb mol
Vs	35.2	= ft/sec

Average Stack Gas Flow at Stack Conditions (Qa), acfm

$$Qa = 60 \times Vs \times As$$

where,

Vs	35.2	= stack gas velocity, ft/sec
As	4.67	= cross-sectional area of stack, ft^2
Qa	9,858	= acfm

Average Stack Gas Flow at Standard Conditions (Qs), dscfm

$$Qs = 17.636 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	9,858	= average stack gas flow at stack conditions, acfm
BWS	0.118	= moisture fraction, dimensionless
Ps	30.04	= absolute stack gas pressure, in. Hg
Ts	581.7	= absolute stack temperature, °R
Qs	7,921	= dscfm

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Run No.: 1
Parameter: HCl

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\frac{\Theta}{Vm} \sqrt{\frac{0.0319 \times Tm \times 29}{\Delta H@ \times \left(Pb + \frac{\Delta Havg.}{13.6} \right) \times Md}} \sqrt{\Delta H}\ avg. \right)}{Y} \times 100$$

where,

Y	1.019	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	44.017	= total meter volume, dcf
Tm	537.2	= absolute meter temperature, °R
ΔH@	1.801	= orifice meter calibration coefficient, in. H_2O
Pb	30.08	= barometric pressure, in. Hg
ΔH avg	1.654	= average pressure differential of orifice, in H_2O
Md	28.82	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.285	= average squareroot pressure differential of orifice, $(in. H2O)^{1/2}$
Yqa	3.2	= dimensionless

Volume of Nozzle (Vn), ft^3

$$Vn = \frac{Ts}{Ps}\left(0.002669 \times Vlc + \frac{Vm \times Pm \times Y}{Tm}\right)$$

where,

Ts	581.7	= absolute stack temperature, °R
Ps	30.04	= absolute stack gas pressure, in. Hg
Vlc	126.0	= volume of H_2O collected, ml
Vm	44.017	= meter volume, cf
Pm	30.20	= absolute meter pressure, in. Hg
Y	1.019	= meter correction factor, unitless
Tm	537.2	= absolute meter temperature, °R
Vn	55.336	= volume of nozzle, ft^3

Isokinetic Sampling Rate (I), %

$$I = \left(\frac{Vn}{\theta \times 60 \times An \times Vs}\right) \times 100$$

where,

Vn	55.336	= nozzle volume, ft3
θ	60.0	= run time, minutes
An	0.00043	= area of nozzle, ft^2
Vs	35.2	= average velocity, ft/sec
I	102.1	= %

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Run No.: 1
Parameter: HCl

Hydrogen Chloride Concentration (C_{HCl}), mg/dscm

$$C_{HCl} = \frac{M_{HCl} \times 35.313}{Vmstd \times 1.0E+03}$$

where,

M_{HCl}	703	= hydrogen chloride mass, ug
Vmstd	44.475	= standard meter volume, dscf
C_{HCl}	0.56	= mg/dscm

Hydrogen Chloride Concentration (C_{HClp}), ppmvd

$$C_{HClp} = \frac{M_{HCl} \times 24.04 \frac{L}{mol}}{MW \times Vmstd \times 28.32}$$

where,

M_{HCl}	703	= hydrogen chloride mass, ug
MW	36.5	= molecular weight, g/g mol
Vmstd	44.475	= standard meter volume, dscf
C_{HClp}	0.37	= ppmvd

Hydrogen Chloride Emission Rate (ER_{HCl}), lb/hr

$$ER_{HCl} = \frac{M_{HCl} \times Qs \times 60 \frac{min}{hr}}{Vmstd \times 4.54\ E+08}$$

where,

M_{HCl}	703	= hydrogen chloride mass, ug
Qs	7,921	= average stack gas flow at standard conditions, dscfm
Vmstd	44.475	= standard meter volume, dscf
ER_{HCl}	0.017	= lb/hr

