



BEFORE THE DIRECTOR OF THE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

In the Matter of:
Minerals Research, Inc. - Cottonwood Plant
located at 705 E Birch St., Cottonwood,
Yavapai County, Arizona
Place ID 172594

TERMINATION OF CONSENT ORDER
Docket No. A-12-23

TO: Michael Vick

Effective February 21, 2024, the Arizona Department of Environmental Quality is hereby terminating Consent Order, Docket No. A-12-23. The Order is being terminated for the following reason:

- 1. Minerals Research, Inc. has violated condition III.E.d of the Consent Order for PM10 emissions from baghouse BH-600 as demonstrated by an initial performance test conducted on January 31, 2024. The Consent Order limits PM10 emissions from BH-600 to 0.0051 pounds per ton of material processed, but emissions were measured on January 31, 2024 at 0.0162 pounds per ton as shown in the final report dated February 10, 2024, attached hereto as Exhibit 1.

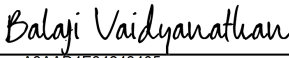
This decision is an appealable agency action pursuant to A.R.S. § 41-1092. You have the right to obtain a hearing on this appealable agency action, pursuant to A.R.S. § 41-1092.03 by filing a written request for a hearing with ADEQ within thirty (30) days of receipt of this determination. The request for a hearing shall include your name, your address, the specific action being appealed, and a concise statement of the reasons for the request for a hearing.

The request for a hearing must be filed with:

ATTENTION: Hearing Administrator,
Arizona Department of Environmental Quality, Office of Administrative Counsel
Mail code 6135C
1110 West Washington Street
Phoenix, Arizona 85007
email: oac@azdeq.gov

Pursuant to A.R.S. § 41-1092.06, as part of the appeal process you have the option of an informal settlement conference. If you would like to request an informal settlement conference, you may file a request with the ADEQ Hearing Administrator no later than twenty (20) days before the hearing date. ADEQ will hold the conference within fifteen (15) days of receiving the request, so we can meet to address your concerns with the agency's determination.

ISSUED this 2/21/2024.

DocuSigned by:

A3AAD7E34243405...
Balaji Vaidyanathan, Section Manager
Facilities Emissions Control Section
Arizona Department of Environmental Quality

I HEREBY CERTIFY that on 2/21/2024, the **ORIGINAL** was filed in the facility file located at:

Arizona Department of Environmental Quality
1110 W Washington St
Phoenix, AZ 85007-2935

I HEREBY CERTIFY that on 2/21/2024, a true and correct copy was emailed, if provided, or sent via USPS regular mail to:

Michael Vick
4620 S. Coach Dr.
Tucson, AZ 85714
(520) 271-6129
mikevick@mineralsresearch.com

I HEREBY CERTIFY that on 2/21/2024, a true and correct copy was emailed, if provided, or sent via USPS regular mail to:

Arizona Department of Environmental Quality
Office of Administrative Counsel

Curtis Cox, Chief Counsel, Environmental Enforcement Section, Office of the Attorney General
Sean Sandy, Unit Manager, Air Quality Compliance Unit
Jean H. Ziga, Case Manager, Air Quality Compliance Unit

ATTN: Amy Miller
Director, Enforcement and Compliance Assurance
US EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

DocuSigned by:

3D26C00C62C74EE
Hearing Administrator

EMISSIONS TEST REPORT

MINERALS RESEARCH, INC. – COTTONWOOD PLANT

BH-600 COMPLIANCE TEST

Arizona Department of Environmental Quality Consent
Order Docket No. A-12-23

Prepared for:

Minerals Research, Inc.
705 E. Birch Street
Cottonwood, Arizona 86326

Prepared by:

Bison Engineering, Inc.
4251 S. Station Master Drive
Tucson, Arizona 85714
(520) 749-2167
www.bison-eng.com

Project Number: MRI224137
Test Date: January 31, 2024
Report Issued: February 10, 2024



EXECUTIVE SUMMARY

Minerals Research, Inc. contracted Bison Engineering, Inc. to perform emissions testing at their Cottonwood Plant in Cottonwood, Arizona. Testing was performed on the BH-600 on January 31, 2024, to demonstrate compliance with the provisions of the Arizona Department of Environmental Quality Consent Order Number A-12-23. This report presents emissions test data, describes the methods employed and details the quality assurance measures taken to ensure accurate data. Table 1 summarizes the test results.

Table 1 BH-600 Results Summary

Parameter	Units	Test Result	Permit Limit
PM ₁₀	lb/ton	0.0162	0.0051

PM₁₀ – particulate matter with an aerodynamic diameter that is less than 10 microns

lb/ton – pounds per ton of material processed

Note: EPA Method 5 measures filterable particulate matter. All particulate matter captured in this compliance test is considered and reported as PM₁₀.

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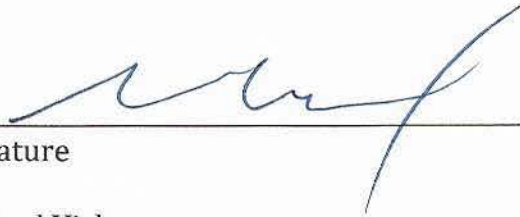
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APPENDIX C:	Plant Operating Records
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CERTIFICATION FROM RESPONSIBLE OFFICIAL

I have reviewed the information being submitted in its entirety. Based on information and belief formed after reasonable inquiry, I certify that the statements and information contained in this submittal are true, accurate, and complete.



Signature

2/13/24

Date

Michael Vick

Name (printed)

President

Title

Minerals Research, Inc.

Company

REVIEW AND CERTIFICATION

All work, calculations, other activities, and tasks performed and documented in this report were carried out under my direction and supervision. This test project conforms to the requirements of Bison Engineering, Inc.'s quality manual and American Society for Testing and Materials (ASTM) D7036-04.

Project Manager: Angel A. Medina, QSTI

Title: Tucson Source Team Lead

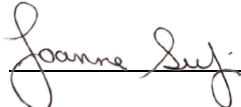
Signature: 

Date: February 10, 2024

I have reviewed all testing details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Reviewer: Joanne Sufi, QSTI

Title: Environmental Engineer

Signature: 

Date: February 10, 2024

1.0 INTRODUCTION

1.1 Project Summary and Objectives

Minerals Research, Inc. contracted Bison Engineering, Inc. (Bison) to perform emissions tests on the BH-600 at their Cottonwood Plant. Testing was conducted on January 31, 2024, to determine compliance with the Arizona Department of Environmental Quality (ADEQ) Consent Order Docket Number A-12-23 for emissions of PM₁₀.

Bison performed the emissions testing in accordance with the pre-test protocol dated January 22, 2024, that was submitted to ADEQ. Testing was performed pursuant to the Arizona Testing Manual. Bison employed U.S. Environmental Protection Agency (EPA) test methods as described in the Code of Federal Regulations, Title 40 (40 CFR). Table 2 summarizes the test methods used during the test campaign.

Table 2 Project Matrix

EPA Method	Parameter	Test Plan and Comments
1	Traverse point locations	Performed once, prior to sampling.
2	Flow/velocity	Assumed molecular weight of 29 lb/lb-mol was used for this ambient source. Concurrent with method 5 testing.
4	Moisture	Concurrent with method 5 testing.
5	PM ₁₀	Three, 2-hour test runs were performed, and a minimum sample volume of 60 dscf was collected.

lb/lb-mol – pound per pound mole
dscf – dry standard cubic feet

1.2 Project Contacts

Facility: Minerals Research, Inc. – Cottonwood Plant
Address: 705 E. Birch Street
Cottonwood, Arizona 86326
Contact: Stephan Gosselin
Phone: (450) 561-6092
Email: stephan.gosselin@mineralsresearch.com

Consultant: Bison Engineering, Inc.
Address: 4251 S. Station Master Drive
Tucson, Arizona 85714
Contact: Angel A. Medina
Phone: (520) 749-2167
Email: amedina@bison-eng.com

State Authority: Arizona Department of Environmental Quality
Address: 110 W. Washington Street
Phoenix, Arizona 85007
Contact: David Demchik
Phone: (602) 771-8544
Email: demchik.david@azdeq.gov

1.3 Testing Personnel

The Bison on-site testing team was led by Angel Medina, Qualified Stack Testing Individual (QSTI), Tucson Source Team Lead. He was assisted during field testing by Jeremy Clark, QSTI, Environmental Scientist and Nathan Wikstrom, Environmental Technician. Mr. Medina served as project manager, processed the test data, and authored this report. Joanne Sufi, QSTI, Environmental Engineer, performed a final quality assurance review of the data and test report.

Michael Vick and Stephan Gosselin were the primary contacts for MRI. Both were on-site during testing. MRI staff members were responsible for monitoring process parameters during testing.

David Demchik from ADEQ was on-site during the test campaign and observed the testing.

2.0 SOURCE DESCRIPTION

2.1 Facility Description

MRI owns and operates a slag processing facility in Cottonwood, Arizona. The Cottonwood Plant generally operates from 6 A.M. to 10 P.M., 7 days a week. The primary crushing and screening plant is limited to 2,000 tons per day of material processed. The secondary crushing and screening plant is limited to 190 tons per day of material processed. The material that is being processed at the facility is slag. Slag is the waste matter generated during the smelting or refining of ore.

2.2 Emission Source Description

BH-600 is a Donaldson Torit Model 484RF10, with a serial number: FIG 516885A, and a nominal rated capacity of 40,000 cubic feet per minute (cfm). The BH-600 exhaust stack is 45.25 inches inner diameter. Purpose-built sampling ports utilized were approximately 35 feet above grade. Test ports were accessed via a manlift. While on-site, Bison verified the exhaust stack meets EPA Method 1 specifications; detailed Method 1 information is included in the appendices to this report.

3.0 EMISSION TEST RESULTS

3.1 Summary of Results

Table 3 summarizes the BH-600 test results. Additional supporting material, including raw data, plant data, example calculations and calibration records, can be found in the appendices to this report.

