TEST REPORT

EMISSION TEST PROGRAM
BOF SLAG SKIMMER BAGHOUSE EXHAUST

UNITED STATES STEEL CORPORATION
GRANITE CITY, ILLINOIS

PREPARED FOR:

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ARI Project No. 436-173 Revision 1
ARI Proposal No. 23509 Revision 1
Test Dates: September 29 through October 1, 2009

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REPORT CERTIFICATION

STATEMENT OF CONFORMANCE AND TEST REPORT CERTIFICATION

I certify, to the best of my knowledge, that this test program was conducted in a manner conforming to the criteria set forth in ASTM D 7036-04: Standard Practice for Competence of Air Emission Testing Bodies, and that project management and supervision of all project related activities were performed by qualified individuals as defined by this practice.

I further certify that this test report and all attachments were prepared under my direction or supervision in accordance with the ARI Environmental, Inc. quality management system designed to ensure that qualified personnel gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed the sampling and analysis relating to this performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete.

Jerry Bovee, QSTI
Senior Project Manager, Source Testing Division
ARI Environmental, Inc.

Hank Taylor
Quality Assurance Manager, Source Testing Division
ARI Environmental, Inc.

SECTIONONE Introduction and Summary

ARI Environmental, Inc. (ARI) was retained by United States Steel Corporation (US Steel) to conduct an emission test program on the Basic Oxygen Furnace (BOF) Slag Skimmer Baghouse exhaust stack at their facility in Granite City, Illinois.

The test program was conducted to determine the concentration and emission rate of particulate matter (PM) from the BOF Slag Skimmer Baghouse Exhaust.

Testing was conducted during the slag skimming operation on September 29 through October 1, 2009 as follows:

Test Run No.	Test Date	Test Run Duration
1	9/29/09	96 minutes
2	9/30/09	72 minutes
3	10/1/09	72 minutes

Testing procedures and sampling methodologies were conducted following the procedural requirements as detailed in the Code of Federal Regulations, Title 40 (40 CFR), Part 60, Appendix A, USEPA Methods 1-5; and the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods.

Mr. Michael McLean of US Steel coordinated the test program and monitored all pertinent process operations during the test program. Messrs. Matt Badertscher, Jerry Bovee and Bill Flaherty of ARI performed the testing. Mr. Jeff Benbenek of the Illinois Environmental Protection Agency witnessed the test program.

This report summarizes the test procedures and results of this test program. Included as appendices are complete documentation of all calculation summaries, field data, laboratory data, test equipment calibration data and test program qualifications.

A summary of the test results is presented below:

TEST RUN :	1	2	3	
TEST DATE :	9/29/09	9/30/09	10/1/09	
TEST TIME :	08:59-17:15	06:41-17:41	06:30-19:43	Average
Particulate Matter				
Concentration, gr/dscf	0.001	0.001	0.001	0.001
Emission Rate, lb/hr	0.75	0.55	0.71	0.67

SECTION TWO Testing and Analytical Procedures

2.1 OVERVIEW

One (1) 96-minute test repetition and two (2) 72-minute test repetitions were performed at the BOF Slag Skimmer Baghouse exhaust stack during the slag skimming operation.

2.2 METHODOLOGY

Testing procedures and sampling methodologies were conducted following the procedural requirements as detailed in 40 CFR, Part 60, Appendix A, USEPA Methods 1-5; and the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods.

2.2.1 Sampling Location (USEPA Method 1)

The sampling location met the minimum USEPA Method 1 requirements for location upstream and downstream of flow disturbances or duct geometry changes. The velocity sampling points were determined following USEPA Method 1. As shown in Figure 2-1, the sampling location and number of velocity sampling points were as follows:

Test Location	Duct Diameter (inches)	No. Ports	No. Downstream Diameters from Flow Disturbance	No. Upstream Diameters from Flow Disturbance	Sampling Points per Port	Total Points
BOF Slag Skimmer Baghouse	73.5	2	6.5	4.1	8	16

2.2.2 Velocity and Volumetric Flow Rate (USEPA Method 2)

Stack gas velocity and volumetric flow rate were determined following USEPA Method 2. Velocity traverses were made with a Type "S" pitot tube and a Dwyer inclined oil manometer. Temperature measurements were conducted using a Chromel-Alumel thermocouple connected to a digital direct read-out potentiometer.

2.2.3 CO_2, O_2 and Stack Gas Molecular Weight Determination (USEPA Method 3A)

The stack gas molecular weight was determined following calculations presented in USEPA Method 3A. Gas samples were collected in 16-liter Tedlar bags using ARI's integrated bag collection system. The samples were analyzed for oxygen (O_2) and carbon dioxide (CO_2) concentration using a Servomex Model 1440 combination paramagnetic O_2 and non-dispersive infrared CO_2 analyzer.

2.2.4 Moisture Content (USEPA Method 4)

Moisture sampling was conducted following USEPA Method 4 procedures and combined with the USEPA Method 5 sampling train.

SECTIONTWO Testing and Analytical Procedures

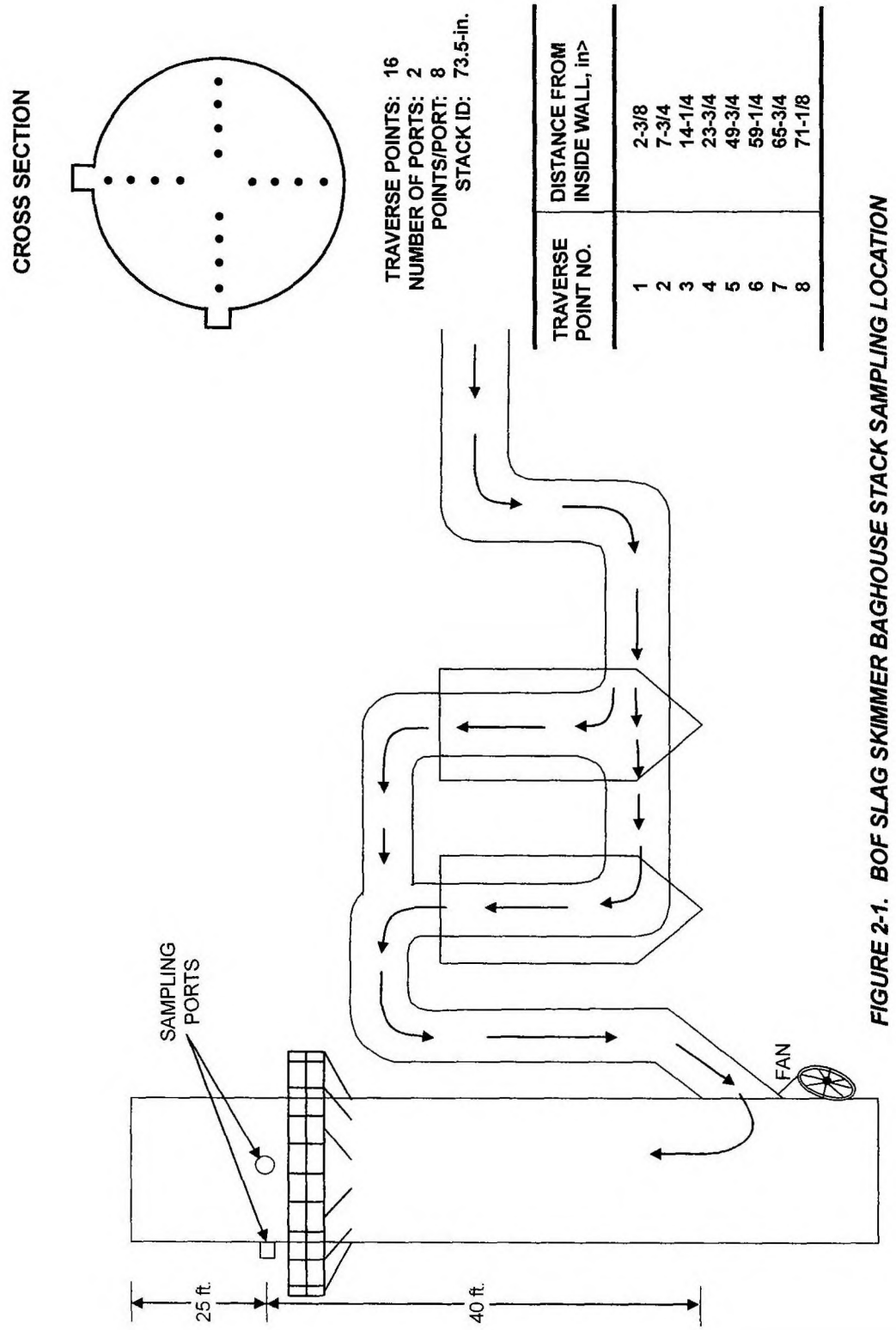


FIGURE 2-1. BOF SLAG SKIMMER BAGHOUSE STACK SAMPLING LOCATION

2.2.5 Particulate Matter Determination (USEPA Method 5)

PM was determined following the procedures described in USEPA Method 5 - Determination of Particulate Emissions from Stationary Sources.

2.2.5.1 Sampling Apparatus

The particulate sampling train met design specifications established by the USEPA. Assembled by ARI personnel, it consisted of the following:

- Nozzle - Stainless steel (316) with sharp, tapered leading edge.
- Probe - Borosilicate glass with a heating system capable of maintaining a probe exit temperature of 248°F ±25°F.
- Pitot Tube - Type-S, attached to probe for monitoring stack gas velocity.
- Filter Holder - Borosilicate glass with a glass frit filter support and a silicone rubber gasket. The holder design provides a positive seal against leakage from the outside or around the filter. The filter holder was heated to 248°F ±25°F.
- Draft Gauge - Inclined manometer with a readability of 0.01-in. H_2O in the 0- to 10-in. range.
- Impingers – Four (4) impingers connected in series with glass ball joints. The first, third and fourth were of the Greenburg-Smith design, but modified by replacing the standard tip with a ½-in.-i.d. glass tube extending to within ½-in. of the bottom of the impinger flask. The second was of the Greenburg-Smith design with a standard tip.
- Metering System - Apex Model 522. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with ±2 percent accuracy, and related equipment as required to maintain an isokinetic sampling rate and to determine sample volume.
- Barometer - Mercury barometer capable of measuring atmospheric pressure to within ±0.1-in.Hg.

2.2.5.2 Sampling Procedure

The minimum number and location of traverse points were selected based on USEPA Method 1 procedures. Stack pressure, temperature and the range of velocity heads were measured according to procedures described in USEPA Method 2. The stack gas molecular weight and moisture content, needed to set isokinetic sampling rates, were assumed based on knowledge of the process.

The sampling train was then prepared by calculating and selecting a proper nozzle size, selecting a probe of adequate length, charging the filter holder with a pre-tared, USEPA Method 5 compliant glass fiber filter and assembling the impinger train. The first and second impingers contained one hundred milliliters (mL) of deionized/distilled water; the third impinger was initially empty; and the fourth impinger contained 200 g of silica gel. The train was set up with the probe, heated filter holder and impingers as shown in Figure 2-2. The impingers were placed in an insulated sampling bucket and ice water bath to reduce the sample gas temperature to ≤68°F upon exiting the last impinger during sampling.