Appendix B

Alliance SOURCE TESTING

Emission Calculations

Location Cleveland Cliffs Inc. - Dearborn Works
Source PLTCM Scrubber Exhaust
Project No. 2022-2229
Parameter HCl

Run Number		Run 1	Run 2	Run 3	Average
Date		8/16/22	8/16/22	8/16/22	--
Start Time		9:35	11:00	12:40	--
Stop Time		10:46	12:15	13:55	--
Run Time, min	(θ)	60.0	60.0	60.0	60.0
INPUT DATA					
Barometric Pressure, in. Hg	(Pb)	30.08	30.08	30.08	30.08
Meter Correction Factor	(Y)	1.019	1.019	1.019	1.019
Orifice Calibration Value	(ΔH @)	1.801	1.801	1.801	1.801
Meter Volume, ft^3	(Vm)	44.017	42.156	43.727	43.300
Meter Temperature, °F	(Tm)	77.5	85.9	86.0	83.1
Meter Temperature, °R	(Tm)	537.2	545.6	545.7	542.8
Meter Orifice Pressure, in. WC	(ΔH)	1.654	1.513	1.679	1.615
Volume H_2O Collected, mL	(Vlc)	126.0	128.2	134.6	129.6
Nozzle Diameter, in	(Dn)	0.280	0.280	0.280	0.280
Area of Nozzle, ft^2	(An)	0.0004	0.0004	0.0004	0.0004
Hydrogen Chloride Mass, ug	(M_{HCl})	702.8	5,212.0	5,299.7	3,738.2
ISOKINETIC DATA					
Standard Meter Volume, ft^3	(Vmstd)	44.475	41.923	43.496	43.298
Standard Water Volume, ft^3	(Vwstd)	5.942	6.046	6.346	6.111
Moisture Fraction Measured	(BWSmsd)	0.118	0.126	0.127	0.124
Moisture Fraction @ Saturation	(BWSsat)	0.121	0.122	0.129	0.124
Moisture Fraction	(BWS)	0.118	0.122	0.127	0.122
Meter Pressure, in Hg	(Pm)	30.20	30.19	30.20	30.20
Volume at Nozzle, ft^3	(Vn)	55.336	52.694	54.908	54.31
Isokinetic Sampling Rate, (%)	(I)	102.1	102.4	101.9	102.1
DGM Calibration Check Value, (+/- 5%)	(Y_{qa})	3.2	2.8	1.0	2.3
EMISSION CALCULATIONS					
Hydrogen Chloride Concentration, mg/dscm	(C_{HCl})	0.56	4.4	4.3	3.1
Hydrogen Chloride Concentration, ppmvd	(C_{HClp})	0.37	2.9	2.8	2.0
Hydrogen Chloride Emission Rate, lb/hr	(ER_{HCl})	0.017	0.12	0.13	0.088

Alliance SOURCE TESTING

Volumetric Flow Rate Data

Location Cleveland Cliffs Inc. - Dearborn Works
Source PLTCM Scrubber Exhaust
Project No. 2022-2229
Parameter HCl