Table 3 Compliance Test Results

Parameter	Units	Run 1	Run 2	Run 3	Average	Limit
Date		1/31/2024				
Run start time		12:15	15:35	18:05		
Run end time		14:19	17:38	20:18		
Run duration	minutes	120	120	120		
Barometric pressure	inHg	26.27	26.27	26.27	26.27	
Isokinetic average	%	100.4	100.5	100.0	100.3	
Sample volume	dscf	73.544	72.358	72.473	72.792	
Stack area	square feet	11.168	11.168	11.168	11.168	
H ₂ O	%v	0.74	0.93	1.16	0.94	
Wet molecular weight	lb/lb-mol	28.92	28.90	28.87	28.90	
Velocity	fps	29.77	29.40	29.29	29.49	
Flow rate	dscfm	16,796	16,506	16,614	16,639	
Stack temperature	°F	75.0	76.6	69.9	73.8	
Filterable particulate	gr/dscf	0.0007	0.0035	0.0029	0.0024	
	lb/hr	0.10	0.50	0.41	0.34	
	lb/ton	0.0050	0.0238	0.0199	0.0162	0.0051
Slag process rate	tons/hr	20.77	20.77	20.77	20.77	

inHg – inches of mercury

%v – percent by volume

fps – feet per second

dscfm – dry standard cubic feet per minute

°F – degrees Fahrenheit

gr/dscf – grains per dry standard cubic foot

lb/hr – pound per hour

tons/hr – tons per hour

3.2 Operating Conditions

MRI personnel compiled the raw process data and details of plant operations during testing and provided them to Bison for use in this report. Process data is presented in the report appendices, demonstrating compliance with operating requirements.

3.3 Field Observations

Testing was performed as outlined in the test protocol. No adverse or unusual environmental conditions were noted that are known to have influenced the outcome of these tests.

4.0 EMISSION TEST METHODS AND PROCEDURES

4.1 Testing Methods and Procedures

Bison testing personnel performed the following EPA methods as described in Title 40 CFR. A 316-grade stainless steel nozzle and probe liner were used for EPA Method 5 testing.

EPA Reference Method 1, "Sample and Velocity Traverses for Stationary Sources." 40 CFR 60, Appendix A. The objective of Method 1 is to determine a suitable location for testing and to determine the velocity and/or sample points for the source. The results of Method 1 sampling location and sample or velocity point measurement locations are included in the appendices.

EPA Reference Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)." 40 CFR 60, Appendix A. The objective of Method 2 is to determine volumetric flow rate using the average stack velocity, temperature, static pressure, and cross-sectional area. This method is incorporated within the performance of Method 5. Method 2 Section 8.6 allows for the use of 29 lb/mol as dry molecular weight for ambient sources, in lieu of performing actual measurements.

EPA Reference Method 4, "Determination of Moisture Content in Stack Gases." 40 CFR 60, Appendix A. The objective of Method 4 is to determine the moisture content of a gas stream. This method is incorporated within the performance of Method 5.

EPA Reference Method 5, "Determination of Particulate Emissions from Stationary Sources" (Methods 2 & 4 Inclusive). 40 CFR 60, Appendix A. Method 5 is an isokinetic sampling method for determination of filterable PM emissions from a source. The exhaust gas stream is sampled along a cross-section of the stack and PM is captured within the nozzle, probe, filter-bell and quartz fiber filter. Method 5 incorporates Method 2 "velocity measurements" and Method 4 "moisture measurements."

4.2 Sample Handling and Analytical Procedures

Sampling procedures are cited in the appropriate methods and there was no deviation from those methods. Bison's project manager retained custody of the samples until relinquishing them to Bison's Tucson, Arizona qualified lab personnel to be analyzed according to published EPA methodology. A chain of custody is included in the appendices.

4.3 Audit Samples

For particulate sample analyses, Bison uses a particulate audit filter from ERA for balance verification.

APPENDIX A: TEST DATA



COMPANY	Minerals Research, Inc.
FACILITY	Cottonwood Plant
LOCATION	Cottonwood, AZ
SOURCE	BH-600
DATE	01/31/24
METHOD	5
POLLUTANT	PM10

**EPA Method 1
Stack Parameters and Traverse Points**

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
Facility: Cottonwood Plant

Type of testing: P (P for Particulate; V for Velocity/Nonparticulate)
 Type of duct: C (C for circular; R for rectangular)

Number of ports available: 2
 Number of ports to be used: 2
 Port diameter: 6 inches
 Sampling location height (approx.): 35 feet
 Stack height (approx.): NA feet

Circular ID (rectangular length): 45.25 inches
 Port depth and/or wall thickness: 4.88 inches
 Stack width (rectangular only): inches
 Port location (length, width or NA) NA

Equivalent Diameter
 If rectangular = $\frac{2 * \text{Length} * \text{Width}}{\text{Length} + \text{Width}}$ = 45.25 inches (If circular = duct ID)

Stack/duct area = 11.168 sq.feet 1608.2 sq. inches

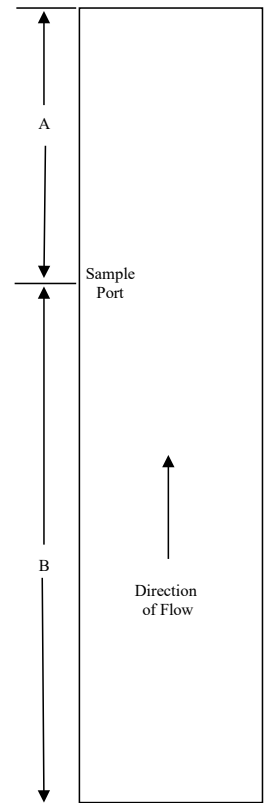
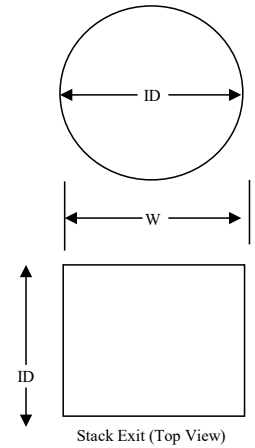
Sample port location: Downstream flow disturbance from process B
 Upstream flow disturbance toward exit A
 Number of inches: 120.00 32.00
 Number of diameters: 2.65 0.71

Recommended number of traverse points: 24

Traverse points less than 1.0 inch from the stack wall are relocated to a distance of 1.0 inch.

Points	% of diameter	Distance from inside wall (in.)	Distance including port (in.)
1	2.1	0.95	5 7/8
2	6.7	3.03	7 7/8
3	11.8	5.34	10 1/4
4	17.7	8.01	12 7/8
5	25.0	11.31	16 1/4
6	35.6	16.11	21
7	64.4	29.14	34
8	75.0	33.94	38 7/8
9	82.3	37.24	42 1/8
10	88.2	39.91	44 3/4
11	93.3	42.22	47 1/8
12	97.9	44.30	49 1/8

Reference Diagram



Drawing NOT to scale and NOT an accurate representation of stack.

Pre-Test Traverse

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
Date: 1/31/2024

Stack Temp: 67 °F

Traverse Point	Velocity ΔP (inH₂O)	Null Angle
1	0.38	11
2	0.37	10
3	0.37	9
4	0.36	9
5	0.35	12
6	0.34	17
7	0.35	9
8	0.33	7
9	0.27	5
10	0.26	8
11	0.26	9
12	0.26	5
13	0.30	10
14	0.30	10
15	0.30	11
16	0.30	4
17	0.29	3
18	0.32	2
19	0.30	1
20	0.31	2
21	0.31	9
22	0.30	8
23	0.29	9
24	0.30	9

Average: 0.31 8

Flow is found to be: Non-cyclonic

Isokinetic Field Data
Field Data Entry

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
EPA Method: 5
Box Operator: AAM
Technician(s): NEW/JPC

Environmental Conditions/Test Notes:
Sunny, 45-75 degrees F

Run: 1
Start Time: 12:15
End Time: 14:19
Date: 1/31/2024

Stack Dimensional Data:

Circular
Diameter 45.250 in
Rectangular
Width in
Length in
Stack Area 11.168 sq.ft.

Equipment:

Meterbox ID SB-5
Y factor 0.9805
 $\Delta H@$ 1.859
Bp ID TTB-2
Balance ID WSS-3
Weights ID WSW-1
Probe ID T-4-1
Nozzle ID 99
Hot box ID HB-2
Pitot Cp 0.84
Pitot ID T-PT-3
Probe Length, ft 4
Liner type SS
Nozzle size 0.273 inches
Nozzle area 0.000406 sq.ft.
Probe heat 248 °F
Filter heat 248 °F
Condenser TC ID 8473

Source Information:

Barometric Pressure 26.27 inHg
Static Pressure -7.52 inH₂O
Ave. ΔP 0.32 inH₂O
Stack Temperature 63 °F
Assumed moisture 0.75 %
Assumed meter temp. 65 °F
Total number of points 24
Time per point 5 min.
Total run time 120 min.

Assumed O₂ NA %
Assumed CO₂ NA %
Rec. Nz. 0.263 inches

Leak Checks:

	Pre-test	Post-test
Pitot	x	x
Leak rate, dcfm	0.008	0.000
Leak check vacuum, inHg	15	6.5

Nozzle check for roundness:

1	2	3
0.273	0.273	0.272 inches
Caliper ID TMC-3		

Post Test Calculations:

Sample volume 85.575 dcf
Wet mol. weight 28.92 M_s (actual)
Actual H₂O 0.74 %
Std. meter vol. 73.544 dscf
Isokinetic Average 100.4 %
Ave. ΔP 0.240 inH₂O
Ave. $\sqrt{\Delta P}$ 0.489 inH₂O
Ave. ΔH 1.421 inH₂O
Ave. T_s 75.0 °F
Ave. T_m 71.0 °F

Moisture/Lab:

Filter, #	Q-2-61		Gain
	Initial	Final	
Impingers, g	2,134.7	2,129.2	-5.5
Silica gel, g	927.3	944.5	17.2
Total water gain, g:			11.7

Traverse Point	Time (min.)	Meter Volume (dcf)	Velocity ΔP (inH ₂ O)	Stack Temp. (°F)	Meter Temp. (°F)	Calc. ΔH	Run ΔH	Vacuum (inHg)	Filter Box (°F)	Condenser Temp ($\leq 68^\circ F$)	Probe Temp (248 \pm 25°F)
		0.000									
1	5.0	3.780	0.27	72	64	1.59	1.60	4	250	49	244
2	10.0	7.460	0.26	74	64	1.52	1.50	4	251	45	250
3	15.0	11.070	0.25	75	65	1.46	1.45	4	249	45	249
4	20.0	14.690	0.25	75	66	1.47	1.45	4	252	47	249
5	25.0	18.270	0.24	75	67	1.41	1.40	4	249	49	247
6	30.0	21.670	0.22	75	67	1.29	1.30	3.5	249	50	248
7	35.0	25.250	0.25	75	68	1.47	1.50	4	250	50	248
8	40.0	28.590	0.21	74	68	1.24	1.25	3.5	252	51	250
9	45.0	32.300	0.27	73	70	1.60	1.60	4.5	248	52	248
10	50.0	36.280	0.30	71	70	1.79	1.80	5	254	53	251
11	55.0	40.010	0.26	71	71	1.55	1.55	4.5	252	54	247
12	60.0	43.791	0.27	73	71	1.60	1.60	4.5	248	55	247
13	65.0	47.320	0.23	76	71	1.36	1.35	3.5	249	53	245
14	70.0	50.650	0.23	76	73	1.36	1.35	3.5	253	54	248
15	75.0	54.200	0.24	76	73	1.42	1.45	4	255	54	248
16	80.0	57.790	0.24	76	73	1.42	1.45	4	250	55	249
17	85.0	61.360	0.24	76	73	1.42	1.40	4	250	56	249
18	90.0	64.860	0.23	76	74	1.37	1.35	4	250	57	249
19	95.0	68.490	0.25	77	75	1.49	1.50	4	249	57	247
20	100.0	72.110	0.24	77	75	1.43	1.45	4	250	58	249
21	105.0	75.540	0.22	77	76	1.31	1.30	3.5	252	58	249
22	110.0	78.630	0.17	77	76	1.01	1.00	3	249	58	249
23	115.0	81.950	0.21	76	77	1.26	1.25	3.5	249	57	247
24	120.0	85.575	0.21	76	77	1.26	1.25	3.5	252	57	248

Isokinetic Field Data
Field Data Entry

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
EPA Method: 5
Box Operator: AAM
Technician(s): NEW/JPC

Environmental Conditions/Test Notes:
Sunny, 45-75 degrees F

Run: 2
Start Time: 15:35
End Time: 17:38
Date: 1/31/2024

Stack Dimensional Data:

Circular
Diameter 45.250 in
Rectangular
Width in
Length in
Stack Area 11.168 sq.ft.

