INITIAL DEMONSTRATION OF FUGITIVE EMISSIONS CONTROL SYSTEM PERFORMANCE

Becton, Dickinson and Company
1211 Mary Magnan Blvd
Madison, GA 30650

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

September 2020

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 has installed two dry bed fugitive emission control systems at its Madison, 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 June 30, 2020 was 0.18 pounds-per-year if annualized of 8,760 hours. The emission rate measured from the System Two outlet on June 30, 2020 was 0.42 pounds-per-year if annualized over 8,760 hours. The total emission rate from both Systems' outlets combined on an annualized basis would be 0.60 pounds.

System One is achieving the target control device effectiveness of 99.84 percent reduction in fugitive ethylene oxide emissions from the facility's seven Sterilization Vessel Rooms, the Vessel to Aeration Transfer Corridors, and the Ethylene Oxide Dispensing Rooms. System Two is achieving the target control device effectiveness of 99.97 percent reduction in fugitive ethylene oxide emissions from the facility's Work-In-Process storage area.

1. BACKGROUND

Becton, Dickinson and Company (BD) operates a medical device sterilization facility utilizing ethylene oxide (EO) at 1211 Mary Magnan Boulevard in Madison, Georgia (see **Figure 1**). As a condition of a Consent Order with the Georgia Environmental Protection Division (EPD) dated October 28, 2019, BD has installed two systems for the capture and control of fugitive emissions of ethylene oxide (EO) that are not captured by current emissions control equipment. The new equipment includes two systems comprised of multiple Advanced Air Technologies Model DR490 "Dry Bed Scrubbers".

System One (SYS1) captures potential fugitive emissions from the facility's seven Sterilization Vessel Rooms (VRM1, VRM2, VRM3, VRM4, VRM5, VRM6, and VRM7), the Vessel to Aeration Transfer Corridors (UCO1 and UCO2), and the EO Dispensing Rooms (DRM1 and DRM2). System Two (SYS2) captures potential fugitive emissions from the Work-In-Progress (WIP) area of the facility where product is stored after sterilization and prior to shipment. Details regarding the two dry bed scrubber systems were presented in the air permit application for their installation that was submitted to the EPD on October 31, 2019.

Paragraph 19 of Attachment A to the October 28, 2019 Consent Order provides; "BD shall complete installation and initial performance testing of the fugitive emissions control system and other related upgrades at the BD Madison facility no later than May 31, 2020."

In response to a BD notification of construction delays at BD Madison, EPD issued a letter on May 14, 2020 stating "EPD is aware that COVID-19 impacts have resulted in some disruptions to supply chains and delays in construction schedules.

BD submitted a test plan for the fugitive emissions control system upgrades on June 23, 2020. **Appendix A** provides the test plan methodology. The testing for SYS1 and SYS2 was performed on June 30, 2020. Both Ray Shen and Marcus Cureton from 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 SYS1 and SYS2 dry bed fugitive emission control system for fugitive releases captured in the Sterilization Vessel Rooms, the Vessel to Aeration Transfer Corridors, the Ethylene Oxide Dispensing Rooms, and the Work-In-Progress storage area of the facility was based on two primary elements:

1. Measurement of the airflow rate at the inlet ducts to the SYS1 and SYS2 dry bed systems and the stack outlets utilizing EPA standard methods 1, 2, and 4; and,

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

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

Ramboll personnel oversaw and coordinated the EO 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. As outlined in the Test Plan, a duplicate sample was collected at the SYS1 and SYS2 stack outlets to allow for precision and repeatability of analyses and the stability of EO samples in the Summa canisters. The original and duplicate samples were collected simultaneously over a 4-hour duration from two separate segments of tubing introduced side-by-side in the sampling port.

Within 30 minutes of the collection of the SYS2 inlet duct 2 (IN2) sample, the Summa canister’s airflow regulator seized. A replacement sample denoted as SYS2-IN2R was collected using a new Summa canister and regulator. Both samples were analyzed, however only the result of the replacement sample (IN2R) that was collected over a nearly four-hour duration was incorporated in the system performance assessment.

3. ANALYTICAL LABORATORY RESULTS AND PERFORMANCE ASSESMENT

The collected samples were transferred to Eurofins Air Toxics, LLC (Eurofins), an independent laboratory in Folsom, California 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.

A duplicate sample collected from SYS1 and SYS2 Outlet was analyzed upon receipt at the laboratory to demonstrate the repeatability and precision of the sampling and analytical method.

Table 1 presents the airflow 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 assessments described above.

The testing and analytical work met quality assurance and quality control set forth in the test plan. The measured EO concentrations in each sample 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 system.

<u>Performance Assessment</u>

SYS1 captures and treats fugitive EO releases from the seven Sterilization Vessel Rooms, the Vessel to Aeration Transfer Corridors, and the Ethylene Oxide Dispensing Rooms. Fugitive emissions from these operational areas were detected at a concentration of 180 micrograms per cubic meter (µg/m^3) at the SYS1 inlet duct. The exhaust mass rate from the SYS1 stack was only 0.00002 pounds-per-hour (lb/hour), or 0.18 pounds-per-year (lb/year) if annualized over 8,760 hours.

SYS2 captures and treats fugitive EO releases from the Work-In-Progress storage area of the facility. Total fugitive emission concentrations from the seven inlet ducts in the storage area ranged between 390 µg/m^3 to 990 µg/m^3. The exhaust mass rate from the SYS2 stack was only 0.00005 lb/hour, or 0.42 lb/year if annualized over 8,760 hours.

As shown in **Table 3**, SYS1 and SYS2 are performing as designed and intended. In particular, the SYS1 and SYS2 dry bed fugitive control system is reducing the EO emissions by 99.84 and 99.97 percent, respectively as designed.