Run Number		Run 1	Run 2	Run 3	Average
Date		8/16/22	8/16/22	8/16/22	--
Start Time		9:35	11:00	12:40	--
Stop Time		10:46	12:15	13:55	--
Run Time, min		60.0	60.0	60.0	60.0
VELOCITY HEAD, in. WC					
Point 1		0.33	0.33	0.33	0.33
Point 2		0.35	0.33	0.35	0.34
Point 3		0.36	0.36	0.35	0.36
Point 4		0.38	0.35	0.36	0.36
Point 5		0.33	0.31	0.32	0.32
Point 6		0.30	0.29	0.32	0.30
Point 7		0.35	0.33	0.34	0.34
Point 8		0.35	0.35	0.35	0.35
Point 9		0.37	0.31	0.33	0.34
Point 10		0.37	0.28	0.32	0.32
Point 11		0.31	0.22	0.33	0.29
Point 12		0.31	0.22	0.33	0.29
CALCULATED DATA					
Square Root of ΔP, (in. WC)$^{1/2}$	(ΔP)	0.585	0.552	0.579	0.572
Pitot Tube Coefficient	(Cp)	0.840	0.840	0.840	0.840
Barometric Pressure, in. Hg	(Pb)	30.08	30.08	30.08	30.08
Static Pressure, in. WC	(Pg)	-0.50	-0.50	-0.25	-0.42
Stack Pressure, in. Hg	(Ps)	30.04	30.04	30.06	30.05
Stack Cross-sectional Area, ft^2	(As)	4.67	4.67	4.67	4.67
Temperature, °F	(Ts)	122.0	122.5	124.5	123.0
Temperature, °R	(Ts)	581.7	582.2	584.2	582.670
Moisture Fraction Measured	(BWSmsd)	0.118	0.126	0.127	0.124
Moisture Fraction @ Saturation	(BWSsat)	0.121	0.122	0.129	0.124
Moisture Fraction	(BWS)	0.118	0.122	0.127	0.122
O_2 Concentration, %	(O_2)	20.5	20.5	20.5	20.5
CO_2 Concentration, %	(CO_2)	0.0	0.0	0.0	0.0
Molecular Weight, lb/lb-mole (dry)	(Md)	28.82	28.82	28.82	28.82
Molecular Weight, lb/lb-mole (wet)	(Ms)	27.55	27.50	27.44	27.50
Velocity, ft/sec	(Vs)	35.2	33.3	35.0	34.5
VOLUMETRIC FLOW RATE					
At Stack Conditions, acfm	(Qa)	9,858	9,319	9,803	9,660
At Standard Conditions, dscfm	(Qs)	7,921	7,445	7,764	7,710

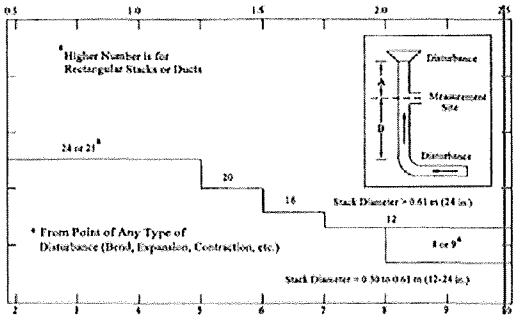
Alliance SOURCE TESTING

Method 1 Data

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Date: MONTROSE MEASUREMENTS FROM 2020

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	36.00	in
Nipple Length:	6.00	in
Depth of Duct:	30.00	in
Width of Duct:	--	in
Cross Sectional Area of Duct:	4.91	ft^2
Equivalent Diameter:	--	in
No. of Test Ports:	2	
Distance A:	30.0	ft
Distance A Duct Diameters:	12.0	(must be > 0.5)
Distance B:	24.7	ft
Distance B Duct Diameters:	9.9	(must be > 2)
Minimum Number of Traverse Points:	12	
Actual Number of Traverse Points:	12	
Number of Readings per Point:	1	