Equipment:

Meterbox ID	SB-5	Probe ID	T-4-1	Liner type	SS
Y factor	0.9805	Nozzle ID	99	Nozzle size	0.273 inches
$\Delta H@$	1.859	Hot box ID	HB-2	Nozzle area	0.000406 sq.ft.
Bp ID	TTB-2	Pitot Cp	0.84	Probe heat	248 °F
Balance ID	WSS-3	Pitot ID	T-PT-3	Filter heat	248 °F
Weights ID	WSW-1	Probe Length, ft	4	Condenser TC ID	8473

Source Information:

Barometric Pressure	26.27 inHg	Assumed O ₂	NA %
Static Pressure	-7.52 inH ₂ O	Assumed CO ₂	NA %
Ave. ΔP	0.24 inH ₂ O	Rec. Nz.	0.282 inches
Stack Temperature	75 °F		
Assumed moisture	0.74 %		
Assumed meter temp.	71 °F		
Total number of points	24		
Time per point	5 min.		
Total run time	120 min.		

Leak Checks:

	Pre-test	Post-test
Pitot	x	x
Leak rate, dcfm	0.000	0.000
Leak check vacuum, inHg	15	6

Nozzle check for roundness:

1	2	3
0.273	0.273	0.272 inches
Caliper ID		TMC-3

Post Test Calculations:

Sample volume	84.566 dcf	Ave. ΔP	0.233 inH ₂ O
Wet mol. weight	28.9 M _s (actual)	Ave. $\sqrt{\Delta P}$	0.482 inH ₂ O
Actual H ₂ O	0.93 %	Ave. ΔH	1.387 inH ₂ O
Std. meter vol.	72.358 dscf	Ave. T _s	76.6 °F
Isokinetic Average	100.5 %	Ave. T _m	73.3 °F

Moisture/Lab:

Filter, #	Q-2-62		Gain
	Initial	Final	
Impingers, g	2,150.9	2,150.4	-0.5
Silica gel, g	933.6	948.5	14.9
Total water gain:			14.4

Traverse Point	Time (min.)	Meter Volume (dcf)	Velocity ΔP (inH ₂ O)	Stack Temp. (°F)	Meter Temp. (°F)	Calc. ΔH	Run ΔH	Vacuum (inHg)	Filter Box (°F)	Condenser Temp ($\leq 68^\circ F$)	Probe Temp (248 \pm 25°F)
1	5.0	3.760	0.27	76	76	1.61	1.60	2.5	253	60	246
2	10.0	7.570	0.27	76	75	1.61	1.60	2.5	247	55	251
3	15.0	11.270	0.26	76	75	1.55	1.55	2.5	247	53	248
4	20.0	14.970	0.25	77	74	1.48	1.50	2.5	249	55	247
5	25.0	18.450	0.23	77	74	1.36	1.35	2.5	249	57	249
6	30.0	22.200	0.27	78	74	1.60	1.60	2.5	252	58	250
7	35.0	25.890	0.25	79	74	1.48	1.50	2.5	250	59	252
8	40.0	29.540	0.25	79	74	1.48	1.50	2.5	249	60	247
9	45.0	33.170	0.25	79	74	1.48	1.50	2.5	253	61	248
10	50.0	36.470	0.20	79	73	1.18	1.20	2.5	252	55	249
11	55.0	39.740	0.20	79	73	1.18	1.20	2.5	255	52	251
12	60.0	43.155	0.20	78	73	1.18	1.20	2.5	250	51	249
13	65.0	46.690	0.24	78	72	1.42	1.40	2.5	255	51	246
14	70.0	50.110	0.24	77	73	1.42	1.40	2.5	249	50	247
15	75.0	53.670	0.24	77	73	1.42	1.40	2.5	257	50	252
16	80.0	57.170	0.23	77	73	1.36	1.35	2.5	253	51	252
17	85.0	60.550	0.21	77	73	1.24	1.25	2.5	252	51	248
18	90.0	64.170	0.25	76	73	1.48	1.50	2.5	251	51	249
19	95.0	67.800	0.24	76	73	1.42	1.40	2.5	250	51	248
20	100.0	71.420	0.25	75	72	1.48	1.50	2.5	246	51	246
21	105.0	75.080	0.25	74	72	1.49	1.50	2.5	251	51	249
22	110.0	78.350	0.20	73	72	1.19	1.20	2.5	252	51	249
23	115.0	81.620	0.20	73	72	1.19	1.20	2.5	250	51	250
24	120.0	84.566	0.15	73	72	0.89	0.89	2	253	51	251

Isokinetic Field Data
Field Data Entry

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
EPA Method: 5
Box Operator: AAM
Technician(s): NEW/JPC

Environmental Conditions/Test Notes:
Sunny, 45-75 degrees F

Run: 3
Start Time: 18:05
End Time: 20:18
Date: 1/31/2024

Stack Dimensional Data:

Circular
Diameter 45.250 in
Rectangular
Width in
Length in
Stack Area 11.168 sq.ft.

Equipment:

Meterbox ID SB-5
Y factor 0.9805
 $\Delta H@$ 1.859
Bp ID TTB-2
Balance ID WSS-3
Weights ID WSW-1
Probe ID T-4-1
Nozzle ID 99
Hot box ID HB-2
Pitot Cp 0.84
Pitot ID T-PT-3
Probe Length, ft 4
Liner type SS
Nozzle size 0.273 inches
Nozzle area 0.000406 sq.ft.
Probe heat 248 °F
Filter heat 248 °F
Condenser TC ID 8473

Source Information:

Barometric Pressure 26.27 inHg
Static Pressure -7.52 inH₂O
Ave. ΔP 0.233 inH₂O
Stack Temperature 76.6 °F
Assumed moisture 0.93 %
Assumed meter temp. 73.3 °F
Total number of points 24
Time per point 5 min.
Total run time 120 min.

Assumed O₂ NA %
Assumed CO₂ NA %
Rec. Nz. 0.284 inches

Leak Checks:

	Pre-test	Post-test
Pitot	x	x
Leak rate, dcfm	0.012	0.015
Leak check vacuum, inHg	12	5.5

Nozzle check for roundness:

1	2	3
0.273	0.273	0.272 inches
Caliper ID		TMC-3

Post Test Calculations:

Sample volume 84.571 dcf
Wet mol. weight 28.87 M_s (actual)
Actual H₂O 1.16 %
Std. meter vol. 72.473 dscf
Isokinetic Average 100.0 %

Ave. ΔP 0.235 inH₂O
Ave. $\sqrt{\Delta P}$ 0.483 inH₂O
Ave. ΔH 1.402 inH₂O
Ave. T_s 69.9 °F
Ave. T_m 72.5 °F

Moisture/Lab:

Filter, # Q-2-93
Impingers, g 2,157.6
Silica gel, g 962.5
Initial 2,160.5
Final 977.6
Gain 2.9
Total water gain: 18.0

Traverse Point	Time (min.)	Meter Volume (dcf)	Velocity ΔP (inH ₂ O)	Stack Temp. (°F)	Meter Temp. (°F)	Calc. ΔH	Run ΔH	Vacuum (inHg)	Filter Box (°F)	Condenser Temp ($\leq 68^\circ F$)	Probe Temp (248 \pm 25°F)
1	5.0	3.510	0.23	73	72	1.37	1.40	2.5	231	56	251
2	10.0	6.900	0.22	73	72	1.31	1.30	2.5	252	48	249
3	15.0	10.270	0.22	73	72	1.31	1.30	2.5	252	44	250
4	20.0	13.710	0.22	73	72	1.31	1.30	2.5	248	45	245
5	25.0	16.940	0.20	73	72	1.19	1.20	2.5	252	45	248
6	30.0	20.310	0.22	73	72	1.31	1.30	2.5	251	45	248
7	35.0	23.730	0.22	73	72	1.31	1.30	2.5	253	46	250
8	40.0	27.490	0.27	72	72	1.61	1.60	3	250	46	247
9	45.0	31.260	0.28	72	72	1.67	1.65	3	250	46	246
10	50.0	35.330	0.32	69	72	1.91	1.90	3	251	47	248
11	55.0	39.430	0.32	69	72	1.91	1.90	3	249	47	248
12	60.0	43.522	0.31	69	72	1.85	1.85	3	252	48	247
13	65.0	46.880	0.21	71	73	1.25	1.25	2.5	254	48	246
14	70.0	50.320	0.21	71	73	1.25	1.25	2.5	249	48	247
15	75.0	53.720	0.22	71	73	1.31	1.30	2.5	250	48	247
16	80.0	57.050	0.21	71	73	1.25	1.25	2.5	253	48	248
17	85.0	60.340	0.20	70	73	1.20	1.20	2.5	251	48	248
18	90.0	63.730	0.22	69	73	1.32	1.30	2.5	250	49	248
19	95.0	67.040	0.20	69	73	1.20	1.20	2.5	252	49	246
20	100.0	70.660	0.25	66	73	1.51	1.50	2.5	251	49	244
21	105.0	74.850	0.33	65	73	1.99	2.00	3	250	48	249
22	110.0	78.280	0.20	64	73	1.21	1.20	2.5	253	49	248
23	115.0	81.330	0.17	64	73	1.03	1.05	2.5	248	49	247
24	120.0	84.571	0.19	65	73	1.15	1.15	2.5	249	49	249