SECTIONTWO Testing and Analytical Procedures

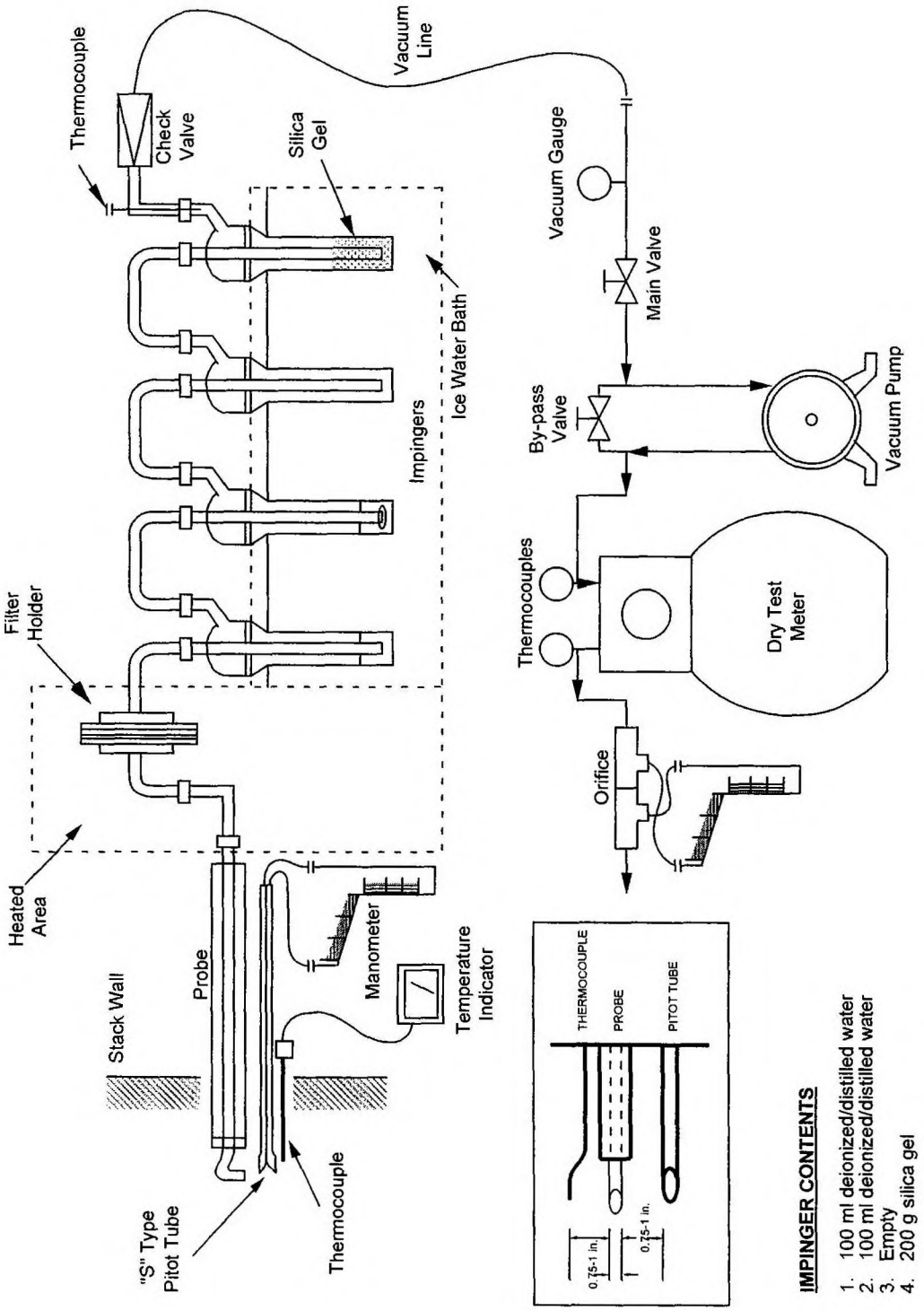


FIGURE 2-2. USEPA METHOD 5 PARTICULATE MATTER SAMPLING TRAIN

SECTIONTWO Testing and Analytical Procedures

The sampling train was leak-checked at the sampling site by plugging the inlet to the nozzle and pulling a vacuum of 15-in. Hg. Leakage rates of less than 0.02 ft^3/min, at a vacuum of 15-in. Hg were considered acceptable. At the completion of each test run, the sampling train was again leak-checked by the same procedure, but at 2-in. Hg above the highest vacuum attained during the test run. Both pre- and post-test leak checks of the pitot tube and lines were made for each test run. These checks were made by blowing into the impact opening of the pitot tube until 3 or more inches of water column was achieved on the manometer and then capping the impact opening. The leak check was considered successful if the manometer level held steady for more than 15 seconds. The static pressure side of the pitot tube was leak-checked by the same procedure, except suction was used to obtain the 3-in. H_2O manometer reading.

During sampling the probe and glass-fiber filter temperatures were maintained at 248°F ±25°F. Stack gas and sampling train data were recorded at specified intervals. Isokinetic sampling rates were set throughout the sampling period with the aid of a programmable calculator.

2.2.5.3 Sample Recovery Procedure

After sampling was completed, the sampling train was moved carefully from the test site to the cleanup area. The sample fractions were recovered as follows:

Container 1 - The filter was removed from its holder, placed in a petri dish, and sealed.

Container 2 - An unused filter was taken as a blank.

Container 3 - Loose particulate and acetone washings from all sample-exposed surfaces prior to the filter were placed in a glass jar, sealed and labeled. Particulate was removed from the probe with the aid of a brush and acetone rinsing. The liquid level was marked after the container was sealed.

Container 4 - A minimum of 200 mL of acetone was taken for the blank analysis. The blank was obtained and treated in a similar manner as the contents of Container 3.

Contents of impingers 1-3 were measured for volume and then discarded. Impinger 4 contents (silica gel) were placed in a polyethylene bottle for subsequent weighing to the nearest 0.5 gram.

2.2.5.4 Analytical Procedure

The analytical procedures followed those described in USEPA Method 5.

Container No. 1 - The filter and any loose PM from this sample container were placed in a tared glass weighing dish, desiccated for 24 hours to a constant weight and weighed to the nearest 0.1 mg. Container No. 2 was analyzed in the same manner.

Container No. 3 - The acetone washings were transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure. Then the contents were desiccated for 24 hours and weighed to a constant weight to the nearest 0.1 mg. Container No. 4 was analyzed in the same manner.

SECTIONTWO Testing and Analytical Procedures

The filter and acetone blanks were analyzed in the same way as their respective sample fractions.

The term "constant weight" means a difference of no more than 0.5 mg or 1 percent of the total weight less tare weight, whichever is greater between two consecutive readings, with no less than 6 hours of desiccation between weighings.

SECTIONTHREE Process Description

Iron ore is converted to molten iron in the "A" and "B" Blast Furnaces. Iron ore, coke and a variety of fluxes (collectively called the burden) are charged into the top of the furnace, while heated air is blown up through the burden at high velocity. Molten iron and slag accumulates in the bottom of the furnace, where a taphole is drilled. The molten iron and slag pours out of the furnace into a trough, where the slag is separated from the iron. The iron moves down the runners until it pours into torpedo cars. From here, the iron is taken to the Basic Oxygen Furnace (BOF), where it is converted into steel. The slag travels down a separate runner and dumps into the slag pits. The molten slag is quenched with a mixture of water and potassium permanganate solution.

Molten iron from the blast furnaces is transported to the BOF by torpedo cars. The iron is then transferred to the charging ladles and the reladling station. In the desulfurization stations a combination of lime and magnesium is injected into the molten iron to remove the sulfur. The sulfur reacts with the lime and magnesium and forms a layer of slag on the surface of the iron. A collection system routing emissions to a baghouse is used to control emissions of particulate matter from these stations.

After the molten iron is desulfurized it is moved to the slag skimming station where a mechanical arm is used to scrape slag from the surface of the iron. This slag is scraped from the iron ladles and into slag pots. A collection system routing emissions to the Slag Skimming Baghouse is used to control emissions from this process.

SECTIONFOUR Test Results

The results of the emission compliance test program are presented in Table 4-1.

Appendix A presents the calculation summaries. Appendix B presents all raw field data. Laboratory data are presented in Appendix C. All calibration data are presented in Appendix D. The test program qualifications are presented in Appendix E.

TABLE 4-1. BOF SLAG SKIMMER BAGHOUSE EXHAUST TEST RESULTS SUMMARY

COMPANY	:	US Steel			
LOCATION	:	Granite City, Illinois			
SOURCE	:	BOF Slag Skimmer Baghouse			
OPERATORS	:	M. Badertscher, J. Bovee, B. Flaherty			
RUN NO.	:	1	2	3	
TEST DATE	:	9/29/09	9/30/09	10/1/09	
TEST TIME	:	08:59-17:15	06:41-17:41	06:30-19:43	Average
Stack Gas Parameters					
Temperature, °F		98.31	92.9	87.8	93.0
Velocity, av. ft/sec		61.08	61.62	63.72	62.14
Volumetric flow, acfm		107,979	108,938	112,658	109,858
Volumetric flow, scfh		6,151,928	6,267,337	6,469,821	6,296,362
Volumetric flow, dscfh		6,049,947	6,163,443	6,351,197	6,188,196
Moisture, av. % vol		1.66	1.83	1.48	1.66
Carbon Dioxide, av. % vol		0.16	0.14	0.14	0.15
Oxygen, av. % vol		20.33	20.29	20.28	20.30
Particulate Matter (PM)					
Sample Volume, dscf		61.712	72.833	74.810	
Isokinetic Ratio, %		106.3	105.3	104.4	
Total particulate, mg		3.5	3.0	3.8	
Concentration					
grains/dscf		0.001	0.001	0.001	0.001
x 10^{-6} lb/dscf		0.125	0.090	0.112	0.109
Emission Rate					
lb/hr		0.75	0.55	0.71	0.67

APPENDIX A

Calculation Summaries

Company	:	USS GCW			
Location	:	Granite City, IL			
Source	:	Slag Skimmer Baghouse			
Operators	:	J. Bovee; M. Badertscher; B. Flaherty			
Test Run	:	1	2	3	
Test Date	:	9/29/2009	9/30/2009	10/1/2009	
Test Time	:	8:59 - 17:15	6:41 - 17:41	6:30 - 19:43	Average
STACK GAS					
Temperature, av. °F		98.31	92.9	87.8	93.0
Velocity, av. ft/sec		61.08	61.62	63.72	62.14
Volume flow, acfm		107,979	108,938	112,658	109,858
Volume flow, scfh		6,151,928	6,267,337	6,469,821	6,296,362
Volume flow, dscfh		6,049,947	6,163,443	6,351,197	6,188,196
Moisture, av. % vol		1.66	1.83	1.48	1.66
CO_2, av. % vol, db		0.16	0.14	0.14	0.15
O_2, av. % vol, db		20.33	20.29	20.28	20.30
PARTICULATE MATTER					
Sample Volume, dscf		61.712	72.833	74.810	
% Isokinetic		106.3	105.3	104.4	
Total Particulate, mg		3.5	3.0	3.8	
Total Concentration					
gr/dscf		0.001	0.001	0.001	0.001
lb/dscf x 10^{-6}		0.125	0.090	0.112	0.109
Total Emission rate					
lb/hr		0.75	0.55	0.71	0.67

ARI ENVIRONMENTAL, INC.
FLOW RATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
RUN NUMBER: 1
SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/29/2009

BAROMETRIC:	30.13 **in. Hg**	**STACK DIAM:**	73.5 **inches**
STATIC PRES:	-1.2 **in.H_2O**	**CO_2:**	0.16 **% by volume**
STACK TEMP:	98.31 **°F**	**O_2:**	20.33 **% by volume**
SQ.RT ΔP:	1.0562 **in.H_2O**		

DRY MOLECULAR WEIGHT OF STACK GAS

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO)$$ = 28.84 **lb/lb-mole**

MOLECULAR WEIGHT OF STACK GAS, wet basis

$$M_s = M_d(1 - B_{ws}) + 18B_{ws}$$ = 28.66 **lb/lb-mole**

PITOT TUBE COEFFICIENT

C_p (from calibration curve or geometric specifications) = 0.84

AVERAGE VELOCITY HEAD OF STACK GAS, in. H_2O

$$\overline{\sqrt{\Delta P}} = \frac{1}{n}\sum_{i=1}^{n}\sqrt{\Delta p}$$ = 1.0562 **in. H_2O**

AVERAGE ABSOLUTE STACK GAS TEMPERATURE

T_s = 98.3 °F + 460 = 558.3 **°R**

ABSOLUTE STACK GAS PRESSURE

$$P_s = P_{bar} + \frac{P_{static}}{13.6}$$ = 30.04 **in.Hg**

STACK GAS VELOCITY

$$V_s = (85.49)(C_p)\left(\text{avg}\sqrt{\Delta P}\right)\sqrt{\frac{T_s}{(P_s)(M_s)}}$$ = 61.078 **ft/sec**