CIRCULAR DUCT

LOCATION OF TRAVERSE POINTS

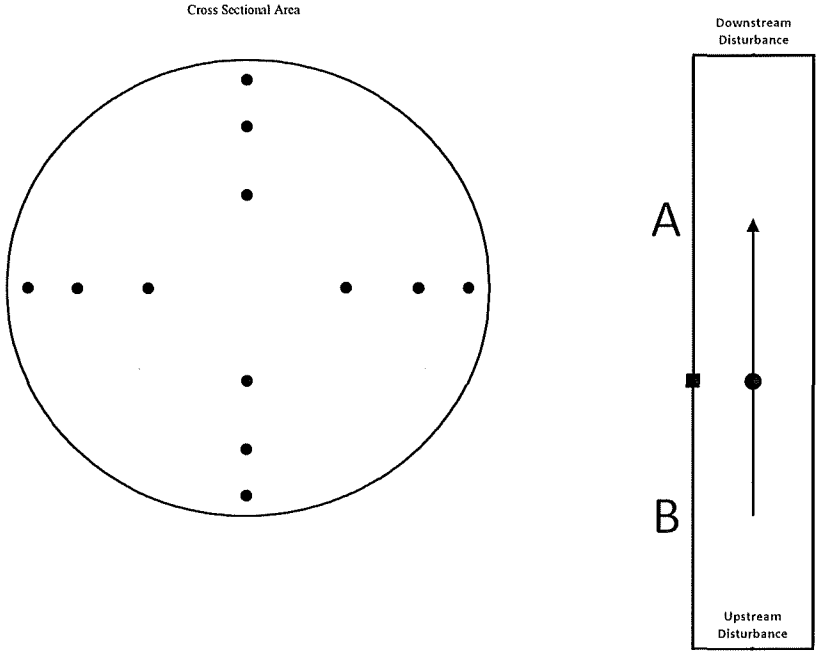
Number of traverse points on a diameter

	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

*Percent of stack diameter from inside wall to traverse point.

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	4.4	1.32	7.32
2	14.6	4.38	10.38
3	29.6	8.88	14.88
4	70.4	21.12	27.12
5	85.4	25.62	31.62
6	95.6	28.68	34.68
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 30 ft.
B = 24.666666
Depth of Duct = 30 in.



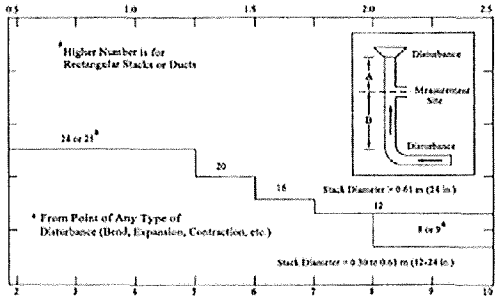
Alliance SOURCE TESTING

Method 1 Data

Location: Cleveland Cliffs Inc. - Dearborn Works
Source: PLTCM Scrubber Exhaust
Project No.: 2022-2229
Date: 08/16/22

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	36.00	in
Nipple Length:	6.75	in
Depth of Duct:	29.25	in
Width of Duct:		in
Cross Sectional Area of Duct:	4.67	ft^2
Equivalent Diameter:	--	in
No. of Test Ports:	2	
Distance A:	30.0	ft
Distance A Duct Diameters:	12.3	(must be > 0.5)
Distance B:	24.7	ft
Distance B Duct Diameters:	10.1	(must be > 2)
Minimum Number of Traverse Points:	12	
Actual Number of Traverse Points:	12	
Number of Readings per Point:	1	
Measurer (Initial and Date):	EW 8/15/2022	
Reviewer (Initial and Date):	GM 8/15/2022	



CIRCULAR DUCT

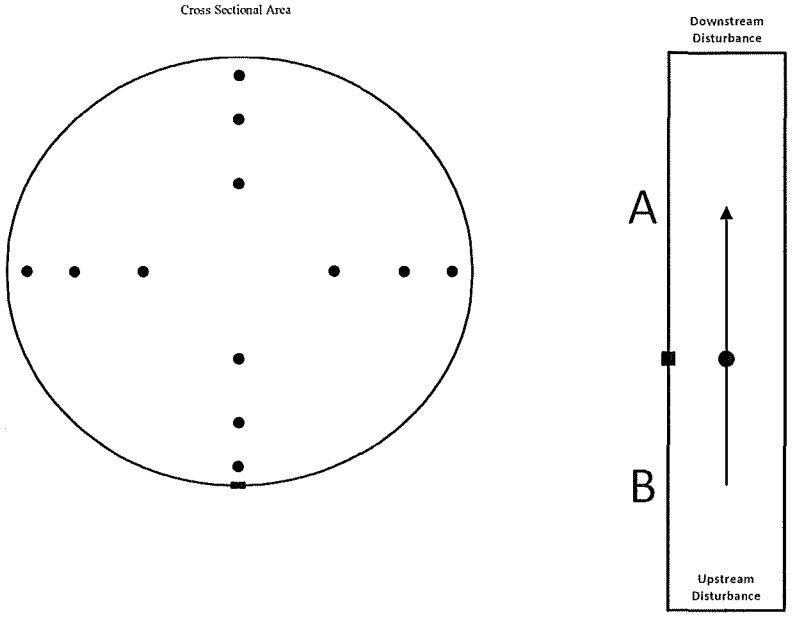
LOCATION OF TRAVERSE POINTS
Number of traverse points on a diameter