**EPA Method 4
Impinger Weights Summary**

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600

Run 1 1/31/2024

Impinger #	Initial (g)	Final (g)	Gain (g)
1	743.7	736.2	-7.5
2	740.3	740.5	0.2
3	650.7	652.5	1.8
4			
5			
6			
Total	2,134.7	2,129.2	-5.5

Run 2 1/31/2024

Impinger #	Initial (g)	Final (g)	Gain (g)
1	746.7	743.9	-2.8
2	744.3	744.9	0.6
3	659.9	661.6	1.7
4			
5			
6			
Total	2,150.9	2,150.4	-0.5

Run 3 1/31/2024

Impinger #	Initial (g)	Final (g)	Gain (g)
1	750.5	749.9	-0.6
2	752.2	753.4	1.2
3	654.9	657.2	2.3
4			
5			
6			
Total	2,157.6	2,160.5	2.9

**EPA Method 5
Filterable Particulate Matter
Results Summary**

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600

Parameter	Units	Run1	Run2	Run3	Average	
Date		1/31/2024	1/31/2024	1/31/2024		
Run Start Time		12:15	15:35	18:05		
Run End Time		14:19	17:38	20:18		
Run Duration	minutes	120	120	120		
Barometric Pressure	inHg	26.27	26.27	26.27	26.27	
Nozzle Diameter	inches	0.273	0.273	0.273	0.273	
Isokinetic Average	%	100.4	100.5	100.0	100.3	
Sample Volume	dscf	73.544	72.358	72.473	72.792	
	dscm	2.083	2.049	2.052	2.061	
Stack Diameter	inches	45.25	45.25	45.25	45.25	
Stack Area	square feet	11.168	11.168	11.168	11.168	
Static Pressure	inH ₂ O	-7.52	-7.52	-7.52	-7.52	
H ₂ O	%vd	0.74	0.93	1.16	0.94	
Wet Molecular Weight	lb/lb-mole	28.92	28.90	28.87	28.90	
Velocity	fps	29.77	29.40	29.29	29.49	
Flow Rate	adcfm	19,800	19,517	19,399	19,572	
	acfm	19,948	19,700	19,627	19,758	
	dscfm	16,796	16,506	16,614	16,639	
Stack Temperature	°F	75.0	76.6	69.9	73.8	
Filterable Particulate	Concentration, C _s	gr/dscf	0.0007	0.0035	0.0029	0.0024
	Mass	lb/hr	0.10	0.50	0.41	0.34
		lb/ton processed	0.0050	0.0238	0.0199	0.0162
Production Data	Slag Process Rate	tons/hr	20.77	20.77	20.77	20.77

Isokinetic Field Data
Field Data and Calculations
Particulate Emissions and Gas Stream Characteristics

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
Method: 5

Run: 1
Start Time: 12:15
End Time: 14:19
Date: 1/31/2024

Sampling Data				Traverse Data			
Time min.	Meter ft ³	ΔH inH ₂ O	Meter T _m °F	Traverse Point	D _p inH ₂ O	Stack T _s °F	\sqrt{Dp}
	0.000						
5	3.780	1.60	64	1	0.27	72	0.520
10	7.460	1.50	64	2	0.26	74	0.510
15	11.070	1.45	65	3	0.25	75	0.500
20	14.690	1.45	66	4	0.25	75	0.500
25	18.270	1.40	67	5	0.24	75	0.490
30	21.670	1.30	67	6	0.22	75	0.469
35	25.250	1.50	68	7	0.25	75	0.500
40	28.590	1.25	68	8	0.21	74	0.458
45	32.300	1.60	70	9	0.27	73	0.520
50	36.280	1.80	70	10	0.30	71	0.548
55	40.010	1.55	71	11	0.26	71	0.510
60	43.791	1.60	71	12	0.27	73	0.520
65	47.320	1.35	71	13	0.23	76	0.480
70	50.650	1.35	73	14	0.23	76	0.480
75	54.200	1.45	73	15	0.24	76	0.490
80	57.790	1.45	73	16	0.24	76	0.490
85	61.360	1.40	73	17	0.24	76	0.490
90	64.860	1.35	74	18	0.23	76	0.480
95	68.490	1.50	75	19	0.25	77	0.500
100	72.110	1.45	75	20	0.24	77	0.490
105	75.540	1.30	76	21	0.22	77	0.469
110	78.630	1.00	76	22	0.17	77	0.412
115	81.950	1.25	77	23	0.21	76	0.458
120	85.575	1.25	77	24	0.21	76	0.458

Client: Minerals Research, Inc.

Run: 1

Source: BH-600

Date: 01/31/24

Field Data Input Continued

Moisture Data

Total Test Time	120.0 min
Sample Time Interval	5.0 min
Meter Volume, V_m	85.575 dcf
Water Weight	11.7 g
Nozzle Diameter, N_z	0.273 in.
Nozzle Area	0.000406 sq.ft.

Stack Dimensional Data:

Circular	
Diameter	45.250 in
Rectangular	
Width	in
Length	in
Stack Area	11.168 sq.ft.

Traverse Data

Barometric Pressure, P_b	26.27 inHg
Static Pressure	-7.52 inH ₂ O
Pitot Factor, cp	0.84
Meter Cal Factor	0.9805 Y

Molecular Weight:

CO ₂ Average	NA	%vd
O ₂ Average	NA	%vd

Field Data Averages

Meter

ΔH	1.421 inH ₂ O
Temperature, T_m	71.0 °F
Temperature, T_m	530.7 °A (°R)
Pressure Meter, P_m	26.374 inHg

Stack

\sqrt{Dp}	0.489 inH ₂ O
Temperature, T_s	75.0 °F
Temperature, T_s	534.7 °A (R)
Pressure Stack, P_s	25.717 inHg

Field Data Calculations

Meter Box Capture

Standard Volume, $V_{m(std)}$	73.544 dscf
	2.083 dscm
Actual Volume, $V_{m(actual)}$	87.345 awcf

EPA Method 2 Stack Gas Flowrate:

Velocity, V_s	29.77 fps
Volume (actual)	19,948 acfm
	19,800 adcfm
Volume (standard)	1,015,295 wscf/hr

Gas Stream Moisture

Moisture Vapor, $V_{w(std)}$	0.552 scf	1,007,782 dscf/hr
Moisture, B_{ws}	0.0074	16,796 dscf/min
Moisture EPA M4	0.74 %v	16,922 wscf/min
Moisture @ Saturation	3.41 %v (for $T_s < 212^\circ F$)	

EPA Method 3 Gas Density

Dry, M_d	29.00 lb/lb-mole
Wet, M_s	28.92 lb/lb-mole

Percent Isokinetic 100.4 %

Laboratory Results

EPA Method 5

Filterable PM	0.0034 grams	Concentration, C_s	0.0007 gr/dscf
		Mass Emissions	0.10 lb/hr

Isokinetic Field Data
Field Data and Calculations
Particulate Emissions and Gas Stream Characteristics

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
Method: 5

Run: 2
Start Time: 15:35
End Time: 17:38
Date: 1/31/2024

Sampling Data				Traverse Data			
Time min.	Meter ft ³	ΔH inH ₂ O	Meter T _m °F	Traverse Point	D _p inH ₂ O	Stack T, °F	\sqrt{Dp}
	0.000						
5	3.760	1.60	76	1	0.27	76	0.520
10	7.570	1.60	75	2	0.27	76	0.520
15	11.270	1.55	75	3	0.26	76	0.510
20	14.970	1.50	74	4	0.25	77	0.500
25	18.450	1.35	74	5	0.23	77	0.480
30	22.200	1.60	74	6	0.27	78	0.520
35	25.890	1.50	74	7	0.25	79	0.500
40	29.540	1.50	74	8	0.25	79	0.500
45	33.170	1.50	74	9	0.25	79	0.500
50	36.470	1.20	73	10	0.20	79	0.447
55	39.740	1.20	73	11	0.20	79	0.447
60	43.155	1.20	73	12	0.20	78	0.447
65	46.690	1.40	72	13	0.24	78	0.490
70	50.110	1.40	73	14	0.24	77	0.490
75	53.670	1.40	73	15	0.24	77	0.490
80	57.170	1.35	73	16	0.23	77	0.480
85	60.550	1.25	73	17	0.21	77	0.458
90	64.170	1.50	73	18	0.25	76	0.500
95	67.800	1.40	73	19	0.24	76	0.490
100	71.420	1.50	72	20	0.25	75	0.500
105	75.080	1.50	72	21	0.25	74	0.500
110	78.350	1.20	72	22	0.20	73	0.447
115	81.620	1.20	72	23	0.20	73	0.447
120	84.566	0.89	72	24	0.15	73	0.387

Client: Minerals Research, Inc.

Run: 2

Source: BH-600

Date: 01/31/24

Field Data Input Continued

Moisture Data

Total Test Time	120.0 min
Sample Time Interval	5.0 min
Meter Volume, V _m	84.566 dcf
Water Weight	14.4 g
Nozzle Diameter, N _z	0.273 in.
Nozzle Area	0.000406 sq.ft.

Stack Dimensional Data:

Circular	
Diameter	45.250 in
Rectangular	
Width	in
Length	in
Stack Area	11.168 sq.ft.

Traverse Data

Barometric Pressure, P _b	26.27 inHg
Static Pressure	-7.52 inH ₂ O
Pitot Factor, cp	0.84
Meter Cal Factor	0.9805 Y

Molecular Weight:

CO ₂ Average	NA	%vd
O ₂ Average	NA	%vd

Field Data Averages

Meter

ΔH	1.387 inH ₂ O
Temperature, T _m	73.3 °F
Temperature, T _m	533.0 °A (°R)
Pressure Meter, P _m	26.372 inHg

Stack

√Dp	0.482 inH ₂ O
Temperature, T _s	76.6 °F
Temperature, T _s	536.3 °A (R)
Pressure Stack, P _s	25.717 inHg

Field Data Calculations

Meter Box Capture

Standard Volume, V _{m(std)}	72.358 dscf
	2.049 dscm
Actual Volume, V _{m(actual)}	86.358 awcf

EPA Method 2 Stack Gas Flowrate:

Velocity, V _s	29.40 fps
Volume (actual)	19,700 acfm
	19,517 adcfm
Volume (standard)	999,684 wscf/hr

Gas Stream Moisture

Moisture Vapor, V _{w(std)}	0.679 scf
Moisture, B _{ws}	0.0093
Moisture EPA M4	0.93 %v
Moisture @ Saturation	3.59 %v (for T _s < 212°F)

	990,387 dscf/hr
	16,506 dscf/min
	16,661 wscf/min

EPA Method 3 Gas Density

Dry, M _d	29.00 lb/lb-mole
Wet, M _s	28.90 lb/lb-mole

Percent Isokinetic 100.5 %

Laboratory Results

EPA Method 5

Filterable PM	0.0164 grams	Concentration, C _s	0.0035 gr/dscf
		Mass Emissions	0.50 lb/hr