STACK GAS VOLUMETRIC FLOW RATE, actual

$$Q_s = 60 \times V_s \times A_s$$ = 107,979 **acfm**

Stack Area = 29.4647 ft^2

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, wet basis

$$Q_{stdw} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)$$ = 102,532.1 **scfm, wb**
6,151,928 **scfh, wb**

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, dry basis

$$Q_{std} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)(1 - B_{ws})$$ = 100,832.5 **dscfm**
6,049,947 **dscfh**

ARI ENVIRONMENTAL, INC.
MOISTURE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/29/2009
RUN NUMBER: 1

γ FACTOR:	0.995	**STACK DIAM:**	73.5 **inches**
BAROMETRIC:	30.13 **in. Hg**	**METER VOLUME:**	61.782 **ft^3**
STATIC PRES:	-1.20 **in.H_2O**	**METER TEMP:**	71.3 **°F**
STACK TEMP:	98.3 **°F**	**LIQUID COLL:**	22.1 **milliliters**
SQ.RT ΔP:	1.0562 **in.H_2O**	**CO_2:**	0.16 **% by volume**
ΔH:	1.28 **in.H_2O**	**O_2:**	20.33 **% by volume**

ENGLISH UNITS
(29.92 in.Hg & 68 °F)

VOLUME OF SAMPLE
@ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right] = 61.712 \text{ dscf}$$

γ = 0.995

VOLUME OF WATER IN SAMPLE
@ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc} = 1.040 \text{ scf}$$

V_{lc} = 22.1 mL

FRACTIONAL MOISTURE CONTENT OF STACK GAS AS MEASURED

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} = 0.0166$$

FRACTIONAL MOISTURE CONTENT OF STACK GAS @ SATURATION

$$MF = \frac{\left(10^{\left[8.361 - \left(\frac{1893.5}{T - 27.65}\right)\right]}\right) - 0.5}{P} = 0.058$$

T = 309.8 °K
P = 763.1 mmHg

FRACTIONAL MOISTURE CONTENT USED IN CALCULATIONS

B_{ws} = 0.0166

ARI ENVIRONMENTAL, INC.
TOTAL PARTICULATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/29/2009
RUN NUMBER: 1

INPUT

Vm:	61.782	**ft3**	**Qs:**	100,832	**dscfm**
γ FACTOR:	0.995		**Ts:**	98.31	**°F**
Pbar:	30.13	**in.Hg**	**Runtime:**	96	**minutes**
ΔH:	1.28	**in.H2O**	**Vs:**	61.078	**ft/sec**
Tm:	71.3	**°F**	**Ps:**	30.04	**in.Hg**
Vlc:	22.1	**mL**	**Noz. diam:**	0.18	**inches**
Filter:	0.65	**mg**			
Probe Wash:	2.84	**mg**	**ENGLISH UNITS**		
Total:	3.49	**mg**	**(29.92 in.Hg & 68 °F)**		

VOLUME OF SAMPLE @ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$ = 61.712 **dscf**

γ = 0.995

VOLUME OF WATER IN SAMPLE @ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc}$$ = 1.040 **scf**

FRACTIONAL MOISTURE CONTENT OF STACK GAS

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} \times 100$$ = 1.66 **%**

PARTICULATE CONCENTRATION IN STACK GAS ON A DRY BASIS

$$C_s = (0.01543)\left(\frac{M_n}{V_{mstd}}\right)$$ Total = 0.0008726 **gr/dscf**

$$C_s' = \left(2.205 \times 10^{-6}\right)\left(\frac{M_n}{V_{mstd}}\right)_{/dscf})(Q_{std})$$ C's Total = 0.12470 **x 10-6 lbs/dscf**

EMISSION RATE

$$pmr = \left(\frac{C_s}{7000}\right)(Q_{std})(60)$$ Total = 0.75418 **lbs/hr**

ISOKINETIC SAMPLING RATE

$$\%ISO = \frac{(100)(T_s)\left[(0.002669 \times V_{lc}) + \left(\frac{V_m}{T_m}\right)(\gamma)\left(P_{bar} + \left(\frac{\Delta H}{13.6}\right)\right)\right]}{(60)(\theta)(V_s)(P_s)(A_n)}$$ = 106.30 **% I**

An = 0.00017671 ft2 Runtime = 96 minutes

ARI ENVIRONMENTAL, INC.
FLOW RATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
RUN NUMBER: 2

SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/30/2009

BAROMETRIC:	30.13 **in. Hg**	**STACK DIAM:**	73.5 **inches**
STATIC PRES:	-1.2 **in.H_2O**	**CO_2:**	0.14 **% by volume**
STACK TEMP:	92.9 **°F**	**O_2:**	20.29 **% by volume**
SQ.RT ΔP:	1.0707 **in.H_2O**		

DRY MOLECULAR WEIGHT OF STACK GAS

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO)$$ = 28.83 **lb/lb-mole**

MOLECULAR WEIGHT OF STACK GAS, wet basis

$$M_s = M_d(1 - B_{ws}) + 18B_{ws}$$ = 28.65 **lb/lb-mole**

PITOT TUBE COEFFICIENT

C_p (from calibration curve or geometric specifications) = 0.84

AVERAGE VELOCITY HEAD OF STACK GAS, in. H_2O

$$\overline{\sqrt{\Delta P}} = \frac{1}{n}\sum_{i=1}^{n}\sqrt{\Delta p}$$ = 1.0707 **in. H_2O**

AVERAGE ABSOLUTE STACK GAS TEMPERATURE

T_s = 92.9 °F + 460 = 552.9 **°R**

ABSOLUTE STACK GAS PRESSURE

$$P_s = P_{bar} + \frac{P_{static}}{13.6}$$ = 30.04 **in.Hg**

STACK GAS VELOCITY

$$V_s = (85.49)(C_p)(\text{avg}\sqrt{\Delta P})\sqrt{\frac{T_s}{(P_s)(M_s)}}$$ = 61.621 **ft/sec**

STACK GAS VOLUMETRIC FLOW RATE, actual

$$Q_s = 60 \times V_s \times A_s$$ = 108,938 **acfm**

Stack Area = 29.4647 ft^2

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, wet basis

$$Q_{stdw} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)$$ = 104,455.6 **scfm, wb**
6,267,337 **scfh, wb**

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, dry basis

$$Q_{std} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)(1 - B_{ws})$$ = 102,724.1 **dscfm**
6,163,443 **dscfh**

ARI ENVIRONMENTAL, INC.
MOISTURE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/30/2009
RUN NUMBER: 2

γ FACTOR:	0.995	**STACK DIAM:**	73.5 **inches**
BAROMETRIC:	30.13 **in. Hg**	**METER VOLUME:**	72.605 **ft^3**
STATIC PRES:	-1.20 **in.H_2O**	**METER TEMP:**	71.5 **°F**
STACK TEMP:	92.9 **°F**	**LIQUID COLL:**	28.9 **milliliters**
SQ.RT ΔP:	1.0707 **in.H_2O**	**CO_2:**	0.14 **% by volume**
ΔH:	3.19 **in.H_2O**	**O_2:**	20.29 **% by volume**

ENGLISH UNITS
(29.92 in.Hg & 68 °F)

VOLUME OF SAMPLE
@ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right] = 72.833 \text{ dscf}$$

γ = 0.995

VOLUME OF WATER IN SAMPLE
@ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc} = 1.360 \text{ scf}$$

V_{lc} = 28.9 mL

FRACTIONAL MOISTURE CONTENT OF STACK GAS AS MEASURED

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} = 0.0183$$

FRACTIONAL MOISTURE CONTENT OF STACK GAS @ SATURATION

$$MF = \frac{\left(10^{\left[8.361 - \left(\frac{1893.5}{T - 27.65}\right)\right]}\right) - 0.5}{P} = 0.049$$

T = 306.8 °K
P = 763.1 mmHg

FRACTIONAL MOISTURE CONTENT USED IN CALCULATIONS

B_{ws} = 0.0183

ARI ENVIRONMENTAL, INC.
TOTAL PARTICULATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 9/30/2009
RUN NUMBER: 2

INPUT

Vm:	72.605	**ft3**	**Qs:**	102,724	**dscfm**
γ FACTOR:	0.995		**Ts:**	92.9	**°F**
Pbar:	30.13	**in.Hg**	**Runtime:**	72	**minutes**
ΔH:	3.19	**in.H2O**	**Vs:**	61.621	**ft/sec**
Tm:	71.5	**°F**	**Ps:**	30.04	**in.Hg**
Vlc:	28.9	**mL**	**Noz. diam:**	0.225	**inches**
Filter:	2.40	**mg**			
Probe Wash:	0.57	**mg**	**ENGLISH UNITS**		
Total:	2.97	**mg**	**(29.92 in.Hg & 68 °F)**		

VOLUME OF SAMPLE @ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

$C_{gas,lb/dscf} = (C_{gas,ppm}$

$\gamma =$ 0.995

= 72.833 **dscf**

VOLUME OF WATER IN SAMPLE @ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc}$$

= 1.360 **scf**

FRACTIONAL MOISTURE CONTENT OF STACK GAS

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} \times 100$$

= 1.83 **%**

PARTICULATE CONCENTRATION IN STACK GAS ON A DRY BASIS

$$C_s = (0.01543)\left(\frac{M_n}{V_{mstd}}\right)$$

Total = 0.0006292 **gr/dscf**

$$C_s' = \left(2.205 \times 10^{-6}\right)\left(\frac{M_n}{V_{mstd}}\right)$$

C's Total = 0.08992 **x 10-6 lbs/dscf**

EMISSION RATE

$$pmr = \left(\frac{C_s}{7000}\right)(Q_{std})(60)$$

Total = 0.55402 **lbs/hr**

ISOKINETIC SAMPLING RATE

$$\%ISO = \frac{(100)(T_s)\left[(0.002669 \times V_{lc}) + \left(\frac{V_m}{T_m}\right)(\gamma)\left(P_{bar} + \left(\frac{\Delta H}{13.6}\right)\right)\right]}{(60)(\theta)(V_s)(P_s)(A_n)}$$

= 105.27 **% I**

An = 0.00027612 ft2 Runtime = 72 minutes

ARI ENVIRONMENTAL, INC.
FLOW RATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
RUN NUMBER: 3

SOURCE: Slag Skimmer Baghouse
TEST DATE: 10/1/2009

BAROMETRIC:	29.80 **in. Hg**	**STACK DIAM:**	73.5 **inches**
STATIC PRES:	-1.2 **in.H_2O**	**CO_2:**	0.14 **% by volume**
STACK TEMP:	87.8 **°F**	**O_2:**	20.28 **% by volume**
SQ.RT ΔP:	1.1059 **in.H_2O**		

DRY MOLECULAR WEIGHT OF STACK GAS

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO)$$ = 28.83 **lb/lb-mole**

MOLECULAR WEIGHT OF STACK GAS, wet basis

$$M_s = M_d(1 - B_{ws}) + 18B_{ws}$$ = 28.63 **lb/lb-mole**

PITOT TUBE COEFFICIENT

C_p (from calibration curve or geometric specifications) = 0.84

AVERAGE VELOCITY HEAD OF STACK GAS, in. H_2O

$$\overline{\sqrt{\Delta P}} = \frac{1}{n}\sum_{i=1}^{n}\sqrt{\Delta p}$$ = 1.1059 **in. H_2O**

AVERAGE ABSOLUTE STACK GAS TEMPERATURE

T_s = 87.8 °F + 460 = 547.8 **°R**

ABSOLUTE STACK GAS PRESSURE

$$P_s = P_{bar} + \frac{P_{static}}{13.6}$$ = 29.71 **in.Hg**

STACK GAS VELOCITY

$$V_s = (85.49)(C_p)(\text{avg}\sqrt{\Delta P})\sqrt{\frac{T_s}{(P_s)(M_s)}}$$ = 63.725 **ft/sec**

STACK GAS VOLUMETRIC FLOW RATE, actual

$$Q_s = 60 \times V_s \times A_s$$ = 112,658 **acfm**

Stack Area = 29.4647 ft^2

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, wet basis

$$Q_{stdw} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)$$ = 107,830.3 **scfm, wb**
6,469,821 **scfh, wb**

