ANNUAL DEMONSTRATION OF FUGITIVE EMISSIONS CONTROL SYSTEM PERFORMANCE

Becton, Dickinson and Company
8195 Industrial Blvd
Covington, GA 30014

Ramboll US Corporation
1600 Parkwood Circle
Suite 310
Atlanta, Georgia 30339

May 2021

ENVIRONMENT
& HEALTH

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EXECUTIVE SUMMARY

In fulfillment of obligations first set in a Consent Order with the Georgia Environmental Protection Division on October 28, 2019, Becton, Dickinson and Company installed two dry bed fugitive emission control systems at its Covington, Georgia, medical device sterilization facility for the reduction of potential emissions of ethylene oxide.

Under an EPD-approved Test Plan, these systems have been tested to assess their performance and effectiveness. The testing has found that the emissions to the atmosphere of ethylene oxide from both systems (System One and System Two) are consistent with the levels expected from the dry bed system outlets. The emission rate measured from the System One outlet on March 26, 2021 was 1.54 pounds-per-year if annualized over 8,760 hours. The emission rate measured from the System Two outlet on March 26, 2021 was 160.92 pounds-per-year if annualized over 8,760 hours. The total emission rate from both Systems' outlets combined on an annualized basis would be 162.46 pounds.

1. BACKGROUND

Becton, Dickinson and Company (BD) operates a medical device sterilization facility utilizing ethylene oxide (EO) at 8195 Industrial Boulevard in Covington, Georgia (see **Figure 1**). As a condition of a Consent Order with the Georgia Environmental Protection Division (EPD) dated October 28, 2019 BD installed two systems for the capture and control of fugitive emissions of ethylene oxide (EO) not captured by current emissions control equipment. The fugitive emissions control equipment include two systems comprised of multiple Advanced Air Technologies Model DR490 "Dry Bed Scrubbers".

System One (SYS1) captures potential fugitive emissions from the five Sterilization Vessel Rooms (VRM1, VRM2, VRM3, VRM4, VRM5), the Vessel to Aeration Transfer Corridor (NCO1), and the EO Dispensing Room (DRM1). System Two (SYS2) captures potential fugitive emissions from the Work In Progress (WIP) areas where product is stored after sterilization and prior to shipment. Details regarding these systems were presented in the air permit application for their installation submitted to the EPD on December 17, 2020.

The annual testing was performed on March 26, 2021. Mr. Bob Scott and Mr. Ray Shen of the EPD Stationary Source Compliance, Source Monitoring Unit were present to observe the testing activities.

2. TESTING ACTIVITES

The testing program for assessing the effectiveness of the dry bed fugitive emission control systems for fugitive releases captured in the facility was based on two primary elements:

1. Measurement of the air flow rates at the inlet ducts to the dry bed systems and the stack outlets utilizing EPA standard methods 1, 2, and 4; and,

2. Measurement of the concentration of EO in those inlet ducts and outlet stacks.

Measurement of the air flow rates was conducted by Advanced Industrial Resources (AIR) of Acworth, Georgia, a qualified stack testing contractor.

Ramboll personnel oversaw and coordinated the sample collection during the testing. Air samples were collected in 6-liter Summa canisters individually tested and certified by the laboratory to be free of EO. The samples were analyzed for EO via EPA Method TO-15 modified to achieve sub-part-per-billion detection limits for EO.

The Test Plan presented in **Appendix A** was followed for the flow measurement, and sample collection. **Figure 2** identifies the specific sampling points used for both SYS1 and SYS2.

As outlined in the Test Plan, duplicate samples were collected at two locations, the two stack outlets, to allow for precision and repeatability of analyses and the stability of EO samples in the Summa canisters. The duplicate samples were collected simultaneously from two separate segments of tubing introduced side-by-side in the sampling port.

Sample collection duration was 4 hours for both systems. Roughly 45 minutes into the testing period for SYS2, it was recognized that the flow regulator on the Summa canister for the Inlet Duct 1 was malfunctioning and the sample was not being collected. That canister was replaced by a backup canister and flow regulator at that point which operated properly and was submitted for analysis. Despite having to replace the Summa canister, the sample duration for the SYS2 Inlet Duct 1 was approximately 4 hours and the sample was collected at the same time as the SYS2 outlet.

3. ANALYTICAL LABORATORY RESULTS AND PERFORMANCE ASSESMENT

The collected samples were transferred to Eurofins Air Toxics, LLC (Eurofins), an independent laboratory with recognized expertise with EO analytical methods, for analysis using a modified EPA Method TO-15 with GC/MS in the Selective Ion Monitoring (SIM) acquisition mode to obtain detection limits sufficiently low for use in testing the dry bed system performance.

Two supplemental analyses were also performed by the laboratory to evaluate quality control parameters. Duplicate samples were collected from the SYS1 and SYS2 Outlet. Both were analyzed upon receipt at the laboratory to demonstrate the repeatability and precision of the sampling and analytical methods.

Table 1 presents the air flow rate and moisture results from the EPA Method 1, 2, and 4 tests performed by AIR. AIR's complete report is provided as **Appendix B.**

Table 2 presents the EO concentration results from Eurofins. The complete laboratory report is provided as **Appendix C,** including results from the quality control assessment described above.

All testing and analytical work met quality assurance and quality control set forth in the test plan. All measured EO concentrations were above the detection limits of the laboratory method – there were no "non-detect" results.

Table 3 combines the air flow and EO concentration data for an assessment of the performance of the dry bed fugitive emissions control systems.

<u>SYS1 Performance Assessment</u>

SYS1 captures and treats fugitive EO releases from the EO dispensing room, sterilization vessel rooms, and the vessel-to-aeration corridor. The exhaust mass rate from the SYS1 stack is 0.0002 lb/hour, or 1.54 lb/year if annualized over 8,760 hours.

<u>SYS2 Performance Assessment</u>

SYS2 captures and treats fugitive EO releases from multiple WIP areas within the facility where product is stored after sterilization and prior to shipment. The outlet mass rate of EO is 0.0184 lb/hr, or 160.91 lb/year if annualized over 8,760 hours.

4. CONCLUSIONS

The following conclusions can be drawn from this testing as an initial assessment of the performance of the dry bed fugitive emission control systems at the BD Covington facility:

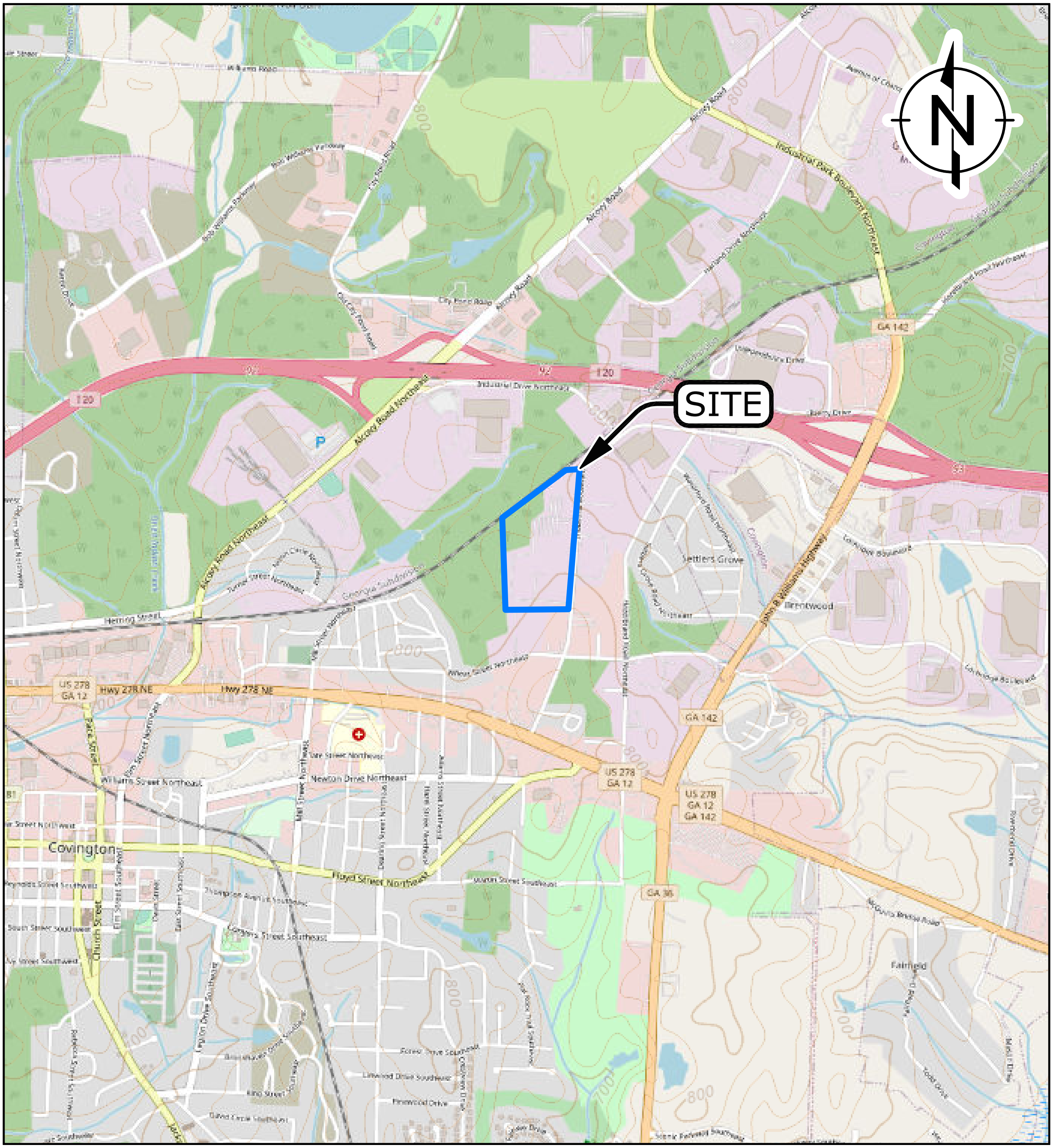
1. Post-control-device emissions of EO from SYS1 are 0.0002 lb/hour.

2. Post-control-device emissions of EO from SYS2 are 0.0184 lb/hour.

3. The Summa canister testing and analytical approach applied for this testing successfully allowed monitoring of low EO concentrations that allowed calculation of control efficiency from the dry bed treatment system and achieved all stability and precision objectives.

4. The analytical method has been shown to have good sample stability.

FIGURES



0 0.5 1

SCALE IN MILES

0 2,000 4,000

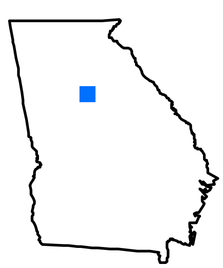
SCALE IN FEET

LEGEND:

PROPERTY BOUNDARY (APPROXIMATE)

SOURCE:
contours: USGS The National Map: 3D Elevation Program. Data Refreshed July, 2020.
OpenStreetMap: © OpenStreetMap (and) contributors, CC-BY-SA
www.openstreetmap.org/key

Map Scale 1:24,000
Spatial Reference: NAD 1983 UTM Zone 17N; Map Center: 83°15'7"W 32°42'41"N



Key Map

SITE LOCATION MAP

BECTON, DICKENSON AND COMPANY
8195 INDUSTRIAL BOULEVARD
COVINGTON, GEORGIA

RAMBOLL

FIGURE

1

DRAFTED BY: RGM | DATE: 7/24/2020 | PROJECT: 1690014483

F:\Graeme\1690014483\SLM_COVINGTON_GA\SLM_COVINGTON_GA.aprx

LEGEND:

● SAMPLING LOCATION (APPROXIMATE)

SOURCE:
POND March 2020.

0 40
SCALE IN FEET

SYSTEM SAMPLING POINT DESIGNATION

BECTON, DICKENSON AND COMPANY
8195 INDUSTRIAL BOULEVARD
COVINGTON, GEORGIA

RAMBOLL

FIGURE
2

DRAFTED BY: CAD | DATE: 4/7/2020 | PROJECT: 1690014483

GMILES 4/21/20 F:\GRAEME\1690014483 < SITE_LAYOUT_COVINGTON_GA2 >

TABLES

TABLE 1
System 1 Airflow Rates
Becton, Dickinson and Company
Covington, Georgia Facility

Sample ID	Sample Location	Pre-Test Flow Rate (dscfm)	Pre-Test Average Temperature (°F)	Post-Test Flow Rate (dscfm)	Post-Test Average Temperature (°F)	Average Flow Rate (dscfm)	Average Temperature (°F)
System 1							
SYS1-IN 20210326	SYS1 In	23,669	81	23,463	99	23,566	90
SYS1-STACK 20210326	SYS1 Out	26,377	84	25,809	87	26,093	86
System 2							
2BF-1 20210326	2BF-1	9,205	74	9,004	81	9,104	78
2BF-2 20210326	2BF-2	8,837	76	9,093	87	8,965	82
2BF-3 20210326	2BF-3	8,820	74	9,027	87	8,924	81
2BF-4 20210326	2BF-4	9,172	72	9,187	83	9,179	78
2BF-5 20210326	2BF-5	8,911	74	8,986	84	8,948	79
2BF-6 20210326	2BF-6	12,552	73	12,425	85	12,489	79
SYS2-STACK 20210326	SYS2 Out	69,588	73	70,531	77	70,059	75
Notes:					**Sum of System 2 Inlets**	**57,609**	

Pre and Post-Test average tempertures and airflow rates provided by Advanced Industrial Resources, Inc. (AIR).
dscfm - dry standard cubic feet per minute

TABLE 2
System 1 Ethylene Oxide Sample Results
Becton, Dickinson and Company
Covington, Georgia Facility

Sample ID	Sample Location	Date	Start Time	Stop Time	Duration (hours)	Vacuum[1] Initial (In. Hg)	Vacuum[1] Final (In. Hg)	EO Concentration ($\mu g/m^3$)
System 1								
SYS1-IN 20210326	SYS1 In	3/26/2021	10:35	14:35	4:00	29.0	8.7	470
SYS1-STACK 20210326[2]	SYS1 Out	3/26/2021	10:35	14:35	4:00	27.0	6.5	1.8
SYS1-STACK DUP 20210326	SYS1 Out	3/26/2021	10:50	14:35	3:45	27.0	9.0	2.1
System 2								
2BF-1 20210326	2BF-1	3/26/2021	10:35	11:22	0:47	26.5	26.5	2600
2BF-1R 20210326	2BF-1	3/26/2021	11:22	14:35	3:13	29.5	10.5	2300
2BF-2 20210326	2BF-2	3/26/2021	10:35	14:35	4:00	28.5	21.0	3600
2BF-3 20210326	2BF-3	3/26/2021	10:35	14:35	4:00	28.5	21.0	980
2BF-4 20210326	2BF-4	3/26/2021	10:35	14:35	4:00	28.0	8.0	6100
2BF-5 20210326	2BF-5	3/26/2021	10:35	14:35	4:00	28.8	7.0	5300
2BF-6 20210326	2BF-6	3/26/2021	10:35	14:35	4:00	29.0	11.0	2000
SYS2-STACK 20210326	SYS2 Out	3/26/2021	10:35	14:35	4:00	30.0	7.0	70
SYS2-STACK DUP 20210326[3]	SYS2 Out	3/26/2021	10:35	14:35	4:00	30.0	13.7	76

Notes:

[1]Vacuum readings recorded in the field from the regulator gauge.

[2]The listed EO concentration is the average of SYS1 - STACK 20210326 (1.5 $\mu g/m^3$) and SYS1-STACK DUP 20210326 (2.1 µg/m3) values.

[3]The laboratory conducted a lab duplicate for analytical repeatability; results were 73 and 79 µg/m3. Listed EO concentration is an average of the two values.

In. Hg - inches of mercury

$\mu g/m^3$ - micrograms per cubic meter

EO - Ethylene Oxide

TABLE 3
System 1 Performance Assessment
Becton, Dickinson and Company
Covington, Georgia Facility

Sample ID	Sample Location	EO Concentration ($\mu g/m^3$)	Duct Flow (dscfm)	EO Rate (lb/hr)
System 1				
SYS1-IN 20210326	SYS1 In	470	23,566	0.0415
SYS1-STACK 20210326	**SYS1 Out**	**1.8**	26,093	**0.0002**
System 2				
2BF-1 20210326[1]	2BF-1	2,359	9,104	0.0804
2BF-2 20210326	2BF-2	3,600	8,965	0.1209
2BF-3 20210326	2BF-3	980	8,924	0.0328
2BF-4 20210326	2BF-4	6,100	9,179	0.2097
2BF-5 20210326	2BF-5	5,300	8,948	0.1776
2BF-6 20210326	2BF-6	2,000	12,489	0.0936
SYS2-STACK 20210326	**SYS2 Out**	**70**	70,059	**0.0184**
		Total Inlet	57,609	0.7150
			Flow-weighted average inlet (ug/m3)	3,314

Notes:

EO - Ethylene Oxide

$\mu g/m^3$ - micrograms per cubic meter

dscfm - dry standard cubic feet per meter

lb/hr - pounds per hour

[1]The EO concentration is a time-weighted average of the concentration reported for 2BF-1 20210326 and 2BF-1R 20210326.

	System 1	System 2
Potential Annual EO emissions (lb/year)	**1.54**	**160.91**
Concentration-based percent removal	99.6	97.9
Mass-based percent removal	99.6	97.4

APPENDIX A

STACK TESTING SCOPE

Test Plan

for the

Performance Testing of the Fugitive Emissions Control System 1 Upgrades

at

Becton, Dickinson and Company (BD)
Urology and Critical Care Division

Covington, Georgia

Proposed Test Date:

26 March 2021

Submitted By:

Becton, Dickinson and Company
Urology and Critical Care Division
8195 Industrial Blvd
Covington GA 30014

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I. Introduction

Condition 13 of Attachment A to the October 28, 2019 Consent Order provides; "in accordance with an EPD-approved plan, BD shall conduct an initial demonstration of the fugitive emissions control system upgrades proposed in the permit application for the BD Covington facility no later than March 31, 2020." On March 25, 2020, a Second Amendment to the Consent Order was issued by EPD which extended the deadline for the Condition 13 testing to April 15, 2020.

BD has complied with the conditions set forth in the 2019 Consent Order by performing the initial control system demonstration on April 2, 2020 and again on June 19, 2020 following EPD-approved test plans submitted on March 27, 2020 and May 21, 2020.

Upon achieving a full year of operation of the fugitive emissions control system and as requested by EPD, BD will again test the system in an annual test scheduled to be performed on March 26, 2021 at the BD Sterilization Operation in Covington, Georgia. The purpose of the testing is to assess the removal efficiency of EO by the existing dry bed fugitive emissions control systems after one year of operation.

Both System 1 and System 2 control efficiency for EO will be tested and demonstrated on a concentration basis by withdrawing exhaust air from the ductwork at the inlet side of the dry beds and at the outlet stack from into Summa Canisters in accordance with EPA Method TO-15.

The air testing services of a reputable contractor will be obtained to conduct the required testing. Mr. John LaMontagne, of BD, and other BD personnel, will provide on-site coordination of the testing.

II. Process and Control Equipment Description and Operating Conditions

The equipment being tested is for the control of fugitive emissions of EO at an existing medical device sterilization facility. The existing regulated process which includes the Sterilization Chamber Exhaust Vent, Chamber Vent, Aeration Exhaust, and Thermal Oxidizer are not being modified and are excluded from this performance test.

Testing for this equipment is specific to the additional emission control systems being installed to capture and treat fugitive emissions of EO not captured by current emissions control equipment. The equipment to be tested includes one system comprised of multiple Advanced Air Technologies Model DR490 "Dry Bed Scrubbers".

System One (SYS1) captures potential emissions from the five Sterilization Vessel Rooms (VRM1, VRM2, VRM3, VRM4, VRM5), the Vessel to Aeration Transfer Corridor (NCO1), and the EO Dispensing Room (DRM1). System Two (SYS2) captures potential emissions from the Work in Progress Area (WIP1) where product is stored after Sterilization and prior to shipment.

III. Dry Bed Validation Testing Plan

Analytical Methods

The samples will be collected in Summa canisters and analyzed using EPA Method TO-15 with GC/MS in the Selective Ion Monitoring (SIM) acquisition mode to determine the concentration of ethylene oxide. The samples will be sent using overnight delivery to the analytical laboratory under formal chain of custody procedures. The analysis will be performed by Eurofins Air Toxics, an independent laboratory located in Folsom, California. Results will be reported in units of micrograms per cubic meter (ug/m^3).

To accommodate the conditions relating to canister placement, sampling probes will be connected using flexible tubing (Teflon FEP, 1/4” OD), with the length not to exceed five (5) feet. Duplicate samples will be collected at the outlets from each dry bed system and submitted to the laboratory for precision and repeatability of sample collection.

Efficiency Assessment

The performance testing will be performed as follows:

Sample duration:	4 hours
System 1:	Inlet duct and outlet duct simultaneously across all of System 1.
System 2:	Inlet ducts to all of the 6 dry bed sets simultaneously with the outlet stack for System 2.
Sample Collection:	Samples will be collected at a single point within each corresponding stack or duct.
Parameters:	Outlet stack airflow rate and moisture will be measured simultaneously by EPA Methods 1, 2, and 4.
Velocity Profiles:	Velocity traverses of the inlet ducts will be performed periodically during the testing.
Efficiencies:	Control efficiency will be calculated on the basis of the reduction in concentration of EO across the dry beds for each System. Mass emission rate of EO (lb/hr) will be determined using the measured outlet concentration and airflow rate.