4. CONCLUSIONS

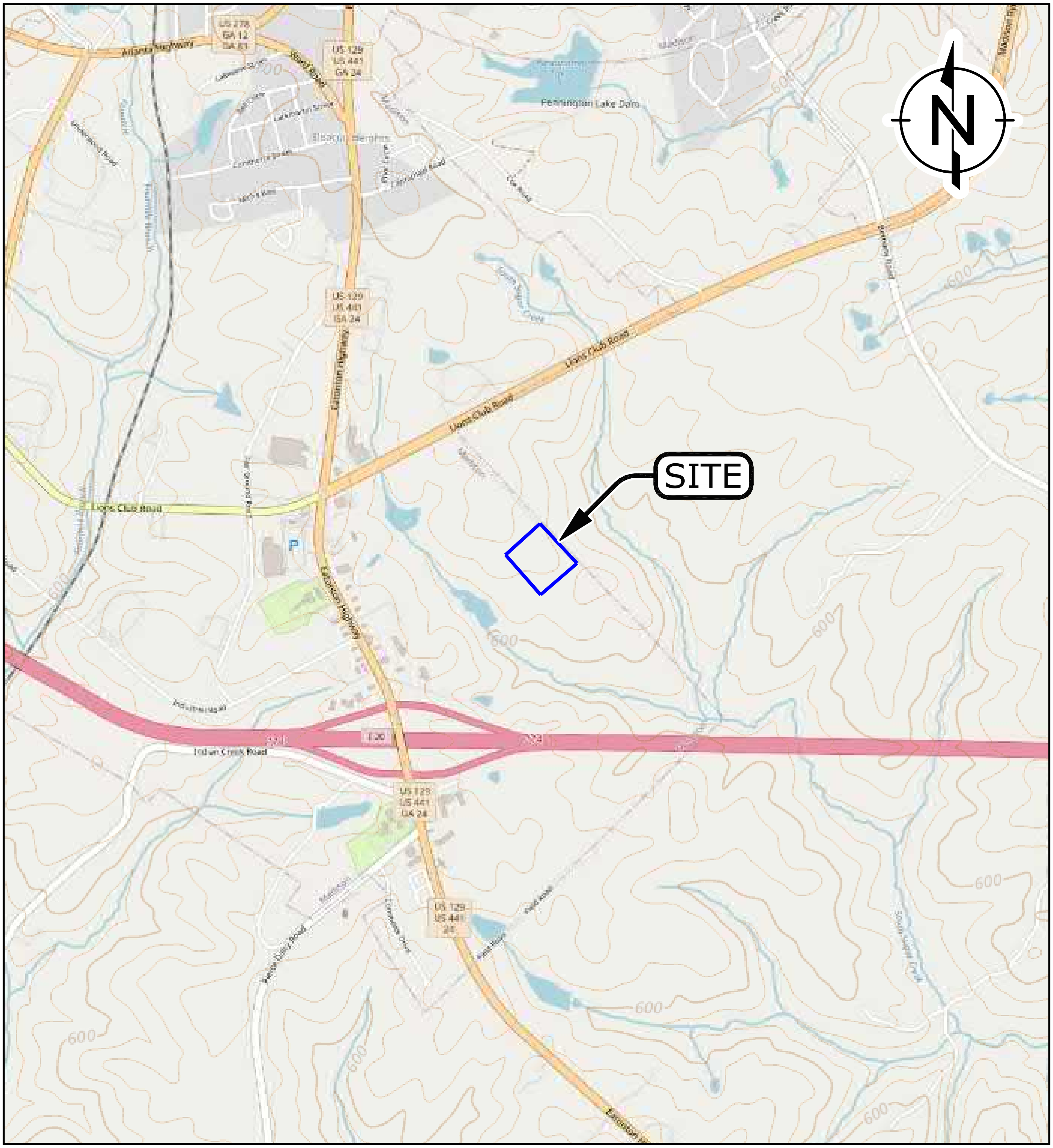
The following conclusions can be drawn from this testing as an initial assessment of the performance of the SYS1 and SYS2 dry bed fugitive emission control system at the BD Madison facility:

1. Post-control-device emissions of EO from SYS1 and SYS2 are 0.00002 lb/hour and 0.00005 lb/hour, respectively.

2. SYS1 and SYS2 exceeded the 99 percent design removal efficiency in fugitive EO emissions from the seven Sterilization Vessel Rooms, the Vessel to Aeration Transfer Corridors, the Ethylene Oxide Dispensing Rooms, and the Work-In-Progress storage area.

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

FIGURES



0 0.5 1
SCALE IN MILES

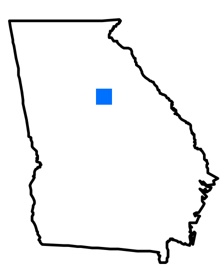
0 2,000 4,000
SCALE IN FEET

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 DICKINSON AND COMPANY
1211 MARY MAGNAN BOULEVARD
MADISON, GEORGIA

RAMBOLL

FIGURE
1

DRAFTED BY: RGM | DATE: 8/3/2020 | PROJECT: 1690014483

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TABLES

TABLE 1
System 1 and System 2 Air Flow Rates
Becton, Dickinson and Company
Madison, 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 - June 30, 2020							
SYS1 - IN 20200630	SYS1 In	19477	91	19170	120	19324	106
SYS1 - STACK 20200630	SYS1 Out	18164	113	17984	127	18074	120
System 2 - June 30, 2020							
SYS2 - IN1 20200630	SYS2 - IN1	11484	84	11437	85	11461	85
SYS2 - IN2R 20200630	SYS2 - IN2	11224	85	11193	87	11209	86
SYS2 - IN3 20200630	SYS2 - IN3	9753	88	9731	88	9742	88
SYS2 - IN4 20200630	SYS2 - IN4	10002	86	9805	88	9903	87
SYS2 - IN5 20200630	SYS2 - IN5	5534	86	5529	87	5531	87
SYS2 - IN6 20200630	SYS2 - IN6	3841	86	3796	91	3819	89
SYS2 - IN7 20200630	SYS2 - IN7	9599	85	9510	92	9555	89
SYS2 - STACK 20200630	SYS2 Out	53619	86	53190	98	53405	92
					Total System 2 Inlet[1]	51664	86

Notes:
Pre and Post-Test average tempertures and airflow rates provided by Advanced Industrial Resources, Inc. (AIR).
dscfm - dry standard cubic feet per minute
[1]Total System 2 Inlet Average Temperature is a weighted average.