	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

*Percent of stack diameter from inside wall to traverse point.

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	4.4	1.29	8.04
2	14.6	4.27	11.02
3	29.6	8.66	15.41
4	70.4	20.59	27.34
5	85.4	24.98	31.73
6	95.6	27.96	34.71
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 30 ft.
B = 24.7 ft.
Depth of Duct = 29.25 in.



Alliance SOURCE TESTING

Cyclonic Flow Check

Location Cleveland Cliffs Inc. - Dearborn Works
Source PLTCM Scrubber Exhaust
Project No. 2022-2229
Date 08/15/22

Sample Point	Angle (ΔP=0)
1	5
2	7
3	7
4	5
5	3
6	3
7	0
8	0
9	4
10	4
11	2
12	1
Average	3

Location Cleveland Cliffs Inc. - Dearborn Works
Source PLTCM Scrubber Exhaust
Project No. 2022-2229
Parameter HCl
Analysis Gravimetric

Run 1	Date:	8/16/22			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	740.9	711.7	653.8	908.9	3015.3
Final Mass, g	830.0	734.7	658.0	918.6	3141.3
Gain	89.1	23.0	4.2	9.7	126.0
Run 2	**Date:**	8/16/22			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	760.1	744.8	537.8	887.0	2929.7
Final Mass, g	857.5	763.3	541.8	895.3	3057.9
Gain	97.4	18.5	4.0	8.3	128.2
Run 3	**Date:**	8/16/22			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	714.8	745.9	659.7	918.4	3038.8
Final Mass, g	818.9	765.3	663.0	926.2	3173.4
Gain	104.1	19.4	3.3	7.8	134.6

Alliance
SOURCE TESTING

Isokinetic Field Data

Location:	Cleveland Cliffs Inc. - Dearborn Works			Start Time:	9:35	Source:	PLTCM Scrubber Exhaust
Date:	8/16/22	Run 1	VALID	End Time:	10:46	Project No.:	2022-2229	Parameter:	HCl

STACK DATA (EST)			EQUIPMENT			STACK DATA (EST)			FILTER NO.	STACK DATA (FINAL)		MOIST. DATA
Moisture:	13.0	% est.	Meter Box ID:	Unit 2051		Est. Tm:	68	°F	NA	Pb:	30.08 in. Hg	Vlc (ml)
Barometric:	29.90	in. Hg	Y:	1.019		Est. Ts:	123	°F		Pg:	-0.50 in. WC	126.0
Static Press:	-0.48	in. WC	ΔH @ (in.WC):	1.801		Est. ΔP:	0.40	in. WC		O_2:	20.5 %	K-FACTOR
Stack Press:	29.86	in. Hg	Probe ID:	PR-404-9		Est. Dn:	0.277	in.		CO_2:	0.0 %	4.740
CO_2:	0.0	%	Liner Material:	glass		Target Rate:	0.75	scfm				
O_2:	21.0	%	Pitot ID:	PR-404-9		LEAK CHECK:	Pre	Mid 1	Mid 2 / Mid 3	Post	Check Pt. Initial / Final / Corr.	
N_2/CO:	79.0	%	Pitot Cp/Type:	0.840	S-type	Leak Rate (cfm):	0.000	--	-- / --	0.002	Mid 1 (cf)	--
Md:	28.84	lb/lb-mole	Nozzle ID:	TF-S03	teflon	Vacuum (in Hg):	10	--	-- / --	8	Mid 2 (cf)	--
Ms:	27.43	lb/lb-mole	Nozzle Dn (in.):	0.280		Pitot Tube:	Pass	--	-- / --	Pass	Mid 3 (cf)	--
											Mid-Point Leak Check Vol (cf):	--