IV. <u>Plant Entry and Safety</u>

General safety rules must be adhered to when inside the plant area. Visitors must first sign in at the reception area at 8195 Industrial Blvd. prior to admission to the Sterilization Facility. Entry to the Sterilization Facility is restricted. John LaMontagne is responsible for this project. He can be reached at 770-784-6186 (office) or 770 652-2049 (cell).

APPENDIX B

TESTING SUBCONTRACTOR FINAL REPORT

DRY BED SYSTEM
ANNUAL PERFORMANCE TEST
AT
BECTON DICKINSON BARD
COVINGTON FACILITY
PROJECT ID: KR-10687

PREPARED FOR:

BECTON DICKINSON BARD
8195 INDUSTRIAL BLVD
COVINGTON, GEORGIA 30014

PREPARED BY:

ADVANCED INDUSTRIAL RESOURCES, INC.
3407 NOVIS POINTE
ACWORTH, GEORGIA 30101

TEST DATE:
MARCH 26, 2021

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1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Becton Dickinson Bard (BD Bard) operates a medical products sterilization facility located at 8195 Industrial Blvd, Covington, Georgia 30014. Sterilization is completed using ethylene oxide gas. The facility has installed two (2) dry bed systems designed to control fugitive and process ethylene oxide emissions from the interior of the facility.

The 2nd annual performance test of the dry bed systems was conducted on March 26, 2021 by Ramboll and Advanced Industrial Resources, Inc. (AIR). The purpose of the performance test was to confirm the respective control systems' ethylene oxide removal efficiencies. Testing was conducted by quantifying the inlet loading of ethylene oxide to the dry bed systems and simultaneously quantifying the emission rate of ethylene oxide at the outlet of the respective dry bed systems. US EPA Methods 1, 2, 4, and 18 were used to conduct testing.

Testing was conducted by Advanced Industrial Resources, Inc. (*AIR*) and Ramboll in accordance with approved USEPA Methods (i.e., 40 CFR 60 Appendix A, Methods 1, 2, 4, and 18).

1.2 KEY PERSONNEL

The key personnel who coordinated the test program and their telephone numbers are:

Keith A. Cole, P.E., *Ramboll*, Sr. Managing Consultant	678-388-1648
Derek Stephens, *AIR*, VP/QA Director	404-843-2100
Stephen Wilson, *AIR*, Chief Operations Officer	404-403-6079
Scott Wilson, *AIR*, Program Director	800-224-5007

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS & CONTROL EQUIPMENT DESCRIPTION

Becton Dickinson Bard (BD Bard) operates a medical products sterilization facility in Covington, Georgia. Sterilization is completed using ethylene oxide gas in various chambers within the facility. The facility has installed two (2) dry bed systems designed to control fugitive and process ethylene oxide emissions from the interior of the facility.

2.2 SAMPLING LOCATION

Each sampling location has a circular cross section with at least two (2) sampling ports oriented 90 degrees from one another. The sampling locations are located at least two (2) equivalent diameters downstream from the nearest upstream flow disturbance and at least one-half (0.5) equivalent diameters upstream from the nearest downstream flow disturbance. In accordance with EPA Method 1, a minimum of sixteen (16) total traverse points (≥ 8 per port) were used to measure velocities within the respective ducts via EPA Method 2. The centroids of the respective ducts were used to collect the ethylene oxide samples.

The following table summarizes the sampling locations:

Source	**Stack diameter (D_s)**	**Downstream flow disturbance distance (A)**		**Downstream flow disturbance distance (B)**		**Traverse Points (per port)**
	inches	inches	equiv. diameter	inches	equiv. diameter	
System 1 Outlet	73	45	0.62	252	3.45	24 (12)
System 1 Inlet	50.5	27	0.53	> 101	> 2	16 (8)
System 2 Outlet	73	45	0.62	252	3.45	24 (12)

Source	**Stack diameter (D_S)**	**Downstream flow disturbance distance (A)**		**Downstream flow disturbance distance (B)**		**Traverse Points (per port)**
	inches	inches	equiv. diameter	inches	equiv. diameter	
System 2 Inlet 2BF-1	30	35.5	1.18	97	3.23	16 (8)
System 2 Inlet 2BF-2	30	26.5	0.88	151	5.03	16 (8)
System 2 Inlet 2BF-3	30	39	1.30	163	5.43	16 (8)
System Inlet 2 2BF-4	30	60.5	2.02	115.75	3.85	16 (8)
System 2 Inlet 2BF-5	30	36.5	1.22	63.5	2.12	16 (8)
System 2 Inlet 2BF-6	36	114.0	3.17	72.5	2.42	16 (8)

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 OBJECTIVES

The purpose of the annual performance test was to confirm the control systems' ethylene oxide removal efficiencies. Testing was conducted by quantifying the inlet loading of ethylene oxide to the dry bed systems and simultaneously quantifying the emission rate of ethylene oxide at the outlet of the respective dry bed systems.

3.2 FIELD TEST CHANGES AND PROBLEMS

No problems were encountered during testing that required deviation from the planned test protocol.

3.3 PRESENTATION OF TEST RESULTS

Volumetric flow rates and associated data are presented in Appendix A. Actual raw field data sheets are presented in Appendix C.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Testing were performed in accordance with 40 *CFR* 60 Appendix A. Specifically:

- EPA Method 1 was used for the qualification of the location of sampling ports and for the determination of the number and positions of stack traverse points, as applicable to sample traverses for EPA Method 2.

- EPA Method 2 was employed for the determination of the stack gas velocity and volumetric flow rate during sampling using Type “S” Pitot tubes. EPA Method 2 was conducted prior to and at the conclusion of the single ethylene oxide sample period and the average of the two (2) traverses, per sample location, were used to determine the volumetric flow rate used for calculating the mass rate (lb/hr) of ethylene oxide. The pre- and post-test velocity traverses for each sample location varied by less than 10%.

- EPA Method 3 was used for the calculation of the density and dry molecular weight of the effluent stack gas. The gas streams were assumed to be at ambient conditions (20.9% O2, 0.0% CO2).

- EPA Method 4 was employed for the determination of the stack gas moisture content of the respective system exhaust stacks. A single test run was conducted on each stack which lasted the duration of the test run (240 min.). Wet bulb/dry bulb measurements were conducted on each of the inlet ducts to determine moisture content.

5.0 QUALITY ASSURANCE ACTIVITIES

5.1 INTERNAL QUALITY ASSURANCE

The quality assurance/quality control (QA/QC) measures associated with the sampling and analysis procedures given in the noted EPA reference methodologies, in Subparts A of 40 *CFR* 60 and 40 *CFR 63*, and in the *EPA QA/QC Handbook*, Volume III (EPA 600/R-94/038c) were employed, as applicable. Such measures include, but are not limited to, the procedures detailed below.

5.1.1 SAMPLING TRAIN LEAK CHECKS

Determinations of the leakage rate of the Method 4 sampling trains were made before and after each sampling run using the procedure detailed in Section 8.1.3.2 of EPA Method 4. Before the sampling run, after the sampling trains had been assembled and probe and filter box temperatures had time enough to settle at their appropriate operating values, the probe inlet was plugged and the system was evacuated to a pressure of 15 inches of Hg below ambient pressure. The volumetric leakage rate was be measured by the dry gas meter over the course of one (1) minute. The leakage rate was less than 0.020 cfm for each run, thereby meeting the maximum allowable leakage rate.

After the sampling run, before the train was disassembled the probe inlet was plugged and the system depressurized to a vacuum equal to or greater than the maximum value reached during the sampling run. The dry gas meter measured the volumetric leakage rate over the course of one (1) minute. The leakage rate was determined to be less than 0.020 cfm, thereby meeting the maximum allowable leakage rate.

The Type “S” Pitot tube assemblies were also checked for leaks before and after sampling runs using the procedure in Section 8.1 of EPA Method 2. The impact opening of the Pitot tubes were blown through until a pressure of at least 3 inches of water registered on the manometer. The impact opening was quickly plugged and held for at least 15 seconds, during which time the manometer reading held. The same operation was performed on the static pressure side of the Pitot tubes, except suction was used to obtain the pressure differential.

5.1.2 PROBE NOZZLE DIAMETER CHECKS

No probe nozzles were used during this test program.

5.1.3 PITOT TUBE FACE PLANE ALIGNMENT CHECK

Before field testing, each Type S Pitot tube was examined in order to verify that the face planes of the tube were properly aligned, per Method 2 of 40 *CFR* 60, Appendix A. The external tubing diameter and base-to-face plane distances were measured in order to verify the use of 0.84 as the baseline (isolated) Pitot coefficient. At that time the entire probe assembly (i.e., the sampling probe, nozzle, thermocouple, and Pitot tube) was inspected in order to verify that its components met the interference-free alignment specifications given in EPA Method 2. Because the specifications were met, then the baseline Pitot coefficient was used for the entire probe assembly.

After field testing, the face plane alignment of each Pitot tube was checked. No damage to the tube orifices was noted.

5.1.4 METERING SYSTEM CALIBRATION

Every three months each dry gas meter (DGM) console is calibrated at five orifice settings according to Method 5 of 40 *CFR* 60, Appendix A. From the calibration data, calculations of the values of Y_m and $\Delta H_@$ are made, and an average of each set of values is obtained. The limit of total variation of Y_m values is ± 0.02, and the limit for $\Delta H_@$ values is ± 0.20.

After field testing, the calibration of the DGM console was checked by performing three calibration runs at a single intermediate orifice setting that is representative of the range used during field-testing. Each DGM was within the limit of acceptable relative variation from Y_m of 5.0%.

5.1.5 TEMPERATURE GAUGE CALIBRATION

After field testing, the temperature measuring instruments on each sampling train was calibrated against standardized mercury-in-glass reference thermometers. Each indicated temperature was within the limit of acceptable variation between the absolute reference temperature and the absolute indicated temperature of 1.5%.

5.1.6 DATA REDUCTION CHECKS

AIR ran an independent check (using a validated computer program) of the calculations with predetermined data before the field test, and the *AIR* Team Leader conducted spot checks on-site to assure that data was being recorded accurately. After the test, *AIR* checked the data input to assure that the raw data had been transferred to the computer accurately. Flow rates, temperatures and moisture levels were relatively constant (variation <5%) during the three test runs, which indicates that data recording and Method 2 and 4 sampling and calculation errors are not likely.

6.0 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) process is generally a seven-step iterative planning approach to ensure development of sampling designs for data collection activities that support decision making. The seven steps are as follows: (1) defining the problem; (2) stating decisions and alternative actions; (3) identifying inputs into the decision; (4) defining the study boundaries; (5) defining statistical parameters, specifying action levels, and developing action logic; (6) specifying acceptable error limits; and (7) selecting resource-effective sampling and analysis plan to meet the performance criteria. The first five steps are primarily focused on identifying qualitative criteria such as the type of data needed and defining how the data will be used. The sixth step defines quantitative criteria and the seventh step is used to develop a data collection design. In regards to emissions sampling, these steps have already been identified for typical monitoring parameters.

Monitoring methods presented in 40 *CFR* 60 Appendix A indicate the following regarding DQOs: Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods. At a minimum, each method provides the following types of information: summary of method; equipment and supplies; reagents and standards; sample collection, preservation, storage, and transportation; quality control; calibration and standardization; analytical procedures, data analysis and calculations; and alternative procedures. These test methods have been designed and tested according to DQOs for emissions testing and analysis.

APPENDIX A

TEST RESULTS

Volumetric flow rate summary

Pre&Post - Average	**System 1**		
	Inlet	Difference	Outlet
	23,566	**-2,527**	**26,093**
Pre-only	**System 1**		
	Inlets	Difference	Outlet
	23,669	**-2,707**	**26,377**
Post-only	**System 1**		
	Inlets	Difference	Outlet
	23,463	**-2,346**	**25,809**

Volumetric flow rate summary

Pre&Post - Average	System 2			
	DSCFM			
	Inlets		Difference	Outlet
	2BF-1	9,104		
	2BF-2	8,965		
	2BF-3	8,924		
	2BF-4	9,179		
	2BF-5	8,948		
	2BF-6	12,489		
	Total	**57,609**	**-12,450**	**70,059**
Pre Only	System 2			
	DSCFM			
	Inlets		Difference	Outlet
	2BF-1	9,205		
	2BF-2	8,837		
	2BF-3	8,820		
	2BF-4	9,172		
	2BF-5	8,911		
	2BF-6	12,552		
	Total	**57,496**	**-12,092**	**69,588**
Post Only	System 2			
	DSCFM			
	Inlets		Difference	Outlet
	2BF-1	9,004		
	2BF-2	9,093		
	2BF-3	9,027		
	2BF-4	9,187		
	2BF-5	8,986		
	2BF-6	12,425		
	Total	**57,723**	**-12,808**	**70,531**

APPENDIX B

EXAMPLE CALCULATIONS

AND

NOMENCLATURE

EXAMPLE CALCULATIONS

$A_n = D_n^2 \pi / 4$
$A_s = D_s^2 \pi / 4$
$B_{ws} = V_{w(std)} / (V_{m(std)} + V_{w(std)})$
$c_{analyte} = (m_{analyte} / V_{m(std)}) (35.31466 \text{ ft}^3/\text{m}^3)$
$‘c_{analyte} = (m_{analyte} / V_{m(std)}) (0.015432 \text{ gr/mg})$
$c_{analyte} = ‘c_{analyte} MW_{analyte} / 24.04 \text{ l/mol}$
$CC = t_{0.975} (S_d / n^{1/2})$
$d = 1/n (Sd_i)$
$DE = (E_{Inlet} – E_{Outlet}) / E_{,Inlet} \text{ x } 100\%$
$E_{analyte} = (m_{analyte} / V_{m(std)}) Q_{sd} (60 \text{ min/hr}) (2.2046\text{x}10^{-6} \text{ lb./mg})$
$E_{analyte} = c_{analyte} Q_{sd} (60 \text{ min/hr}) (2.2046\text{x}10^{-6} \text{ lb./mg})$
$I = 100 T_s (K_3 V_{lc} + Y_m V_m P_m / T_m) / (60 \theta v_s P_s A_n)$
where $K_3 = 0.002669 (\text{in. Hg ft}^3) / (\text{mL } °\text{R})$
$K_I = [(2.0084\text{x}10^7 \Delta H_@) A_n (1 – B_{ws})]^2 (M_d / M_s) (T_m / T_s) (P_s / P_m)$
$M_d = 0.44 (\% CO_2) + 0.32 (\% O_2) + 0.28 (\% N_2 + \% CO)$
$M_s = M_d (1 – B_{ws}) + M_w B_{ws}$
$P = Qsd / \text{F-Factor x } 60 \text{ x } (20.9-O_2) / 20.9$
$P_m = P_{bar} + \Delta H / 13.6$
$P_s = P_{bar} + p_g / 13.6$
$Q_a = (60 \text{ s/min}) v_s A_s$
$Q_{sd} = (60 \text{ s/min}) (1 - B_{ws}) v_s A_s (T_{std} / T_s) (P_s / P_{std})$
$RA = [Abs(d) + Abs(CC)]/RM$
$S_d = [(Sd_i^2 – (Sdi)^2/n)/(n-1)]^{1/2}$
$T_m = t_m + 460°$
$T_s = t_s + 460°$
$V_{m(std)} = V_m Y_m (T_{std} / T_m) (P_m / P_{std})$
$V_{w(std)} = (V_{lc} \rho_w R T_{std}) / (M_w P_{std})$
$v_s = K_p C_p [\Delta p]^{1/2} [T_s / (P_s M_s)]^{1/2}$

NOMENCLATURE

Symbol	Units	Description
Abs(x)	dimensionless	Absolute value of parameter x
A_n	ft^2	Area of the nozzle
A_s	ft^2	Area of the stack
B_{ws}	dimensionless	Volume proportion of water in the stack gas stream
C_p	dimensionless	Type S pitot tube coefficient
$c_{analyte}$	mg/dscm	Concentration of analyte in dry stack gas, standardized
$'c_{analyte}$	gr./dscf	Concentration of analyte in dry stack gas, standardized
$'c_{analyte}$	ppm	Concentration of analyte in dry stack gas, standardized
CC	dimensionless	One-tailed 2.5% error confidence coefficient
d	ppm	Arithmetic mean of differences
d_i	ppm	Difference between individual CEM and reference method concentration value
D_n	inches	Internal diameter of the nozzle at the entrance orifice
D_s	inches	Internal diameter of the stack at sampling location
DE	percent	Destruction efficiency
aH	inches H_2O	Average pressure differential across the meter orifice
$aH_@$	inches H_2O	Orifice pressure differential that corresponds to 0.75 cfm of air at 68 °F and 29.92 inches of Hg
ap	inches H_2O	Velocity head of stack gas
$E_{analyte}$	lb./hour	Emission rate of analyte, time basis
I	percent	Isokinetic sampling ratio expressed as percentage
K_I	dimensionless	K-factor, ratio of DH to DP, ideal
K_p	$ft[(lb/lb\text{-}mol)(in.\ Hg)]^{1/2}$	Type S pitot tube constant,
	$s[(°R)(in.\ H_2O)]^{1/2}$	= 85.49
L_p	cfm	Measured post-test leakage rate of the sampling train
M_d	lb./lb.-mole	Molecular weight of gas at the DGM
M_s	lb./lb.-mole	Molecular weight of gas at the stack

NOMENCLATURE

Symbol	Units	Description
M_w	lb./lb.-mole	Molecular weight of water,
		= 18.0
$m_{analyte}$	mg	Mass of analyte in the sample
n	dimensionless	Number of data points
P	MMBtu	Fuel firing rate
P_{bar}	inches Hg	Barometric pressure at measurement site
P_{input}	tons/hour	Process dry mass input rate
p_g	inches H_2O	Gauge (static) pressure of stack gas
P_m	inches Hg	Absolute pressure of meter gases
P_s	inches Hg	Absolute pressure of stack gases
P_{std}	inches Hg	Standard absolute pressure
		= 29.92
Q_a	cfm	Volumetric flow rate of actual stack gas
Q_{sd}	dscfm	Volumetric flow rate of dry stack gas, standardized
R	(in. Hg)(ft^3)	Ideal gas constant,
	(lb-mole)(°R)	= 21.85
RA	percent	Relative accuracy
RE	percent	Removal efficiency
RM	ppm	Average reference method concentration
r_w	lb/mL	Density of water,
		= 0.002201
r_a	g/mL	Density of acetone,
		= 0.7899
S_d	dimensionless	Standard deviation
T_m	°R	Absolute temperature of dry gas meter
T_s	°R	Absolute temperature of stack gas
T_{std}	°R	Standard absolute temperature,
		= 528
$t_{0.975}$	dimensionless	2.5 percent error t-value
t_m	°F	Temperature of DGM
t_s	°F	Temperature of stack gas
[illegible]	minutes	Total sampling time

NOMENCLATURE

Symbol	**Units**	**Description**
$\mathbf{V_{lc}}$	mL	Total volume of liquid collected
$\mathbf{V_{m}}$	dcf	Volume of gas sample as measured by the DGM
$\mathbf{V_{m(std)}}$	dscf	Volume of gas sample as measured by the DGM, standardized
$\mathbf{V_{w(std)}}$	scf	Volume of water vapor in the gas sample, standardized
$\mathbf{v_{s}}$	ft./sec	Velocity of stack gas
$\mathbf{Y_{m}}$	dimensionless	DGM calibration coefficient
$\mathbf{Y_{c}}$	dimensionless	DGM calibration check value
$\mathbf{Y_{w}}$	dimensionless	Reference (wet) gas meter calibration coefficient
% CO_2	percent	Percent CO_2 by volume, dry basis
% O_2	percent	Percent O_2 by volume, dry basis
% N_2	percent	Percent N_2 by volume, dry basis

APPENDIX C

FIELD DATA

System 1
Inlet

Input values:

		Run Number		Metric		
		Pre-1	Post-1	Pre-1	Post-1	
T_{db}	F	81	99	27.2	37.2	C
T_{wb}	F	61	65	16.1	18.3	C
P_g	in H_20	-2.10	-1.60	-0.5	-0.4	kPa
P_{bar}	in Hg	29.25	29.25	99.0	99.0	kPa
O_2	%	20.9	20.9	20.9	20.9	%
CO_2	%	0.0	0.0	0.0	0.0	%

Calculated values:

P	in Hg	29.10	29.13	98.5	98.6	kPa
MW_{air}	lb/mol	28.84	28.84	28.84	28.84	g/mol
p_{sat}	in Hg	0.54	0.62	1.83	2.11	kPa
p	in Hg	0.32	0.25	1.10	0.85	kPa
H	lb H_2O/lb air	0.0070	0.0054	0.0070	0.0054	
B_{ws}		**1.1%**	**0.87%**	**1.12%**	**0.87%**	

* Data entry in non-shaded cells only. Shaded cells contain calculations.
Note: % O_2 and % CO_2 are not important variables. Use 21% and 0% if values have not been measured.