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

Sample ID	Sample Location	Date	Start Time	Stop Time	Duration (hours)	Vacuum[1]		EO Concentration (µg/m³)
						Initial (In. Hg)	Final (In. Hg)	
System 1 - June 30, 2020								
SYS1 - IN 20200630	SYS1 In	6/30/2020	11:45	15:45	4:00	28.5	7.5	180
SYS1 - STACK 20200630[2]	SYS1 Out	6/30/2020	11:45	15:45	4:00	26.0	7.0	0.30
SYS1 - STACK DUP 20200630	SYS1 Out	6/30/2020	11:45	15:45	4:00	27.5	6.0	0.24
System 2 - June 30, 2020								
SYS2 - IN1 20200630	SYS2 IN1	6/30/2020	11:46	15:45	3:59	28.0	10.0	400
SYS2 - IN2R 20200630	SYS2 IN2	6/30/2020	12:22	15:46	3:24	27.5	12.0	730
SYS2 - IN3 20200630[3]	SYS2 IN3	6/30/2020	11:48	15:59	4:11	28.5	6.0	980
SYS2 - IN4 20200630	SYS2 IN4	6/30/2020	11:47	15:47	4:00	29.5	9.0	990
SYS2 - IN5 20200630	SYS2 IN5	6/30/2020	11:45	15:45	4:00	28.0	8.5	710
SYS2 - IN6 20200630	SYS2 IN6	6/30/2020	11:45	15:45	4:00	28.5	7.5	670
SYS2 - IN7 20200630	SYS2 IN7	6/30/2020	11:47	15:47	4:00	27.0	10.5	390
SYS2 - STACK 20200630[4]	SYS2 Out	6/30/2020	11:45	15:45	4:00	29.0	6.0	0.24
SYS2- STACK DUP 20200630	SYS2 Out	6/30/2020	11:45	15:45	4:00	28.0	5.0	0.25

Notes:

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

[2]The listed EO concentration is the average of SYS1 -STACK 20200630 (0.36 µg/m³) and SYS1 -STACK DUP 20200630 (0.24 µg/m³) values.

[3]The laboratory conducted a lab duplicate for analytical repeatability; results were 1000 and 960 µg/m³. The listed EO concentration is an average of the two values.

[4]The listed EO concentration is the average of SYS2 - STACK 20200630 (0.23 µg/m³), SYS2 - STACK DUP 20200630 (0.25 µg/m³) values.

In. Hg - inches of mercury

µg/m³ - micrograms per cubic meter

EO - Ethylene Oxide

TABLE 3
Performance Assessment
Becton, Dickinson and Company
Madison, Georgia Facility

Sample ID	Sample Location	EO Concentration ($\mu g/m^3$)	Duct Flow (dscfm)	EO Rate (lb/hr)
System 1 - June 30, 2020				
SYS1 - IN 20200630	SYS1 In	180	19,323.5	0.01303
SYS1 - STACK 20200630	**SYS1 Out**	**0.30**	18,074.0	**0.00002**
System 2 - June 30, 2020				
SYS2 - IN1 20200630	SYS2 IN1	400	11,460.5	0.01717
SYS2 - IN2R 20200630	SYS2 IN2	730	11,208.5	0.03065
SYS2 - IN3 20200630	SYS2 IN3	980	9,741.9	0.03576
SYS2 - IN4 20200630	SYS2 IN4	990	9,903.4	0.03673
SYS2 - IN5 20200630	SYS2 IN5	710	5,531.4	0.01471
SYS2 - IN6 20200630	SYS2 IN6	670	3,818.6	0.00958
SYS2 - IN7 20200630	SYS2 IN7	390	9,554.7	0.01396
SYS2- Stack 20200630	**SYS2 Out**	**0.24**	53,404.5	**0.00005**
		Total Inlet	51,664.3	0.145
			Flow-weighted average inlet ($\mu g/m^3$)	747.2

Notes:
EO - Ethylene Oxide
$\mu g/m^3$ - micrograms per cubic meter
dscfm - dry standard cubic feet per meter
lb/hr - pounds per hour

	System 1 June 30, 2020	System 2 June 30, 2020
Potential Annual EO emissions (lb/year)	**0.18**	**0.42**
Concentration-based percent removal	99.83	99.97
Mass-based percent removal	99.84	99.97

APPENDIX A

STACK TESTING SCOPE

Test Plan

for the

Performance Testing of the Fugitive Emissions Control System Upgrades

at

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

Madison Georgia

Proposed Test Dates:

30 June 2020

Submitted By:

Becton, Dickinson and Company
Urology and Critical Care Division
1211 Mary Magnan Boulevard
Madison, Georgia 30650

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I. Introduction

Paragraph 19 of Attachment A to the October 28, 2019 Consent Order provides; "BD shall complete installation and initial performance testing of the fugitive emissions control system and other related upgrades at the BD Madison facility no later than May 31, 2020."

In response to a BD notification of construction delays at BD Madison, EPD issued a letter on May 14, 2020 stating "EPD is aware that COVID-19 impacts have resulted in some disruptions to supply chains and delays in construction schedules. Based upon the entirety of the circumstances of the delay, EPD has decided not to pursue action against BD for its failure to meet the May 31, 2020 deadline. EPD expects BD to make all efforts to meet the schedule described in BD's notification to EPD, which includes completion of construction, performance testing and commencing operation of the new fugitive emission control system on or before the June 30, 2020 deadline in the Consent Order."

In compliance with Attachment A to the October 28, 2019 Consent Order, BD is providing a test plan for the fugitive emissions control system upgrades proposed in the permit application of the BD Madison facility. Upon completion of the system installations and placement into service, the following testing will be conducted, consistent with the outline provided in Attachment F to the air permit application submitted on December 18, 2019.

Each system's control efficiency for ethylene oxide (EO) will be tested and demonstrated on a concentration basis by withdrawing exhaust air from the ductwork at the inlet and outlet side of a dry bed into Summa Canisters in accordance with EPA Method TO-15.

Testing is scheduled to be performed June 30, 2020 at the BD Sterilization Operation in Madison, Georgia. The purpose of the testing is to determine removal efficiency of EO by the dry bed fugitive emissions control systems.

The 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 new equipment to be tested includes two systems comprised of multiple Advanced Air Technologies Model DR490 "Dry Bed Scrubbers".

System One (SYS1) will capture potential emissions from the seven Sterilization Vessel Rooms (VRM1, VRM2, VRM3, VRM4, VRM5, VRM6, and VRM7), the Vessel to Aeration Transfer Corridors (UCO1 and UCO2), and the EO Dispensing Rooms (DRM1 and DRM2).