Sample Pt.	Sample Time (minutes) Begin	End	Dry Gas Meter Reading (ft^3)	Pitot Tube ΔP (in WC)	Gas Temperatures (°F) DGM Average Amb.	Stack Amb.	Orifice Press. ΔH (in. WC) Ideal	Actual	Pump Vac (in. Hg)	Gas Temperatures (°F) Probe Amb.	Filter Amb.	Imp Exit Amb.	Aux Amb.	% ISO	Vs (fps)
A-1	0.00	5.00	950.159	0.33	70	124	1.57	1.55	2	258	263	67	-	101.7	34.82
A-2	5.00	10.00	953.660	0.35	71	124	1.67	1.70	3	256	262	64	-	103.9	35.86
A-3	10.00	15.00	957.350	0.36	73	125	1.72	1.70	2	254	259	56	-	101.6	36.40
A-4	15.00	20.00	961.020	0.38	74	124	1.82	1.80	2	254	261	57	-	100.2	37.37
A-5	20.00	25.00	964.750	0.33	76	120	1.60	1.60	2	260	261	53	-	107.3	34.70
A-6	25.00	30.00	968.500	0.30	78	115	1.47	1.50	2	253	263	52	-	103.0	32.94
B-1	30.00	35.00	971.960	0.35	78	121	1.70	1.70	2	253	264	55	-	110.9	35.77
B-2	35.00	40.00	975.960	0.35	80	123	1.70	1.70	2	252	263	57	-	99.2	35.83
B-3	40.00	45.00	979.547	0.37	81	121	1.80	1.80	2	255	261	52	-	105.5	36.78
B-4	45.00	50.00	983.480	0.37	82	122	1.80	1.80	3	257	263	52	-	99.6	36.81
B-5	50.00	55.00	987.200	0.31	83	122	1.51	1.50	3	254	260	54	-	102.2	33.69
B-6	55.00	60.00	990.700	0.31	84	123	1.51	1.50	2	252	263	56	-	101.4	33.72
	Final DGM:		994.176												

RESULTS	Run Time		Vm		ΔP		Tm		Ts		Max Vac	ΔH		%ISO	BWS	Y_{qa}
	60.0	min	44.017	ft^3	0.34	in. WC	77.5	°F	122.0	°F	3	1.654	in. WC	102.1	0.118	3.2

Alliance SOURCE TESTING

Isokinetic Field Data

Location: Cleveland Cliffs Inc. - Dearborn Works | Start Time: 11:00 | Source: PLTCM Scrubber Exhaust
Date: 8/16/22 | Run 2 | VALID | End Time: 12:15 | Project No.: 2022-2229 | Parameter: HCl