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BD Bard - Covington, GA

Flow Measurements & Calculations

System 1 Inlet

Pre-Test

		Measured values:	
Test Team:	RB, SW, DS	**D_s (in.):**	50.50
EPA Methods:	2, 3	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-2.10
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	1.12
Cp:	0.84	**Test Time:**	10:22

3

Wet bulb (F): 61

Dry bulb (F): 81

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.28	0.529	80
2	0.28	0.529	81
3	0.28	0.529	81
4	0.28	0.529	81
5	0.29	0.539	81
6	0.29	0.539	81
7	0.26	0.510	81
8	0.22	0.469	81
9	0.25	0.500	81
10	0.25	0.500	81
11	0.26	0.510	81
12	0.27	0.520	81
13	0.38	0.616	81
14	0.27	0.520	81
15	0.28	0.529	81
16	0.25	0.500	81
Average	**0.27**	**0.523**	**81**

Calculations:

Molar weight, M_s =	**28.72**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**30.22**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**23,669**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**25,218**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**23,936**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

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BD Bard - Covington, GA

Flow Measurements & Calculations

System 1 Inlet

Post-Test

Test Team:	RB, SW, DS	**Measured values:** D_s **(in.):**	50.50
EPA Methods:	2, 3	P_{bar} **(in. Hg):**	29.25
Test Date:	March 26, 2021	p_g **(in.** H_2O**):**	-1.60
Console ID:	N/A	O_2 **(%):**	20.90
Y_m	N/A	CO_2 **(%):**	0.00
Probe Assembly ID:	P4-04	B_{ws}**(%):**	0.87
Cp:	0.84	**Test Time:**	14:40

Wet bulb (F): 65
Dry bulb (F): 99

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.30	0.548	99
2	0.30	0.548	99
3	0.28	0.529	99
4	0.29	0.539	99
5	0.27	0.520	99
6	0.28	0.529	99
7	0.26	0.510	99
8	0.24	0.490	99
9	0.20	0.447	99
10	0.25	0.500	99
11	0.24	0.490	99
12	0.25	0.500	99
13	0.37	0.608	99
14	0.30	0.548	99
15	0.31	0.557	99
16	0.30	0.548	99
Average	**0.28**	**0.526**	**99**

Calculations:

Molar weight, M_s **=**	**28.74**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s **=**	**30.84**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ **=**	**23,463**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ **=**	**25,736**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ **=**	**23,668**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client: BD Berol
Location: Covington, GA
Source: System 1 Inlet
Test Team: RB / SW / DS
EPA Methods: 1, 2, 3, 4
Test Date: 3/26/21
Console ID: N/A
Probe Assembly ID: P4-04

Measured values:
D_s (in.): 50.5
Y_m / $\Delta H_@$: N/A
C_p: 0.84
t_{amb} (°F): 67
Assumed B_{ws} (%): 1
O_2 (%): 21
CO_2 (%): 0

Start time: 10:22 Start time: 14:40 Start time: Start time:
Stop time: Stop time: Stop time: Stop time:

Test #	Pre test		Post Test					
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	-2.1		-1.6					
Traverse Point	Δp ('' H_2O)	t_s (°F)	Δp ('' H_2O)	t_s (°F)	Δp ('' H_2O)	t_s (°F)	Δp ('' H_2O)	t_s (°F)
1	0.28	80	0.30	99				
2	0.28	81	0.30	99				
3	0.28	81	0.28	99				
4	0.28	81	0.29	99				
5	0.29	81	0.29	99				
6	0.29	81	0.28	99				
7	0.26	81	0.26	99				
8	0.22	81	0.24	99				
9	0.25	81	0.20	99				
10	0.25	81	0.25	99				
11	0.26	81	0.24	99				
12	0.27	81	0.25	99				
13	0.38	81	0.37	99				
14	0.27	81	0.30	99				
15	0.28	81	0.31	99				
16	0.25	81	0.30	99				
17								
18	td =	81						
19	tw =	61	tw =	65				
20								
21								
22								
23								
24								
Average								

Test Team Leader Review: [signature]
Data Entry Review:

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD Bard **Date:** 3/26/21
Location: Covington, GA **Test Team:** RB/SW/DS
Source: System 1 Inlet

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	50.5
A_s (ft^2):	13.91
Length A (in.):	27
Length B (in.):	>161
t_{amb} (°F):	67
Assumed B_{ws}:	1
P_{bar} (in. Hg):	29.25
P_g (in. H_2O):	-2.1
% O_2:	21
% CO_2:	0
Console ID:	N/A
Y:	N/A
$\Delta H_@$:	N/A
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.28	80
2	0.28	81
3	0.28	81
4	0.28	81
5	0.29	81
6	0.29	81
7	0.26	81
8	0.22	81
~~9~~		
~~10~~		
~~11~~		
~~12~~		
Change Ports		
1	0.25	81
2	0.25	81
3	0.26	81
4	0.27	81
5	0.39	81
6	0.27	81
7	0.28	81
8	0.25	81
~~9~~		
~~10~~		
~~11~~		
~~12~~		

Sketch of Stack

Test Team Leader Review: ______

Data Entry Review: DCS

Advanced Industrial Resources, Inc.
Cyclonic Flow Absence Verification Field Data
EPA Method 1

Client:	BN Bend	**Date:**	3/26/21
Location:	Covington, GA	**D_s (in.):**	50.5
Source:	System 1 Inlet	**A_s (ft^2):**	13.91
Test Team:	RB/ SW/ DS	**D_n (in.):**	N/A
Probe ID:	P4-04	**A_n (ft^2):**	N/A
C_p:	0.84		

t_m (°F):	67
Console ID:	N/A
Y_m:	N/A
$\Delta H_@$:	N/A
Assumed B_{ws}:	1
P_{bar} (in. Hg):	29.25

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
~~9~~	~~0.0~~	
~~10~~	~~0.0~~	
~~11~~	~~0.0~~	
~~12~~	~~0.0~~	
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
~~9~~	~~0.0~~	
~~10~~	~~0.0~~	
~~11~~	~~0.0~~	
~~12~~	~~0.0~~	

Test Team Leader Review: ____________

Data Entry Review: DDS

REV021717

SYSTEM 1
OUTLET

Advanced Industrial Resources

BD Bard - Covington, GA

Moisture Measurements & Calculations

System 1 Outlet

Test Team:	GSG, KF		**Measured values:**	
			P_{bar} (in. Hg):	29.25
EPA Methods:	4		**p_g (in. H_2O):**	0.20
Test Date:	March 26, 2021		**Y_m**	1.000
Console ID:	C-017		**Probe Assembly ID:**	P7-01

Moisture Run	Run #1
Used for flow runs:	Pre & Post
Water recovery (ml):	44
Start	980.415
Stop	1161.400
Sample volume (cf):	180.985
Meter temperature (F):	77.6

Calculations:

Moisture volume, V_w =	**2.07**	**scf**	= ml x 0.04715
Sample volume, V_s =	**173.86**	**scf**	$=V_m \times Y_m \times \{528 / (T_m + 460)\} \times \{(P_{bar} + P_g / 13.6) / 29.92\}$
Moisture content, B_{ws} =	**1.18**	**%**	$=V_w / (V_w + V_s)$

T_m
65
67
68
69
70
72
83
89
96
97

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

System 1 Outlet

Pre-Test

		Measured values:	
Test Team:	GSG KF	**D_s (in.):**	73.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	0.20
Console ID:	C-017	**O_2 (%):**	20.90
Y_m	1.000	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01	**B_{ws}(%):**	1.18
Cp:	0.84	**Start Time:**	9:32 - 9:44

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.09	0.300	74
2	0.09	0.300	79
3	0.09	0.300	82
4	0.08	0.283	83
5	0.08	0.283	85
6	0.08	0.283	85
7	0.06	0.245	85
8	0.06	0.245	85
9	0.07	0.265	85
10	0.08	0.283	85
11	0.08	0.283	85
12	0.08	0.283	85
13	0.10	0.316	85
14	0.10	0.316	85
15	0.10	0.316	85
16	0.08	0.283	85
17	0.08	0.283	85
18	0.07	0.265	85
19	0.07	0.265	85
20	0.07	0.265	85
21	0.06	0.245	85
22	0.06	0.245	85
23	0.07	0.265	85
24	0.08	0.283	85
Average	**0.08**	**0.279**	**84**

Calculations:

Molar weight, M_s =	**28.71**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**16.13**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**26,377**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**28,121**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**26,691**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

System 1 Outlet

Post-Test

		Measured values:	
Test Team:	GSG KF	**D_s (in.):**	73.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	0.20
Console ID:	C-017	**O_2 (%):**	20.90
Y_m	1.000	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01	**B_{ws}(%):**	1.18
Cp:	0.84	**Start Time:**	14:52 - 15:04

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.09	0.300	85
2	0.09	0.300	86
3	0.09	0.300	86
4	0.08	0.283	86
5	0.08	0.283	86
6	0.07	0.265	86
7	0.06	0.245	87
8	0.06	0.245	87
9	0.06	0.245	87
10	0.07	0.265	87
11	0.07	0.265	87
12	0.08	0.283	87
13	0.09	0.300	86
14	0.10	0.316	87
15	0.10	0.316	87
16	0.08	0.283	87
17	0.08	0.283	87
18	0.07	0.265	87
19	0.06	0.245	87
20	0.06	0.245	87
21	0.06	0.245	87
22	0.07	0.265	87
23	0.07	0.265	87
24	0.07	0.265	87
Average	**0.08**	**0.274**	**87**

Calculations:

Molar weight, M_s =	**28.71 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**15.85 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**25,809 dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**27,646 acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**26,117 scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources, Inc.

Field Data Sheet

Client:	BD BARD	Test Date:	3/26/21
Location:	COVINGTON GA	Console ID:	C-017
Source:	SYSTEM 1 OUTLET	Y_m / $\Delta H_@$:	1.000 / 1.849
Test Team:	GSG KF	Sampling Box ID:	B-
EPA Methods:	1,2,3,4	Probe Assembly ID:	P7-01
D_s (in.):	73	D_n (in.):	N/A
% O_2	20.9	Assumed B_{ws}:	1
% CO_2	0.0	P_{bar} (in. Hg):	29.25
Start Run:	9:32 | 14:52	p_g (in. H_2O):	0.20
End Run:	9:44 | 15:04	Minutes/Point:	
Run Number:		K-Factor:	N/A

PRE Tamb 64   POST Tamb 71

Point	Meter (dcf)	Inches H_2O: PRE Δp	ΔH	Temperature Readings (°F): t_s	POST ΔP (Probe)	Ts (Filter Box)	Last Impinger	t_m Inlet	t_m Outlet	Filter Exit (M5 or CPM)	Vacuum (in. Hg)
1 (10:35)	980.415	0.09	1.85	74	0.09	85	48	65	65		4
2		0.09		79	0.09	86		67	67		
3		0.09		82	0.09	86		68	68		
4		0.08		83	0.08	86	50	69	69		
5	995.96	0.08		85	0.08	86		70	70		4
6		0.08		85	0.07	87					
7		0.06		85	0.06	87					
8		0.06		85	0.06	87	51	77	77		4
9		0.07		85	0.06	87					
10		0.08		85	0.07	87					
11		0.08		85	0.07	87		83	83		
12		0.08		85	0.08	87	54				4
Change Ports											
1		0.10		85	0.09	86	56	89	85		0
2		0.10		85	0.10	87					
3		0.10		85	0.10	87					
4		0.08		85	0.08	87					
5		0.08		85	0.08	87					
6		0.07		85	0.07	87	59	86	96		4
7		0.07		85	0.06	87					
8		0.07		85	0.06	87					
9		0.06		85	0.06	87					4
10		0.06		85	0.07	87					
11		0.07		85	0.07	87					
12 (14:35)		0.08		85	0.07	87	63	97	97		4
End	1161.400										

Moisture Collected (g)

	Initial	Final	Net
Body:	200	236	36
Silica Gel:	200.0	208.0	8.0
Gel Number:		Total:	44.0

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.001 @ 6"
Pitot A: ✓
Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.001 @ 5"
Pitot A: ✓
Pitot B: ✓

Silica Gel Desc. (initial): ______

Silica Gel Desc. (final): ______

Test Team Leader Review: ______

Data Entry Review: [signature]

Reagent 1: ______ Lot No: ______

Reagent 2: ______ Lot No: ______

Advanced Industrial Resources, Inc.

Source Description Sheets

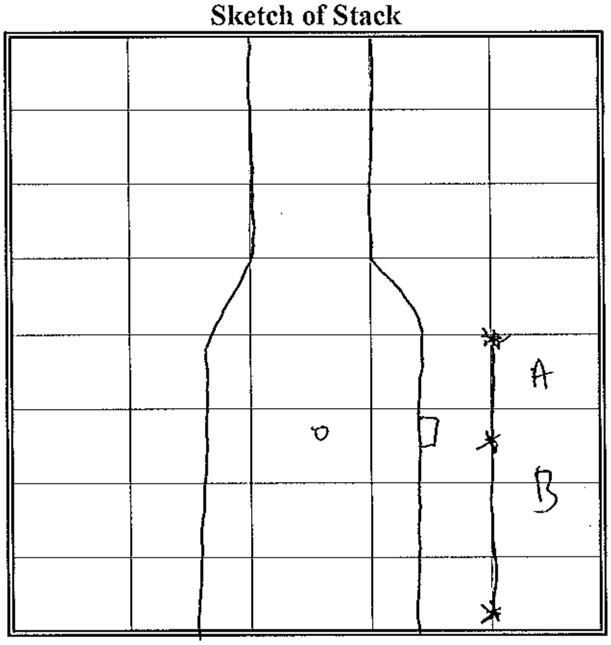
Client: BD BARD
Location: COVINGTON GA
Source: SYSTEM 1 OUTLET

Date: 3/26/21
Test Team: GJG, KF

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	73
A_s (ft^2):	29.065
Length A (in.):	45
Length B (in.):	252
t_{amb} (°F):	64
Assumed B_{ws}:	1
P_{bar} (in. Hg):	29.25
P_g (in. H_2O):	0.20
% O_2:	20.9
% CO_2:	0.0
Console ID:	C-017
Y:	1.000
$\Delta H_@$:	1.849
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.09	82
2	0.09	83
3	0.09	85
4	0.08	85
5	0.08	85
6	0.08	85
7	0.06	85
8	0.06	85
9	0.07	85
10	0.08	85
11	0.08	85
12	0.08	85
Change Ports		
1	0.10	85
2	0.10	85
3	0.10	85
4	0.08	85
5	0.08	85
6	0.07	85
7	0.07	85
8	0.07	85
9	0.06	85
10	0.06	85
11	0.07	85
12	0.08	85

Sketch of Stack



Test Team Leader Review:
Data Entry Review: DJS

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD BARD

Location: COVINGTON, GA

Source: 145 Tan 1 OUTLET

Test Team: GJG KF

Probe ID: P7.01

C_p: 0.84

Date: 3/24/21

D_s (in.): 73

A_s (ft^2): 29.065

D_n (in.): N/A

A_n (ft^2): N/A

t_m (°F): 64

Console ID: C-017

Y_m: 1.900

$\Delta H_@$: 1.849

Assumed B_{ws}: 1

P_{bar} (in. Hg): 29.25

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	0
10	0.0	0
11	0.0	0
12	0.0	0
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	0
10	0.0	0
11	0.0	0
12	0.0	0

Test Team Leader Review:

Data Entry Review: DRS

SYSTEM 2
INLET

Wet bulb / Dry bulb moisture calculation worksheet
BD Bard - Covington, GA

Input values:		2BF-1		2BF-2		2BF-3		2BF-4		2BF-5		2BF-6	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
T_{db}	F	74	81	76	87	74	87	72	83	74	84	73	85
T_{wb}	F	55	60	56	59	55	58	55	57	55	58	55	58
P_g	in H_20	-0.82	-1.30	-0.45	-1.00	-1.60	-1.60	-0.90	-1.50	-1.00	-1.30	-0.80	-0.75
P_{bar}	in Hg	29.25	29.25	29.25	29.25	29.25	29.25	29.25	29.25	29.25	29.25	29.25	29.25
O_2	%	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
CO_2	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Calculated values:

P	in Hg	29.19	29.15	29.22	29.18	29.13	29.13	29.18	29.14	29.18	29.15	29.19	29.19
MW_{air}	lb/mol	28.84	28.84	28.84	28.84	28.84	28.84	28.84	28.84	28.84	28.84	28.84	28.84
p_{sat}	in Hg	0.44	0.52	0.45	0.50	0.44	0.49	0.44	0.47	0.44	0.49	0.44	0.49
p	in Hg	0.23	0.29	0.23	0.20	0.23	0.17	0.25	0.19	0.23	0.21	0.24	0.19
H	lb H_2O/lb air	0.0050	0.0064	0.0051	0.0043	0.0050	0.0037	0.0054	0.0040	0.0050	0.0045	0.0052	0.0041
$\mathbf{B_{ws}}$		**0.8%**	**1.0%**	**0.8%**	**0.7%**	**0.8%**	**0.6%**	**0.9%**	**0.6%**	**0.8%**	**0.7%**	**0.8%**	**0.7%**

* Data entry in non-shaded cells only. Shaded cells contain calculations.
Note: % O_2 and % CO_2 are not important variables. Use 21% and 0% if values have not been measured.

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-1

Pre-Test

Test Team:	RB SW DS		**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4		**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021		**p_g (in. H_2O):**	-0.82
Console ID:	N/A		**O_2 (%):**	20.90
Y_m	N/A		**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04		**B_{ws}(%):**	0.79
Cp:	0.84		**Start Time:**	9:10

Measured values: (right column)

Wet bulb (F): 55
Dry bulb (F): 74

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.42	0.648	74
2	0.39	0.624	74
3	0.38	0.616	74
4	0.32	0.566	74
5	0.38	0.616	74
6	0.28	0.529	74
7	0.28	0.529	74
8	0.37	0.608	74
9	0.32	0.566	74
10	0.38	0.616	74
11	0.32	0.566	74
12	0.29	0.539	74
13	0.26	0.510	74
14	0.28	0.529	74
15	0.28	0.529	74
16	0.28	0.529	74
Average	**0.33**	**0.570**	**74**

Calculations:

Molar weight, M_s =	**28.75**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**32.66**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,205**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,618**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,278**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-1

Post-Test

		Measured values:	
Test Team:	RB SW DS	**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-1.30
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	1.01
Cp:	0.84	**Start Time:**	15:00

Wet bulb (F): 60

Dry bulb (F): 81

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.41	0.640	81
2	0.38	0.616	81
3	0.37	0.608	81
4	0.30	0.548	81
5	0.32	0.566	81
6	0.25	0.500	81
7	0.29	0.539	81
8	0.33	0.574	81
9	0.42	0.648	81
10	0.37	0.608	81
11	0.31	0.557	81
12	0.26	0.510	81
13	0.27	0.520	81
14	0.26	0.510	81
15	0.28	0.529	81
16	0.28	0.529	81
Average	**0.32**	**0.563**	**81**

Calculations:

Molar weight, M_s =	**28.73 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**32.47 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,004 dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,564 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,095 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD Bard	**Measured values:**	
Location:	Covington, GA	D_s (in.):	30.0
Source:	2BF-1	Y_m / $\Delta H_@$:	N/A
Test Team:	RB/SW/DS	C_p:	0.84
EPA Methods:	1,2,3,4	t_{amb} (°F):	67
Test Date:	3/26/21	Assumed B_{ws} (%):	1
Console ID:	N/A	O_2 (%):	21
Probe Assembly ID:	P4-04	CO_2 (%):	0

wb = 55 wb = 60

	Start time: 9:00	Start time: 15:00	Start time:	Start time:
	Stop time:	Stop time:	Stop time:	Stop time:

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	-0.82		-1.3					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.42	74	0.41	81				
2	0.39	74	0.38	81				
3	0.38	74	0.37	81				
4	0.32	74	0.30	81				
5	0.38	74	0.32	81				
6	0.28	74	0.25	81				
7	0.28	74	0.29	81				
8	0.37	74	0.33	81				
9	0.32	74	0.42	81				
10	0.38	74	0.37	81				
11	0.32	74	0.31	81				
12	0.29	74	0.26	81				
13	0.26	74	0.27	81				
14	0.28	74	0.26	81				
15	0.28	74	0.28	81				
16	0.23	74	0.28	81				
Average								

Test Team Leader Review: ______

Data Entry Review: [signature]

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD Bard
Location: Covington, GA
Source: ZBF-1
Test Team: RB/Sw/DS
Probe ID: P4-04
C_p: 0.84

Date: 3/26/21
D_s (in.): 30.0
A_s (ft^2): 4.91
D_n (in.): N/A
A_n (ft^2): N/A

t_m (°F): 67
Console ID: N/A
Y_m: N/A
$\Delta H_@$: N/A
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	2
5	0.0	2
6	0.0	2
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	2
4	0.0	3
5	0.0	1
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review:
Data Entry Review: DCS

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BN Bard
Location: Covington, GA
Source: 2BF-1

Date: 3/26/21
Test Team: RR/SW/DS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 30.0
A_s (ft^2): 4.91
Length A (in.): 35.5
Length B (in.): 97.0

t_{amb} (°F): 67
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): -0.82
% O_2: 21
% CO_2: 0
Console ID: N/A
Y: N/A
$\Delta H_@$: N/A
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.42	74
2	0.39	74
3	0.39	74
4	0.32	74
5	0.39	74
6	0.29	74
7	0.37	74
8	0.37	74
~~9~~		
~~10~~		
~~11~~		
~~12~~		
Change Ports		
1	0.32	74
2	0.38	74
3	0.32	74
4	0.29	74
5	0.26	74
6	0.28	74
7	0.28	74
8	0.28	74
~~9~~		
~~10~~		
~~11~~		
~~12~~		

Sketch of Stack

Test Team Leader Review: ______

Data Entry Review: DDR

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-2

Pre-Test

Test Team:	RB, SW, DS	**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-0.45
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.80
Cp:	0.84	**Start Time:**	9:20

Measured values:

Wet bulb (F): 56

Dry bulb (F): 76

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.25	0.500	76
2	0.29	0.539	76
3	0.26	0.510	76
4	0.26	0.510	76
5	0.38	0.616	76
6	0.38	0.616	76
7	0.29	0.539	76
8	0.28	0.529	76
9	0.30	0.548	76
10	0.30	0.548	76
11	0.29	0.539	76
12	0.26	0.510	76
13	0.29	0.539	76
14	0.36	0.600	76
15	0.36	0.600	76
16	0.28	0.529	76
Average	**0.30**	**0.548**	**76**