System Two (SYS2) will capture potential emissions from the Work in Progress Area (WIP) 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 EO. Analysis will be performed by Eurofins Air Toxics, an independent laboratory. 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 5 feet.

Duplicate samples will be collected at the outlets from each dry bed system and submitted to the laboratory to be analyzed to evaluate the precision and repeatability of sample collection.

Initial Efficiency Assessment

The initial performance testing will be performed during the commissioning phase of system installation as follows:

- Sample duration – 4 hours
- System 1: Inlet duct and outlet duct simultaneously across all of System 1.
- System 2: Inlet ducts for 7 dry bed influent sets simultaneously with the outlet stack for System 2.
- Samples will be collected at a single point within each corresponding stack or duct.
- Outlet stack airflow rate and moisture will be measured simultaneously by EPA Methods 1, 2, and 4.

- Velocity traverses of the inlet ducts will be performed periodically during the testing.

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. Plant Entry and Safety

General safety rules must be adhered to when inside the plant area. Visitors must first sign in at the reception area at 1211 Mary Magnan 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 or 770 652-2049 (cell).

APPENDIX B

TESTING SUBCONTRACTOR FINAL REPORT

DRY BED SYSTEM
INITIAL DEMONSTRATION
AT
BECTON DICKINSON BARD
MADISON FACILITY
PROJECT ID: KR-10529

PREPARED FOR:

BECTON DICKINSON BARD
1211 MARY MAGNAN BLVD.
MADISON, GEORGIA 30650

PREPARED BY:

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

TEST DATE:
JUNE 30, 2020

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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 1211 Mart Magnan Blvd. in Madison, GA   Sterilization is completed using ethylene oxide gas. The facility recently installed two (2) dry bed systems designed to control fugitive and process ethylene oxide emissions from the interior of the facility.

An initial performance test of the dry bed systems was conducted on June 30th, 2020 by Ramboll and Advanced Industrial Resources, Inc. (AIR). The purpose of the initial performance test was to establish the newly installed 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. U.S. EPA Methods 1, 2, 4, and 18 were used to conduct testing

Testing was conducted on June 30th, 2020 by Advanced Industrial Resources, Inc. (*AIR*) 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 Madison, Georgia. Sterilization is completed using ethylene oxide gas in various chambers within the facility. The facility recently 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 location diameters, up- and down-stream flow disturbance distances, and quantity of traverse points used to conduct Method 2 velocity measurements.

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	
SYS1 Stack #1	73.5	38.5	0.52	217	2.95	16 (8)
SYS1 Inlet	58.0	259	4.5	1200	20.7	16 (8)
SYS2 Stack #2	61.0	255	4.2	170	2.8	16 (8)
SYS2 – IN1	34	96	2.8	498	14.6	16 (8)
SYS2 – IN2	34	96	2.8	462	13.6	16 (8)
SYS2 – IN3	30	255	8.5	770	25.7	16 (8)
SYS2 – IN4	30	60	2.0	60	2.0	16 (8)
SYS2 – IN5	26	24	0.9	56	2.2	16 (8)
SYS2- IN6	22	30	1.4	410	18.6	16 (8)
SYS2 – IN7	30	30	1.0	288	9.6	16 (8)

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 OBJECTIVES

The purpose of the initial performance test was to establish the newly installed 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 was 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 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 8.13.2 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 $\pm$0.02, and the limit for $\Delta H_@$ values is $\pm$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

SYSTEM 1

System #1				
Inlet		Outlet		Difference
Time	dscfm	Time	dscfm	dscfm
9:15-9:25	19,477	10:08 - 10:56	18,164	1,313
15:50-16:00	19,170	15:30-15:40	17,984	1,186
Average:	19,323		18,074	1,250

Input values:

		Pre	Post		Metric Pre	Metric Post	
T_{db}	F	121	121	C	49.4	49.4	C
T_{wb}	F	98	98	C	36.7	36.7	C
P_g	in H_20	-2.60	-2.60	kPa	-0.6	-0.6	kPa
P_{bar}	in Hg	29.12	29.12	kPa	98.6	98.6	kPa
O_2	%	20.9	20.9	%	20.9	20.9	%
CO_2	%	0.0	0.0	%	0.0	0.0	%

Calculated values:

		Pre	Post		Metric Pre	Metric Post	
P	in Hg	28.93	28.93	kPa	97.9	97.9	kPa
MW_{air}	lb/mol	28.84	28.84	g/mol	28.84	28.84	g/mol
p_{sat}	in Hg	1.82	1.82	kPa	6.17	6.17	kPa
p	in Hg	1.57	1.57	kPa	5.31	5.31	kPa
H	lb H_2O/lb air	0.0357	0.0357		0.0357	0.0357	
B_{ws}		**5.42%**	**5.42%**		**0.0542**	**0.0542**	

Note: % O_2 and % CO_2 are not important variables. Use 21% and 0% if values have not been measured.

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Flow Measurements & Calculations

SYS1-IN1

Pre-Test

			Measured values:	
Test Team:	JL		**D_s (in.):**	58.00
EPA Methods:	1,2		**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020		**p_g (in. H_2O):**	-2.60
Console ID:	C-004		**O_2 (%):**	20.90
Y_m	0.991		**CO_2 (%):**	0.00
Probe Assembly ID:	P6-01		**B_{ws}(%):**	5.42
Cp:	0.84		**Test Time:**	9:15-9:25

Wet bulb (F): 98

Dry bulb (F): 121

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.09	0.300	89
2	0.09	0.300	89
3	0.12	0.346	90
4	0.13	0.361	90
5	0.14	0.374	91
6	0.09	0.300	91
7	0.10	0.316	92
8	0.11	0.332	92
9	0.12	0.346	92
10	0.10	0.316	92
11	0.12	0.346	93
12	0.14	0.374	92
13	0.15	0.387	92
14	0.15	0.387	91
15	0.13	0.361	91
16	0.11	0.332	91
Average	**0.12**	**0.342**	**91**

Calculations:

Molar weight, M_s =	**28.25**	**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 =	**20.19**	**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, $Q_{s,ds}$ =	**19,477**	**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, $Q_{s,act}$ =	**22,231**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**20,592**	**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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Flow Measurements & Calculations