Isokinetic Field Data
Field Data and Calculations
Particulate Emissions and Gas Stream Characteristics

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600
Method: 5

Run: 3
Start Time: 18:05
End Time: 20:18
Date: 1/31/2024

Sampling Data				Traverse Data			
Time min.	Meter ft ³	ΔH inH ₂ O	Meter T _m °F	Traverse Point	D _p inH ₂ O	Stack T _s °F	\sqrt{Dp}
	0.000						
5	3.510	1.40	72	1	0.23	73	0.480
10	6.900	1.30	72	2	0.22	73	0.469
15	10.270	1.30	72	3	0.22	73	0.469
20	13.710	1.30	72	4	0.22	73	0.469
25	16.940	1.20	72	5	0.20	73	0.447
30	20.310	1.30	72	6	0.22	73	0.469
35	23.730	1.30	72	7	0.22	73	0.469
40	27.490	1.60	72	8	0.27	72	0.520
45	31.260	1.65	72	9	0.28	72	0.529
50	35.330	1.90	72	10	0.32	69	0.566
55	39.430	1.90	72	11	0.32	69	0.566
60	43.522	1.85	72	12	0.31	69	0.557
65	46.880	1.25	73	13	0.21	71	0.458
70	50.320	1.25	73	14	0.21	71	0.458
75	53.720	1.30	73	15	0.22	71	0.469
80	57.050	1.25	73	16	0.21	71	0.458
85	60.340	1.20	73	17	0.20	70	0.447
90	63.730	1.30	73	18	0.22	69	0.469
95	67.040	1.20	73	19	0.20	69	0.447
100	70.660	1.50	73	20	0.25	66	0.500
105	74.850	2.00	73	21	0.33	65	0.574
110	78.280	1.20	73	22	0.20	64	0.447
115	81.330	1.05	73	23	0.17	64	0.412
120	84.571	1.15	73	24	0.19	65	0.436

Client: Minerals Research, Inc.

Run: 3

Source: BH-600

Date: 01/31/24

Field Data Input Continued

Moisture Data

Total Test Time	120.0 min
Sample Time Interval	5.0 min
Meter Volume, V_m	84.571 dcf
Water Weight	18.0 g
Nozzle Diameter, N_z	0.273 in.
Nozzle Area	0.000406 sq.ft.

Stack Dimensional Data:

Circular	
Diameter	45.250 in
Rectangular	
Width	in
Length	in
Stack Area	11.168 sq.ft.

Traverse Data

Barometric Pressure, P_b	26.27 inHg
Static Pressure	-7.52 inH ₂ O
Pitot Factor, cp	0.84
Meter Cal Factor	0.9805 Y

Molecular Weight:

CO ₂ Average	NA	%vd
O ₂ Average	NA	%vd

Field Data Averages

Meter

ΔH	1.402 inH ₂ O
Temperature, T_m	72.5 °F
Temperature, T_m	532.2 °A (°R)
Pressure Meter, P_m	26.373 inHg

Stack

\sqrt{Dp}	0.483 inH ₂ O
Temperature, T_s	69.9 °F
Temperature, T_s	529.6 °A (R)
Pressure Stack, P_s	25.717 inHg

Field Data Calculations

Meter Box Capture

Standard Volume, $V_{m(std)}$	72.473 dscf
	2.052 dscm
Actual Volume, $V_{m(actual)}$	85.615 awcf

EPA Method 2 Stack Gas Flowrate:

Velocity, V_s	29.29 fps
Volume (actual)	19,627 acfm
	19,399 adcfm
Volume (standard)	1,008,544 wscf/hr

Gas Stream Moisture

Moisture Vapor, $V_{w(std)}$	0.849 scf
Moisture, B_{ws}	0.0116
Moisture EPA M4	1.16 %v
Moisture @ Saturation	2.87 %v (for $T_s < 212^\circ F$)

996,845 dscf/hr
16,614 dscf/min
16,809 wscf/min

EPA Method 3 Gas Density

Dry, M_d	29.00 lb/lb-mole
Wet, M_s	28.87 lb/lb-mole

Percent Isokinetic 100.0 %

Laboratory Results

EPA Method 5

Filterable PM	0.0136 grams	Concentration, C_s	0.0029 gr/dscf
		Mass Emissions	0.41 lb/hr

**EPA Method 5
Filterable Particulate Matter
Laboratory Gravimetric Data**

**Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600**

Run	Sample Description	g, #	Initial Weight (g)	Final Weight (g)	Net Gain (g)	Blank Correction (g)	Corrected Gain (g)
1	Probe Rinse (Acetone FH)	43.5	86.5879	86.5908	0.0029	0.0002	0.0027
	Filter	Q-2-61	0.3512	0.3519	0.0007		0.0007
						Filterable PM (g)	0.0034
2	Probe Rinse (Acetone FH)	45.7	86.3121	86.3227	0.0106	0.0002	0.0104
	Filter	Q-2-62	0.4891	0.4951	0.0060		0.0060
						Filterable PM (g)	0.0164
3	Probe Rinse (Acetone FH)	37.0	86.5607	86.5684	0.0077	0.0002	0.0075
	Filter	Q-2-93	0.4880	0.4941	0.0061		0.0061
						Filterable PM (g)	0.0136
	Acetone Blank	144.4	174.9975	174.9981	0.0006	0.0000 g/g	

EPA Methods 1-4, 5
Example Calculations

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Source: BH-600

Run: 1
Start Time: 12:15
End Time: 14:19
Date: 1/31/24

EPA Methods 1-4:

$$1) P_m = P_b + (\Delta H/13.6) = 26.374 \text{ inHg}$$

where P_b : 26.27 inHg
 ΔH : 1.421 inH₂O

$$2) P_s = P_b + (\text{Static Press.}/13.6) = 25.717 \text{ inHg}$$

where P_b : 26.27 inHg
 Static Press.: -7.52 inH₂O

$$3) V_{m(\text{std})} = V_m \left(\frac{T_{\text{std}}}{P_{\text{std}}} \right) (Y) \left(\frac{P_m}{T_m} \right) = 73.544 \text{ dscf}$$

where V_m : 85.575 dcf
 Y : 0.9805
 P_m : 26.374 inHg
 T_m : 530.7 °A
 T_{std} : 527.67 °R
 P_{std} : 29.92 inHg

$$4) V_{w(\text{std})} = V_{\text{H}_2\text{O}} \left(\frac{\rho_w * R * T_{\text{std}}}{P_{\text{std}} * M_w} \right) = 0.552 \text{ scf}$$

where H_2O : 11.70 g
 ρ_w : 2.2046E-03 lb/mol
 R : 21.85 inHg ft³/lb-mol °R
 T_{std} : 527.67 °R
 P_{std} : 29.92 inHg
 M_w : 18.015 lb/lb-mol

$$5) B_{ws} = \left(\frac{V_{w(\text{std})}}{V_{w(\text{std})} + V_{m(\text{std})}} \right) = 0.0074$$

where $V_{w(\text{std})}$: 0.552 scf
 $V_{m(\text{std})}$: 73.544 dscf

$$6) \% \text{H}_2\text{O} = B_{ws} \times 100 = 0.74 \%v$$

7) Moisture Saturation @ Stack Temperature (for $T_s < 212^\circ\text{F}$)

$$\% \text{H}_2\text{O}_{\text{Sat}} = \frac{\% \text{RHSat}}{P_s} 10^{6.6912 - \left(\frac{3144}{T_s + 390.86} \right)} = 3.41 \%v$$

where RH: 100 %
 P_s : 25.717 inHg
 T_s : 75 °F

EPA Methods 1-4, 5
Example Calculations

$$8) V_m(\text{actual}) = \left(\frac{Y \times V_m}{(1 - B_{ws})} \right) \left(\frac{T_s}{T_m} \right) \left(\frac{P_m}{P_s} \right) = 87.345 \text{ awcf}$$

where Y: 0.9805
 V_m : 85.5750 dcf
 B_{ws} : 0.0074
 T_s : 534.7 °A
 T_m : 530.7 °A
 P_m : 26.374 inHg
 P_s : 25.717 inHg

$$9) M_d = 0.44(\text{CO}_2) + 0.32(\text{O}_2) + 0.28(\text{N}_2 + \text{CO}) = 29.00 \text{ lb/lb-mole}$$

where CO_2 : NA %vd
 O_2 : NA %vd
 $\text{N}_2 + \text{CO} = (100 - (\text{O}_2 + \text{CO}_2))$: NA %vd

$$10) M_s = M_d(1 - B_{ws}) + (18 \times B_{ws}) = 28.92 \text{ lb/lb-mole}$$

where M_d : 29.00 lb/lb-mole
 B_{ws} : 0.0074

$$11) \text{Stack Area(cir.)} = \pi (\text{stack diameter}/24)^2 = 11.168 \text{ sq. ft.}$$

where Stack ID: 45.25 inches

$$\text{Stack Area(rect.)} = \text{stack width}/12 \times \text{stack length}/12 = \text{NA sq. ft.}$$

where Stack Width: inches
Stack Length: inches

$$12) \text{Velocity, } V_s = 85.49(C_p)(\text{Ave. Sqrt } \Delta P) \left(\sqrt{\frac{T_s}{(P_s \times M_s)}} \right) = 29.77 \text{ fps}$$

where C_p : 0.84
Ave. Sqrt ΔP : 0.4890
 T_s : 534.7 °A
 P_s : 25.717 inHg
 M_s : 28.92 lb/lb-mole

$$13) \text{ACFM} = (V_s)(\text{stack area})(60 \text{ sec}/\text{min}) = 19,948 \text{ acfm}$$

where V_s : 29.77 fps
Stack Area: 11.168 sq. ft.

$$14) \text{ADCFM} = (\text{ACFM})(1 - B_{ws}) = 19,800 \text{ adcfm}$$

where acfm: 19,948.0
 B_{ws} : 0.0074

$$15) Q_{sw} = 3600(V_s)(\text{stack area}) \left(\frac{527.67^\circ\text{A}}{T_s} \right) \left(\frac{P_s}{29.92 \text{ "Hg}} \right) = 1,015,295 \text{ wscf/hr}$$

where V_s : 29.77 ft/sec
Stack Area: 11.1680 sq. ft.
 T_s : 534.7 °A
 P_s : 25.717 inHg

EPA Methods 1-4, 5
Example Calculations

16) $Q_{sd} = (wscf/hr)(1-B_{ws}) =$ 1,007,782 dscf/hr
 where wscf/hr: 1,015,295.0
 B_{ws} : 0.0074

17) DSCFM = (dscf/hr)/60 mins/hr = 16,796 dscfm
 where dscf/hr: 1,007,782.0

18) Nozzle Area = π (Nozzle Size/24)² = 0.000406 sq. ft.
 where Nozzle Size: 0.2730 inches