STACK GAS VOLUMETRIC FLOW RATE, standard conditions, dry basis

$$Q_{std} = \left(\frac{528}{29.92}\right)(Q_s)\left(\frac{P_s}{T_s}\right)(1 - B_{ws})$$ = 105,853.3 **dscfm**
6,351,197 **dscfh**

ARI ENVIRONMENTAL, INC.
MOISTURE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 10/1/2009
RUN NUMBER: 3

γ FACTOR:	0.995	**STACK DIAM:**	73.5 **inches**
BAROMETRIC:	29.80 **in. Hg**	**METER VOLUME:**	74.425 **ft^3**
STATIC PRES:	-1.20 **in.H_2O**	**METER TEMP:**	64.9 **°F**
STACK TEMP:	87.8 **°F**	**LIQUID COLL:**	23.9 **milliliters**
SQ.RT ΔP:	1.1059 **in.H_2O**	**CO_2:**	0.14 **% by volume**
ΔH:	3.38 **in.H_2O**	**O_2:**	20.28 **% by volume**

ENGLISH UNITS
(29.92 in.Hg & °F)

VOLUME OF SAMPLE
@ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right] = 74.810 \text{ dscf}$$

γ = 0.995

VOLUME OF WATER IN SAMPLE
@ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc} = 1.125 \text{ scf}$$

V_{lc} = 23.9 mL

FRACTIONAL MOISTURE CONTENT OF STACK GAS AS MEASURED

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} = 0.0148$$

FRACTIONAL MOISTURE CONTENT OF STACK GAS @ SATURATION

$$MF = \frac{\left(10^{\left[8.361 - \left(\frac{1893.5}{T - 27.65}\right)\right]}\right) - 0.5}{P} = 0.042$$

T = 304.0 °K
P = 754.7 mmHg

FRACTIONAL MOISTURE CONTENT USED IN CALCULATIONS

B_{ws} = 0.0148

ARI ENVIRONMENTAL, INC.
TOTAL PARTICULATE CALCULATION SUMMARY

COMPANY: USS GCW
LOCATION: Granite City, IL
SOURCE: Slag Skimmer Baghouse
TEST DATE: 10/1/2009
RUN NUMBER: 3

INPUT

Vm:	74.425	**ft3**	**Qs:**	105,853	**dscfm**
γ ΦAXTOP:	0.995		**Ts:**	87.8	**°F**
Pbar:	29.8	**in.Hg**	**Runtime:**	72	**minutes**
ΔH:	3.38	**in.H2O**	**Vs:**	63.725	**ft/sec**
Tm:	64.9	**°F**	**Ps:**	29.71	**in.Hg**
Vlc:	23.9	**mL**	**Noz. diam:**	0.225	**inches**
Filter:	2.00	**mg**			
Probe Wash:	1.79	**mg**	**ENGLISH UNITS**		
Total:	3.79	**mg**	**(29.92 in.Hg & 68 °F)**		

VOLUME OF SAMPLE @ STANDARD CONDITIONS, DRY BASIS

$$V_{mstd} = \left(\frac{528}{29.92}\right) \times V_m \times \gamma \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right) = 74.810 \text{ dscf}$$

$\gamma =$ 0.995

VOLUME OF WATER IN SAMPLE @ STANDARD CONDITIONS

$$V_{wstd} = 0.04707 \times V_{lc} = 1.125 \text{ scf}$$

FRACTIONAL MOISTURE CONTENT OF STACK GAS

$$B_{ws} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}} \times 100 = 1.48 \%$$

PARTICULATE CONCENTRATION IN STACK GAS ON A DRY BASIS

$$C_s = (0.01543)\left(\frac{M_n}{V_{mstd}}\right) \quad \text{Total} = 0.0007817 \text{ gr/dscf}$$

$$C_s' = \left(2.205 \times 10^{-6}\right)\left(\frac{M_n}{V_{mstd}}\right) \quad \text{C's Total} = 0.11171 \text{ x 10-6 lbs/dscf}$$

EMISSION RATE

$$pmr = \left(\frac{C_s}{7000}\right)(Q_{std})(60) \quad \text{Total} = 0.70925 \text{ lbs/hr}$$

ISOKINETIC SAMPLING RATE

$$\%ISO = \frac{(100)(T_s)\left[(0.002669 \times V_{lc}) + \left(\frac{V_m}{T_m}\right)(\gamma)\left(P_{bar} + \left(\frac{\Delta H}{13.6}\right)\right)\right]}{(60)(\theta)(V_s)(P_s)(A_n)} = 104.37 \text{ \% I}$$

An = 0.00027612 ft2 Runtime = 72 minutes

APPENDIX B

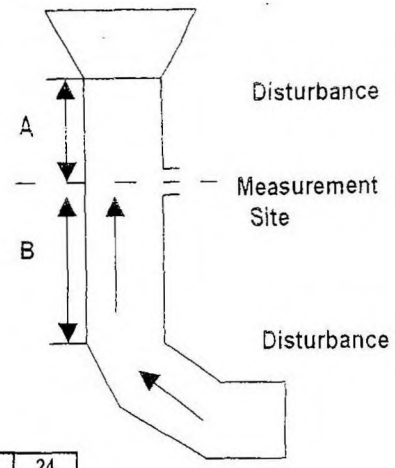
Field Data

TRAVERSE POINT LOCATION FOR CIRCULAR AND RECTANGULAR DUCTS

PLANT US Steel
DATE 9-29-09
SAMPLING LOCATION Slag Skimmer Stack
INSIDE OF FAR WALL TO OUTSIDE OF PORT (DISTANCE C) 79.5"
INSIDE OF NEAR WALL TO OUTSIDE OF PORT (DISTANCE D) 6"
STACK ID 73.5"
NEAREST UPSTREAM FROM DISTURBANCE (A) ~25 ft (4.1dd)
NEAREST DOWNSTREAM FROM DISTURBANCE (B) 40ft (6.5dd)
CALCULATOR MB

Location of Traverse Points in Rectangular Stacks

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8



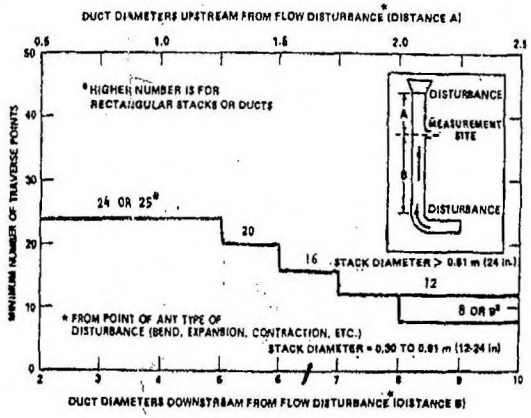
Rectangular Duct Equivalent Diameter Determination $\frac{2 \times L \times W}{L + W}$

LOCATION OF TRAVERSE POINTS ON CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 1 AND 2 (TO NEAREST1/8 INCH)	DISTANCE D (PORT DEPTH)	TRAVERSE POINT LOCATION FROM OUTSIDE OF PORT(SUM OF COLUMNS 3 AND 4)
1	3.2	73.5"	2.35	6"	8.35
2	10.5		7.72		13.72
3	19.4		14.26		20.26
4	32.3		23.74		29.74
5	67.7		49.76		55.76
6	80.6		59.24		65.24
7	89.5		65.78		71.78
8	96.8		71.15		77.15
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					

B-1



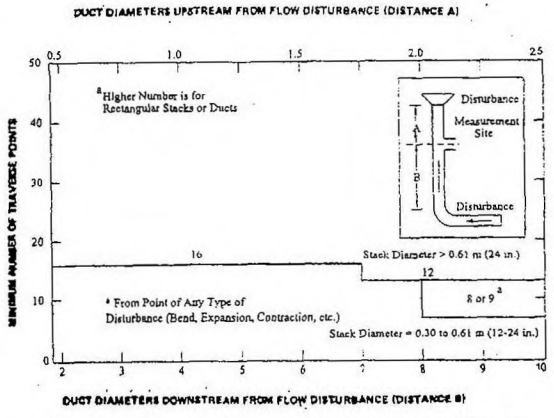


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses.

16 total pts

VELOCITY TRAVERSE AND CYCLONIC FLOW VERIFICATION

PLANT: US Steel
DATE: 9-29-09
LOCATION: Gravity City, IL
SOURCE: Slag Skimmer Bld
STACK ID: 73.5"
PROBE # / TC #: 4817 (8'MS)
BAROMETRIC PRESSURE, in. Hg: 30.13
OPERATORS: MB & BF

SCHEMATIC OF TRAVERSE POINT LAYOUT

RUN NO. Preliminary STATIC, in.H2O -1.2

TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔPs), in.H2O	STACK TEMP. (Ts), °F	YAW ANGLE °
A-1	1.4	84	3
2	1.2	89	2
3	1.2	92	2
4	1.1	94	1
5	1.1	97	1
6	1.2	95	1
~~B-7~~	1.0	92	3
8	1.0	101	6
B-~~1~~	1.2	103	4
~~2~~	1.2	97	7
~~3~~	0.91	94	3
~~4~~	0.81	~~97~~	1
5	1.1	98	~~0~~
6	1.3	~~97~~	~~0~~
~~7~~	0.89	94	2
8	0.82	91	3
AVERAGE			

RUN NO. _____ STATIC, in.H2O _____

TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔPs), in.H2O	STACK TEMP. (Ts), °F	YAW ANGLE °
AVERAGE			

FIELD DATA

PLANT	U.S.S.	AMBIENT TEMPERATURE	59	PROBE HEATER SETTING	248
DATE	4-29-09	BAROMETRIC PRESSURE	~~29.80~~ 30.13	BOX HEATER SETTING	248
LOCATION	GRANITE CITY	ASSUMED MOISTURE, %	2%	METER $H_{@}$	1.907
OPERATOR	BF	PROBE LENGTH, in.	96"	C_p FACTOR	0.84
STACK NO.	Slag Skimmer	NOZZLE DIAMETER, in.	0.180	Y_d FACTOR	0.995
RUN NO.	1	STACK DIAMETER, in.	~~73~~ 73.5	PITOT/THERM #	4817
SAMPLE BOX NO.	080823	MINUTES PER POINT	~~5.5~~ 6		
METER BOX NO.	APEX	NUMBER OF POINTS	16		
START TIME	8:59	NUMBER OF PORTS	2		

WEIGHT OF PARTICULATE, mg		
Filter No.	36244	
Sample		
Final wt		
Tare wt		
Wt. gain		
TOTAL		mg

A=____ B=____

CROSS SECTION

START Time	CLOCK TIME START / STOP	TRAVERSE POINT NUMBER	SAMPLING TIME (Θ) min.	STATIC PRESSURE (in. H_2O)	STACK TEMP (T_S) °F	VELOCITY HEAD (ΔP_S)	VELOCITY HEAD $\sqrt{\Delta P_S}$	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	(ΔH) in. H_2O DESIRED	GAS SAMPLE VOLUME (Vm) ft^3	GAS SAMPLE TEMP AT DRY GAS METER INLET (Tm_{in}) °F	GAS SAMPLE TEMP AT DRY GAS METER OUTLET (Tm_{out}) °F	Filter SAMPLE BOX TEMP. °F	PROBE ~~COND.~~ EXIT TEMP °F	AUX ~~SORBENT MODULE~~ TEMP. °F	LAST IMPINGER OUTLET TEMP. °F	PUMP VACUUM in. Hg
8:59	9:05 / 9:23	A - 1	0	-1.2	~~78~~ 86	1.3		1.4	1.38	592.835	55	AVG	229	230	~~248~~ 248	48	2
9:24	9:30 / 9:42	2	5.56		86	1.2		1.3	1.27	596.33	58	↵	231	245	239	46	2
9:30	10:03 / 10:13	3	4 12		90	1.1		1.2	1.17	600.82	59		229	240	245	47	2
9:43	10:16 / 10:33	4	~~16.5~~ 18		92	1.1		1.2	1.17	603.93	64		244	245	266	44	2
9:52	10:26 / 10:38	5	~~22~~ 24		92	1.2		1.4	1.35	607.48	69		235	236	275	46	3
9:56	10:42	6	30 ~~37.5~~		93	1.1		1.3	1.26	611.24	72		239	239	261	48	2
10:42	10:48	7	36 ~~33~~		105	0.99		1.1	1.13	615.20	73		245	254	270	49	2
10:48	10:54	8	42 ~~38.5~~		110	0.86		0.98	0.98	619.21	74		246	254	265	51	2
2:32	2:38	B - 1	48 44	-1.2	~~96~~	1.3		1.5	1.49	622.65	77		247	251	261	55	3
2:38	2:40 / 1:03	2	~~54~~ 47.5		105	1.2		1.4	1.38	626.72	79		241	250	267	56	3
1:13	1:14 / 1:36	3	~~60~~ 55		98	1.3		1.5	1.49	630.70	79		252	250	271	56	4
1:41	1:42 / 2:14	4	~~66~~ 60.5		101	1.3		1.5	1.49	634.80	81		248	247	273	56	4
1:19	2:20 / 3:01	5	~~72~~ 66		103	1.0		1.2	1.15	639.30	73		249	250	268	57	2
3:40	3:46 / 4:27	6	~~78~~ 71.5		103	1.3		1.5	1.49	643.17	76		249	245	267	57	2
3:46	3:47 / 4:31	7	~~84~~ 77		108	0.87		1.0	1.00	647.25	79		245	243	270	57	2
1:36	4:38 / 5:15	8	~~90~~ 82.5 96		105	0.83		0.96	0.95	650.03	73		250	251	272	58	1
										654.617							
AVERAGE				-1.2	98.31	1.05~~62~~ 1.0562		1.28~~5~~	1.26	61.782	71.3						