SYS1-IN1

Post-Test

			Measured values:	
Test Team:	JL		**D_s (in.):**	58.00
EPA Methods:	1,2		**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020		**p_g (in. H_2O):**	-2.60
Console ID:	C-004		**O_2 (%):**	20.90
Y_m	0.991		**CO_2 (%):**	0.00
Probe Assembly ID:	P6-01		**B_{ws}(%):**	5.42
Cp:	0.84		**Test Time:**	15:50-16:00

Wet bulb (F): 98

Dry bulb (F): 121

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.10	0.316	121
2	0.09	0.300	120
3	0.14	0.374	120
4	0.15	0.387	120
5	0.12	0.346	121
6	0.10	0.316	121
7	0.10	0.316	122
8	0.08	0.283	121
9	0.13	0.361	120
10	0.14	0.374	120
11	0.12	0.346	119
12	0.16	0.400	120
13	0.13	0.361	121
14	0.13	0.361	120
15	0.12	0.346	120
16	0.12	0.346	121
Average	**0.12**	**0.346**	**120**

Calculations:

Molar weight, M_s =	**28.25**	**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 =	**20.93**	**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, $Q_{s,ds}$ =	**19,170**	**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, $Q_{s,act}$ =	**23,045**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**20,268**	**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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Moisture Measurements & Calculations

System 1 Outlet

Test Team:	JL, AS	**Measured values:**	
EPA Methods:	4	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	0.16
Console ID:	C-004	**Y_m**	0.991
		Probe Assembly ID:	P7-01

Moisture Run	Run #1
Used for flow runs:	1, 2 & 3
Water recovery (ml):	75
Sample volume (cf):	179.456
Meter temperature (F):	116.5

Calculations:

Moisture volume, V_w =	**3.54**	**scf**	= ml x 0.04715
Sample volume, V_s =	**158.59**	**scf**	$=V_m \times Y_m \times \{528 / (T_m + 460)\} \times \{(P_{bar} + P_g / 13.6) / 29.92\}$
Moisture content, B_{ws} =	**2.18**	**%**	$=V_w / (V_w + V_s)$

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Flow Measurements & Calculations

SYS1-Stack #1

Pre-Test

Test Team:	JL, AS	**D_s (in.):**	73.50
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	0.16
Console ID:	C-004	**O_2 (%):**	20.90
Y_m	0.991	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01	**B_{ws}(%):**	2.18
Cp:	0.84	**Start Time:**	10:08 - 10:56

Measured values:

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.045	0.212	112
2	0.042	0.205	113
3	0.040	0.200	113
4	0.037	0.192	113
5	0.040	0.200	113
6	0.041	0.202	113
7	0.042	0.205	113
8	0.043	0.207	113
9	0.052	0.228	114
10	0.030	0.173	113
11	0.030	0.173	113
12	0.030	0.173	113
13	0.036	0.190	114
14	0.035	0.187	113
15	0.037	0.192	114
16	0.042	0.205	114
Average	**0.039**	**0.197**	**113**

Calculations:	**Outlet**			**Inlet**	Diff.
Molar weight, M_s =	**28.60**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$	**28.25**	
Velocity, v_s =	**11.71**	**ft/sec**	$=85.49C_p \times (\Delta p)^{1/2} \times \{(t_s+460)/(P_{bar}+p_g/13.6)/M_s)\}^{1/2}$	**20.19**	
Flow Rate, $Q_{s,ds}$ =	**18,164**	**dscfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92 \times (1-B_{ws}/100)$	**19,477**	-1,313
Flow Rate, $Q_{s,act}$ =	**20,704**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$	**22,231**	-1,527
Flow Rate, $Q_{s,std}$ =	**18,569**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$	**20,592**	-2,024

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Flow Measurements & Calculations

SYS1-Stack #1

Post-Test

		Measured values:	
Test Team:	JL, AS	**D_s (in.):**	73.50
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	0.15
Console ID:	C-004	**O_2 (%):**	20.90
Y_m	0.991	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01	**B_{ws}(%):**	2.18
Cp:	0.84	**Start Time:**	15:30-15:40

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.046	0.214	125
2	0.045	0.212	126
3	0.039	0.197	127
4	0.035	0.187	126
5	0.039	0.197	127
6	0.040	0.200	126
7	0.045	0.212	126
8	0.044	0.210	127
9	0.054	0.232	126
10	0.029	0.170	127
11	0.028	0.167	128
12	0.032	0.179	128
13	0.034	0.184	127
14	0.035	0.187	127
15	0.039	0.197	126
16	0.041	0.202	125
Average	**0.039**	**0.197**	**127**

Calculations:	**Outlet**		
Molar weight, M_s =	**28.60**	**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 =	**11.87**	**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, $Q_{s,ds}$ =	**17,984**	**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, $Q_{s,act}$ =	**20,976**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**18,385**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

SYSTEM 2

System #2							
Inlets							
	Pre	Post	Average		Pre	Post	Average
SYS2-IN1	11,484	11,437	11,460	SYS2-Stack #2	53,619	53,190	53,404
SYS2-IN2	11,224	11,193	11,209				
SYS2-IN3	9,753	9,731	9,742				
SYS2-IN4	10,002	9,805	9,903				
SYS2-IN5	5,534	5,529	5,531				
SYS2-IN6	3,841	3,796	3,819				
SYS2-IN7	9,599	9,510	9,555				
Total	51,838	51,491	51,665	Total	53,619	53,190	53,404

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Flow Measurements & Calculations

SYS2-Stack #2

Pre-Test

Test Team:	JL, LS	**Measured values:** D_s **(in.):**	61.00
EPA Methods:	1,2	P_{bar} **(in. Hg):**	29.12
Test Date:	June 30, 2020	p_g **(in.** H_2O**):**	0.30
Console ID:	C-018	O_2 **(%):**	20.90
Y_m	1.029	CO_2 **(%):**	0.00
Probe Assembly ID:	P5-06	B_{ws}**(%):**	1.85
Cp:	0.84	**Test Time:**	9:54 - 10:04

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.52	0.721	86
2	0.63	0.794	86
3	0.69	0.831	86
4	0.73	0.854	86
5	0.66	0.812	86
6	0.64	0.800	87
7	0.75	0.866	87
8	0.78	0.883	87
9	0.72	0.849	86
10	0.74	0.860	87
11	0.76	0.872	87
12	0.60	0.775	87
13	0.56	0.748	87
14	0.61	0.781	87
15	0.70	0.837	85
16	0.71	0.843	85
Average	**0.68**	**0.820**	**86**