19) Isokinetic % = $\left(\frac{0.0945(T_s)(V_m(std))}{P_s(V_s)(nozzle\ area)(sampling\ time)(1-B_{ws})} \right) =$ 100.4 %
 where T_s : 534.7 °A
 $V_{m(Std)}$: 73.544 dscf
 P_s : 25.717 inHg
 V_s : 29.77 fps
 Nozzle Area: 0.000406 sq. ft.
 Sampling Time: 120 min.
 B_{ws} : 0.0074

EPA Method 5:

20) Filterable PM = filter gain + probe rinse gain = 0.0034 grams
 where Filter Gain: 0.0007 grams
 Probe Rinse: 0.0027 grams

21) $C_s = (Sample\ grams/V_{m(Std)})(15.43\text{grains/gram}) =$ 0.0007 gr/dscf
 where Sample: 0.0034 grams
 $V_{m(std)}$: 73.544 dscf

22) Mass Emission Rate = $(C_s)(Stack\ flow)/7000\text{gr/lb} =$ 0.10 lb/hr
 where C_s : 0.0007 gr/dscf
 Stack Flow: 1,007,782.0 dscf/hr

23) Emission Standard = (Mass Emission Rate)/(Slag Process Rate) = 0.0050 lb/ton
 where Mass Emission Rate: 0.10 lb/hr
 Slag Process Rate: 20.77 tons/hr

APPENDIX B: LABORATORY REPORTS

Bison Engineering, Inc.
Gravimetric Information

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Project Number: MRI224237
Test Date: 1/31/2024

Filters:

Sample Identification	Filter #	Date	Tare 1 (g)	Date	Tare 2 (g)	CHECK	Average	Filter #	Date	Final 1 (g)	Date	Final 2 (g)	CHECK	Average	Gain
BH-600 Run 1	Q-2-61	12/6/2023	0.3512	1/23/2024	0.3512	0.0000	0.3512	Q-2-61	2/5/2024	0.3520	2/6/2024	0.3518	-0.0002	0.3519	0.0007
BH-600 Run 2	Q-2-62	12/7/2023	0.4889	1/23/2024	0.4893	0.0004	0.4891	Q-2-62	2/5/2024	0.4950	2/6/2024	0.4951	0.0001	0.4951	0.0060
BH-600 Run 3	Q-2-93	1/23/2024	0.4879	1/24/2024	0.4881	0.0002	0.4880	Q-2-93	2/5/2024	0.4941	2/6/2024	0.4941	0.0000	0.4941	0.0061

Liquid Fractions:

Wt (g)	Sample Identification	Dish #	Date	Tare 1 (g)	Date	Tare 2 (g)	CHECK	Average	Dish #	Date	Final 1 (g)	Date	Final 2 (g)	CHECK	Average	Gain
43.5	BH-600 Run 1	D400	12/6/2023	86.5878	1/23/2024	86.5879	0.0001	86.5879	D400	2/5/2024	86.5907	2/6/2024	86.5909	0.0002	86.5908	0.0029
45.7	BH-600 Run 2	D401	12/6/2023	86.3122	1/23/2024	86.3119	-0.0003	86.3121	D401	2/5/2024	86.3226	2/6/2024	86.3228	0.0002	86.3227	0.0106
37	BH-600 Run 3	D402	12/6/2023	86.5606	1/23/2024	86.5607	0.0001	86.5607	D402	2/5/2024	86.5682	2/6/2024	86.5686	0.0004	86.5684	0.0077
71.9	BH-600 BLANK 1/2	D403	12/6/2023	87.3629	1/23/2024	87.3625	-0.0004	87.3627	D403	2/5/2024	87.3629	2/6/2024	87.3629	0.0000	87.3629	0.0002
72.5	BH-600 BLANK 2/2	D404	11/1/2023	87.6347	1/23/2024	87.6348	0.0001	87.6348	D404	2/5/2024	87.6351	2/6/2024	87.6352	0.0001	87.6352	0.0004

Bison Engineering, Inc.
Balance Verification

Client: Minerals Research, Inc.
Location: Cottonwood, AZ
Project Number: MRI224237
Test Date: 1/31/2024

Balance ID	Date	Time	Standard Balance Masses (g)											Ref. Filter Mass		0.1239	Environmental Conditions			
			1.0000	2.0000	3.0000	5.0000	10.0000	20.0000	30.0000	50.0000	80.0000	1000.0000	120.0000	Filter + PM (g)	PM (g)	CHECK	Room		Dessicator	
			T (°F)	RH (%)	T (°F)	RH (%)														
TSB-1	11/1/23	12:42 PM	1.0000	2.0000	3.0000	5.0000	10.0000	20.0001	30.0002	50.0000	80.0003	100.0001	120.0002	0.2356	0.1117	GO	68.7	26.5	66.0	11.0
TSB-2	11/1/23	12:42 PM	1.0000	2.0000	3.0000	5.0000	10.0000	20.0000	30.0001	50.0001	80.0002	100.0001	120.0002	0.2355	0.1116	GO	68.7	26.5	66.0	11.0
TSB-1	12/6/23	10:12 AM	1.0000	2.0000	3.0001	5.0000	10.0002	20.0000	30.0002	50.0001	80.0002	100.0000	120.0001	0.2354	0.1115	GO	71.8	25.8	71.6	11.0
TSB-2	12/6/23	10:12 AM	1.0000	2.0000	3.0000	5.0000	10.0000	20.0000	30.0000	49.9999	80.0004	100.0000	120.0001	0.2355	0.1116	GO	71.8	25.8	71.6	11.0
TSB-1	12/7/23	9:35 AM	1.0000	2.0000	3.0000	5.0000	10.0000	20.0000	30.0001	50.0000	80.0001	100.0000	120.0001	0.2355	0.1116	GO	71.8	24.7	71.0	11.0
TSB-2	12/7/23	9:35 AM	1.0000	2.0000	3.0000	5.0000	10.0000	20.0000	30.0001	50.0000	80.0001	100.0000	120.0000	0.2356	0.1117	GO	71.8	24.7	71.0	11.0
TSB-1	1/23/24	12:38 PM	1.0000	2.0000	3.0000	5.0000	10.0001	20.0001	30.0001	50.0001	80.0001	100.0001	120.0001	0.2355	0.1116	GO	70.0	38.5	70.7	11.0
TSB-2	1/23/24	12:38 PM	1.0000	2.0000	3.0000	5.0001	10.0000	20.0001	30.0002	50.0001	80.0002	100.0001	120.0000	0.2356	0.1117	GO	70.0	38.5	70.7	11.0
TSB-1	1/24/24	12:39 PM	1.0000	2.0000	3.0000	5.0001	10.0001	20.0000	30.0001	50.0001	80.0001	100.0001	120.0001	0.2356	0.1117	GO	70.2	42.5	69.6	11.0
TSB-2	1/24/24	12:39 PM	1.0001	2.0000	3.0000	5.0000	10.0000	20.0000	30.0000	50.0000	80.0002	100.0001	120.0001	0.2356	0.1117	GO	70.2	42.5	69.6	11.0
TSB-1	2/5/2024	10:38 AM	1.0000	1.9999	2.9999	5.0000	10.0001	20.0001	30.0001	50.0002	80.0003	100.0004	120.0002	0.2355	0.1116	GO	71.4	29.9	70.0	11.0
TSB-2	2/5/2024	10:38 AM	1.0000	2.0000	3.0000	5.0001	10.0000	19.9999	30.0000	49.9999	80.0000	100.0000	120.0000	0.2356	0.1117	GO	71.4	29.9	70.0	11.0
TSB-1	2/6/2024	11:51 AM	1.0000	2.0000	3.0001	5.0001	10.0000	20.0001	30.0002	50.0001	80.0001	100.0002	120.0000	0.2356	0.1117	GO	68.9	30.7	67.5	11.0
TSB-2	2/6/2024	11:51 AM	1.0000	2.0000	3.0000	4.9999	10.0000	20.0001	30.0001	50.0000	80.0001	100.0000	119.9999	0.2356	0.1117	GO	68.9	30.7	67.5	11.0

BISON ENGINEERING, INC. SOURCE SAMPLE RECEIPT CHECKLIST

Client: MRI (Minerals Research Inc.) Date: 2/1/24
 Location: Cottonwood, AZ Time: 10:00 AM
 Project number: MRI 224137 Project QI: AAU

Is the Chain of Custody present with samples? Y *

Analytical method(s) to be used S †

Has the CoC form been signed by the responsible party? Y

Are the Date and Time noted? Y

All sample containers inspected? Y

Does the number of samples match the number on the CoC form? Y †

Do all the sample IDs match the CoC form? Y †

Were sample volumes marked prior to transport? Y †

Are sample weights noted on containers or CoC? Y †

Are all sample containers intact? Y †

Are any signs of leakage present? N *

Temperature of samples upon arrival ('ambient' if no special conditioning required)? AMBIENT

Is the Chain of Custody signed by the Bison analyst? Y

Corrective actions:

Project QI consulted due to mismatching Sample IDs

Project QI consulted due to broken sample container(s)

Project QI consulted due to leaking sample(s)

Project QI consulted for verification of methodology

Other?

Corrective actions documented?

Corrective actions accomplished?

N/A

*must be addressed prior to analysis and noted in final report
 † Must be addressed prior to sample analysis

Bison analyst: JOANNE SUFI Joanne Sufi 2/1/24
 (Print, sign, date)

Notes: _____



✓31

SC Research

SAMPLE CHAIN OF CUSTODY RECORD

Client: Minerals Research
 Location: Cottonwood, Arizona
 Project Number: MRI224137
 Project Manager: Angel Medina

PM phone: (520) 709-0075
 PM e-mail: amedina@bison-eng.com

SC ✓31

Date	Sample ID	Source	Run #	Method/Analysis	Remarks
1/31/24	Filter Q-2-61	BH-600	1	5	
1/31/24	Probe Rinse Probe Rinse	BH-600	1	5	
	Filter Q-2-62	BH-600	2	5	
	Probe Rinse	BH-600	2	5	
	Filter Q-2-63	BH-600	3	5	
	Probe Rinse	BH-600	3	5	
1/31/24	Acetone Blank	BH-600	N/A	5	
Bison Responsible Party: (name, signature, date and time) <u>Angel Medina</u> 20:30 1/31/24					
Received by: (signature, date and time) <u>Jeanne J...</u> 2/1/24 900			Relinquished by: (signature, date and time) <u>Angel Medina</u> 2/1/24 900		
Received by: (signature, date and time)			Relinquished by: (signature, date and time)		

Y:Source\Laboratory\Chain of Custody\Bison Field Chain of Custody

APPENDIX C: PLANT OPERATING RECORDS

	Wednesday January 31st : BH-600 stack test			
	Differential pressures readings Baghouse BH-600 and 601			
Time		BH-601		BH-600
12.30 pm		1.68		4.69
12.45		1.76		5.13
1		1.9		5.2
1.15		2.15		4.93
1.3		1.73		5.25
1.45		1.96		5.41
3.3		0.4		5.2
4		1.33		5.84
4.15		2.11		5.99
4.3		2.6		6.19
4.45		2.14		6.28
5		3.01		6.36
5.15		1.64		6.38
5.3		2.01		6.84
5.45		2.41		6.4
6		2.49		7.03
6.15		2.73		6.99
6.3		2.63		6.9
6.45		2.86		7.14
7		3.01		6.99
7.15		2.83		7.11
7.45		2.38		7.2
Operator:	_____			
Tonnages	6.66 hours of operation			

		138.3 nt fed			
		Average tons per hour: 20.7			
Plant Mngr		<hr/>			

APPENDIX D: CALIBRATIONS AND CERTIFICATIONS

Accredited Air Emission Testing Body

A2LA has accredited

Bison Engineering, Inc.