Calculations:

Molar weight, M_s =	**28.75 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**31.44 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**8,837 dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,261 acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**8,908 scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-2

Post-Test

Test Team:	RB, SW, DS	**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-1.00
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.68
Cp:	0.84	**Start Time:**	15:17

(Measured values: right column)

Wet bulb (F): 59

Dry bulb (F): 87

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.32	0.566	87
2	0.31	0.557	87
3	0.31	0.557	87
4	0.30	0.548	87
5	0.31	0.557	87
6	0.29	0.539	87
7	0.30	0.548	87
8	0.33	0.574	87
9	0.34	0.583	87
10	0.34	0.583	87
11	0.33	0.574	87
12	0.30	0.548	87
13	0.39	0.624	87
14	0.36	0.600	87
15	0.35	0.592	87
16	0.32	0.566	87
Average	**0.33**	**0.570**	**87**

Calculations:

Molar weight, M_s =	**28.76**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**33.03**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,093**	**dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,727**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,156**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client: BP Barol
Location: Covington, GA
Source: 2BF-2
Test Team: RB | JW | DS
EPA Methods: 1, 2, 3, 4,
Test Date: 3/26/21
Console ID: N/A
Probe Assembly ID: P4-04

Measured values:
D_s (in.): 30.0
Y_m / $\Delta H_@$: N/A
C_p: 0.84
t_{amb} (°F): 67
Assumed B_{ws} (%): 1
O_2 (%): 21
CO_2 (%): 0

wb=56 wb=59

Start time: 9:20	Start time: 15:17	Start time:	Start time:
Stop time:	Stop time:	Stop time:	Stop time:

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.25		29.95					
p_g (in. H_2O):	-0.45		-1.0					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.25	76	0.32	87				
2	0.29	76	0.31	87				
3	0.26	76	0.31	87				
4	0.26	76	0.30	87				
5	0.38	76	0.31	87				
6	0.38	76	0.29	87				
7	0.29	76	0.30	87				
8	0.28	76	0.33	87				
9	0.30	76	0.34	87				
10	0.30	76	0.34	87				
11	0.29	76	0.33	87				
12	0.26	76	0.30	87				
13	0.29	76	0.39	87				
14	0.36	76	0.36	87				
15	0.36	76	0.35	87				
16	0.28	76	0.32	87				
Average								

Test Team Leader Review: [signature]
Data Entry Review:

Advanced Industrial Resources, Inc.
Cyclonic Flow Absence Verification Field Data
EPA Method 1

Client: BD Bard
Location: Covington, GA
Source: 2BF-2
Test Team: RB / SW / DS
Probe ID: P4-04
C_p: 0.84

t_m (°F): 67
Console ID: N/A
Y_m: N/A
$\Delta H_@$: N/A
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Date: 3/26/21
D_s (in.): 30.0
A_s (ft^2): 4.91
D_n (in.): N/A
A_n (ft^2): N/A

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	3
3	0.0	2
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review:
Data Entry Review: DAS

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD [illegible]
Location: Covington, GA
Source: 2BF-2

Date: 3/26/21
Test Team: RB/SW/DS

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	30.0
A_s (ft^2):	4.91
Length A (in.):	26.5
Length B (in.):	151
t_{amb} (°F):	67
Assumed B_{ws}:	1
P_{bar} (in. Hg):	29.25
P_g (in. H_2O):	-0.45
% O_2:	21
% CO_2:	0
Console ID:	N/A
Y:	N/A
$\Delta H_@$:	N/A
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.25	76
2	0.29	76
3	0.26	76
4	0.26	76
5	0.38	76
6	0.38	76
7	0.29	76
8	0.28	76
~~9~~		
~~10~~		
~~11~~		
~~12~~		
Change Ports		
1	0.30	76
2	0.30	76
3	0.29	76
4	0.26	76
5	0.29	76
6	0.36	76
7	0.36	76
8	0.28	76
~~9~~		
~~10~~		
~~11~~		
~~12~~		

Sketch of Stack

Test Team Leader Review:
Data Entry Review: [illegible]

Advanced Industrial Resources
BD Bard - Covington, GA
Flow Measurements & Calculations
2BF-3
Pre-Test

Test Team:	RB, SW, DS	**Measured values:**	
EPA Methods:	1,2	**D_s (in.):**	30.00
Test Date:	March 26, 2021	**P_{bar} (in. Hg):**	29.25
Console ID:	N/A	**p_g (in. H_2O):**	-1.60
Y_m	N/A	**O_2 (%):**	20.90
Probe Assembly ID:	P4-04	**CO_2 (%):**	0.00
Cp:	0.84	**B_{ws}(%):**	0.79
		Start Time:	9:35

Wet bulb (F): 55
Dry bulb (F): 74

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.30	0.548	74
2	0.27	0.520	74
3	0.30	0.548	74
4	0.28	0.529	74
5	0.27	0.520	74
6	0.31	0.557	74
7	0.27	0.520	74
8	0.28	0.529	74
9	0.28	0.529	74
10	0.31	0.557	74
11	0.33	0.574	74
12	0.33	0.574	74
13	0.30	0.548	74
14	0.31	0.557	74
15	0.32	0.566	74
16	0.33	0.574	74
Average	**0.30**	**0.547**	**74**

Calculations:

Molar weight, M_s =	**28.75 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**31.35 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**8,820 dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,234 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**8,890 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-3

Post-Test

Test Team:	RB, SW, DS		
EPA Methods:	1,2		
Test Date:	March 26, 2021		
Console ID:	N/A		
Y_m	N/A		
Probe Assembly ID:	P4-04		
Cp:	0.84		

Measured values:

D_s (in.):	30.00
P_{bar} (in. Hg):	29.25
p_g (in. H_2O):	-1.60
O_2 (%):	20.90
CO_2 (%):	0.00
B_{ws}(%):	0.59
Start Time:	15:07

Wet bulb (F): 58

Dry bulb (F): 87

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.35	0.592	87
2	0.34	0.583	87
3	0.33	0.574	87
4	0.32	0.566	87
5	0.31	0.557	87
6	0.30	0.548	87
7	0.34	0.583	87
8	0.32	0.566	87
9	0.32	0.566	87
10	0.32	0.566	87
11	0.30	0.548	87
12	0.31	0.557	87
13	0.30	0.548	87
14	0.31	0.557	87
15	0.31	0.557	87
16	0.34	0.583	87
Average	**0.32**	**0.566**	**87**

Calculations:

Molar weight, M_s =	**28.77 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**32.81 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,027 dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,662 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,081 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BN Band	**Measured values:**	
Location:	Covington, GA	**D_s (in.):**	30.0
Source:	2BF-3	**Y_m / $\Delta H_@$:**	N/A
Test Team:	RB / SW / DS	**C_p:**	0.84
EPA Methods:	1, 2, 3, 4	**t_{amb} (°F)**	67
Test Date:	3/26/21	**Assumed B_{ws} (%):**	1
Console ID:	N/A	**O_2 (%):**	21
Probe Assembly ID:	P4-04	**CO_2 (%):**	0

wb = 55 wb = 58

	Start time: 9:35	Start time: 15:07	Start time:	Start time:
	Stop time:	Stop time:	Stop time:	Stop time:

Test #	Pre Test		Post Test					
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	~~-.08~~ -1.6		~~-1.4~~ -1.6					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.30	74	0.35	87				
2	0.27	74	0.34	87				
3	0.30	74	0.33	87				
4	0.28	74	0.32	87				
5	0.27	74	0.31	87				
6	0.31	74	0.30	87				
7	0.27	74	0.34	87				
8	0.28	74	0.32	87				
9	0.29	74	0.32	87				
10	0.31	74	0.32	87				
11	0.33	74	0.30	87				
12	0.33	74	0.31	87				
13	0.30	74	0.30	87				
14	0.31	74	0.31	87				
15	0.32	74	0.31	87				
16	0.33	74	0.34	87				
Average								

Test Team Leader Review: [signature]
Data Entry Review: [signature]

Advanced Industrial Resources, Inc.
Cyclonic Flow Absence Verification Field Data
EPA Method 1

Client: BD Bard
Location: Covington, GA
Source: 2BF-3
Test Team: RB | SW | DS
Probe ID: P4-04
C_p: 0.84

t_m (°F): 67
Console ID: N/A
Y_m: N/A
$\Delta H_@$: N/A
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Date: 3/26/21
D_s (in.): 30.0
A_s (ft^2): 4.91
D_n (in.): N/A
A_n (ft^2): N/A

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review:
Data Entry Review: DR

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD Bard
Location: Covington, GA
Source: 2BF-3

Date: 3/26/21
Test Team: RB/SW/DS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 30.0
A_s (ft^2): 4.91
Length A (in.): 39.0
Length B (in.): 163.0

t_{amb} (°F): 67
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): -1.6
% O_2: 21
% CO_2: 0
Console ID: N/A
Y: N/A
$\Delta H_@$: N/A
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.30	74
2	0.27	74
3	0.30	74
4	0.28	74
5	0.27	74
6	0.31	74
7	0.27	74
8	0.29	74
9		
10		
11		
12		
Change Ports		
1	0.29	74
2	0.31	74
3	0.33	74
4	0.33	74
5	0.30	74
6	0.31	74
7	0.32	74
8	0.33	74
9		
10		
11		
12		

Sketch of Stack

Test Team Leader Review:
Data Entry Review: DS

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-4

Pre-Test

Test Team:	RB, SW, DS	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-0.90
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.86
Cp:	0.84	**Start Time:**	9:51

Measured values: (right column)

Wet bulb (F): 55

Dry bulb (F): 72

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.33	0.574	72
2	0.32	0.566	72
3	0.33	0.574	72
4	0.32	0.566	72
5	0.28	0.529	72
6	0.26	0.510	72
7	0.30	0.548	72
8	0.31	0.557	72
9	0.34	0.583	72
10	0.33	0.574	72
11	0.35	0.592	72
12	0.37	0.608	72
13	0.35	0.592	72
14	0.34	0.583	72
15	0.33	0.574	72
16	0.30	0.548	72
Average	**0.32**	**0.567**	**72**

Calculations:

Molar weight, M_s =	**28.74 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**32.45 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,172 dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,557 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,251 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-4
Post-Test

Test Team:	RB, SW, DS	**D_s (in.):**	30.00
EPA Methods:	1,2,3,4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-1.50
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.64
Cp:	0.84	**Start Time:**	15:28

Measured values:

Wet bulb (F): 57
Dry bulb (F): 83

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.30	0.548	83
2	0.30	0.548	83
3	0.34	0.583	83
4	0.33	0.574	83
5	0.35	0.592	83
6	0.36	0.600	83
7	0.35	0.592	83
8	0.36	0.600	83
9	0.27	0.520	83
10	0.29	0.539	83
11	0.31	0.560	83
12	0.31	0.557	83
13	0.34	0.583	83
14	0.35	0.592	83
15	0.35	0.592	83
16	0.36	0.600	83
Average	**0.33**	**0.574**	**83**

Calculations:

Molar weight, M_s =	**28.77**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**33.15**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**9,187**	**dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,764**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,247**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD Bard	**Measured values:**	
Location:	Covington, GA	D_s (in.):	30.0
Source:	2BF-4	Y_m / $\Delta H_@$:	N/A
Test Team:	RB/SW/DS	C_p:	0.84
EPA Methods:	1,2,3,4	t_{amb} (°F)	67
Test Date:	3/26/21	Assumed B_{ws} (%):	1
Console ID:	N/A	O_2 (%):	21
Probe Assembly ID:	P4-04	CO_2 (%):	0

wb = 55 wb = 57

	Start time: 9:51	Start time: 15:29	Start time:	Start time:
	Stop time:	Stop time:	Stop time:	Stop time:

Test #	Pre Test		Post Test					
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	-0.90		-1.5					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.33	72	0.30	83				
2	0.32	72	0.30	83				
3	0.33	72	0.34	83				
4	0.32	72	0.33	83				
5	0.28	72	0.35	83				
6	0.26	72	0.36	83				
7	0.30	72	0.35	83				
8	0.31	72	0.36	83				
9	0.34	72	0.27	83				
10	0.33	72	0.29	83				
11	0.35	72	0.31	83				
12	0.37	72	0.31	83				
13	0.35	72	0.34	83				
14	0.34	72	0.35	83				
15	0.33	72	0.35	83				
16	0.30	72	0.36	83				
17								
18								
19								
20								
21								
22								
23								
24								
Average								

Test Team Leader Review: [signature]
Data Entry Review:

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD Bard
Location: Covington, GA
Source: RBF-4
Test Team: RB/SW/DS
Probe ID: P4-4
C_p: 0.84

t_m (°F): 67
Console ID: N/A
Y_m: N/A
$\Delta H_@$: N/A
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Date: 3/26/21
D_s (in.): 30.0
A_s (ft^2): 4.91
D_n (in.): N/A
A_n (ft^2): N/A

Point	Δp (in. H_2O)	α (degrees)
1	0.0	3
2	0.0	3
3	0.0	3
4	0.0	4
5	0.0	2
6	0.0	5
7	0.0	2
8	0.0	2
9	0.0	
10	0.0	
11	0.0	
12	0.0	
Change Ports		
1	0.0	2
2	0.0	2
3	0.0	4
4	0.0	4
5	0.0	2
6	0.0	3
7	0.0	5
8	0.0	2
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review: ____________
Data Entry Review: DCR

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD Bard
Location: Covington, GA
Source: 2BG-4

Date: 3/26/21
Test Team: RB/SW/DS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 30.0
A_s (ft^2): 4.91
Length A (in.): 60.5
Length B (in.): 115.75

t_{amb} (°F): 67
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): -0.40
% O_2: 21
% CO_2: 0
Console ID: N/A
Y: N/A
$\Delta H_@$: N/A
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.33	72
2	0.32	72
3	0.33	72
4	0.32	72
5	0.28	72
6	0.26	72
7	0.30	72
8	0.31	72
9		
10		
11		
12		
Change Ports		
1	0.34	72
2	0.33	72
3	0.35	72
4	0.37	72
5	0.35	72
6	0.34	72
7	0.33	72
8	0.30	72
9		
10		
11		
12		

Sketch of Stack

Test Team Leader Review:
Data Entry Review: DS

Advanced Industrial Resources
BD Bard - Covington, GA
Flow Measurements & Calculations
2BF-5
Pre-Test

Test Team:	RB, SW, DS	**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-1.00
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.79
Cp:	0.84	**Start Time:**	9:45

Measured values: (right column)

Wet bulb (F): 55
Dry bulb (F): 74

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.29	0.539	74
2	0.30	0.548	74
3	0.26	0.510	74
4	0.29	0.539	74
5	0.34	0.583	74
6	0.38	0.616	74
7	0.29	0.539	74
8	0.29	0.539	74
9	0.30	0.548	74
10	0.36	0.600	74
11	0.35	0.592	74
12	0.31	0.557	74
13	0.28	0.529	74
14	0.27	0.520	74
15	0.28	0.529	74
16	0.30	0.548	74
Average	**0.31**	**0.552**	**74**

Calculations:

Molar weight, M_s =	**28.75 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**31.63 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**8,911 dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,316 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**8,982 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-5

Post-Test

Test Team:	RB, SW, DS		**D_s (in.):**	30.00
EPA Methods:	1, 2, 3, 4		**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021		**p_g (in. H_2O):**	-1.30
Console ID:	N/A		**O_2 (%):**	20.90
Y_m	N/A		**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04		**B_{ws}(%):**	0.71
Cp:	0.84		**Start Time:**	15:23

Measured values: (D_s, P_{bar}, p_g, O_2, CO_2, B_{ws}, Start Time above)

Wet bulb (F): 58
Dry bulb (F): 84

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.37	0.608	83
2	0.36	0.600	83
3	0.30	0.548	83
4	0.30	0.548	83
5	0.31	0.557	84
6	0.33	0.574	83
7	0.30	0.548	84
8	0.27	0.520	84
9	0.33	0.574	84
10	0.38	0.616	84
11	0.35	0.592	84
12	0.33	0.574	84
13	0.30	0.548	84
14	0.29	0.539	84
15	0.27	0.520	84
16	0.27	0.520	84
Average	**0.32**	**0.562**	**84**

Calculations:

Molar weight, M_s =	**28.76 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**32.47 ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**8,986 dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**9,564 acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,050 scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD Bard	**Measured values:**	
Location:	Covington, GA	D_s (in.):	30.0
Source:	2BF-5	Y_m / $\Delta H_@$:	N/A
Test Team:	RB / SW / DS	C_p:	0.84
EPA Methods:	1,2,3,4	t_{amb} (°F)	67
Test Date:	3/26/21	Assumed B_{ws} (%):	1
Console ID:	N/A	O_2 (%):	21
Probe Assembly ID:	P4-04	CO_2 (%):	0

wb: 55 wb: 58

Start time: 9:45 Start time: 15:23 Start time: Start time:
Stop time: Stop time: Stop time: Stop time:

Test #	Pre Test		Post Test					
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	-1.0		-1.3					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.29	74	0.37	83				
2	0.30	74	0.36	83				
3	0.26	74	0.30	83				
4	0.29	74	0.30	83				
5	0.34	74	0.31	84				
6	0.33	74	0.33	83				
7	0.29	74	0.30	84				
8	0.29	74	0.27	84				
9	0.30	74	0.33	84				
10	0.36	74	0.38	84				
11	0.35	74	0.35	84				
12	0.31	74	0.33	84				
13	0.28	74	0.30	84				
14	0.27	74	0.29	84				
15	0.28	74	0.27	84				
16	0.30	74	0.27	84				
Average								

Test Team Leader Review: [signature]
Data Entry Review:

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD Bard
Location: Covington, GA
Source: 2BF-5
Test Team: RB/SW/DS
Probe ID: P4-04
C_p: 0.84

t_m (°F): 67
Console ID: N/A
Y_m: N/A
$\Delta H_@$: N/A
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Date: 3/26/21
D_s (in.): 30.0
A_s (ft^2): 4.91
D_n (in.): N/A
A_n (ft^2): N/A

Point	Δp (in. H_2O)	α (degrees)
1	0.0	3
2	0.0	2
3	0.0	1
4	0.0	4
5	0.0	3
6	0.0	2
7	0.0	2
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	
Change Ports		
1	0.0	0
2	0.0	2
3	0.0	0
4	0.0	2
5	0.0	3
6	0.0	2
7	0.0	0
8	0.0	0
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review:
Data Entry Review: DDS

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD Bard
Location: Covington, GA
Source: 2BF-5

Date: 3/26/21
Test Team: RB/SW/DS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 30.0
A_s (ft^2): 4.91
Length A (in.): 36.5
Length B (in.): 63.5

t_{amb} (°F): 67
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): ~1.0
% O_2: 21
% CO_2: 0
Console ID: N/A
Y: N/A
$\Delta H_@$: N/A
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.29	74
2	0.30	74
3	0.26	74
4	0.29	74
5	0.34	74
6	0.39	74
7	0.29	74
8	0.29	74
9		
10		
11		
12		
Change Ports		
1	0.30	74
2	0.36	74
3	0.35	74
4	0.31	74
5	0.29	74
6	0.27	74
7	0.29	74
8	0.30	74
9		
10		
11		
12		

Sketch of Stack

Test Team Leader Review:
Data Entry Review: DDS

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-6

Pre-Test

		Measured values:	
Test Team:	RB, DG	**D_s (in.):**	36.00
EPA Methods:	1, 2, 3, 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	-0.80
Console ID:	N/A	**O_2 (%):**	20.90
Y_m	N/A	**CO_2 (%):**	0.00
Probe Assembly ID:	P4-04	**B_{ws}(%):**	0.82
Cp:	0.84	**Start Time:**	9:38

Wet bulb (F): 55

Dry bulb (F): 73

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.33	0.574	73
2	0.35	0.592	73
3	0.32	0.566	73
4	0.29	0.539	73
5	0.23	0.480	73
6	0.25	0.500	73
7	0.27	0.520	73
8	0.28	0.529	73
9	0.35	0.592	73
10	0.35	0.592	73
11	0.31	0.557	73
12	0.30	0.548	73
13	0.31	0.557	73
14	0.27	0.520	73
15	0.23	0.480	73
16	0.24	0.490	73
Average	**0.29**	**0.540**	**73**

Calculations:

Molar weight, M_s =	**28.75**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**30.88**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**12,552**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**13,095**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**12,656**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

2BF-6

Post-Test

Test Team:	RB, SW, DS	**Measured values:**	
EPA Methods:	1, 2, 3, 4	**D_s (in.):**	36.00
Test Date:	March 26, 2021	**P_{bar} (in. Hg):**	29.25
Console ID:	N/A	**p_g (in. H_2O):**	-0.75
Y_m	N/A	**O_2 (%):**	20.90
Probe Assembly ID:	P4-04	**CO_2 (%):**	0.00
Cp:	0.84	**B_{ws}(%):**	0.66
		Start Time:	15:17

Wet bulb (F): 58

Dry bulb (F): 85

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.31	0.557	85
2	0.33	0.574	85
3	0.33	0.574	85
4	0.30	0.548	85
5	0.25	0.500	85
6	0.24	0.490	85
7	0.28	0.529	85
8	0.32	0.566	85
9	0.34	0.583	85
10	0.34	0.583	85
11	0.31	0.557	85
12	0.27	0.520	85
13	0.29	0.539	85
14	0.27	0.520	85
15	0.25	0.500	85
16	0.24	0.490	85
Average	**0.29**	**0.539**	**85**