STACK DATA (EST)			EQUIPMENT			STACK DATA (EST)			FILTER NO.	STACK DATA (FINAL)		MOIST. DATA
Moisture:	13.0	% est.	Meter Box ID:	Unit 2051		Est. Tm:	78	°F	NA	Pb:	30.08	in. Hg	Vlc (ml)
Barometric:	29.90	in. Hg	Y:	1.019		Est. Ts:	122	°F		Pg:	-0.50	in. WC	128.2
Static Press:	-0.48	in. WC	ΔH @ (in.WC):	1.801		Est. ΔP:	0.34	in. WC		O_2:	20.5	%	K-FACTOR
Stack Press:	29.86	in. Hg	Probe ID:	PR-404-9		Est. Dn:	0.252	in.		CO_2:	0.0	%	4.83
CO_2:	0.0	%	Liner Material:	glass		Target Rate:	0.59	scfm				Check Pt.	Initial	Final	Corr.
O_2:	21.0	%	Pitot ID:	PR-404-9		LEAK CHECK!	Pre	Mid 1	Mid 2	Mid 3	Post	Mid 1 (cf)			--
N_2/CO:	79.0	%	Pitot Cp/Type:	0.840	S-type	Leak Rate (cfm):	0.005	--	--	--	0.001	Mid 2 (cf)			--
Md:	28.84	lb/lb-mole	Nozzle ID:	TF-503	teflon	Vacuum (in Hg):	10	--	--	--	7	Mid 3 (cf)			--
Ms:	27.43	lb/lb-mole	Nozzle Dn (in.):	0.280		Pitot Tube:	Pass	--	--	--	Pass	Mid-Point Leak Check Vol (cf):			--

Sample Pt.	Sample Time (minutes) Begin	End	Dry Gas Meter Reading (ft^3)	Pitot Tube ΔP (in WC)	Gas Temperatures (°F) DGM Average Amb.	Stack Amb.	Orifice Press. ΔH (in. WC) Ideal	Actual	Pump Vac (in. Hg)	Gas Temperatures (°F) Probe Amb.	Filter Amb.	Imp Exit Amb.	Aux Amb.	% ISO	Vs (fps)
A-1	0.00	5.00	994.444	0.33	80	123	1.60	1.60	2	258	260	66	-	101.6	34.79
A-2	5.00	10.00	998.010	0.33	85	122	1.62	1.60	2	253	261	66	-	101.2	34.76
A-3	10.00	15.00	1001.600	0.36	87	124	1.76	1.75	2	255	260	58	-	99.7	36.37
A-4	15.00	20.00	1005.300	0.35	87	123	1.72	1.75	2	263	264	55	-	101.0	35.83
A-5	20.00	25.00	1009.000	0.31	88	124	1.52	1.55	2	255	262	55	-	100.0	33.75
A-6	25.00	30.00	1012.450	0.29	88	122	1.43	1.45	2	250	260	52	-	102.9	32.59
B-1	30.00	35.00	1015.890	0.33	85	124	1.61	1.60	2	252	263	58	-	105.9	34.82
B-2	35.00	40.00	1019.640	0.35	85	123	1.71	1.70	2	251	262	56	-	103.0	35.83
B-3	40.00	45.00	1023.400	0.31	87	124	1.52	1.55	2	255	261	54	-	102.2	33.75
B-4	45.00	50.00	1026.920	0.28	87	123	1.38	1.40	2	260	261	50	-	106.2	32.05
B-5	50.00	55.00	1030.400	0.22	86	118	1.09	1.10	1	269	264	50	-	102.9	28.28
B-6	55.00	60.00	1033.400	0.22	86	120	1.09	1.10	1	260	262	51	-	110.0	28.33
	Final DGM:		1036.600												

RESULTS	Run Time	Vm	ΔP	Tm	Ts	Max Vac	ΔH	%ISO	BWS	Y_{qa}
	60.0 min	42.156 ft^3	0.31 in. WC	85.9 °F	122.5 °F	2	1.513 in. WC	102.4	0.122	2.8

Alliance SOURCE TESTING

Isokinetic Field Data

Location:	Cleveland Cliffs Inc. - Dearborn Works			Start Time:	12:40	Source:	PLTCM Scrubber Exhaust
Date:	8/16/22	Run 3	VALID	End Time:	13:55	Project No.:	2022-2229	Parameter:	HCl