In recognition of the successful completion of the joint A2LA and Stack Testing Accreditation Council (STAC) evaluation process, this laboratory is accredited to perform testing activities in compliance with ASTM D7036:2004 - Standard Practice for Competence of Air Emission Testing Bodies.

Presented this 30th day of August 2023.



Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 4675.01
Valid to November 30, 2025

This accreditation program is not included under the A2LA ILAC Mutual Recognition Arrangement.

APEX INSTRUMENTS METERBOX CALIBRATION USING REFERENCE DGM

Meter Console Information	
Console Model Number	SB-5
Console Serial Number	6240
DGM Model Number	SK25EX
DGM Serial Number	6240

Calibration Conditions			
Date	Time	1-Feb-24	12:55
Barometric Pressure		26.27	in Hg
Calibration Technician		NEW	
Calibration Meter Gamma		1.0000	

Standardized Factors/Conversions		
Temperature	528	R
Pressure	29.92	in Hg
K ₁	17.647	R/in Hg

<<<<<<<Your reference meter here

Calibration Data											
Run Time	Metering Console						Reference Meter				
	Manometer	Volume	Volume	Sample	Outlet Temp	Outlet Temp	Volume	Volume	Sample	Outlet Temp	Outlet Temp
Elapsed	ΔH	Initial	Final	Volume	Initial	Final	Initial	Final	Volume	Initial	Final
Θ minutes	P _m in H ₂ O	V _{mi} cubic feet	V _{mf} cubic feet	V _m cubic feet	t _{oi} °F	t _{of} °F	V _{wi} cubic feet	V _{wf} cubic feet	V _w cubic feet	t _{wi} °F	t _{wf} °F
10.00	6.00	0.000	14.014	14.014	74	76	0.000	14.088	14.088	73	74
10.00	4.00	0.000	11.557	11.557	76	79	0.000	11.509	11.509	74	76
10.00	2.00	0.000	8.276	8.276	79	79	0.000	8.156	8.156	76	77
10.00	1.00	0.000	5.990	5.990	79	80	0.000	5.871	5.871	77	77
12.00	0.50	0.000	5.151	5.151	80	80	0.000	5.037	5.037	77	78

Results								
Standardized Data				Dry Gas Meter				
Dry Gas Meter		Calibration Meter		Calibration Factor		Flowrate	ΔH _@	
				Value	Variation	Std & Corr	0.75 SCFM	Variation
V _{m(std)} cubic feet	Q _{m(std)} ft ³ /min	V _{w(std)} cubic feet	Q _{w(std)} ft ³ /min	Y	ΔY	Q _{m(std)(corr)} ft ³ /min	ΔH _@ in H ₂ O	ΔΔH _@
12.347	1.235	12.242	1.224	0.9914	0.006	1.224	1.953	0.036
10.079	1.008	9.973	0.997	0.9894	0.004	0.997	1.953	0.036
7.158	0.716	7.047	0.705	0.9846	-0.001	0.705	1.950	0.033
5.162	0.516	5.068	0.507	0.9819	-0.004	0.507	1.883	-0.033
4.428	0.369	4.344	0.362	0.9810	-0.005	0.362	1.844	-0.073
Pre-test Y	0.9805	% Deviation	PASS	0.9856	Y Average		1.917	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.

Note: For ΔH_@, 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) H₂O.

Initials NEW Date 1-Feb-24
NEW

APEX INSTRUMENTS METERBOX CALIBRATION USING REFERENCE DGM

Meter Console Information	
Console Model Number	SB-5
Console Serial Number	6240
DGM Model Number	SK25EX
DGM Serial Number	6240

Calibration Conditions			
Date	Time	22-Dec-23	10:23
Barometric Pressure		27.45	in Hg
Calibration Technician		NEW	
Calibration Meter Gamma		1.0000	

Standardized Factors/Conversions		
Temperature	528	R
Pressure	29.92	in Hg
K ₁	17.647	R/in Hg

<<<<<<<Your reference meter here

Calibration Data											
Run Time	Metering Console						Reference Meter				
	Manometer	Volume	Volume	Sample	Outlet Temp	Outlet Temp	Volume	Volume	Sample	Outlet Temp	Outlet Temp
Elapsed	ΔH	Initial	Final	Volume	Initial	Final	Initial	Final	Volume	Initial	Final
Θ minutes	P _m in H ₂ O	V _{mi} cubic feet	V _{mf} cubic feet	V _m cubic feet	t _{oi} °F	t _{of} °F	V _{wi} cubic feet	V _{wf} cubic feet	V _w cubic feet	t _{wi} °F	t _{wf} °F
10.00	7.00	0.000	14.920	14.920	68	69	0.000	14.948	14.948	67	68
10.00	4.00	0.000	11.478	11.478	69	70	0.000	11.371	11.371	68	68
10.00	2.00	0.000	8.275	8.275	70	71	0.000	8.120	8.120	68	69
10.00	1.00	0.000	5.909	5.909	71	70	0.000	5.774	5.774	69	69
10.00	0.50	0.000	4.238	4.238	70	70	0.000	4.139	4.139	69	69

Results								
Standardized Data				Dry Gas Meter				
Dry Gas Meter		Calibration Meter		Calibration Factor		Flowrate	ΔH _@	
				Value	Variation	Std & Corr	0.75 SCFM	Variation
V _{m(std)} cubic feet	Q _{m(std)} ft ³ /min	V _{w(std)} cubic feet	Q _{w(std)} ft ³ /min	Y	ΔY	Q _{m(std)(corr)} ft ³ /min	ΔH _@ in H ₂ O	ΔΔH _@
13.932	1.393	13.727	1.373	0.9853	0.005	1.373	1.917	0.058
10.613	1.061	10.432	1.043	0.9829	0.002	1.043	1.893	0.034
7.597	0.760	7.443	0.744	0.9797	-0.001	0.744	1.856	-0.003
5.410	0.541	5.287	0.529	0.9772	-0.003	0.529	1.839	-0.020
3.879	0.388	3.790	0.379	0.9772	-0.003	0.379	1.791	-0.068
Pre-test Y	0.9791	% Deviation	PASS	0.9805	Y Average		1.859	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.

Note: For ΔH_@, 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) H₂O.

Initials NEW Date 22-Dec-23
NEW

Field Barometer Calibration Form

Project #: MRI224137

IN OFFICE PRE-TEST CALIBRATION

Reference Standard Used:

Standard ID	Serial number	Adjusted on:	Calibration due:
Tucson Mercury Barometer	TUC01	1/29/2024	Must be properly adjusted prior to each use

Field Barometer Verification:

Barometer ID: TTB-2

Reference Value (in. Hg)	Observed (in. Hg)	Correction*	Tolerance**
27.52	27.51	-0.01	PASS

*Correction is the difference between the observed and reference values

**EPA Method 5, Section 6.1.2 and EPA Method 2, Section 6.5. Tolerance is +/- 0.1 inHg

Technician: NEW

Date: 1/29/2024



Field Balance and Weights Calibration Form

Project #: MRI224137

IN OFFICE PRE-TEST CHECKS

Date: 1/29/2024

Performed by: NEW

Environmental conditions in the lab:

Temperature (°F)	Pressure (in. Hg)
68	27.51

Reference Standard(s) Used:

Standard ID	Serial number(s)	Calibrated on:	Calibration due:
Troemner	4000021445	8/22/2023	8/22/2024

Verification of Field Balance Against Reference Standard Weights:

Balance ID: WSS-3

Nominal Value (g)	Observed (g)	Correction*	Tolerance**
200	200.0	0.0	PASS
500	500.0	0.0	PASS
1000	999.8	0.2	PASS

Verification of Field Standard Weights :

Weights ID: WSW-1

Nominal Value (g)	Observed (g)	Correction*	Tolerance**
200	199.9	0.1	PASS
500	499.8	0.2	PASS
1000	999.8	0.2	PASS

*Correction is the difference between the observed and nominal mass values

**EPA Method 5, Section 6.3.4, must be +/- 0.5g

ONSITE BALANCE VERIFICATION

Date: 1/31/2024
Performed by: JPC

Environmental conditions onsite:

Temperature (°F)	Pressure (in. Hg)
65	26.27

Field Balance Verification:

Balance ID: WSS-3

Weights ID: WSW-1

Nominal Value (g)	Observed (g)	Correction*	PASS/FAIL Tolerance**
200	199.6	0.4	PASS
500	499.7	0.3	PASS
1000	999.7	0.3	PASS

*Correction is the difference between the observed and nominal mass values

**EPA Method 5, Section 6.3.4, must be +/- 0.5g

Field Caliper Calibration Form

Project #: MRI224137

IN OFFICE PRE-TEST CHECKS

Date: 1/29/2024

Performed by: NEW

Reference Standard Used:

Standard ID	Serial number	Calibrated on:	Calibration due:
Mitutoyo	A17170739	1/9/2024	1/9/2025

Caliper Verification:

Field Caliper ID: TMC-3

Inside Diameter

Reference Value (inches)	Observed (inches)	Correction*	Tolerance**
0.624	0.623	-0.001	PASS

*Correction is the difference between the observed and reference values

Outside Diameter

Reference Value (inches)	Observed (inches)	Correction*	Tolerance**
0.288	0.288	0.000	PASS