VOLUME OR WEIGHT OF LIQUID WATER COLLECTED	IMPINGER VOLUME (ml) OR WEIGHT (g) #1	#2	#3	#4	SILICA GEL WEIGHT g
FINAL	100	102	8		212.1
INITIAL	100	106	8	56	200.9
LIQUID COLLECTED	0	~~4~~ 2	8		
TOTAL COLLECTED (specify ml or g)					(10)

ORSAT DATA	TIME	CO_2	O_2
TRIAL 1			
TRIAL 2			
TRIAL 3			
Average			

LEAK CHECK	
SYSTEM PRE:	0.005 CFM@15"Hg
POST:	0.005 CFM@15"Hg
PITOT PRE:	+/- OK @ > 3"H_2O
POST:	+/- OK @ > 3"H_2O

FIELD DATA

PLANT	U.S.S.	AMBIENT TEMPERATURE	57	PROBE HEATER SETTING	248
DATE	9-30-09	BAROMETRIC PRESSURE	BF ~~29.65~~ 30.13	HEATER BOX SETTING	248
LOCATION	Granite City	ASSUMED MOISTURE, %	1.7 %	METER $H_@$	1.907
OPERATOR	B.F.	PROBE LENGTH, in.	96	C_p FACTOR	0.84
STACK NO.	SKIm slagger	NOZZLE DIAMETER, in.	0.225	Y_d FACTOR	0.995
RUN NO.	2	STACK DIAMETER, in.	~~73~~ 73.5	PITOT/THERM #	4817
SAMPLE BOX NO.	APEX	MINUTES PER POINT	4.5		
METER BOX NO.	0803023	NUMBER OF POINTS	16		
START TIME	6:41 A.M.	NUMBER OF PORTS	2		

WEIGHT OF PARTICULATE, mg		
Filter No.	36239	
Sample		
Final wt.		
Tare wt.	532.1	
Wt. gain		
TOTAL		mg

A= B=

CROSS SECTION

CLOCK TIME (START / STOP)	TRAVERSE POINT NUMBER	SAMPLING TIME (Θ) min.	STATIC PRESSURE (in. H_2O)	STACK TEMP (T_s) °F	VELOCITY HEAD (ΔP_s)	VELOCITY HEAD ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O DESIRED	GAS SAMPLE VOLUME (Vm) ft^3	GAS SAMPLE TEMP AT DRY GAS METER INLET (Tm_{in}) °F	GAS SAMPLE TEMP AT DRY GAS METER OUTLET (Tm_{out}) °F	Filter ~~SAMPLE~~ BOX TEMP. °F	PROBE ~~COND. EXIT~~ TEMP °F	AUX ~~SORBENT~~ MODULE TEMP. °F	LAST IMPINGER OUTLET TEMP. °F	PUMP VACUUM in. Hg
6:41 / 6:45	A - 1	0	BF ~~-.27~~	74	1.3	AVG	3.6	3.59	654.850	51	AVG	244	241	275	47	5
6:45 / 6:46 7:40 7:44	-2	4.5	-1.2	79	1.2	↵	3.3	3.32	659.51	55	↵	247	260	274	39	4
8:58	-3	9.		90	1.4		3.9	3.87	664.14	56		249	255	270	42	5
9:46 / 9:50	-4	13.5		92	1.3		3.6	3.59	669.50	62		256	257	259	45	5
10:29 / 10:31 11:05 11:07	-5	18		92	1.0		2.8	2.76	674.01	70		256	248	232	47	5
11:07 / 11:10 11:30 11:31	-6	22.5		95	0.95		2.6	2.63	678.47	74		247	255	256	52	4
11:31 / 11:34 12:04	-7	27		100	0.87		2.4	2.40	682.30	76		249	256	250	55	4
12:06 / 12:08 12:33 12:37	-8	31.5		100	0.83		2.3	2.29	686.41	78		251	257	266	56	4
13:08 / 13:12 13:52	B - 1	36	-1.2	98	1.2		3.3	3.32	690.89	81		256	254	270	55	6
1:53 / 1:57	2	40.5		91	1.1		3.0	3.04	695.40	79		254	248	270	53	5
2:27 / 2:31	3	45		94	1.2		3.3	3.32	699.40	76		249	250	259	54	5
3:00 / 3:04	4	49.5		99	1.2		3.3	3.32	704.15	78		252	250	255	55	6
3:45 / 3:50	5	54		101	1.4		3.9	3.87	708.59	82		258	245	260	57	7
4:12 / 4:16	6	58.5		95	1.3		3.6	3.59	713.62	77		246	243	255	59	6
4:58 / 5:03	7	63		94	1.2		3.3	3.32	718.86	75		257	242	263	60	6
5:36 / 5:41	8	67.5		93	1.0		2.8	2.76	723.10	74		242	247	249	62	5
		72							727.455							
AVERAGE		72		92.4		1.0707	3.19		72.605	71.5					< 68	

VOLUME OR WEIGHT OF LIQUID WATER COLLECTED	IMPINGER VOLUME (ml) OR WEIGHT (g) #1	#2	#3	#4	SILICA GEL WEIGHT
FINAL					216.8 g
INITIAL	100	100	0	50	200
LIQUID COLLECTED	100	104	4	—	16.8
TOTAL COLLECTED (specify ml or g)					

(12 ml)

ORSAT DATA	TIME	CO_2	O_2
TRIAL 1			
TRIAL 2			
TRIAL 3			
Average			

LEAK CHECK		
SYSTEM PRE:	0.000	CFM@15"Hg
POST:	0.000	CFM@15"Hg
PITOT PRE:	+/- OK	@ > 3"H_2O
POST:	+/- OK	@ > 3"H_2O

FIELD DATA

PLANT	V.S.S	AMBIENT TEMPERATURE	55	PROBE HEATER SETTING	248
DATE	10-1-09	BAROMETRIC PRESSURE	29.80	HEATER BOX SETTING	248
LOCATION	GRANITE CITY	ASSUMED MOISTURE, %	1.7	METER $H_@$	1.907
OPERATOR	BF	PROBE LENGTH, in.	96	C_p FACTOR	0.84
STACK NO.	SLAG SKIMMER	NOZZLE DIAMETER, in.	0.225	Y_d FACTOR	0.995
RUN NO.	3	STACK DIAMETER, in.	~~73~~ 73.5	PITOT/THERM #	
SAMPLE BOX NO.	APEX	MINUTES PER POINT	4.5 77		
METER BOX NO.	080823	NUMBER OF POINTS	16		
START TIME	6:30 AM	NUMBER OF PORTS	2		

WEIGHT OF PARTICULATE, mg	
Filter No.	
Sample	
Final wt.	
Tare wt.	
Wt. gain	
TOTAL	mg

CROSS SECTION

CLC TIME	TRAVERSE POINT NUMBER	SAMPLING TIME (Θ) min.	STATIC PRESSURE (in. H_2O)	STACK TEMP (T_s) °F	VELOCITY HEAD (ΔP_s)	VELOCITY HEAD ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O DESIRED	GAS SAMPLE VOLUME (Vm) ft^3	GAS SAMPLE TEMP AT DRY GAS METER INLET ($T_{m_{in}}$) °F	GAS SAMPLE TEMP AT DRY GAS METER OUTLET ($T_{m_{out}}$) °F	FILTER BOX TEMP. °F	PROBE COMP. EXIT TEMP. °F	AUX SORBENT MODULE TEMP. °F	EXIT IMPINGER OUTLET TEMP. °F	PUMP VACUUM in. Hg
Stop Start																
6:35	A-1	0	BF ~~2.1~~	82	1.3	AVG	3.6	3.59	728.025	58	AVG	263	248	230	43	3
7:20	2	4.5	~~1.2~~	78	1.2	↵	3.3	3.32	733.30	61	↵	260	233	240	42	3
7:54	3	9		78	1.2		3.3	3.32	737.72	62		254	264	245	43	3
8:36 8:30	4	13.5		80	1.1		3.0	3.04	742.33	63		251	260	246	43	3
9:00	5	18		84	1.3		3.6	3.59	746.77	63		251	258	255	43	3
9:01 9:43 9:45	6	22.5		90	1.3		3.6	3.59	751.50	64		248	253	260	44	4
10:46 10:20	7	27		92	1.3		3.4	3.59	756.42	65		250	249	250	44	4
11:05	8	31.5		84	1.2		3.3	3.32	761.11	60		249	253	258	46	4
1:11 1:00	B-1	36	BF ~~2.1~~	89	1.4		3.9	3.87	765.65	62		258	264	267	47	5
11-12 1:30	2	40.5	~~1.2~~	79	1.4		3.9	3.87	770.38	62		258	258	270	46	4
12:18	3	45		90	1.2		3.3	3.32	775.40	62		253	257	262	50	5
2:22 3:02	4	49.5		97	1.1		3.0	3.04	779.88	67		256	257	265	60	4
3:06 4:12	5	54		92	1.1		3.0	3.04	784.21	70		251	258	264	60	4
4:17 5:31	6	58.5		95	1.1		3.0	3.04	788.52	72		252	259	247	46	4
5:43 7:39	7	63		99	1.2		3.3	3.32	792.82	74		248	259	245	44	5
7:43	8	67.5		95	1.2		3.3	3.32	797.46	74		249	257	260	52	5
		72							802.45							
AVERAGE		72		87.3	1.225	1.059	3.38		74.425	64.4						

VOLUME OR WEIGHT OF LIQUID WATER COLLECTED	IMPINGER VOLUME (ml) OR WEIGHT (g) #1	#2	#3	#4	SILICA GEL WEIGHT
FINAL					213.4
INITIAL	100	100	0	56	200
LIQUID COLLECTED	96	103	0		13.4
TOTAL COLLECTED (specify ml or g)	40 ml				23.9

ORSAT DATA	TIME	CO_2	O_2
TRIAL 1			
TRIAL 2			
TRIAL 3			
Average			

LEAK CHECK		
SYSTEM PRE:	0.000	CFM@15"Hg
POST:	0.000	CFM@15"Hg
PITOT PRE:	+/- OK	@>3"H_2O
POST:	+/- OK	@>3"H_2O

APPENDIX C

Laboratory Data

ANALYTICAL SUMMARY

CLIENT: U.S. Steel
LOCATION: Granite City, IL
SOURCE: Cast House and Slag Skimmer Baghouse
SAMPLE DATE: 9/28/2009 - 10/1/2009
ANALYSIS: Particulates
METHOD: USEPA Method 5