STACK DATA (EST)			EQUIPMENT			STACK DATA (EST)			FILTER NO.		STACK DATA (FINAL)			MOIST. DATA
Moisture:	12.0	% est.	Meter Box ID:	Unit 2051		Est. Tm:	86	°F	NA		Pb:	30.08	in. Hg	Vlc (ml)
Barometric:	29.90	in. Hg	Y:	1.019		Est. Ts:	123	°F			Pg:	-0.25	in. WC	134.6
Static Press:	-0.48	in. WC	ΔH @ (in.WC):	1.801		Est. ΔP:	0.31	in. WC			O_2:	20.5	%	K-FACTOR
Stack Press:	29.86	in. Hg	Probe ID:	PR-404-9		Est. Dn:	0.256	in.			CO_2:	0.0	%	4.998
CO_2:	0.0	%	Liner Material:	glass		Target Rate:	0.59	scfm				Check Pt.	Initial	Final	Corr.
O_2:	21.0	%	Pitot ID:	PR-404-9		LEAK CHECKS	Pre	Mid 1	Mid 2	Mid 3	Post	Mid 1 (cf)			--
N_2/CO:	79.0	%	Pitot Cp/Type:	0.840	S-type	Leak Rate (cfm):	0.002	--	--	--	0.001	Mid 2 (cf)			--
Md:	28.84	lb/lb-mole	Nozzle ID:	TF-503	teflon	Vacuum (in Hg):	10	--	--	--	5	Mid 3 (cf)			--
Ms:	27.54	lb/lb-mole	Nozzle Dn (in.):	0.280		Pitot Tube:	Pass	--	--	--	Pass	Mid-Point Leak Check Vol (cf):			--

Sample Pt.	Sample Time (minutes)		Dry Gas Meter Reading (ft^3)	Pitot Tube ΔP (in WC)	Gas Temperatures (°F)		Orifice Press. ΔH (in. WC)		Pump Vac (in. Hg)	Gas Temperatures (°F)				% ISO	Vs (fps)
					DGM Average	Stack				Probe	Filter	Imp Exit	Aux		
	Begin	End			Amb.	Amb.	Ideal	Actual		Amb.	Amb.	Amb.	Amb.		
					--	--				--	--	--	--		
A-1	0.00	5.00	36.786	0.33	83	124	1.64	1.65	3	259	262	65	-	100.1	34.75
A-2	5.00	10.00	40.350	0.35	80	125	1.72	1.75	3	259	262	55	-	109.8	35.82
A-3	10.00	15.00	44.350	0.35	87	125	1.75	1.75	3	257	263	46	-	100.5	35.82
A-4	15.00	20.00	48.060	0.36	87	126	1.79	1.80	3	260	262	46	-	94.7	36.36
A-5	20.00	25.00	51.600	0.32	88	126	1.60	1.60	3	255	266	46	-	101.3	34.28
A-6	25.00	30.00	55.180	0.32	88	125	1.60	1.60	3	255	262	46	-	100.2	34.25
B-1	30.00	35.00	58.725	0.34	83	123	1.69	1.70	3	261	263	45	-	101.6	35.24
B-2	35.00	40.00	62.400	0.35	85	124	1.74	1.75	3	256	264	47	-	103.5	35.79
B-3	40.00	45.00	66.210	0.33	87	124	1.65	1.65	3	256	262	47	-	105.7	34.75
B-4	45.00	50.00	70.000	0.32	88	124	1.60	1.60	3	262	262	47	-	94.1	34.22
B-5	50.00	55.00	73.330	0.33	88	124	1.65	1.65	3	258	263	48	-	99.1	34.75
B-6	55.00	60.00	76.890	0.33	88	124	1.65	1.65	3	262	262	50	-	100.8	34.75
	Final DGM:		80.513												

RESULTS	Run Time		Vm		ΔP		Tm		Ts		Max Vac	ΔH		%ISO	BWS	Y_q
	60.0	min	43.727	ft^3	0.34	in. WC	86.0	°F	124.5	°F	3	1.679	in. WC	101.9	0.127	1.0