Calculations:

Molar weight, M_s =	**28.76**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**31.20**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**12,425**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**13,232**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**12,508**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD Bard	**Measured values:**	
Location:	Covington, GA	D_s (in.):	36.0
Source:	2BF-6	Y_m / $\Delta H_@$:	N/A
Test Team:	RB/SW/DS	C_p:	0.84
EPA Methods:	1,2,3,4	t_{amb} (°F)	67
Test Date:	3/26/21	Assumed B_{ws} (%):	1
Console ID:	N/A	O_2 (%):	21
Probe Assembly ID:	P4-04	CO_2 (%):	0

wb= 58

wb= 58

Start time: 9:35 Start time: 15:17 Start time: ___ Start time: ___
Stop time: ___ Stop time: ___ Stop time: ___ Stop time: ___

Test #	Pre Test		Post Test					
P_{bar} (in. Hg):	29.25		29.25					
p_g (in. H_2O):	-0.30		-0.75					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.33	73	0.31	85				
2	0.35	73	0.33	85				
3	0.32	73	0.33	85				
4	0.29	73	0.30	85				
5	0.23	73	0.25	85				
6	0.25	73	0.24	85				
7	0.27	73	0.28	85				
8	0.28	73	0.32	85				
9	0.35	73	0.34	85				
10	0.35	73	0.34	85				
11	0.31	73	0.31	86				
12	0.30	73	0.27	85				
13	0.31	73	0.29	85				
14	0.27	73	0.27	85				
15	0.23	73	0.25	85				
16	0.24	73	0.24	85				
Average								

Test Team Leader Review: [signature]
Data Entry Review:

Advanced Industrial Resources, Inc.
Cyclonic Flow Absence Verification Field Data
EPA Method 1

Client:	BD Bard	**Date:**	3/26/21
Location:	Covington, GA	**D_s (in.):**	36.0
Source:	2BF-6	**A_s (ft^2):**	7.07
Test Team:	RB / SW / DS	**D_n (in.):**	N/A
Probe ID:	P4-04	**A_n (ft^2):**	N/A
C_p:	0.84		

t_m (°F):	67
Console ID:	N/A
Y_m:	N/A
$\Delta H_@$:	N/A
Assumed B_{ws}:	1
P_{bar} (in. Hg):	29.25

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
~~9~~	~~0.0~~	
~~10~~	~~0.0~~	
~~11~~	~~0.0~~	
~~12~~	~~0.0~~	
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0
8	0.0	0
~~9~~	~~0.0~~	
~~10~~	~~0.0~~	
~~11~~	~~0.0~~	
~~12~~	~~0.0~~	

Test Team Leader Review: ______

Data Entry Review: DS

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD Bard
Location: Covington, GA
Source: 2BF-6

Date: 3/26/21
Test Team: RB / SW / DS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 36.0
A_s (ft^2): 7.07
Length A (in.): 114.0
Length B (in.): 72.5

t_{amb} (°F): 67
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): -0.80
% O_2: 21
% CO_2: 0
Console ID: N/A
Y: N/A
$\Delta H_{@}$: N/A
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.33	73
2	0.35	73
3	0.32	73
4	0.29	73
5	0.23	73
6	0.25	73
7	0.27	73
8	0.29	73
9		
10		
11		
12		
Change Ports		
1	0.35	73
2	0.35	73
3	0.31	73
4	0.30	73
5	0.31	73
6	0.27	73
7	0.23	73
8	0.24	73
9		
10		
11		
12		

Sketch of Stack

Test Team Leader Review:
Data Entry Review: DCF

System 2
Outlet

Advanced Industrial Resources

BD Bard - Covington, GA

Moisture Measurements & Calculations

System 2 Outlet

Test Team:	GE, GSG, DZ		**Measured values:**	
			P_{bar} (in. Hg):	29.25
EPA Methods:	4		**p_g (in. H_2O):**	0.13
Test Date:	March 26, 2021		**Y_m**	0.955
Console ID:	C-009		**Probe Assembly ID:**	P7-04

Moisture Run	Run #1
Used for flow runs:	Run 1
Water recovery (ml):	22.5
Start	114.865
Stop	294.843
Sample volume (cf):	179.978
Meter temperature (F):	72.3

Calculations:

Moisture volume, V_w =	**1.06**	**scf**	= ml x 0.04715
Sample volume, V_s =	**166.74**	**scf**	$=V_m \times Y_m \times \{528 / (T_m + 460)\} \times \{(P_{bar} + P_g / 13.6) / 29.92\}$
Moisture content, B_{ws} =	**0.63%**	**%**	$=V_w / (V_w + V_s)$

T_m
62
62
63
64
64
69
74
80
85
86
86

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

System 2 Outlet

Pre-Test

		Measured values:	
Test Team:	GSG, DK	**D_s (in.):**	73.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	0.13
Console ID:	C-09	**O_2 (%):**	20.90
Y_m	0.955	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-04	**B_{ws}(%):**	0.63%
Cp:	0.84	**Start Time:**	9:10 - 9:24

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.86	0.927	66
2	0.90	0.949	67
3	0.78	0.883	68
4	0.68	0.825	70
5	0.64	0.800	73
6	0.54	0.735	74
7	0.41	0.640	74
8	0.36	0.600	74
9	0.29	0.539	74
10	0.28	0.529	74
11	0.25	0.500	74
12	0.24	0.490	74
13	0.80	0.894	74
14	0.79	0.889	74
15	0.78	0.883	74
16	0.75	0.866	74
17	0.67	0.819	74
18	0.58	0.762	74
19	0.40	0.632	74
20	0.40	0.632	74
21	0.40	0.632	74
22	0.44	0.663	74
23	0.44	0.663	74
24	0.43	0.656	74
Average	**0.55**	**0.725**	**73**

Calculations:

Molar weight, M_s =	**28.77**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**41.45**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**69,588**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**72,279**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**70,031**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, GA

Flow Measurements & Calculations

System 2 Outlet

Post-Test

Test Team:	GSG, DK	**D_s (in.):**	73.00
EPA Methods:	1, 2, 3A & 4	**P_{bar} (in. Hg):**	29.25
Test Date:	March 26, 2021	**p_g (in. H_2O):**	0.13
Console ID:	C-09	**O_2 (%):**	20.90
Y_m	0.955	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-04	**B_{ws}(%):**	0.63%
Cp:	0.84	**Start Time:**	14:39-14:50

Measured values:

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.86	0.927	77
2	0.83	0.911	77
3	0.77	0.877	77
4	0.68	0.825	77
5	0.65	0.806	77
6	0.60	0.775	77
7	0.43	0.656	77
8	0.38	0.616	77
9	0.42	0.648	77
10	0.33	0.574	77
11	0.30	0.548	77
12	0.28	0.529	77
13	0.80	0.894	77
14	0.78	0.883	77
15	0.74	0.860	77
16	0.75	0.866	77
17	0.66	0.812	77
18	0.57	0.755	77
19	0.46	0.678	77
20	0.40	0.632	77
21	0.40	0.632	77
22	0.44	0.663	77
23	0.44	0.663	77
24	0.46	0.678	77
Average	**0.56**	**0.738**	**77**

Calculations:

Molar weight, M_s =	**28.77**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**42.33**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$
Flow Rate, $Q_{s,ds}$ =	**70,531**	**dscfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$
Flow Rate, $Q_{s,act}$ =	**73,819**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**70,979**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources, Inc.

Field Data Sheet

Client:	BD BARD	Test Date:	3/26/21
Location:	COVINGTON GA	Console ID:	C-09
Source:	SYSTEM 2 OUTLET	Y_m / $\Delta H_@$:	0.955 / 1.613
Test Team:	GSG DK	Sampling Box ID:	B-09
EPA Methods:	1, 2, 3, 4	Probe Assembly ID:	P7-02
D_s (in.):	73	D_n (in.):	N/A
% O_2	20.9	Assumed B_{ws}:	1
% CO_2	0.0	P_{bar} (in. Hg):	29.25
Start Run: (FLOW)	9:10 / 14:39	p_g (in. H_2O):	0.13
End Run:	9:24 / 14:50	Minutes/Point:	
Run Number:		K-Factor:	N/A

PRE Tamb 63

POST Tamb 71

Point	Meter (dcf)	Inches H_2O: PRE Δp	Inches H_2O: ΔH	Temperature Readings (°F): PRE t_s	POST ΔP (~~Probe~~)	POST TS (~~Filter/Box~~)	Last Impinger	t_m Inlet	t_m Outlet	Filter Exit (M5 or CPM)	Vacuum (in. Hg)
10:35 1	119.865	0.86	1.60	66	0.86	77	49	62	62		3
2		0.90		67	0.87	77		62	62		
3		0.78		68	0.77	77		63	69		
4	130.70	0.68		70	0.68	77		64	64		
5	~~195.40~~ POST	0.69		73	0.65	77	50	64	64		3
6		0.54		74	0.60	77		67	69		
7		0.41		74	0.43	77					
8		0.36		74	0.38	77					
9		0.29		74	0.32	77	52	74	74		3
10		0.28		74	0.33	77					
11		0.25		74	0.30	77		80	80		
12		0.24		74	0.28	77	58				3
Change Ports											
1		0.80		74	0.80	77		85	85		3
2		0.79		74	0.78	77					
3		0.78		74	0.74	77	60				
4		0.75		74	0.75	77					3
5		0.65		74	0.66	77					
6		0.58		74	0.57	77	62				
7		0.40		74	0.46	77		86	86		3
8		0.40		74	0.40	77					
9		0.40		74	0.40	77	64				
10		0.44		74	0.44	77					
11		0.44		74	0.44	77					
12		0.43		74	0.46	77	66	86	86		3
14:35 End	294.843										

Moisture Collected (g)

	Initial	Final	Net
Body:	200	218	18
Silica Gel:	200.0	204.5	4.5
Gel Number:		Total:	22.5

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.000 @ 8"

Pitot A: ok

Pitot B: ok

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.001 @ 8"

Pitot A: ok

Pitot B: ok

Silica Gel Desc. (initial):

Silica Gel Desc. (final):

Test Team Leader Review: [signature]

Data Entry Review:

Reagent 1: Lot No:

Reagent 2: Lot No:

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD BARD
Location: COVINGTON GA
Source: SYSTEM 2 OUTLET
Test Team: GJG DJK
Probe ID: P7-02
C_p: 0.84

Date: 3/24/21
D_s (in.): 73
A_s (ft^2): 29.065
D_n (in.): N/A
A_n (ft^2): N/A

t_m (°F): 63
Console ID: C009
Y_m: 0.955
$\Delta H_@$: 1.617
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25

Point	Δp (in. H_2O)	α (degrees)
1	0.0	0
2	0.0	1
3	0.0	1
4	0.0	1
5	0.0	0
6	0.0	2
7	0.0	1
8	0.0	0
9	0.0	0
10	0.0	1
11	0.0	3
12	0.0	2
Change Ports		
1	0.0	1
2	0.0	2
3	0.0	1
4	0.0	1
5	0.0	0
6	0.0	0
7	0.0	1
8	0.0	2
9	0.0	1
10	0.0	0
11	0.0	1
12	0.0	0

Test Team Leader Review: ____________

Data Entry Review: OOS

Advanced Industrial Resources, Inc.

Source Description Sheets

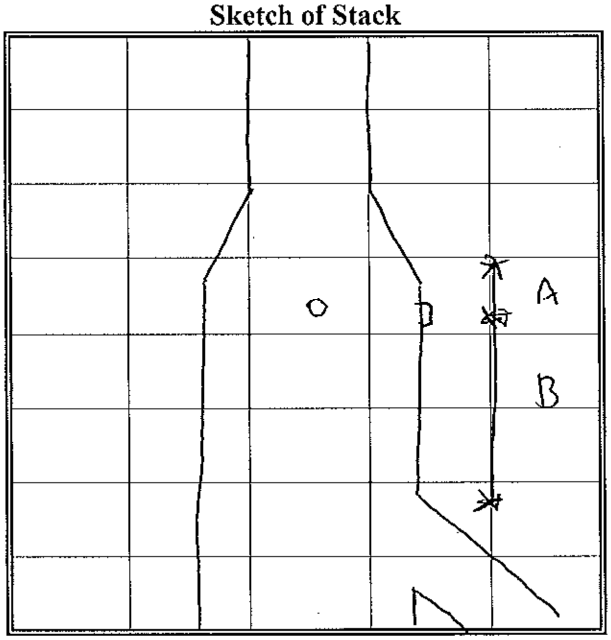
Client: BD BARD **Date:** 3/24/21
Location: COVINGTON GA **Test Team:** CSG DK
Source: SYSTEM 2 OUTLET

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 73
A_s (ft^2): 29.065
Length A (in.): 45
Length B (in.): 252

t_{amb} (°F): 63
Assumed B_{ws}: 1
P_{bar} (in. Hg): 29.25
P_g (in. H_2O): 0.13
% O_2: 20.9
% CO_2: 0.0
Console ID: C.009.
Y: 0.955
$\Delta H_@$: 1.613
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.86	72
2	0.90	73
3	0.78	74
4	0.68	74
5	0.64	74
6	0.54	74
7	0.41	74
8	0.36	74
9	0.29	74
10	0.28	74
11	0.25	74
12	0.24	74
Change Ports		
1	0.80	72
2	0.79	73
3	0.78	74
4	0.75	74
5	0.67	74
6	0.58	74
7	0.90	74
8	0.90	74
9	0.90	74
10	0.94	74
11	0.94	74
12	0.93	74

Sketch of Stack



Test Team Leader Review: ____________
Data Entry Review: DM

APPENDIX D

CALIBRATION DATA

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-17
Serial Number:	1306025

Reference Meter	
Meter ID:	M5RFM1
Calibration Factor, Y_w:	0.998

Date: 11/06/20

Barometric Pressure, P_b (in. Hg): 29.30

Performed By: LS

Reviewed By:

Data

Vacuum (in. Hg)	ΔH (in. H_2O)	Reference Meter Volume V_w (ft^3)	Dry Gas Meter Volume V_m (ft^3)	Temperatures (°F): Reference Meter t_w	Dry Gas Meter init. t_i	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
1.0	0.50	5.100	5.232	68	72.0	74.0	73.0	13.40
2.0	1.00	5.110	5.051	69	74.0	76.0	75.0	9.20
4.0	2.00	5.065	5.112	69	76.0	79.0	77.5	6.50
6.0	3.00	6.437	6.506	69	79.0	81.0	80.0	6.60
8.0	4.00	6.261	6.342	69	81.0	83.0	82.0	5.60

Calculations

ΔH (inches H_2O)	Y_m (dimensionless)	Variation		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.981	-0.019	**PASS**	1.961	0.114	**PASS**
1.00	1.019	0.019	**PASS**	1.842	-0.005	**PASS**
2.00	1.000	0.000	**PASS**	1.863	0.016	**PASS**
3.00	1.000	0.001	**PASS**	1.775	-0.072	**PASS**
4.00	0.999	0.000	**PASS**	1.795	-0.052	**PASS**
Averages:	**1.000**	**PASS**		**1.847**	**PASS**	

Where:

Y_m is the ratio of the reading of the reference meter to that of the dry gas meter (DGM); variance limit: ±0.02.

$$Y_m = \frac{Y_w \, V_w \, P_b \, (t_m + 460)}{V_m \, (P_b + \Delta H/13.6) \, (t_w + 460)}$$

$\Delta H_@$ is the orifice pressure differential (inches H_2O) that corresponds to 0.75 cfm of air at 68 °F and 29.92 inches of mercury; variance limit: ±0.20.

$$\Delta H_@ = \frac{0.0317 \, \Delta H \, ((t_w + 460) \, \theta)^2}{P_b \, (t_m + 460) \, (Y_w \, V_w)^2}$$

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-017
Serial Number:	

Reference Meter	
Meter ID:	M5 RFM 1
Calibration Factor, Y_w:	0.9980

Date:	04/27/21	**Accepted Y_m:**	1.000
Barometric Pressure, P_b (in. Hg):	29.16	**Performed By:**	KF

Data

Vacuum (in. Hg)	ΔH (in. H_2O)	Net Reference Meter Volume V_w (ft^3)	Net Dry Gas Meter Volume V_m (ft^3)	Temperatures (°F) Reference Meter t_w	Dry Gas Meter init. t_i	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
5.0	3.00	5.162	5.122	75	73	74	73.5	5.25
5.0	3.00	5.169	5.140	75	74	77	75.5	5.25
5.0	3.00	4.938	4.934	75	77	79	78.0	5.00

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
3.00	0.995	-0.0010	**PASS**	1.817	0.014	**PASS**
3.00	0.997	0.0006	**PASS**	1.805	0.003	**PASS**
3.00	0.997	0.0004	**PASS**	1.786	-0.017	**PASS**
Averages:	**0.996**	**PASS**		**1.803**	**PASS**	

Calculations

**Note	Low Tolerance	High Tolerance	% diff	Pass or Fail?
****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	**0.950**	**1.050**	**0%**	**PASS**

Where:

Y_m is the ratio of the reading of the reference meter to that of the dry gas meter (DGM); variance limit: ±0.02.

$$Y_m = \frac{Y_w V_w P_b (t_m + 460)}{V_m (P_b + \Delta H/13.6)(t_w + 460)}$$

$\Delta H_@$ is the orifice pressure differential (inches H_2O) that corresponds to 0.75 cfm of air at 68 °F and 29.92 inches of mercury; variance limit: ±0.20.

$$\Delta H_@ = \frac{0.0317 \Delta H ((t_w + 460)\theta)^2}{P_b (t_m + 460)(Y_w V_w)^2}$$

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-009
Serial Number:	

Reference Meter	
Meter ID:	MSRFM1
Calibration Factor, Y_w:	0.998

Date: 08/17/20

Barometric Pressure, P_b (in. Hg): 29.80

Performed By: SS

Reviewed By:

Data								
				Temperatures (°F)				Time Elapsed
Vacuum (in. Hg)	ΔH (in. H_2O)	Reference Meter Volume V_w (ft^3)	Dry Gas Meter Volume V_m (ft^3)	Reference Meter t_w	Dry Gas Meter init. t_i	final t_f	avg. t_m	θ (min.)
5.0	0.50	6.004	6.305	76	75.0	77.0	76.0	14.00
5.0	1.00	5.897	6.168	78	77.0	80.0	78.5	10.00
5.0	2.00	5.923	6.140	80	80.0	82.0	81.0	7.00
5.0	3.00	6.230	6.456	82	82.0	84.0	83.0	6.00
5.0	4.00	6.543	6.786	84	84.0	85.0	84.5	5.50

Calculations						
ΔH (inches H_2O)	Y_m (dimensionless)	Variation		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.949	-0.005	**PASS**	1.556	-0.056	**PASS**
1.00	0.953	-0.002	**PASS**	1.651	0.038	**PASS**
2.00	0.960	0.005	**PASS**	1.608	-0.005	**PASS**
3.00	0.958	0.003	**PASS**	1.608	-0.005	**PASS**
4.00	0.954	-0.001	**PASS**	1.641	0.028	**PASS**
Averages:	**0.955**	**PASS**		**1.613**	**PASS**	

Where:

Y_m is the ratio of the reading of the reference meter to that of the dry gas meter (DGM); variance limit: ±0.02.

$$Y_m = \frac{Y_w\, V_w\, P_b\, (t_m + 460)}{V_m\, (P_b + \Delta H/13.6)\, (t_w + 460)}$$

$\Delta H_@$ is the orifice pressure differential (inches H_2O) that corresponds to 0.75 cfm of air at 68 °F and 29.92 inches of mercury; variance limit: ±0.20.

$$\Delta H_@ = \frac{0.0317\, \Delta H\, ((t_w + 460)\, \theta)^2}{P_b\, (t_m + 460)\, (Y_w\, V_w)^2}$$

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-009
Serial Number:	

Reference Meter	
Meter ID:	M5 RFM 1
Calibration Factor, Y_w:	0.9980

Date:	04/27/21	**Accepted Y_m:**	0.955
Barometric Pressure, P_b (in. Hg):	29.16	**Performed By:**	KF

Data

Vacuum (in. Hg)	ΔH (in. H_2O)	Net Reference Meter Volume V_w (ft^3)	Net Dry Gas Meter Volume V_m (ft^3)	Temperatures (°F) Reference Meter t_w	Dry Gas Meter init. t_i	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
5.0	3.00	5.002	5.116	75	69	72	70.5	4.75
5.0	3.00	5.002	5.134	75	72	74	73.0	4.75
5.0	3.00	4.999	5.142	75	75	77	76.0	4.75

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
3.00	0.960	-0.0019	**PASS**	1.593	0.007	**PASS**
3.00	0.961	-0.0007	**PASS**	1.586	0.000	**PASS**
3.00	0.965	0.0026	**PASS**	1.579	-0.007	**PASS**
Averages:	**0.962**	**PASS**		**1.586**	**PASS**	

Calculations

**Note	Low Tolerance	High Tolerance	% diff	Pass or Fail?
****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	**0.907**	**1.003**	**1%**	**PASS**

Where:

Y_m is the ratio of the reading of the reference meter to that of the dry gas meter (DGM); variance limit: ±0.02.

$$Y_m = \frac{Y_w\ V_w\ P_b\ (t_m + 460)}{V_m\ (P_b + \Delta H/13.6)\ (t_w + 460)}$$

$\Delta H_@$ is the orifice pressure differential (inches H_2O) that corresponds to 0.75 cfm of air at 68 °F and 29.92 inches of mercury; variance limit: ±0.20.

$$\Delta H_@ = \frac{0.0317\ \Delta H\ ((t_w + 460)\ \theta)^2}{P_b\ (t_m + 460)\ (Y_w\ V_w)^2}$$