Calculations:

Molar weight, M_s **=**	**28.64**	**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 **=**	**47.67**	**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, $Q_{s,ds}$ **=**	**53,619**	**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, $Q_{s,act}$ **=**	**58,042**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ **=**	**54,631**	**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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SYS2-Stack #2
Post-Test

Test Team:	JL LS	**Measured values:**	
EPA Methods:	1, 2, 3A & 4	**D_s (in.):**	61.00
Test Date:	June 30, 2020	**P_{bar} (in. Hg):**	29.12
Console ID:	C-018	**p_g (in. H_2O):**	0.31
Y_m	1.029	**O_2 (%):**	20.90
Probe Assembly ID:	P5-06	**CO_2 (%):**	0.00
Cp:	0.84	**B_{ws}(%):**	1.85
		Test Time:	15:16 - 15:26

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.54	0.735	98
2	0.65	0.806	99
3	0.70	0.837	99
4	0.72	0.849	98
5	0.67	0.819	98
6	0.62	0.787	97
7	0.79	0.889	98
8	0.82	0.906	98
9	0.70	0.837	96
10	0.71	0.843	97
11	0.76	0.872	97
12	0.59	0.768	98
13	0.53	0.728	98
14	0.59	0.768	99
15	0.73	0.854	98
16	0.74	0.860	98
Average	**0.68**	**0.822**	**98**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**48.28**	**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, $Q_{s,ds}$ =	**53,190**	**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, $Q_{s,act}$ =	**58,788**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**54,193**	**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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Moisture Measurements & Calculations

SYS2-Stack #2

Test Team:	JL, LS		
EPA Methods:	4		
Test Date:	June 30, 2020		
Console ID:	C-018		

Measured values:

P_{bar} (in. Hg):	29.12
p_g (in. H_2O):	0.30
Y_m	1.029
Probe Assembly ID:	P5-06

Moisture Run	Run #1
Used for flow runs:	1, 2 & 3
Water recovery (ml):	67
Sample volume (cf):	178.269
Meter temperature (F):	103.3

Calculations:

Moisture volume, V_w =	**3.16**	**scf**	= ml x 0.04715
Sample volume, V_s =	**167.46**	**scf**	$=V_m \times Y_m \times \{528 / (T_m + 460)\} \times \{(P_{bar} + P_g / 13.6) / 29.92\}$
Moisture content, B_{ws} =	**1.85**	**%**	$=V_w / (V_w + V_s)$

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Flow Measurements & Calculations

SYS2-IN1

Pre-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	34.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-1.10
Console ID:	C-13	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.85
Cp:	0.84	**Test Time:**	9:30 - 9:41

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.31	0.557	80
2	0.31	0.557	80
3	0.31	0.557	80
4	0.31	0.557	80
5	0.31	0.557	80
6	0.29	0.539	80
7	0.30	0.548	82
8	0.31	0.557	82
9	0.32	0.566	88
10	0.37	0.608	88
11	0.37	0.608	87
12	0.37	0.608	87
13	0.34	0.583	88
14	0.32	0.566	86
15	0.30	0.548	86
16	0.28	0.529	86
Average	**0.32**	**0.565**	**84**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**32.82**	**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, $Q_{s,ds}$ =	**11,484**	**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, $Q_{s,act}$ =	**12,416**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**11,701**	**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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Flow Measurements & Calculations

SYS2-IN1

Post-Test

Test Team:	GE, SSW, JH	**Measured values:**	
EPA Methods:	1,2	**D_s (in.):**	34.00
Test Date:	June 30, 2020	**P_{bar} (in. Hg):**	29.12
Console ID:	C-13	**p_g (in. H_2O):**	-1.10
Y_m	0.907	**O_2 (%):**	20.90
Probe Assembly ID:	P5-02	**CO_2 (%):**	0.00
Cp:	0.84	**B_{ws}(%):**	1.85
		Test Time:	16:50 - 16:58

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.30	0.548	85
2	0.30	0.548	85
3	0.30	0.548	85
4	0.32	0.566	85
5	0.32	0.566	85
6	0.30	0.548	85
7	0.30	0.548	86
8	0.30	0.548	86
9	0.30	0.548	85
10	0.35	0.592	85
11	0.36	0.600	85
12	0.37	0.608	85
13	0.35	0.592	85
14	0.32	0.566	85
15	0.30	0.548	86
16	0.30	0.548	86
Average	**0.32**	**0.564**	**85**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**32.77**	**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, $Q_{s,ds}$ =	**11,437**	**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, $Q_{s,act}$ =	**12,398**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**11,652**	**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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Flow Measurements & Calculations

SYS2-IN2

Pre-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	34.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.80
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.85
Cp:	0.84	**Test Time:**	9:19 - 9:27

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.25	0.500	85
2	0.30	0.548	84
3	0.31	0.557	84
4	0.31	0.557	85
5	0.32	0.566	85
6	0.33	0.574	85
7	0.31	0.557	84
8	0.32	0.566	82
9	0.32	0.566	85
10	0.29	0.539	85
11	0.29	0.539	85
12	0.31	0.557	85
13	0.31	0.557	85
14	0.31	0.557	86
15	0.30	0.548	84
16	0.31	0.557	84
Average	**0.31**	**0.553**	**85**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**32.10**	**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, $Q_{s,ds}$ =	**11,224**	**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, $Q_{s,act}$ =	**12,143**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**11,436**	**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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Flow Measurements & Calculations

SYS2-IN2

Post-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	34.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.80
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.85
Cp:	0.84	**Test Time:**	4:41PM

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.26	0.510	86
2	0.30	0.548	86
3	0.30	0.548	86
4	0.32	0.566	87
5	0.32	0.566	87
6	0.32	0.566	87
7	0.32	0.566	87
8	0.32	0.566	87
9	0.32	0.566	87
10	0.30	0.548	86
11	0.30	0.548	86
12	0.30	0.548	86
13	0.30	0.548	86
14	0.30	0.548	87
15	0.30	0.548	87
16	0.30	0.548	87
Average	**0.31**	**0.552**	**87**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**32.13**	**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, $Q_{s,ds}$ =	**11,193**	**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, $Q_{s,act}$ =	**12,155**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**11,405**	**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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Flow Measurements & Calculations