Run #		Mass (g)	Tare	WT 1	WT 2	Particulate (mg)	Blank Corrected Particulate (mg)	Total M5 Particulate (mg)	Wt. Diff (mg)
Slag Skimmer Run 1	FILTER	-	539.9	540.6	540.5	0.65		3.49	0.10
Slag Skimmer Run 2	FILTER	-	532.1	534.7	534.3	2.40		2.97	0.40
Slag Skimmer Run 3	FILTER	-	536.9	538.9	538.9	2.00		2.57	0.00
Blank Filter	FILTER	-	529.9	530.1	530.1	0.20			0.00
Slag Skimmer Run 1	PW	137.3	101920.5	101924.5	101924.5	4.00	2.84		0.00
Slag Skimmer Run 2	PW	121.0	101882.0	101883.6	101883.6	1.60	0.57		0.00
Slag Skimmer Run 3	PW	107.8	97892.4	97895.1	97895.1	2.70	1.79		0.00
Blank	PW	141.6	112835.2	112836.6	112836.2	1.20			0.40

Analyst: E. Vogt
Date of Completion: 10/8/09

Company	:	USS GCW			
Location	:	Granite City, IL			
Source	:	Slag Skimmer Baghouse			
Test Run	:	1	2	3	
Test Date	:	10/22/2009	10/22/2009	10/22/2009	
Test Time	:	8:59 - 17:15	6:41 - 17:41	6:30 - 19:43	Average

STACK GAS

O_2, av. % vol, db	20.33	20.29	20.28	20.30
CO_2, av. % vol, db	0.16	0.14	0.14	0.14

MONITOR DATA SUMMARY

COMPANY :	USS GCW
LOCATION:	Granite City, IL
SOURCE :	Slag Skimmer Baghouse
REPETITION :	1
TEST DATE :	10/22/09
STARTING HOUR :	14:31
STARTING MINUTE :	14:32

GAS ANALYZER **O_2**

SCALE :	0 - 22.00 %
AVERAGE CAL. BIAS (C_m):	10.960
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol O_2
CALIBRATION % (C_{ma}):	11.00
% CORRECTED (C_{gas}):	**20.33**

GAS ANALYZER **CO_2**

SCALE :	0 - 22.40 %
AVERAGE CAL. BIAS (C_m):	11.100
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol CO_2
CALIBRATION % (C_{ma}):	11.20
% CORRECTED (C_{gas}):	**0.16**

$$C_{gas} = (C - C_o)\frac{C_{ma}}{(C_m - C_o)}$$

	ELAPSED TIME	O_2	CO_2
14:31	0	-------	-------
14:32	1	20.24	0.17
	AVG (C) =	**20.24**	**0.17**

MONITOR DATA SUMMARY

COMPANY :	USS GCW
LOCATION:	Granite City, IL
SOURCE :	Slag Skimmer Baghouse
REPETITION :	2
TEST DATE :	10/22/09
STARTING HOUR :	14:37
STARTING MINUTE :	14:38

GAS ANALYZER **O_2**

SCALE :	0 - 22.00 %
AVERAGE CAL. BIAS (C_m):	10.960
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol O_2
CALIBRATION % (C_{ma}):	11.00
% CORRECTED (C_{gas}):	**20.29**

GAS ANALYZER **CO_2**

SCALE :	0 - 22.40 %
AVERAGE CAL. BIAS (C_m):	11.100
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol CO_2
CALIBRATION % (C_{ma}):	11.20
% CORRECTED (C_{gas}):	**0.14**

	ELAPSED TIME	O_2	CO_2
14:37	0	-------	-------
14:38	1	20.19	0.15
	AVG (C) =	**20.19**	**0.15**

$$C_{gas} = (C - C_o)\frac{C_{ma}}{(C_m - C_o)}$$

MONITOR DATA SUMMARY

COMPANY :	USS GCW
LOCATION:	Granite City, IL
SOURCE :	Slag Skimmer Baghouse
REPETITION :	3
TEST DATE :	10/22/09
STARTING HOUR :	14:43
STARTING MINUTE :	14:44

GAS ANALYZER O_2

SCALE :	0 - 22.00 %
AVERAGE CAL. BIAS (C_m):	10.960
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol O_2
CALIBRATION % (C_{ma}):	11.00
% CORRECTED (C_{gas}):	**20.28**

GAS ANALYZER CO_2

SCALE :	0 - 22.40 %
AVERAGE CAL. BIAS (C_m):	11.100
AVERAGE ZERO BIAS (C_o):	0.020
CALIBRATION GAS:	Diluted EPA Protocol CO_2
CALIBRATION % (C_{ma}):	11.20
% CORRECTED (C_{gas}):	**0.14**

$$C_{gas} = (C - C_o)\frac{C_{ma}}{(C_m - C_o)}$$

	ELAPSED TIME	O_2	CO_2
14:43	0	-------	-------
14:44	1	20.19	0.15
	AVG (C) =	**20.19**	**0.15**

USS Granite City Works: Granite City, Illinois
Slag Skimmer Baghouse
Tedlar Sample Bag Analytical Data

Date/Time	O_2 % db	CO_2 % db	Comments
10/22/09 14:15:00	-0.14	-0.05	
10/22/09 14:15:15	-0.15	-0.03	
10/22/09 14:15:30	-0.01	0.02	
10/22/09 14:15:45	0.02	0.02	
10/22/09 14:16:00	0.01	0.02	
10/22/09 14:16:15	0.01	0.02	
10/22/09 14:16:30	0.01	0.02	
10/22/09 14:16:45	0.04	0.02	Calibration Error
10/22/09 14:17:00	**0.03**	**0.02**	**0.02 Zero O_2**
10/22/09 14:17:15	**0.02**	**0.02**	**0.02 Zero CO_2**
10/22/09 14:17:30	**0.01**	**0.02**	
10/22/09 14:17:45	**0.00**	**0.02**	
10/22/09 14:18:00	0.03	0.02	
10/22/09 14:18:15	0.27	4.83	
10/22/09 14:18:30	5.32	13.39	
10/22/09 14:18:45	12.83	18.71	
10/22/09 14:19:00	18.13	21.45	
10/22/09 14:19:15	20.79	22.17	
10/22/09 14:19:30	21.66	22.32	
10/22/09 14:19:45	21.93	22.31	
10/22/09 14:20:00	21.98	22.31	
10/22/09 14:20:15	22.00	22.30	
10/22/09 14:20:30	22.02	22.31	
10/22/09 14:20:45	22.04	22.31	
10/22/09 14:21:00	22.15	22.32	
10/22/09 14:21:15	22.23	22.32	
10/22/09 14:21:30	22.12	22.33	
10/22/09 14:21:45	22.04	22.33	
10/22/09 14:22:00	22.05	22.33	Calibration Error
10/22/09 14:22:15	**22.06**	**22.34**	**22.04 22.00% O_2**
10/22/09 14:22:30	**22.06**	**22.34**	**22.33 22.40% CO_2**
10/22/09 14:22:45	**22.01**	**22.34**	
10/22/09 14:23:00	**22.01**	**22.29**	
10/22/09 14:23:15	22.01	22.30	
10/22/09 14:23:30	22.01	22.30	
10/22/09 14:23:45	21.80	18.53	
10/22/09 14:24:00	18.77	13.64	
10/22/09 14:24:15	14.39	11.40	
10/22/09 14:24:30	11.94	11.04	
10/22/09 14:24:45	11.22	11.00	
10/22/09 14:25:00	11.04	11.03	
10/22/09 14:25:15	11.00	11.06	
10/22/09 14:25:30	10.98	11.05	Calibration Error
10/22/09 14:25:45	**10.97**	**11.09**	**10.96 11.00% O_2**
10/22/09 14:26:00	**10.96**	**11.11**	**11.10 11.20% CO_2**
10/22/09 14:26:15	**10.96**	**11.10**	
10/22/09 14:26:30	**10.95**	**11.10**	
10/22/09 14:26:45	10.94	11.09	
10/22/09 14:27:00	10.94	11.08	
10/22/09 14:27:15	10.97	10.19	
10/22/09 14:27:30	11.94	5.03	
10/22/09 14:27:45	15.74	1.01	
10/22/09 14:28:00	18.92	0.26	
10/22/09 14:28:15	20.01	0.21	
10/22/09 14:28:30	20.25	0.20	
10/22/09 14:28:45	20.30	0.19	
10/22/09 14:29:00	20.31	0.19	
10/22/09 14:29:15	20.30	0.19	
10/22/09 14:29:30	20.29	0.19	
10/22/09 14:29:45	20.29	0.18	
10/22/09 14:30:00	20.28	0.18	
10/22/09 14:30:15	20.27	0.18	
10/22/09 14:30:30	20.26	0.18	
10/22/09 14:30:45	20.26	0.18	Slag Skimmer Baghouse - Run #1
10/22/09 14:31:00	**20.25**	**0.18**	**20.24 11.00% O_2**
10/22/09 14:31:15	**20.24**	**0.17**	**0.17 11.20% CO_2**
10/22/09 14:31:30	**20.24**	**0.17**	
10/22/09 14:31:45	**20.23**	**0.17**	
10/22/09 14:32:00	20.23	0.17	
10/22/09 14:32:15	20.23	0.17	
10/22/09 14:32:30	20.22	0.16	
10/22/09 14:32:45	20.23	0.12	
10/22/09 14:33:00	20.26	0.09	
10/22/09 14:33:15	20.27	0.10	
10/22/09 14:33:30	20.27	0.09	
10/22/09 14:33:45	20.26	0.09	
10/22/09 14:34:00	20.25	0.09	
10/22/09 14:34:15	20.25	0.09	
10/22/09 14:34:30	20.24	0.09	
10/22/09 14:34:45	20.23	0.09	
10/22/09 14:35:00	20.23	0.09	
10/22/09 14:35:15	20.22	0.09	

USS Granite City Works: Granite City, Illinois
Slag Skimmer Baghouse
Tedlar Sample Bag Analytical Data

Date/Time	O_2 % db	CO_2 % db	Comments
10/22/09 14:35:30	20.21	0.08	
10/22/09 14:35:45	20.22	0.08	
10/22/09 14:36:00	20.22	0.09	
10/22/09 14:36:15	20.24	0.08	
10/22/09 14:36:30	20.26	0.08	
10/22/09 14:36:45	20.27	0.08	
10/22/09 14:37:00	20.27	0.08	
10/22/09 14:37:15	20.27	0.11	
10/22/09 14:37:30	20.25	0.15	**Slag Skimmer Baghouse - Run #2**
10/22/09 14:37:45	**20.21**	**0.15**	**20.19 11.00% O_2**
10/22/09 14:38:00	**20.19**	**0.16**	**0.15 11.20% CO_2**
10/22/09 14:38:15	**20.19**	**0.15**	
10/22/09 14:38:30	**20.19**	**0.15**	
10/22/09 14:38:45	20.19	0.15	
10/22/09 14:39:00	20.19	0.15	
10/22/09 14:39:15	20.19	0.15	
10/22/09 14:39:30	20.19	0.15	
10/22/09 14:39:45	20.19	0.15	
10/22/09 14:40:00	20.20	0.10	
10/22/09 14:40:15	20.24	0.08	
10/22/09 14:40:30	20.26	0.07	
10/22/09 14:40:45	20.26	0.07	
10/22/09 14:41:00	20.27	0.07	
10/22/09 14:41:15	20.26	0.10	
10/22/09 14:41:30	20.24	0.15	
10/22/09 14:41:45	20.20	0.16	
10/22/09 14:42:00	20.19	0.16	
10/22/09 14:42:15	20.18	0.16	
10/22/09 14:42:30	20.18	0.16	
10/22/09 14:42:45	20.19	0.16	**Slag Skimmer Baghouse - Run #3**
10/22/09 14:43:00	**20.19**	**0.15**	**20.19 11.00% O_2**
10/22/09 14:43:15	**20.19**	**0.15**	**0.15 11.20% CO_2**
10/22/09 14:43:30	**20.19**	**0.15**	
10/22/09 14:43:45	**20.19**	**0.15**	
10/22/09 14:44:00	20.19	0.15	
10/22/09 14:44:15	20.19	0.15	
10/22/09 14:44:30	20.19	0.16	
10/22/09 14:44:45	20.17	0.46	
10/22/09 14:45:00	19.99	0.32	
10/22/09 14:45:15	20.05	0.14	
10/22/09 14:45:30	20.17	0.12	
10/22/09 14:45:45	20.20	0.12	
10/22/09 14:46:00	20.21	0.12	