Environmental Supply Company, Inc.
Quality Source Sampling Systems & Accessories

15 POINT SECONDARY REFERENCE METER CALIBRATION

Date: 8/15/2019 **DGM Model:** T-110
Customer: Advanced Industrial Resources **DGM S/N:** 27979
Reference Prover: Cert.# A-610 Tape # 26727

Pb: 29.89 in Hg

Approx. Flow Rate (cfm) Q	Prover Volume (ft^3) V_w	DGM Volume (ft^3) V_{ds}	Temperature		Time (min) Φ	Flow Rate (cfm) Q	Meter Coefficient Y_{ds}	Average Meter Coefficient Y_{ds}
			Prover (°F) t_w	DGM (°F) t_{ds}				
0.40	2.000	2.020	76.2	76.2	5.148	0.382	0.990	
0.40	2.000	2.019	76.1	76.1	5.117	0.384	0.991	
0.40	2.000	2.009	76.2	76.2	5.122	0.384	0.996	0.992
0.60	2.000	2.018	76.5	76.5	3.320	0.592	0.991	
0.60	2.000	2.017	75.9	75.9	3.318	0.593	0.992	
0.60	2.000	2.017	75.9	75.9	3.308	0.595	0.992	0.991
0.80	2.000	2.017	75.9	75.9	2.438	0.807	0.992	
0.80	2.000	2.017	76.2	76.2	2.432	0.809	0.992	
0.80	2.000	2.023	75.9	75.9	2.428	0.810	0.989	0.991
1.00	2.000	2.022	76.3	76.3	1.943	1.012	0.989	
1.00	2.000	2.017	75.6	75.6	1.947	1.011	0.992	
1.00	2.000	2.016	76.2	76.2	1.942	1.013	0.992	0.991
1.20	2.000	2.007	75.5	75.5	1.622	1.214	0.997	
1.20	2.000	2.016	75.5	75.5	1.623	1.213	0.992	
1.20	2.000	2.017	75.5	75.5	1.623	1.213	0.992	0.993

AVERAGE Y_{ds} **0.992**

$$Y_{ds} = \frac{V_w(t_{ds} + t_{std})}{V_{ds}(t_w + t_{std})} * \frac{P_{bar}}{\left(P_{bar} + P_m/13.6\right)}$$

$$Q = 17.64 \frac{P_{bar}}{(t_w + t_{std})} \frac{V_w}{\Phi}$$

Dry gas meter Serial Number 27979 was calibrated in accordance with the Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5 Section 16.1.1

Signature

708 E. Club Blvd., Durham, North Carolina 27704 www.environsupply.com 919-956-9688 FAX: 919-682-0333

Environmental Supply Company, Inc.
Quality Source Sampling Systems & Accessories

15 POINT SECONDARY REFERENCE METER CALIBRATION

Date: 8/27/2019
Customer: Advanced Industrial Resources
DGM Model: T-110
DGM S/N: 356333
Reference Prover: Cert.# A-610 Tape # 26727

Pb: 29.86 in Hg

Approx. Flow Rate (cfm) Q	Prover Volume (ft^3) V_w	DGM Volume (ft^3) V_{ds}	Temperature		Time (min) Φ	Flow Rate (cfm) Q	Meter Coefficient Y_{ds}	Average Meter Coefficient Y_{ds}
			Prover (°F) t_w	DGM (°F) t_{ds}				
0.40	2.000	1.998	77.9	75.8	5.092	0.385	0.997	
0.40	2.000	1.997	77.4	75.8	5.088	0.385	0.999	
0.40	2.000	1.998	77.4	75.7	5.097	0.385	0.998	0.998
0.60	2.000	2.004	75.8	75.8	3.290	0.598	0.998	
0.60	2.000	2.003	75.8	75.8	3.288	0.598	0.999	
0.60	2.000	2.003	75.8	75.8	3.285	0.599	0.999	0.998
0.80	2.000	2.006	75.8	75.8	2.453	0.801	0.997	
0.80	2.000	2.007	75.8	75.8	2.442	0.805	0.997	
0.80	2.000	2.001	75.5	75.5	2.440	0.806	1.000	0.998
1.00	2.000	2.001	75.9	75.9	1.918	1.025	1.000	
1.00	2.000	2.006	75.9	75.9	1.925	1.021	0.997	
1.00	2.000	2.010	75.9	75.9	1.928	1.019	0.995	0.997
1.20	2.000	2.007	75.9	75.9	1.595	1.232	0.997	
1.20	2.000	2.006	75.9	75.9	1.597	1.231	0.997	
1.20	2.000	2.006	75.9	75.9	1.588	1.238	0.997	0.997

AVERAGE Y_{ds} 0.998

$$Y_{ds} = \frac{V_w(t_{ds} + t_{std})}{V_{ds}(t_w + t_{std})} * \frac{P_{bar}}{\left(P_{bar} + P_m/13.6\right)}$$

$$Q = 17.64 \frac{P_{bar}}{(t_w + t_{std})} \frac{V_w}{\Phi}$$

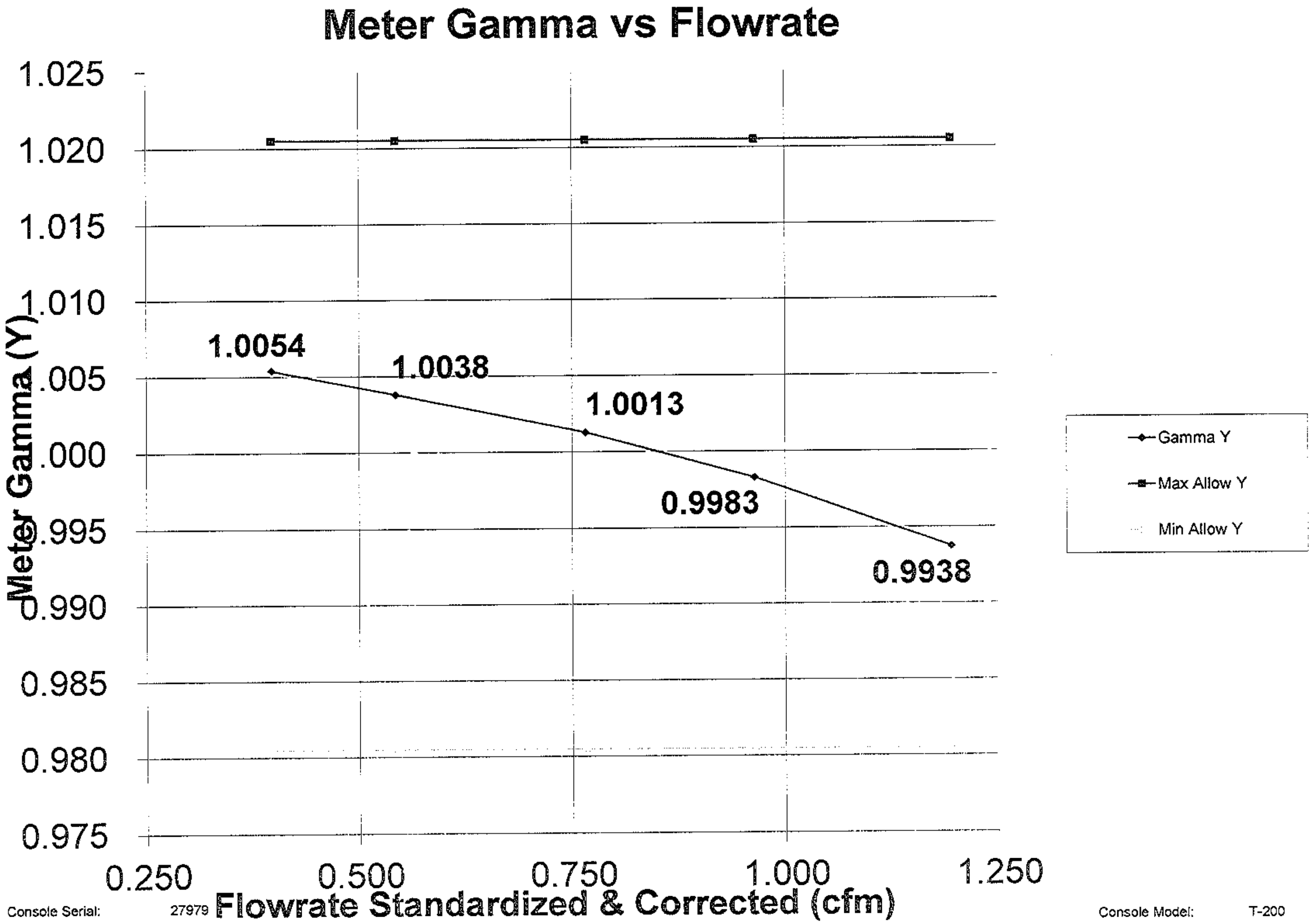
Dry gas meter Serial Number 356333 was calibrated in accordance with the Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5 Section 16.1.1

Signature

708 E. Club Blvd., Durham, North Carolina 27704 www.environsupply.com 919-956-9688 FAX: 919-682-0333

Calibration Date: 10-10-2017

Calibration Technician: EW

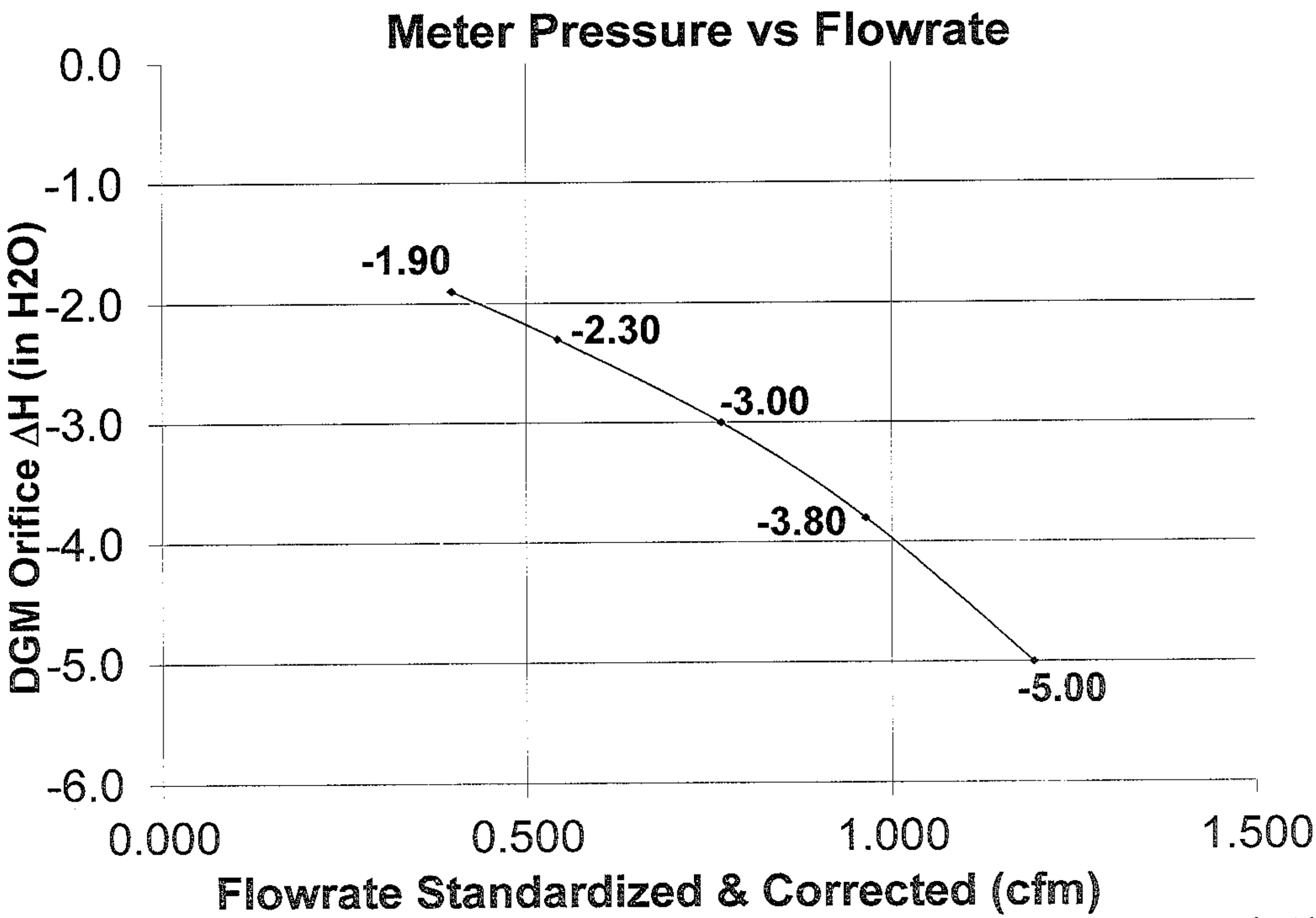


Console Serial: 27979

Console Model: T-200

Calibration Date: 10-10-2017

Calibration Technician: EW



Console Serial: 27979

Console Model: T-200

Advanced Industrial Resources, Inc.

Thermocouple Calibration Data

Thermometer ID: RT-01 ; RT-03 **Date:** 04/26/21

Bias: 0 **Performed By:** LS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P7-01	Stack Temp.	32	492	33	493	0.2
P7-01	Stack Temp.	210	670	211	671	0.1
B-17	Filter Temp.	32	492	32	492	0.0
B-17	Filter Temp.	210	670	210	670	0.0
B-17	Exit Imp. Temp.	32	492	32	492	0.0
B-17	Exit Imp. Temp.	210	670	211	671	0.1
C-017	Meter In Temp.	32	492	33	493	0.2
C-017	Meter In Temp.	210	670	210	670	0.0
C-017	Meter Out Temp.	32	492	33	493	0.2
C-017	Meter Out Temp.	210	670	212	672	0.3
B-17	Filter Exit Temp.	32	492	33	493	0.2
B-17	Filter Exit Temp.	210	670	211	671	0.1
P7-01	Probe Temp.	32	492	32	492	0.0
P7-01	Probe Temp.	210	670	210	670	0.0

Thermocouple Calibration Procedure

A. References

1. Mercury-in-glass refernce thermometer, calibrated against thermometric fixed points.
2. Thermometric fixed points, including ice bath and boiling water (corrected for barometric pressure)

B. Measurement

1. Compare field temperature sensors against the reference thermometer. Agreement must be within ±1.5% of the absolute reference temperature.

Advanced Industrial Resources, Inc.

Thermocouple Calibration Data

Thermometer ID: RT-01 ; RT-03 **Date:** 04/26/21

Bias: 0 **Performed By:** LS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P7-02	Stack Temp.	32	492	33	493	0.2
P7-02	Stack Temp.	210	670	211	671	0.1
B-09	Filter Temp.	32	492	32	492	0.0
B-09	Filter Temp.	210	670	210	670	0.0
B-09	Exit Imp. Temp.	32	492	33	493	0.2
B-09	Exit Imp. Temp.	210	670	210	670	0.0
C-009	Meter In Temp.	32	492	33	493	0.2
C-009	Meter In Temp.	210	670	210	670	0.0
C-009	Meter Out Temp.	32	492	32	492	0.0
C-009	Meter Out Temp.	210	670	211	671	0.1
B-09	Filter Exit Temp.	32	492	32	492	0.0
B-09	Filter Exit Temp.	210	670	212	672	0.3
P7-02	Probe Temp.	32	492	32	492	0.0
P7-02	Probe Temp.	210	670	210	670	0.0

Thermocouple Calibration Procedure

A. References

1. Mercury-in-glass refernce thermometer, calibrated against thermometric fixed points.
2. Thermometric fixed points, including ice bath and boiling water (corrected for barometric pressure)

B. Measurement

1. Compare field temperature sensors against the reference thermometer. Agreement must be within ±1.5% of the absolute reference temperature.

VERIFICATION OF CONSTRUCTION SPECIFICATIONS FOR THE TYPE-S PITOT TUBE

Thomas R. Clark, Wade Mason, Paul Reinermann III
PEDCo Environmental, Inc.,
Cincinnati, Ohio

Revisions to EPA Reference Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube) - promulgated August 18, 1977, exempted certain pitot tubes from calibration and included appropriate construction criteria and application guidelines.

Figure 1 summarizes procedures for determining the calibration coefficients of Type-S pitot tubes. A pitot tube may be calibrated using procedures outlined in Method 2 or assigned a baseline coefficient (C_p) of 0.84 if it meets the following criteria:

- Pitot tube meets the construction criteria of Figures 2 and 3
- The external tubing diameter (D_t) is between 0.48 and 0.95 cm (3/16 and 3/8 in.)
- The base-to-opening plane distances (P_A and P_B) are equal and range between 1.05 and 1.50 D_t
- The pitot tube is used separately, or in a pitot-probe assembly, mounted in accordance with the specifications in Figures 4 and 5

Pitot tubes that meet the construction criteria of Figures 2 and 3, but do not meet the specified limits for D_t, P_A, and P_B may be used, but must be calibrated.

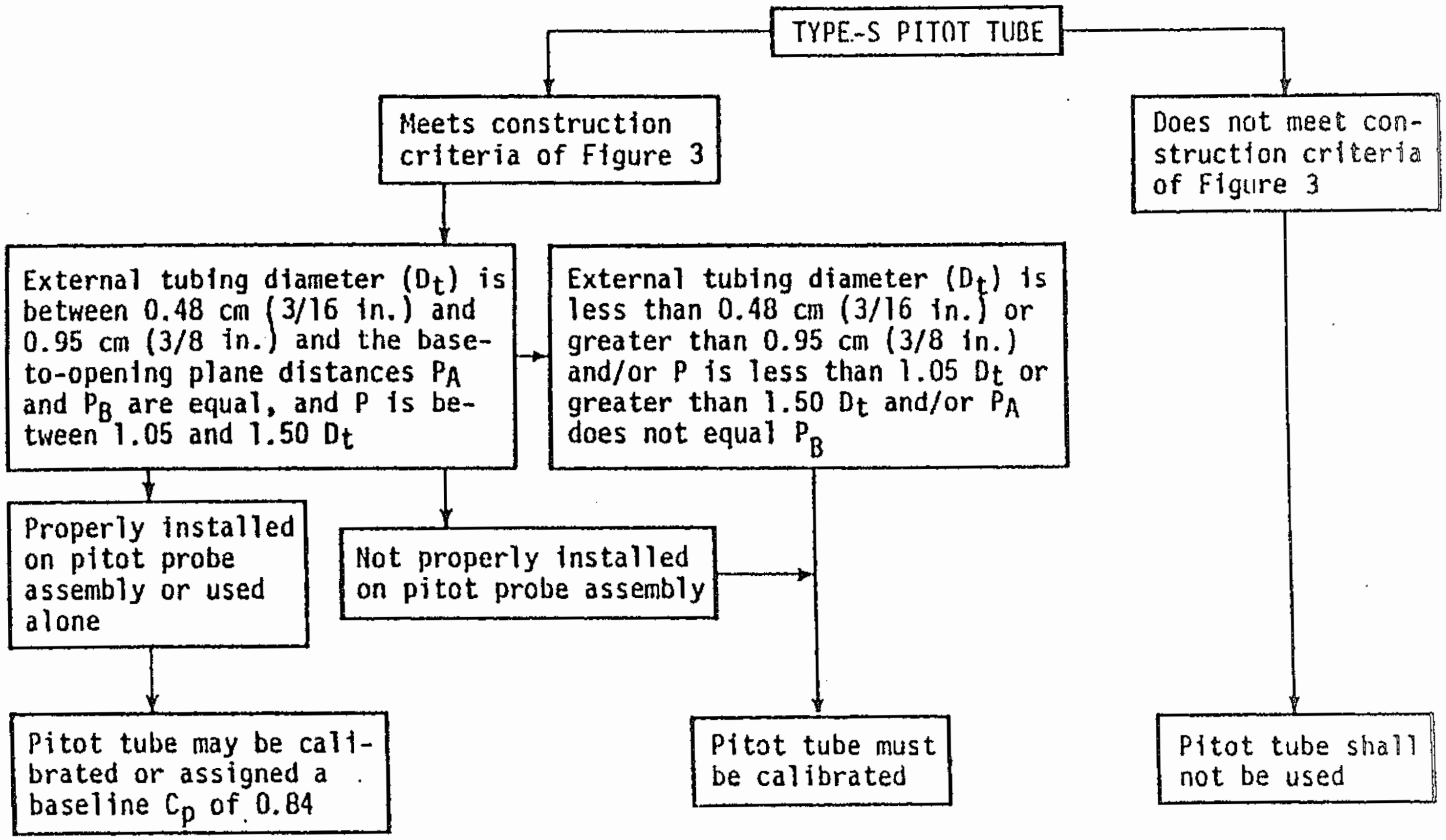


Figure 1. Procedures for determining the calibration coefficients of Type-S pitot tubes.