SYS2-IN3

Pre-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-1.10
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	10:35 - 10:44

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.41	0.640	86
2	0.42	0.648	86
3	0.44	0.663	86
4	0.43	0.656	86
5	0.43	0.656	88
6	0.40	0.632	88
7	0.35	0.592	89
8	0.27	0.520	88
9	0.33	0.574	88
10	0.37	0.608	88
11	0.42	0.648	89
12	0.43	0.656	88
13	0.40	0.632	88
14	0.38	0.616	88
15	0.36	0.600	88
16	0.31	0.557	88
Average	**0.38**	**0.619**	**88**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**36.06**	**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, $Q_{s,ds}$ =	**9,753**	**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, $Q_{s,act}$ =	**10,619**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,937**	**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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Flow Measurements & Calculations

SYS2-IN3

Post-Test

Test Team:	GE, SSW, JH			
EPA Methods:	1,2			
Test Date:	June 30, 2020			
Console ID:	C-013			
Y_m	0.907			
Probe Assembly ID:	P5-02			
Cp:	0.84			

Measured values:

D_s (in.):	30.00
P_{bar} (in. Hg):	29.12
p_g (in. H_2O):	-1.10
O_2 (%):	20.90
CO_2 (%):	0.00
B_{ws}(%):	1.9
Test Time:	16:12 - 16:21

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.40	0.632	88
2	0.40	0.632	88
3	0.43	0.656	88
4	0.43	0.656	88
5	0.43	0.656	88
6	0.40	0.632	88
7	0.36	0.600	88
8	0.30	0.548	89
9	0.32	0.566	87
10	0.35	0.592	88
11	0.40	0.632	88
12	0.44	0.663	87
13	0.42	0.648	87
14	0.37	0.608	87
15	0.37	0.608	87
16	0.30	0.548	87
Average	**0.38**	**0.617**	**88**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**35.98**	**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, $Q_{s,ds}$ =	**9,731**	**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, $Q_{s,act}$ =	**10,597**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,915**	**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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Flow Measurements & Calculations

SYS2-IN4

Pre-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.91
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	10:51 - 11:00

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.35	0.592	85
2	0.37	0.608	85
3	0.37	0.608	85
4	0.38	0.616	85
5	0.40	0.632	85
6	0.40	0.632	85
7	0.41	0.640	85
8	0.41	0.640	85
9	0.44	0.663	86
10	0.45	0.671	86
11	0.44	0.663	86
12	0.40	0.632	86
13	0.40	0.632	86
14	0.40	0.632	86
15	0.40	0.632	86
16	0.40	0.632	86
Average	**0.40**	**0.633**	**86**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**36.82**	**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, $Q_{s,ds}$ =	**10,002**	**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, $Q_{s,act}$ =	**10,843**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**10,191**	**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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Flow Measurements & Calculations

SYS2-IN4

Post-Test

		Measured values:	
Test Team:	GE, SSW, JH	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.91
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.85
Cp:	0.84	**Test Time:**	16:22 - 16:30

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.33	0.574	87
2	0.35	0.592	87
3	0.35	0.592	87
4	0.36	0.600	88
5	0.37	0.608	88
6	0.40	0.632	88
7	0.40	0.632	88
8	0.40	0.632	88
9	0.41	0.640	88
10	0.44	0.663	89
11	0.44	0.663	89
12	0.40	0.632	88
13	0.37	0.608	88
14	0.39	0.624	88
15	0.40	0.632	88
16	0.39	0.624	88
Average	**0.39**	**0.622**	**88**

Calculations:

Molar weight, M_s =	**28.64 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 =	**36.25 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, $Q_{s,ds}$ =	**9,805 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, $Q_{s,act}$ =	**10,677 acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,990 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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Flow Measurements & Calculations

SYS2-IN5

Pre-Test

Test Team:	RB, DG	**D_s (in.):**	26.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.74
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	11:07 - 11:16

(Measured values: right column)

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.18	0.424	86
2	0.18	0.424	86
3	0.19	0.436	86
4	0.20	0.447	86
5	0.20	0.447	86
6	0.24	0.490	86
7	0.24	0.490	86
8	0.23	0.480	86
9	0.16	0.400	86
10	0.22	0.469	86
11	0.26	0.510	86
12	0.27	0.520	86
13	0.26	0.510	86
14	0.23	0.480	86
15	0.21	0.458	86
16	0.23	0.480	86
Average	**0.22**	**0.467**	**86**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**27.13**	**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, $Q_{s,ds}$ =	**5,534**	**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, $Q_{s,act}$ =	**6,002**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**5,639**	**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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Flow Measurements & Calculations

SYS2-IN5

Post-Test

			Measured values:	
Test Team:	RB, DG		**D_s (in.):**	26.00
EPA Methods:	1,2		**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020		**p_g (in. H_2O):**	-0.74
Console ID:	C-013		**O_2 (%):**	20.90
Y_m	0.907		**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02		**B_{ws}(%):**	1.9
Cp:	0.84		**Test Time:**	16:32 - 16:39

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.17	0.412	87
2	0.18	0.424	87
3	0.18	0.424	87
4	0.20	0.447	87
5	0.20	0.447	88
6	0.24	0.490	88
7	0.25	0.500	88
8	0.25	0.500	88
9	0.15	0.387	87
10	0.20	0.447	87
11	0.25	0.500	88
12	0.27	0.520	87
13	0.28	0.529	87
14	0.25	0.500	87
15	0.20	0.447	87
16	0.24	0.490	87
Average	**0.22**	**0.467**	**87**

Calculations:

Molar weight, M_s =	**28.64 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 =	**27.17 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, $Q_{s,ds}$ =	**5,529 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, $Q_{s,act}$ =	**6,011 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**5,633 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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Flow Measurements & Calculations

SYS2-IN6

Pre-Test

Test Team:	GE, SSW, JH	**D_s (in.):**	22.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.65
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	10:01 - 10:10

Measured values: (right column)

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.12	0.346	86
2	0.16	0.400	86
3	0.18	0.424	86
4	0.21	0.458	86
5	0.21	0.458	86
6	0.21	0.458	86
7	0.21	0.458	86
8	0.22	0.469	86
9	0.20	0.447	86
10	0.22	0.469	86
11	0.22	0.469	86
12	0.23	0.480	86
13	0.23	0.480	86
14	0.23	0.480	86
15	0.22	0.469	86
16	0.22	0.469	86
Average	**0.21**	**0.452**	**86**