APPENDIX D

Calibration Data

CEMS CALIBRATION DATA

Plant	USS GCW
Location	Granite City, IL
Source	Slag Skimmer Baghouse
Date	10/22/2009
Run Number	1
Start Time	14:31
Stop Time	14:32

Plant Rep.	Michael McLean
Team Leader	Jerry Bovee
CEM Operator	Jerry Bovee

Analyzer Span Values (% or ppm)		
CO	-	ppm
CO_2	22.40	%
O_2	22.00	%
THC	-	ppm
NO_x	-	ppm
SO_2	-	ppm

	CALIBRATION ERROR - 14:17 hrs				SYSTEM BIAS CHECK					Calibration Correction Factors
					Pretest: 14:17 hrs		14:17 hrs			
	Cylinder Value (% or ppm)	Cylinder Number	Analyzer Calibration Response	Difference (% of Span)	System Response	Syst. Bias (% of Span)	System Response	Syst. Bias (% of Span)	Drift (% of Span)	
CO_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.1	0.02	0.1	0.0	Co=
CO_2 Low		Diluted								**0.020**
CO_2 Mid	11.20	ALM060489	11.10	-0.4	11.10	-0.4	11.10	-0.4	0.0	Cm=
CO_2 High	22.40	22.93%	22.33	-0.3						**11.100**
O_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.0	0.02	0.0	0.0	Co=
O_2 Low		Diluted								**0.020**
O_2 Mid	11.00	ALM060489	10.96	-0.2	10.96	0.0	10.96	0.0	0.0	Cm=
O_2 High	22.00	22.52%	22.04	0.2						**10.960**

CEMS CALIBRATION DATA

Plant	USS GCW
Location	Granite City, IL
Source	Slag Skimmer Baghouse
Date	10/22/2009
Run Number	2
Start Time	14:37
Stop Time	14:38

Plant Rep.	Michael McLean
Team Leader	Jerry Bovee
CEM Operator	Jerry Bovee

Analyzer Span Values (% or ppm)		
CO	-	ppm
CO_2	22.40	%
O_2	22.00	%
THC	-	ppm
NO_x	-	ppm
SO_2	-	ppm

	CALIBRATION ERROR - 14:17 hrs				SYSTEM BIAS CHECK					Calibration Correction Factors
					Pretest: 14:17		Posttest: 14:17 hrs			
	Cylinder Value (% or ppm)	Cylinder Number	Analyzer Calibration Response	Difference (% of Span)	System Response	Syst. Bias (% of Span)	System Response	Syst. Bias (% of Span)	Drift (% of Span)	
CO_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.1	0.02	0.1	0.0	Co=
CO_2 Low		Diluted								**0.020**
CO_2 Mid	11.20	ALM060489	11.10	-0.4	11.10	-0.4	11.10	-0.4	0.0	Cm=
CO_2 High	22.40	22.93%	22.33	-0.3						**11.100**
O_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.0	0.02	0.0	0.0	Co=
O_2 Low		Diluted								**0.020**
O_2 Mid	11.0	ALM060489	10.96	-0.2	10.96	0.0	10.96	0.0	0.0	Cm=
O_2 High	22.0	22.52%	22.04	0.2						**10.960**

CEMS CALIBRATION DATA

Plant	USS GCW
Location	Granite City, IL
Source	Slag Skimmer Baghouse
Date	10/22/2009
Run Number	3
Start Time	14:43
Stop Time	14:44

Plant Rep.	Michael McLean
Team Leader	Jerry Bovee
CEM Operator	Jerry Bovee

Analyzer Span Values (% or ppm)		
CO	-	ppm
CO_2	22.40	%
O_2	22.00	%
THC	-	ppm
NO_x	-	ppm
SO_2	-	ppm

	CALIBRATION ERROR - 14:17 hrs				SYSTEM BIAS CHECK					Calibration Correction Factors
					Pretest: 14:17		Posttest: 14:17 hrs			
	Cylinder Value (% or ppm)	Cylinder Number	Analyzer Calibration Response	Difference (% of Span)	System Response	Syst. Bias (% of Span)	System Response	Syst. Bias (% of Span)	Drift (% of Span)	
CO_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.1	0.02	0.1	0.0	Co=
CO_2 Low		Diluted								**0.020**
CO_2 Mid	11.20	ALM060489	11.10	-0.4	11.10	-0.4	11.10	-0.4	0.0	Cm=
CO_2 High	22.40	22.93%	22.33	-0.3						**11.100**
O_2 Zero	0.00	ALM045344	0.02	0.1	0.02	0.0	0.02	0.0	0.0	Co=
O_2 Low		Diluted								**0.020**
O_2 Mid	11.00	ALM060489	10.96	-0.2	10.96	0.0	10.96	0.0	0.0	Cm=
O_2 High	22.00	22.52%	22.04	0.2						**10.960**

NOZZLE CALIBRATION DATA FORM

USS-GCW Slag Skimmer Baghouse

Date 9/29-30/09 Calibrated by _____

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
0.180" (316SS)	0.179	0.181	0.180	0.002	0.180
0.225" (316SS)	0.225	0.225	0.225	0.001	0.225

where:

[a] $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$ (0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

Interference Response

Analyzer Type:	Oxygen (O_2)
Manufacturer:	Servomex
Detector Type:	Paramagnetic
Model No.:	1440
Serial No.:	1420C/2765
Calibration Span (%):	11.27

Test Gas	Test Gas Conc.	High Standard			Zero			Maximum % Interference
		O_2 without interferent	O_2 with interferent	% Interference	Zero without interferent	Zero with interferent	% Interference	
NH_3	10 ppm	11.27	11.27	0.00	0.03	0.01	0.18	0.18
SO_2	20 ppm	11.25	11.25	0.00	0.01	0.01	0.00	0.00
CH_4	50 ppm	11.24	11.25	0.09	0.02	0.04	-0.18	0.18
CO	50 ppm	11.23	11.24	0.09	0.00	0.01	-0.09	0.09
CO_2	5%	11.23	11.26	0.27	0.00	-0.01	0.09	0.27
CO_2	12.55%	11.25	11.27	0.18	0.03	-0.02	0.44	0.44
NO_2	15 ppm	11.22	11.24	0.18	0.01	0.00	0.09	0.18
NO_x	15 ppm	11.22	11.25	0.27	0.01	0.01	0.00	0.27
H_2	1,020 ppm	11.24	11.23	-0.09	0.02	0.01	0.09	0.09
HCl	10 ppm	11.29	11.31	0.18	0.00	-0.01	0.09	0.18

Sum of the highest absolute value obtained with and without the pollutant present: 1.88 %

Allowable interference response: 2.5 %

Certification Date: _____

Operator: _____

Interference Response

Analyzer Type:	Carbon Dioxide (CO_2)
Manufacturer:	Servomex
Detector Type:	Paramagnetic
Model No.:	1440
Serial No.:	1415C
Calibration Span (%):	11.41

Test Gas	Test Gas Conc.	High Standard			Zero			Maximum % Interference
		CO_2 without interferent	CO_2 with interferent	% Interference	Zero without interferent	Zero with interferent	% Interference	
NH_3	10 ppm	11.41	11.39	-0.18	0.01	0.01	0.00	0.18
SO_2	20 ppm	11.37	11.37	0.00	0.01	0.01	0.00	0.00
CH_4	50 ppm	11.37	11.37	0.00	0.01	0.01	0.00	0.00
CO	50 ppm	11.41	11.41	0.00	0.01	0.01	0.00	0.00
NO_2	15 ppm	11.37	11.37	0.00	0.01	0.01	0.00	0.00
NO_x	15 ppm	11.37	11.37	0.00	0.01	0.01	0.00	0.00
H_2	1,020 ppm	11.37	11.37	0.00	0.01	0.01	0.00	0.00
HCl	10 ppm	11.41	11.38	-0.26	0.01	0.01	0.00	0.26

Sum of the highest absolute value obtained with and without the pollutant present: 0.44 %

Allowable interference response: 2.5 %

Certification Date: _____

Operator: _____

AIR LIQUIDE Air Liquide America Specialty Gases LLC

SCOTT™

RATA CLASS

Dual-Analyzed Calibration Standard

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

CERTIFICATE OF ACCURACY: EPA Protocol Gas

Assay Laboratory

P.O. No.: IL-456-08

AIR LIQUIDE AMERICA SPECIALTY GASES LLC Project No.: 05-70739-007

1290 COMBERMERE STREET

TROY, MI 48083

Customer

ARI ENVIRONMENTAL, INC.

951 OLD RAND ROAD #106

WAUCONDA IL 60084

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: ALM060489 **Certification Date:** 25Nov2008 **Exp. Date:** 25Nov2011

Cylinder Pressure*:** 2000 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ANALYTICAL ACCURACY**	TRACEABILITY
CARBON DIOXIDE	22.93	%	+/- 1%	Direct NIST and NMi
OXYGEN	22.52	%	+/- 1%	Direct NIST and NMi
NITROGEN	BALANCE			

*** Do not use when cylinder pressure is below 150 psig.

** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2300	01Nov2010	1D002807	23.04 %	CARBON DIOXIDE
NTRM 2658	01Jan2010	K001290	10.03 %	OXYGEN

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
VARIAN/3400/10693	21Nov2008	THERMAL CONDUCTIVITY
CAI/110P/V03018	20Nov2008	PARAMAGNETIC

ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

First Triad Analysis **Second Triad Analysis** **Calibration Curve**

CARBON DIOXIDE

Date: 24Nov2008	Response Unit:AREA	
Z1 = 0.00000	R1 = 1203013.	T1 = 1195902.
R2 = 1202957.	Z2 = 0.00000	T2 = 1198107.
Z3 = 0.00000	T3 = 1196462.	R3 = 1200994.
Avg. Concentration:	22.93	%

Concentration = A + Bx + Cx2 + Dx3 + Ex4

r = 0.999999

Constants:	A = -0.03214432
B = 1.89228E-05	C = 0
D = 0	E = 0

OXYGEN

Date: 24Nov2008	Response Unit:%	
Z1 = 0.00000	R1 = 10.03000	T1 = 22.46000
R2 = 10.03000	Z2 = 0.00000	T2 = 22.46000
Z3 = 0.00000	T3 = 22.46000	R3 = 10.03000
Avg. Concentration:	22.52	%

Concentration = A + Bx + Cx2 + Dx3 + Ex4

r = 0.999999

Constants:	A = -0.00380486
B = 0.9998079	C = 0
D = 0	E = 0

APPROVED BY: _____

JEFF CROTEAU

D-7

APEX INSTRUMENTS METHOD 5 POST-TEST CONSOLE CALIBRATION
USING CALIBRATED CRITICAL ORIFICES
3-POINT ENGLISH UNITS

Meter Console Information	
Console Model Number	MC522
Console Serial Number	808023
DGM Model Number	MS-4
DGM Serial Number	DGM 979751

Calibration Conditions			
Date	Time	6-Oct-09	11:00
Barometric Pressure		28.9	in Hg
Theoretical Critical Vacuum[1]		13.6	in Hg
Calibration Technician		B. Crane	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	oR/in Hg

[1]For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2]The Critical Orifice Coefficient, K', must be entered in English units, $(ft^3*°R^{1/2})/(in.Hg*min)$.