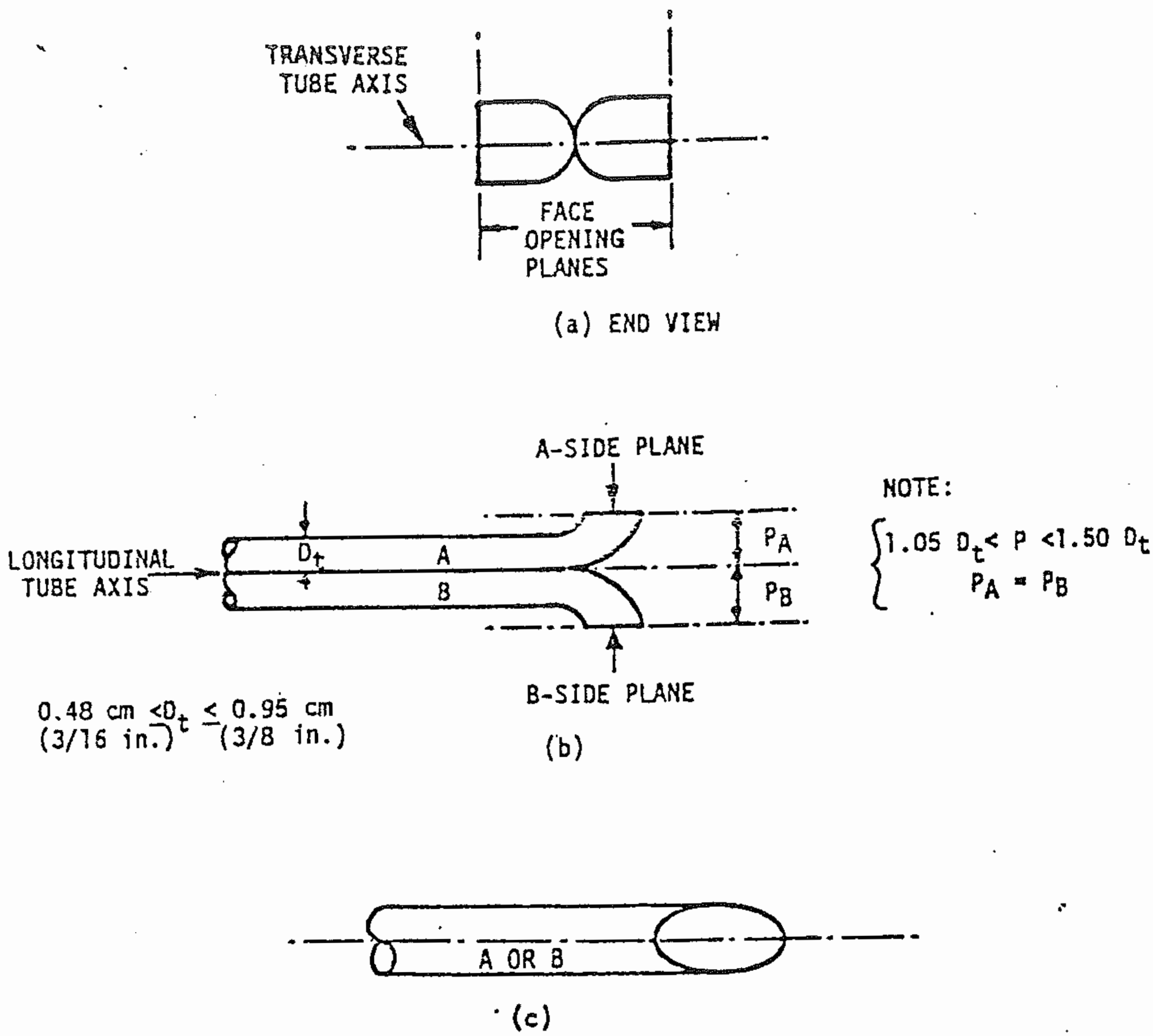


Figure 2. Properly constructed Type-S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening plans parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

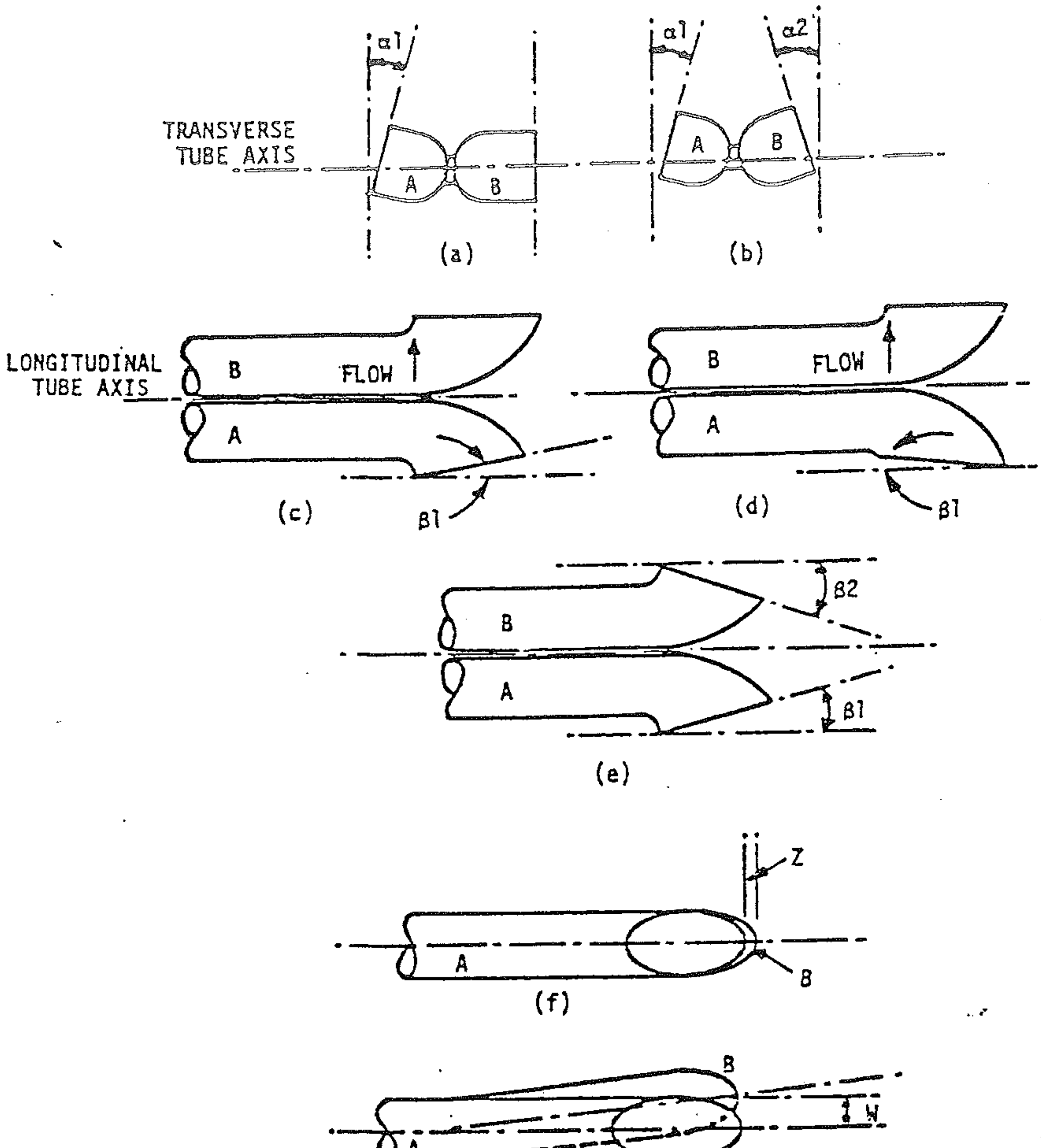


Figure 3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp as long as a_1 and a_2 <10°, β_2 <5°, z <0.32 cm (1/8 in.) and w <0.08 cm (1/32 in.).

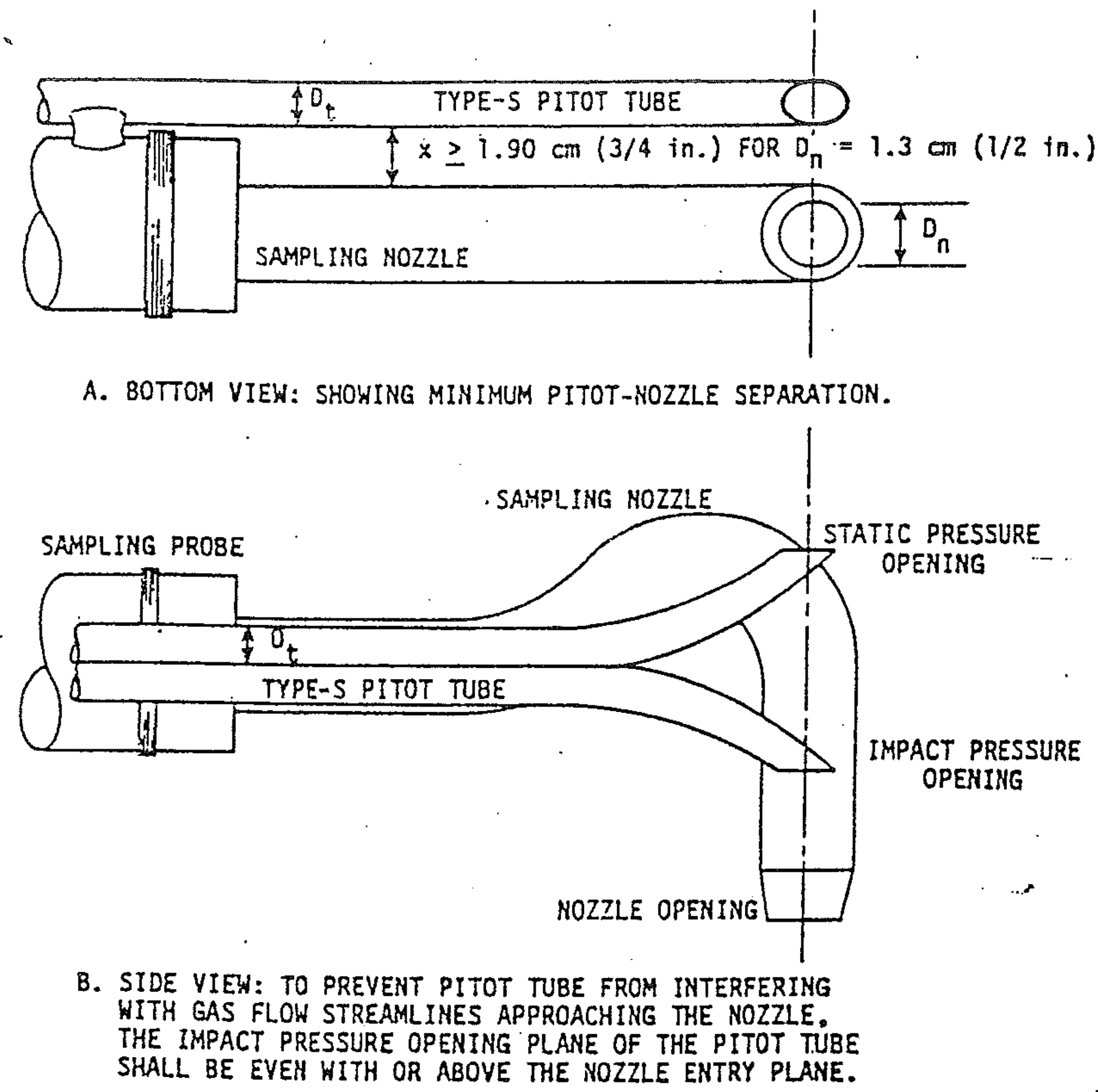


Figure 4. Required pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

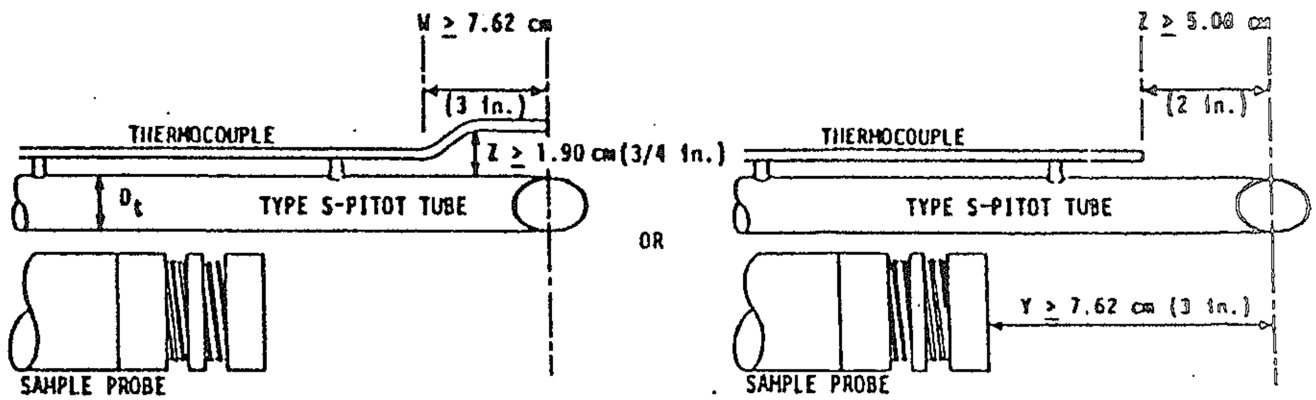


Figure 5. Required thermocouple and probe placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

The EPA has not specified a measurement technique to verify proper construction. The following procedures provide a quick and accurate method of checking construction specifications for Type-S pitot tubes. The apparatus is inexpensive and available in most hardware stores. The method can be used in the laboratory by testers and easily adapted to field use by agency personnel while witnessing tests or performing quality assurance checks.

1. Obtain a section of angle aluminum approximately 20 cm (8 in.) by 1.3 x 2.5 cm (0.5 x 1.0 in.). Mount a bull's-eye level (with ±1 degree accuracy) to the angle aluminum, as shown in Figure 6. After mounting the bull's-eye level to the angle aluminum, level the angle aluminum and place the degree-indicating level in the parallel and perpendicular positions. The indicating level should not read more than 1 degree in either position.

2. Place the pitot tube in the angle aluminum as shown in Figure 6, and level the pitot tube as indicated by the bull's-eye level. A vise may be used to hold the angle aluminum and pitot tube in the laboratory and a C-clamp in the field. Note: A permanently mounted pitot tube and probe assembly may require a shorter section of angle aluminum to allow proper mounting on the assembly.

3. Place a degree-indicating level in the various positions, as illustrated in Figures 7 and 8.

4. Measure distances P_A and P_B with a micrometer.

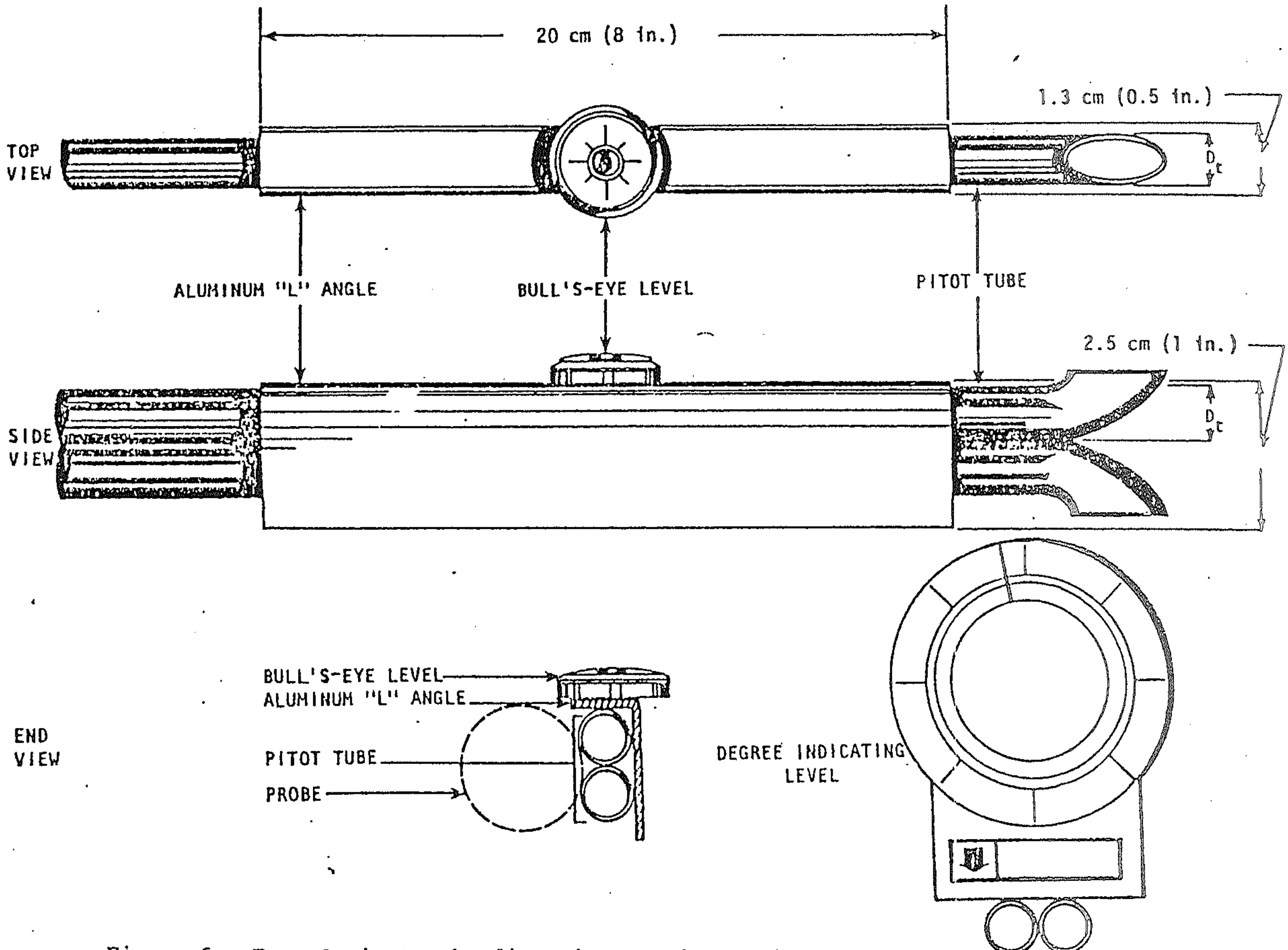


Figure 6. Type S pitot tube dimension specialization measurements.

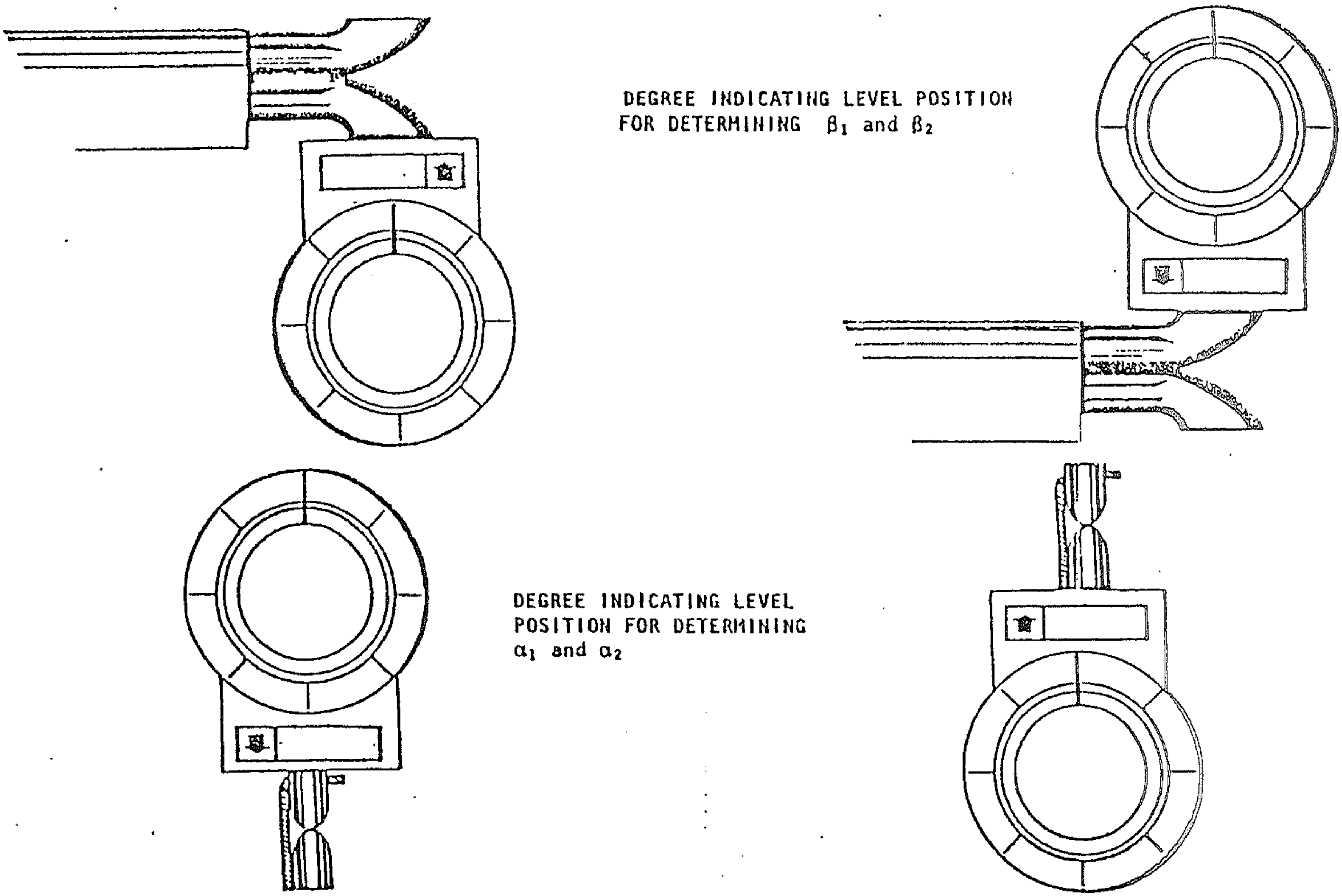
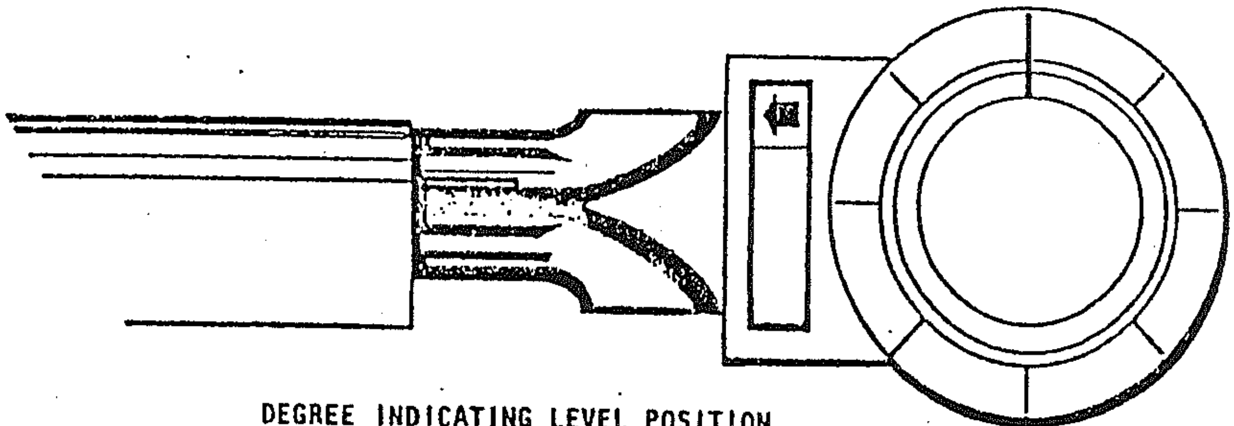
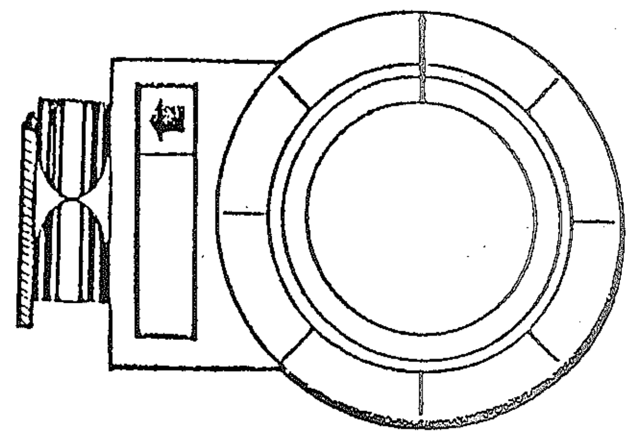


Figure 7. Position of dimension measurement.