*Correction is the difference between the observed and reference values

**Tolerance is +/- 0.0050 inches



Digital Manometer Calibration Form

Project #: MRI224137

IN OFFICE POST-TEST CHECKS

Date: 2/1/2024

Performed by: NEW

Reference Standard Used: Fluid manometer

Digital Manometer ID: TDM-3

Reference Value (inH ₂ O)	Digital readout (in. H ₂ O)	Correction*	Tolerance**	Digital readout (in. H ₂ O)	Correction*	Tolerance**
6.00	5.930	-1.17%	PASS	5.930	-1.18%	PASS
5.00	4.940	-1.20%	PASS	4.920	-1.63%	PASS
4.00	3.970	-0.75%	PASS	3.950	-1.27%	PASS
3.00	2.970	-1.00%	PASS	2.960	-1.35%	PASS
2.00	1.980	-1.00%	PASS	1.970	-1.52%	PASS
1.00	1.000	0.00%	PASS	0.990	-1.01%	PASS
0.50	0.500	0.00%	PASS	0.500	0.00%	PASS
0.30	0.300	0.00%	PASS	0.300	0.00%	PASS

*Correction is the difference between the observed and reference values

** Tolerance is +/- 5%.

Thermocouple Calibration Form

Project #: MRI224137

POST-TEST CHECKS

Reference Standard Used:

Standard ID	Serial number(s)	Calibrated on:	Calibration due:
TOT-1 Omega	T289858	6/20/2023	6/20/2024

Temperature Meter Mode:

Thermocouple	TC ID	Continuity (x = pass)	Observed Temp (°F)	Reference Temp (°F)	Correction*	Tolerance (+/- 2°F)**
Stack Temp	T-4-1	x	74.5	74.0	0.5	PASS
Probe Liner	T-4-1	x	73.7		0.3	PASS
Hot Box	HB-2	x	75.4		1.4	PASS
Condenser	8473	x	73.6		0.4	PASS
DGM Outlet	SB-5	x	74.0		0.0	PASS

Calibration Output Mode:

Switch the Omega from 'Meter Input' to 'Calibration Output' mode. Test the meter box temperature, or handheld temp reader, readout by sending a voltage output equivalent to a temperature similar to stack temperature.

Meter ID	Reference Temp Output (°F)	Meter Readout (°F)	Correction*	Tolerance (+/- 2°F)**
SB-5	75.0	75	0.0	PASS

*Correction is the difference between the observed and reference values

**Alt-011 6/21/94 Alternative Method 2 Thermocouple Calibration Procedure:

Continuity Check - confirm the thermocouple is reading at the tip by subjecting it to a change in temperature (e.g. removing it from the stack or touching it with your hand). Single point temperature check at ambient temperature, or any temperature, within the range specified by the manufacturer.

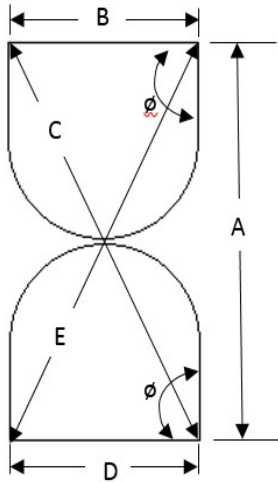
Technician: NEW
Date: 2/1/2024



S-Type Pitot Tube Geometric Calibration 5 FT

Pitot ID: T-PT-291

Date of Geometric Calibration (< 6 months): 1/22/2024



A	1.00
B	0.24
C	1.03
D	0.24
E	1.03

$$\frac{a^2 + b^2 - c^2}{2ab} = \cos \phi$$

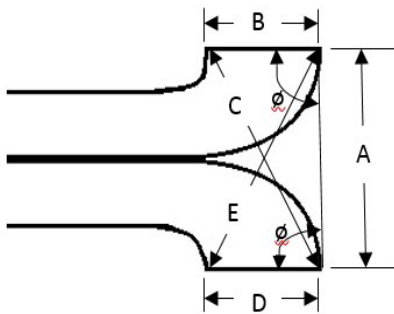
$$\frac{a^2 + d^2 - e^2}{2ad} = \cos \phi$$

ϕ	90.39
--------	-------

(80° < ϕ < 100°)

ϕ	90.39
--------	-------

(80° < ϕ < 100°)



A	1.01
B	0.36
C	1.07
D	0.37
E	1.06

$$\frac{a^2 + b^2 - c^2}{2ab} = \cos \phi$$

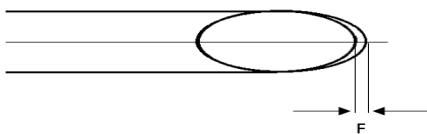
$$\frac{a^2 + d^2 - e^2}{2ad} = \cos \phi$$

ϕ	89.62
--------	-------

(85° < ϕ < 95°)

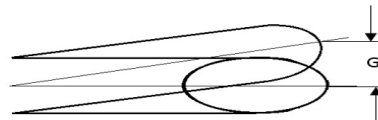
ϕ	87.44
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(85° < ϕ < 95°)



F=	0.010
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(F < 0.125)



G=	0.000
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(G < 0.032)

Results of the Post-Test Pitot Inspection (mark with x below):

No change x

Damaged

New Calibration

Technician: NEW

Date: 2/1/2024



Probe Calibration

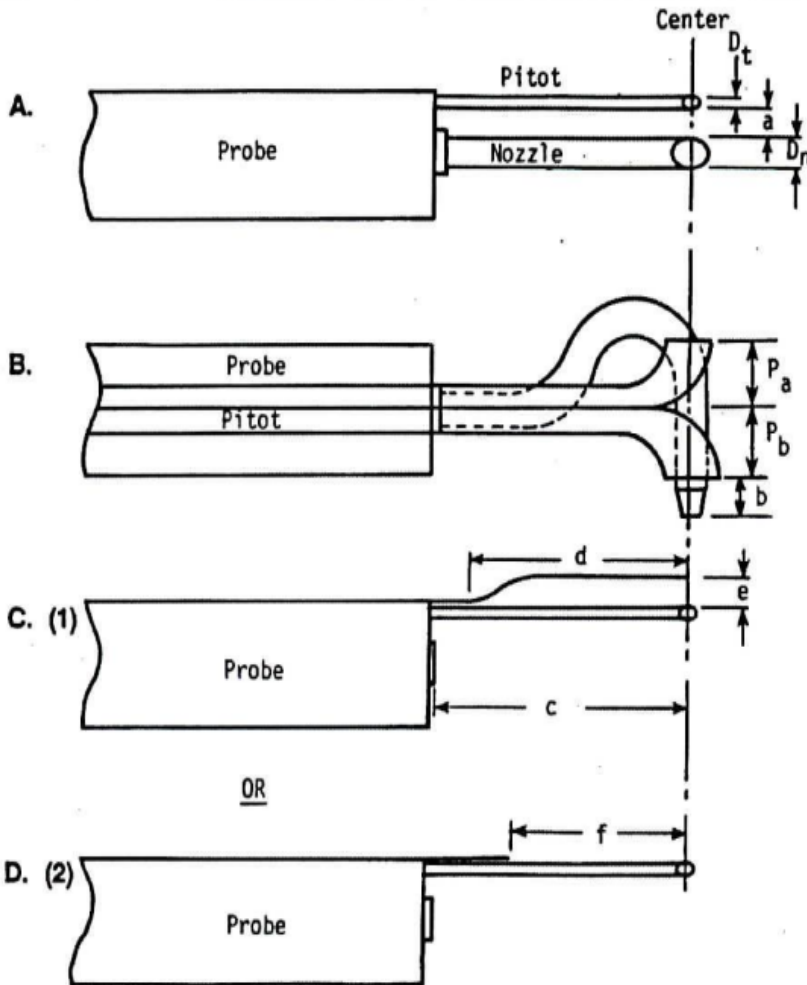
3 FT Effective Probe

4 FT Total

Probe ID: T-4-1

Date of calibration (< 6 months): 1/12/2024

Measure (Inch)



Dt:	0.28
Dn:	0.50
a:	0.98

Dt = 0.187 to 0.375

Dn = 0.5

a ≥ 0.750

Pa:	0.45
Pb:	0.45
b:	1.10

Pa = Pb

B ≥ 0

c:	4.15
d:	6.60
e:	0.84

c ≥ 3.0

d ≥ 3.0

e ≥ 0.750

or

f:	
----	--

f ≥ 2.0

Results of the Post-Test Probe Inspection (mark with x below):

No change x

Damaged

New Calibration

Technician: NEW

Date: 2/1/2024

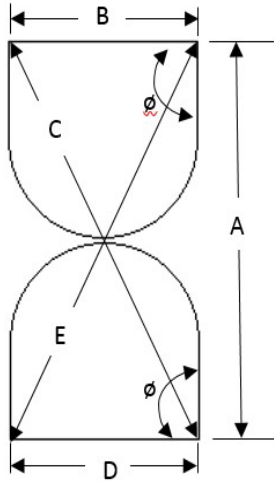
Y:\SOURCE\Calibrations\BLANK CALIBRATION FORMS\Calibration Form Combined
Version: 7/30/2019



S-Type Pitot Tube Geometric Calibration Pitot Tips on Probe T-4-1

Pitot ID: T-PT-3

Date of Geometric Calibration (< 6 months): 1/12/2024



A	0.91
B	0.29
C	0.95
D	0.28
E	0.96

$$\frac{a^2 + b^2 - c^2}{2ab} = \cos \phi$$

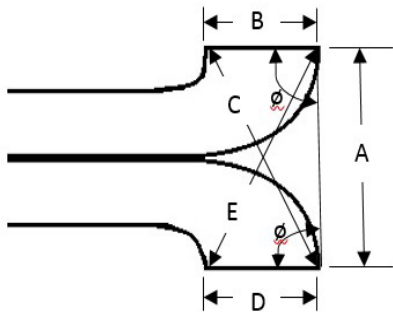
$$\frac{a^2 + d^2 - e^2}{2ad} = \cos \phi$$

φ	88.95
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(80° < φ < 100°)

φ	91.70
---	-------

(80° < φ < 100°)



A	0.91
B	0.42
C	1.00
D	0.42
E	1.00

$$\frac{a^2 + b^2 - c^2}{2ab} = \cos \phi$$

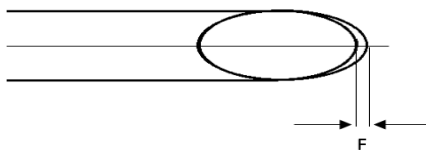
$$\frac{a^2 + d^2 - e^2}{2ad} = \cos \phi$$

φ	89.66
---	-------

(85° < φ < 95°)

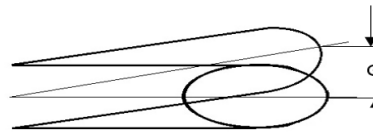
φ	89.66
---	-------

(85° < φ < 95°)



F= 0.020

(F < 0.125)



G= 0.000

(G < 0.032)

Results of the Post-Test Pitot Inspection (mark with x below):

No change x

Damaged

New Calibration

Technician: NEW

Date: 2/1/2024

This is the last page of the report.