Calibration Data

Run Time	Metering Console					Critical Orifice				
Elapsed	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Serial Number	Coefficient	Amb Temp Initial	Amb Temp Final	Actual Vacuum
(Θ)	(P_m)	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})		K'	(t_{amb})	(t_{amb})	
min	in H_2O	cubic feet	cubic feet	°F	°F		see above2	°F	°F	in Hg
10.0	3.0	826.100	836.040	67	69	BB73	0.7725	66	66	14
14.0	3.0	836.040	849.970	69	70	BB73	0.7725	66	66	14
10.0	3.0	849.970	859.950	70	71	BB73	0.7725	66	66	14

Results

Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate	ΔH @	
Dry Gas Meter		Critical Orifice		Value	Variation	Std & Corr	0.75 SCFM	Variation
($V_{m(std)}$)	($Q_{m(std)}$)	($Vcr_{(std)}$)	($Q_{cr(std)}$)	(Y)	(ΔY)	($Q_{m(std)(corr)}$)	(ΔH@)	(ΔΔH@)
cubic feet	cfm	cubic feet	cfm			cfm	in H2O	
9.674	0.967	9.734	0.973	1.006	-0.001	0.973	1.748	0.004
13.519	0.966	13.628	0.973	1.008	0.001	0.973	1.743	-0.001
9.668	0.967	9.734	0.973	1.007	0.000	0.973	1.740	-0.004
Pretest Gamma	0.995	% Deviation	1.2	1.007	Y Average		1.744	ΔH@ Average

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR Title 40, Part 60, Appendix A-3, Method 5, 16.2.3

Signature B. Crane Date 10·6·09

ARI Environmental, Inc.
Gas Meter Thermometer Calibration Data Form
Post Test

Meter Box: 808023
Calibrator: B. Crane
Date: 10/6/2009
Barometric: 28.9
Ambient Temp: 70
Reference Thermometer: Altek Thermocouple Source

Reference Temperature Altek	Thermometer Temperature Inlet	Difference (%) mean Inlet	Thermometer Temperature Oulet	Difference (%) mean Oulet	Thermometer Temperature Probe	Difference (%) mean Probe	Thermometer Temperature Stack	Difference (%) mean Stack
0	NA		2	0.43	2	0.43	2	0.43
100			99	-0.18	100	0.00	100	0.00
200			202	0.30	203	0.45	203	0.45
300			301	0.13	302	0.26	302	0.26
400			398	-0.23	398	-0.23	398	-0.23
500			498	-0.21	499	-0.10	499	-0.10

Reference Temperature Altek	Thermometer Temperature Filter	Difference (%) mean Filter	Thermometer Temperature Exit	Difference (%) mean Exit	Thermometer Temperature Aux	Difference (%) mean Aux
0	2	0.43	2	0.43	2	0.43
100	100	0.00	100	0.00	100	0.00
200	202	0.30	202	0.30	203	0.45
300	302	0.26	301	0.13	302	0.26
400	398	-0.23	398	-0.23	399	-0.12
500	499	-0.10	499	-0.10	499	-0.10

APEX INSTRUMENTS METHOD 5 PRE-TEST CONSOLE CALIBRATION
USING WET-TEST METER #11AE6
5-POINT ENGLISH UNITS

Meter Console Information	
Console Model Number	MC-522
Console Serial Number	0808023
DGM Model Number	S-110
DGM Serial Number	979751

Calibration Conditions			
Date	Time	8-Aug-08	12:00
Barometric Pressure		29.5	in Hg
Calibration Technician		EW	
Calibration Meter Gamma		1.0013	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	°R/in Hg

Calibration Data

Run Time	Metering Console						Calibration Meter				
	DGM Orifice ΔH	Volume Initial	Volume Final	Sample Volume	Outlet Temp Initial	Outlet Temp Final	Volume Initial	Volume Final	Sample Volume	Outlet Temp Initial	Outlet Temp Final
Elapsed (θ)	(ΔH_m)	(V_{mi})	(V_{mf})	(V_m)	(t_{mi})	(t_{mf})	(V_{wi})	(V_{wf})	(V_w)	(t_{wi})	(t_{wf})
min	in H_2O	cubic feet	cubic feet	cubic feet	°F	°F	cubic feet	cubic feet	cubic feet	°F	°F
5.00	5.0	115.142	121.445	6.303	79	79	707.045	713.310	6.265	75.0	75.0
6.00	3.0	127.148	133.039	5.891	79	80	718.970	724.800	5.830	75.0	75.0
7.00	2.0	133.039	138.557	5.518	80	80	724.800	730.260	5.460	75.0	75.0
10.00	1.0	138.557	144.104	5.547	80	80	730.260	735.750	5.490	75.0	75.0
15.00	0.5	121.445	127.148	5.703	79	79	713.310	718.970	5.660	75.0	75.0

Results

Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate	ΔH@	
Dry Gas Meter		Calibration Meter		Value	Variation	Std & Corr	0.75 SCFM	Variation
(V_{mstd})	(Q_{mstd})	(V_{wstd})	(Q_{wstd})	(Y)	(ΔY)	($Q_{std\&corr}$)	(ΔH@)	($\Delta\Delta H^2$@)
cubic feet	cfm	cubic feet	cfm			cfm	in H2O	
6.164	1.233	6.104	1.221	0.990	-0.005	1.221	1.870	-0.037
5.727	0.955	5.680	0.947	0.992	-0.003	0.947	1.845	-0.062
5.346	0.764	5.320	0.760	0.995	0.000	0.760	1.898	-0.009
5.361	0.536	5.349	0.535	0.998	0.003	0.535	1.908	-0.001
5.515	0.368	5.515	0.368	1.000	0.005	0.368	2.016	0.109
				0.995	Y Average		1.907	ΔH@ Average

APEX INSTRUMENTS

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

Note: For $\Delta H_@$, orifice pressure differential that equates to 0.75cfm (0.0212m³/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is +-0.2inches (5.1mm) H_2O.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 157, certified 05/26/2006 using PI Tape S/N 207C0139, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature Date 8/8/08

Temperature Sensor Calibration Data Sheet

Date	8/8/2008	ThermoCouple No.	
Personnel	EW	Reference	
Ambient temp		ASTM Mercury-In-Glass ID	
		NIST Reference TC ID	

Date	Reference Point Number	Source (specify)	Reference Thermometer Temperature F	Thermocouple Display Temperature F	Absolute Temperature Difference %
	1		100	97	0.5
	2		200	201	-0.2
	3		300	299	0.1
	1		500	497	0.3
	2		700	700	0.0
	3		900	899	0.1
	1		1100	1100	0.0
	2		1500	1499	0.1
	3		1900	1900	0.0
	1				
	2				
	3				
	1				
	2				
	3				
	1				
	2				
	3				
	1				
	2				
	3				
	1				
	2				
	3				
					0.106
					<1.5

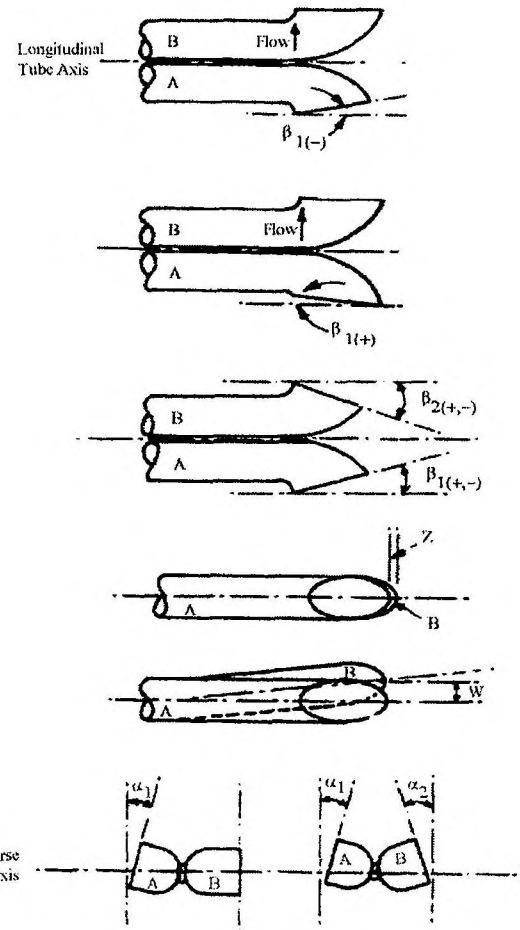
Checked By Eric White 8/8/8
(Personnel (Sign/Date)

Team Leader (Signature/Date)

Pitot Tube Inspection Data

Client Name: _____

	Pre-Sample		Post-Sample
Date:	6/17/2008	**Date:**	11/9/2009



Y	**level?**	Y
N	**obstructions?**	N
N	**damaged?**	N
0	**$-10° < \alpha_1 < +10°$**	0
1	**$-10° < \alpha_2 < +10°$**	1
1	**$-5° < \beta_1 < +5°$**	2
1	**$-5° < \beta_2 < +5°$**	0
1	γ	1
0	θ	0
0.850	**A**	0.85
0.425	**$0.39375 < P_A < 0.5625$**	0.420
0.425	**$0.39375 < P_B < 0.5625$**	0.430
0.375	**$0.1875 \leq D_t \leq 0.375$**	0.375
0.015	**A tan $\gamma < 0.125$"**	0.015
0.00000	**A tan $\theta < 0.03125$"**	0.00000
TRUE	**$P_A = P_B$ +/- 0.063**	TRUE
PASS	**PASS/FAIL**	PASS

Comments: 7' effective length s-type pitot assembly, 3/8" tips, K-type thermocouple, 1/4" Orsat line attached to heated M5 probe.

Pitot tube/probe number 4817 meets or exceeds all specifications and criteria and/or applicable design features (per 40CFR60 Appendix A; Method 2) and is heareby assigned a pitot tube calibration factor of 0.84.

Signature: _____

Date: 11·9·09

ARI Environmental Inc.
Thermocouple Calibration Data Form

Calibrator: B. Crane
Thermocouple ID. 4817

	pretest	posttest
Date:	6/17/2008	11/9/2009
Barometric:	29.26	29.60

Reference Thermometer = Mercury in glass

	Reference Point Number	Source	Reference Thermometer Temperature	Meter Readout Temperature	Difference (%)
Pre-Test	T.C	Ice Water	34.0	35.0	-0.20
		Ambient	69.0	69.7	-0.13
		Hot Water	209.0	208.3	0.10
Post-Test	T.C	Ice Water	34.0	34.6	-0.12
		Ambient	67.0	65.4	0.30
		Hot Water	211.0	210.2	0.12

a (temp. diff.) = (ref.temp + 460) - (Thermo. temp. + 460) / (ref. temp. +460) x 100

Where $-1.5 < a < 1.5$

APPENDIX E Test Program Qualifications

Test Program Qualifications

ARI Environmental's offices in Wauconda, Illinois and Pasadena, Texas specialize in conducting stack emission, fugitive leak detection, ambient air and in-plant OSHA type testing for industrial clients.

ARI is organized so that its facilities and resources meet the requirements of ASTM D7036, Standard Practice for Competence of Air Emission Testing Bodies. ARI's laboratories in Pasadena, Texas and Wauconda, Illinois hold TCEQ NELAP Certificate No. T104704428-8A-TX.

During the past 25 years, ARI personnel have conducted over 5,000 separate stack emission tests for a variety of industrial clients throughout North America for the determination of degree of source compliance and to yield emissions data and control equipment performance data for in-house engineering purposes.

ARI presently has over 80 trained personnel for conducting source emission sampling, fugitive leak detection monitoring, ambient air monitoring and OSHA sampling programs. All test programs are supervised and conducted by onsite Qualified Individuals (QI) and/or Qualified Source Testing Individuals (QSTI) pursuant to ASTM D7036.

The key personnel involved in the test program were as follows:

Jerry Bovee
Mr. Bovee is a Senior Project Manager with ARI. His 18 years of experience includes emission compliance and CEM certification testing for a wide variety of industries including petrochemical, steel mills, electric utilities, cement plants, pulp and paper mills, asphalt plants and general manufacturing plants. Mr. Bovee is presently certified as a QSTI by the Source Evaluation Society (SES) pursuant to the requirements of ASTM D7036-04.

Matt Badertscher
Mr. Badertscher is a field technician specializing in sampling equipment preparation, maintenance and calibration, equipment setup, field sampling, sample recovery, and posttest equipment clean up.

Bill Flaherty
Mr. Flaherty is a field technician specializing in sampling equipment preparation, maintenance and calibration, equipment setup, field sampling, sample recovery, and posttest equipment clean up.

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

JERRY A. BOVEE

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 8TH DAY OF JULY 2009 AND EFFECTIVE UNTIL JULY 7TH 2014

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

John R. Smith, QSTI/QSTO Review Board

APPLICATION NO. 2009-354

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

JERRY A. BOVEE

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 8TH DAY OF JULY 2009 AND EFFECTIVE UNTIL JULY 7TH, 2014

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

John R. Smith, QSTI/QSTO Review Board

APPLICATION NO. 2009-354