DEGREE INDICATING LEVEL POSITION
FOR DETERMINING γ, THEN CALCULATING Z.



DEGREE INDICATING LEVEL
POSITION FOR DETERMINING
θ, THEN CALCULATE W.

Figure 8. Position of dimension measurement.

5. Measure the external tube diameter (D_t). Record all data on a data sheet such as Figure 9.

6. Calculate dimensions w and z using the following equations:

$$w = A \sin \theta \qquad \text{Equation 1}$$

$$z = A \sin \gamma \qquad \text{Equation 2}$$

where,

w = alignment dimension, cm (in.)

z = alignment dimension, cm (in.)

A = distance between tips, ($P_A + P_B$), cm (in.)

Θ = angle in degrees

γ = angle in degrees.

Note: Pitot tubes with bent or damaged tubing may be difficult to check using this procedure.

If the Type-S pitot tube meets the face alignment criteria, an identification number should be assigned and permanently marked or engraved on the body of the tube.

References

1. Federal Register, Vol. 42. No. 160, August 18, 1977.

Advanced Industrial Resources, Inc.
Type-S Pitot Tube Assembly Inspection Data Sheet

Date: 3/29/2021

Pitot Tube Assembly: P7-02 Caliper ID: CL02

Performed by: LS

Pitot tube assembly level? X yes ___ no

Pitot tube openings damaged? ___ yes (explain below) X no

α_1 = 1 ^{o}(<10^o) β_1 = 1 ^{o}(<5^o)

α_2 = 0 ^{o}(<10^o) β_2 = 0 ^{o}(<5^o)

γ = 1 ^{o} θ = 1 ^{o} A= 0.75 in.

z = A sin γ = 0.0131 in. <1/8 in. (0.125 in.)

w = A sin θ = 0.0131 in. <1/32 in. (0.03125 in.)

P_A= 0.375 in. **P_B=** 0.375 in.

D_t = 0.25 in. **P / D_t =** 1.5 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 0.8 (>0.75 in.) (Dist. between pitot and nozzle)

Y = 3.55 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)

Z = 1.07 (>0.75 in.) (Dist. between pitot and stack thermocouple)

Does the pitot tube assembly meet the Method 2 requiremnets? X yes

___ no (explain below)

If the Method 2 requirements are met then a coefficient of **0.84** is assigned to the pitot tube assembly being inspected.

Advanced Industrial Resources, Inc.
Type-S Pitot Tube Assembly Inspection Data Sheet

Date: 3/29/2021
Pitot Tube Assembly: P7-01   Caliper ID: CL02
Performed by: LS

Pitot tube assembly level? X yes ____ no

Pitot tube openings damaged? ____ yes (explain below) X no

α_1 = 1 ^{o}($<10^o$) β_1 = 0 ^{o}($<5^o$)

α_2 = 1 ^{o}($<10^o$) β_2 = 1 ^{o}($<5^o$)

γ = 1 ^{o} θ = 0 ^{o} A= 1.25 in.

z = A sin γ = 0.0218 in.   <1/8 in. (0.125 in.)

w = A sin θ = 0.0000 in.   <1/32 in. (0.03125 in.)

P_A= 0.625 in.   **P_B=** 0.625 in.

D_t = 0.5 in.   **P / D_t =** 1.25 (1.05 </= and </= 1.50)
$P_a = P_b = P$

X = 0.75 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 3.5 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1 (>0.75 in.) (Dist. between pitot and stack thermocouple)

Does the pitot tube assembly meet the Method 2 requiremnets? X yes
____ no (explain below)

If the Method 2 requirements are met then a coefficient of **0.84** is assigned to the pitot tube assembly being inspected.

REV112712

Advanced Industrial Resources, Inc.
Type-S Pitot Tube Assembly Inspection Data Sheet

Date: 3/29/2021

Pitot Tube Assembly: P4-04 Caliper ID: CL02

Performed by: LS

Pitot tube assembly level? X yes ____ no

Pitot tube openings damaged? ____ yes (explain below) X no

α_1 = 2 °(<10°) β_1 = 0 °(<5°)

α_2 = 2 °(<10°) β_2 = 0 °(<5°)

γ = 0 ° θ = 0 ° A = 0.91 in.

z = A sin γ = 0.0000 in. <1/8 in. (0.125 in.)

w = A sin θ = 0.0000 in. <1/32 in. (0.03125 in.)

$\mathbf{P_A}$ = 0.460 in. $\mathbf{P_B}$ = 0.460 in.

D_t = 0.33 in. $\mathbf{P / D_t}$ = 1.39394 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 1.19 (>0.75 in.) (Dist. between pitot and nozzle)

Y = 4.25 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)

Z = 1.2 (>0.75 in.) (Dist. between pitot and stack thermocouple)

Does the pitot tube assembly meet the Method 2 requiremnets? X yes

____ no (explain below)

If the Method 2 requirements are met then a coefficient of **0.84** is assigned to the pitot tube assembly being inspected.

APPENDIX C

LABORATORY ANALYTICAL REPORT

4/6/2021
Mr. Robert DeMott
Ramboll Environ
10150 Highland Manor Drive
Suite 440
Tampa FL 33610

Project Name: K&S Bard
Project #:
Workorder #: 2103803

Dear Mr. Robert DeMott

The following report includes the data for the above referenced project for sample(s) received on 3/30/2021 at Eurofins Air Toxics LLC.

The data and associated QC analyzed by Modified TO-15 SIM are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Eurofins Air Toxics LLC. for your air analysis needs. Eurofins Air Toxics Inc. is committed to providing accurate data of the highest quality. Please feel free to contact the Project Manager: Brian Whittaker at 916-985-1000 if you have any questions regarding the data in this report.

Regards,

Brian Whittaker

Brian Whittaker
Project Manager

eurofins | Air Toxics

WORK ORDER #: 2103803

Work Order Summary

CLIENT:	Mr. Robert DeMott Ramboll 10150 Highland Manor Drive Suite 440 Tampa, FL 33610	**BILL TO:**	Accounts Payable Ramboll 10150 Highland Manor Drive Suite 440 Tampa, FL 33610
PHONE:	813-628-4325	**P.O. #**	1690014483
FAX:	813-628-4983	**PROJECT #**	K&S Bard
DATE RECEIVED:	03/30/2021	**CONTACT:**	Brian Whittaker
DATE COMPLETED:	04/06/2021		

FRACTION #	**NAME**	**TEST**	**RECEIPT VAC./PRES.**	**FINAL PRESSURE**
01A	SYS2-STACK 20210326	Modified TO-15 SIM	7.5 "Hg	2 psi
01AA	SYS2-STACK 20210326 Lab Duplicate	Modified TO-15 SIM	7.5 "Hg	2 psi
02A	SYS2-STACK DUP 20210326	Modified TO-15 SIM	8.5 "Hg	2 psi
03A	SYS1-STACK 20210326	Modified TO-15 SIM	7.0 "Hg	2 psi
04A	SYS1-STACK DUP 20210326	Modified TO-15 SIM	10.0 "Hg	2 psi
05A	2BF-1 20210326	Modified TO-15 SIM	24.5 "Hg	2 psi
06A	2BF-2 20210326	Modified TO-15 SIM	9.5 "Hg	2 psi
07A	2BF-3 20210326	Modified TO-15 SIM	21.5 "Hg	2 psi
08A	2BF-4 20210326	Modified TO-15 SIM	8.5 "Hg	2 psi
09A	2BF-5 20210326	Modified TO-15 SIM	9.0" Hg	2 psi
10A	2BF-6 20210326	Modified TO-15 SIM	9.5 "Hg	2 psi
11A	SYS1-IN 20210326	Modified TO-15 SIM	8.5 "Hg	2 psi
12A	2BF-1R 20210326	Modified TO-15 SIM	12.0 "Hg	2 psi
13A	Lab Blank	Modified TO-15 SIM	NA	NA
13B	Lab Blank	Modified TO-15 SIM	NA	NA
14A	CCV	Modified TO-15 SIM	NA	NA
14B	CCV	Modified TO-15 SIM	NA	NA
15A	LCS	Modified TO-15 SIM	NA	NA
15AA	LCSD	Modified TO-15 SIM	NA	NA
15B	LCS	Modified TO-15 SIM	NA	NA
15BB	LCSD	Modified TO-15 SIM	NA	NA

CERTIFIED BY: Heidi Hayes DATE: 04/06/21

Technical Director

Certification numbers: AZ Licensure AZ0775, FL NELAP – E87680, LA NELAP – 02089, NH NELAP - 209220, NJ NELAP - CA016, NY NELAP - 11291, TX NELAP - T104704434-20-16, UT NELAP – CA009332020-12, VA NELAP - 10615, WA NELAP - C935
Name of Accreditation Body: NELAP/ORELAP (Oregon Environmental Laboratory Accreditation Program)
Accreditation number: CA300005-014, Effective date: 10/18/2020, Expiration date: 10/17/2021.
Eurofins Air Toxics, LLC certifies that the test results contained in this report meet all requirements of the NELAC standards

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000 . (800) 985-5955 . FAX (916) 351-8279

LABORATORY NARRATIVE
EPA TO-15 Ethylene oxide (SIM)
Ramboll Environ
Workorder# 2103803

Twelve 6 Liter Summa Canister (EO) samples were received on March 30, 2021. The laboratory performed analysis via EPA Method TO-15 using GC/MS in the SIM acquisition mode for the measurement of Ethylene oxide in ambient air.

Receiving Notes

There was a difference (greater than or equal to 5.0" Hg) between the measured canister receipt vacuum and that which was reported on the Chain of Custody (COC) for sample SYS2-STACK DUP 20210326. A leak test indicated that the valve was functioning properly.

Samples 2BF-1 20210326 and 2BF-3 20210326 were received with significant vacuum remaining in the canister. The residual canister vacuum resulted in elevated reporting limits.

Analytical Notes

As per project specific client request the laboratory has reported estimated values for target compound hits that are below the Reporting Limit but greater than the Method Detection Limit. The canisters used for this project have been certified to half the Reporting Limit for Ethylene Oxide. Concentrations that are below the level at which the canister was certified may be false positives.

Dilution was performed on samples 2BF-1 20210326, 2BF-2 20210326, 2BF-3 20210326, 2BF-4 20210326, 2BF-5 20210326, 2BF-6 20210326, SYS1-IN 20210326 and 2BF-1R 20210326 due to the presence of high level target species.

Definition of Data Qualifying Flags

Nine qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction not performed).
J - Estimated value.
S - Saturated peak.
Q - Exceeds quality control limits.
U - Compound analyzed for but not detected above the reporting limit, LOD, or MDL value. See data page for project specific U-flag definition.
UJ- Non-detected compound associated with low bias in the CCV
N - The identification is based on presumptive evidence.
CN - See Case Narrative

File extensions may have been used on the data analysis sheets and indicates as follows:
a-File was requantified
b-File was quantified by a second column and detector
r1-File was requantified for the purpose of reissue

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	SYS2-STACK 20210326		
Lab ID:	2103803-01A	**Date/Time Analyzed:**	3/31/21 05:44 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	1.51
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033110sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.036	D	0.14	70

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	SYS2-STACK 20210326 Lab Duplicate		
Lab ID:	2103803-01AA	**Date/Time Analyzed:**	3/31/21 06:24 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	1.51
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033111sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.036	D	0.14	73

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	SYS2-STACK DUP 20210326		
Lab ID:	2103803-02A	**Date/Time Analyzed:**	3/31/21 03:08 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	1.58
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033106sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.037	D	0.14	79

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	SYS1-STACK 20210326		
Lab ID:	2103803-03A	**Date/Time Analyzed:**	3/31/21 07:42 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	1.48
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033113sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.035	D	0.13	1.5

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	SYS1-STACK DUP 20210326		
Lab ID:	2103803-04A	**Date/Time Analyzed:**	3/31/21 07:03 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	1.70
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033112sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.040	D	0.15	2.1

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	2BF-1 20210326		
Lab ID:	2103803-05A	**Date/Time Analyzed:**	3/31/21 08:17 PM
Date/Time Collected:	3/26/21 11:22 AM	**Dilution Factor:**	99.1
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033114sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	2.3	D	8.9	2600

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	2BF-2 20210326		
Lab ID:	2103803-06A	**Date/Time Analyzed:**	3/31/21 08:53 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	26.6
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033115sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.63	D	2.4	3600

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	2BF-3 20210326		
Lab ID:	2103803-07A	**Date/Time Analyzed:**	3/31/21 09:28 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	64.2
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033116sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	1.5	D	5.8	980

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	2BF-4 20210326		
Lab ID:	2103803-08A	**Date/Time Analyzed:**	4/2/21 11:27 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	45.7
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30040220sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.85	D	4.1	6100

D: Analyte not within the DoD scope of accreditation.

eurofins | Air Toxics

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	2BF-5 20210326		
Lab ID:	2103803-09A	**Date/Time Analyzed:**	4/2/21 11:58 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	46.7
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30040221sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.87	D	4.2	5300

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Air Toxics

Client ID:	2BF-6 20210326		
Lab ID:	2103803-10A	**Date/Time Analyzed:**	3/31/21 11:14 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	26.6
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033119sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.63	D	2.4	2000

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	SYS1-IN 20210326		
Lab ID:	2103803-11A	**Date/Time Analyzed:**	3/31/21 11:49 PM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	25.4
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033120sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.60	D	2.3	470

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

eurofins | Air Toxics

Client ID:	2BF-1R 20210326		
Lab ID:	2103803-12A	**Date/Time Analyzed:**	4/1/21 12:25 AM
Date/Time Collected:	3/26/21 02:35 PM	**Dilution Factor:**	30.3
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd19.i / 19033121sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.71	D	2.7	2300

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	Lab Blank		
Lab ID:	2103803-13A	**Date/Time Analyzed:**	3/31/21 11:44 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd19.i / 19033105sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.024	D	0.090	Not Detected

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	Lab Blank		
Lab ID:	2103803-13B	**Date/Time Analyzed:**	4/2/21 12:58 PM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30040205sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.019	D	0.090	Not Detected

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	CCV		
Lab ID:	2103803-14A	**Date/Time Analyzed:**	3/31/21 09:53 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd19.i / 19033102sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	105

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	CCV		
Lab ID:	2103803-14B	**Date/Time Analyzed:**	4/2/21 11:16 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30040202sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	98

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Air Toxics

Client ID:	LCS		
Lab ID:	2103803-15A	**Date/Time Analyzed:**	3/31/21 10:29 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd19.i / 19033103sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	105

D: Analyte not within the DoD scope of accreditation.

* % Recovery is calculated using unrounded analytical results.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	LCSD		
Lab ID:	2103803-15AA	**Date/Time Analyzed:**	3/31/21 11:05 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd19.i / 19033104sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	100

D: Analyte not within the DoD scope of accreditation.

* % Recovery is calculated using unrounded analytical results.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Eurofins Air Toxics

Client ID:	LCS		
Lab ID:	2103803-15B	**Date/Time Analyzed:**	4/2/21 11:50 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30040203sim

Compound	**CAS#**	**%Recovery**
Ethylene Oxide	75-21-8	95

D: Analyte not within the DoD scope of accreditation.

* % Recovery is calculated using unrounded analytical results.

MODIFIED EPA METHOD TO-15 GC/MS SIM
K&S Bard

Client ID:	LCSD		
Lab ID:	2103803-15BB	**Date/Time Analyzed:**	4/2/21 12:23 PM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30040204sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	95

D: Analyte not within the DoD scope of accreditation.

* % Recovery is calculated using unrounded analytical results.

Method: EO by TO-15 SIM – EVALUATION OF TEFLON FEP TUBING TO COLLECT EO STACK SAMPLES ***Instrument ID: MSD-30***
TEST DESCRIPTION: A 100 ppbv EO working standard (3018-1252) was prepared in a 6L canister from a NIST traceable 1.0 ppmv EO stock cylinder. The canister was analyzed in duplicate using a sampling rate of 25 ml/min on the Entech system (MSD30) for a total load volume of 400 mL on cart position 2. The 100 ppbv canister was then connected to cart position 2 with a 5ft segment of Teflon FEP tubing (1/4" OD, 3/16" ID). A pre-purge time of 1 minute was used to purge the dead volume of the tubing calculated to be ~25 mL prior to loading onto the Entech system at the 25 ml/min sampling rate. Two 400 mL runs through the tubing were analyzed. The concentration of 100 ppbv was selected to approximate the expected concentration in the stack inlet test; the 25 ml/min sampling rate was selected to approximate the flow rate of sample collection (4 hour into a 6L canister); and the 5ft segment of tubing is the planned length to be used for collection.

Initials: HH	**Date:03-24-2020**

TEST RESULTS:

Sample Description	**Sample loading configuration**	**Run**	**Data file**	**Conc (ppbv)**	**Ave Conc (ppbv)**	**%RPD**
100 ppbv EO Canister Standard	Direct	1	30032407sim	88	87	1.4%
		2	30032408sim	86		
	5 ft Teflon FEP tubing	1	30032409sim	91	92	1.4%
		2	30032410sim	92		
				%Difference =	*5.5%*	
				%RPD =	*5.3%*	

- No indication of loss (permeability or adsorption) in tubing
- Minimal (~5%) difference between setups
- Repeatability (variability between replicates) robust - < 1.5% RPD

Tester	Name (Please print): Diane Benton	Signature:	Initials: DB	Date: 3/27/20
Reviewer	Name (Please print): Heidi Hayes	Signature:	Initials: HH	Date: 3/27/20

APPENDIX D

SYSTEM 1 PROCESS LOG

JD Edwards

TALIAN JOSEPH
[JPD900]

Open Applications

- Home
- Tracking Detail Browse

Recent Reports

Favorites

- Manage Favorites
- Sterilization Tracking Detail Browse
- Inventory Issue to Account (II)
- FULL WORK ORDER COMPLETION
- Pallet Tags - Spore Room
- Item Ledger Inquiry (CARDEX)
- Inventory Transfer (IT) - Allow Negative Avail
- ENTER/CHANGE MANUFACTURING WORK O...
- Sterilization Tracking Master Browse
- Special Sterilization Browse
- PARTIAL COMPLETION
- Pallet Tags - MD
- Movements and Disposition
- Open Receipts Inquiry
- Ledger Inquiry
- Sterilization Inventory Tracking

Sterilization Tracking Detail Browse - Tracking Detail Browse

Query: All Records

Row Tools

Records 1 - 8

Customize

212817

Tracking Number	Catalog/ Item #	Lot Serial Number	Quantity Received	Quantity Sterilized	EO Release Date	Pallet Number	Cycle Number	Sterilization Site
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	1	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	2	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	3	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	4	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	5	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	6	7	CV
212817	MC1820	REEY3835	1200.0000	1200	03/27/2021	7	7	CV
212817	MC1820	REEY3835	1035.0000	1035	03/27/2021	8	7	CV

vessel 5 to post = 9:00 am
Changed drum 5A - 09:35 AM
vessel 3 ~~to~~ Vent post = 10:52 am
opened post door 3A +transfer 11:03 am
Changed drum 3A - 11:40

from Walt Hays 3/26/21