Calculations:

Molar weight, M_s =	**28.64 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 =	**26.30 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, $Q_{s,ds}$ =	**3,841 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, $Q_{s,act}$ =	**4,165 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**3,914 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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Flow Measurements & Calculations

SYS2-IN6

Post-Test

Measured values:

Test Team:	GE, SSW, JH	**D_s (in.):**	22.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.65
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	16:07 - 16:16

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.13	0.361	90
2	0.15	0.387	91
3	0.18	0.424	91
4	0.20	0.447	91
5	0.20	0.447	91
6	0.21	0.458	91
7	0.22	0.469	91
8	0.22	0.469	91
9	0.21	0.458	91
10	0.21	0.458	91
11	0.22	0.469	91
12	0.23	0.480	91
13	0.22	0.469	91
14	0.22	0.469	91
15	0.22	0.469	91
16	0.20	0.447	91
Average	**0.20**	**0.449**	**91**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**26.22**	**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, $Q_{s,ds}$ =	**3,796**	**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, $Q_{s,act}$ =	**4,153**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**3,868**	**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 - Madison, GA

Flow Measurements & Calculations

SYS2-IN7

Pre-Test

		Measured values:	
Test Team:	GE, SSW	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.92
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	10:11 - 10:20

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.32	0.566	85
2	0.35	0.592	85
3	0.36	0.600	85
4	0.36	0.600	85
5	0.37	0.608	84
6	0.37	0.608	84
7	0.39	0.624	84
8	0.39	0.624	84
9	0.35	0.592	86
10	0.37	0.608	86
11	0.35	0.592	86
12	0.38	0.616	86
13	0.40	0.632	86
14	0.36	0.600	86
15	0.40	0.632	86
16	0.39	0.624	86
Average	**0.37**	**0.608**	**85**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**35.32**	**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, $Q_{s,ds}$ =	**9,599**	**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, $Q_{s,act}$ =	**10,402**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,781**	**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 - Madison, GA

Flow Measurements & Calculations

SYS2-IN7

Post-Test

		Measured values:	
Test Team:	GE, SSW	**D_s (in.):**	30.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.12
Test Date:	June 30, 2020	**p_g (in. H_2O):**	-0.92
Console ID:	C-013	**O_2 (%):**	20.90
Y_m	0.907	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-02	**B_{ws}(%):**	1.9
Cp:	0.84	**Test Time:**	15:58 - 16:06

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.30	0.548	92
2	0.35	0.592	92
3	0.35	0.592	92
4	0.36	0.600	92
5	0.38	0.616	92
6	0.38	0.616	92
7	0.38	0.616	92
8	0.40	0.632	92
9	0.33	0.574	91
10	0.36	0.600	91
11	0.36	0.600	91
12	0.40	0.632	91
13	0.40	0.632	91
14	0.35	0.592	91
15	0.38	0.616	91
16	0.39	0.624	91
Average	**0.37**	**0.605**	**92**

Calculations:

Molar weight, M_s =	**28.64**	**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 =	**35.39**	**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, $Q_{s,ds}$ =	**9,510**	**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, $Q_{s,act}$ =	**10,423**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**9,689**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

APPENDIX B

EXAMPLE CALCULATIONS

AND

NOMENCLATURE

EXAMPLE CALCULATIONS

$A_n = D_n^2 \pi / 4$

$A_s = D_s^2 \pi / 4$

$B_{ws} = V_{w(std)} / (V_{m(std)} + V_{w(std)})$

$c_{analyte} = (m_{analyte} / V_{m(std)}) (35.31466 \ ft^3/m^3)$

$‘c_{analyte} = (m_{analyte} / V_{m(std)}) (0.015432 \ gr/mg)$

$c_{analyte} = ‘c_{analyte} \ MW_{analyte} / 24.04 \ l/mol$

$CC = t_{0.975} (S_d / n^{1/2})$

$d = 1/n (Sd_i)$

$DE = (E_{Inlet} – E_{Outlet}) / E_{,Inlet} \times 100\%$

$E_{analyte} = (m_{analyte} / V_{m(std)}) Q_{sd} (60 \ min/hr) (2.2046x10^{-6} \ lb./mg)$

$E_{analyte} = c_{analyte} Q_{sd} (60 \ min/hr) (2.2046x10^{-6} \ lb./mg)$

$I = 100 \ T_s (K_3 V_{lc} + Y_m V_m P_m / T_m) / (60 \ \theta \ v_s P_s A_n)$

where $K_3 = 0.002669 \ (in. \ Hg \ ft^3) / (mL \ °R)$

$K_I = [(2.0084x10^7 \Delta H_{@}) A_n (1 – B_{ws})]^2 (M_d / M_s) (T_m / T_s) (P_s / P_m)$

$M_d = 0.44 (\% \ CO_2) + 0.32 (\% \ O_2) + 0.28 (\% \ N_2 + \% \ CO)$

$M_s = M_d (1 – B_{ws}) + M_w B_{ws}$

$P = Qsd / F\text{-}Factor \times 60 \times (20.9\text{-}O_2) / 20.9$

$P_m = P_{bar} + \Delta H / 13.6$

$P_s = P_{bar} + p_g / 13.6$

$Q_a = (60 \ s/min) v_s A_s$

$Q_{sd} = (60 \ s/min) (1 - B_{ws}) v_s A_s (T_{std} / T_s) (P_s / P_{std})$

$RA = [Abs(d) + Abs(CC)]/RM$

$S_d = [(Sd_i^2 – (Sdi)^2/n)/(n\text{-}1)]^{1/2}$

$T_m = t_m + 460°$

$T_s = t_s + 460°$

$V_{m(std)} = V_m Y_m (T_{std} / T_m) (P_m / P_{std})$

$V_{w(std)} = (V_{lc} \rho_w R \ T_{std}) / (M_w P_{std})$

$v_s = K_p C_p [\Delta p]^{1/2} [T_s / (P_s M_s)]^{1/2}$

NOMENCLATURE

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

Advanced Industrial Resources, Inc.
Field Data Sheet

Client:	BD	Test Date:	6-30-2020
Location:	Madison, GA	Console ID:	C-004
Source:	SYS 1 - stack #1	Y_m / $\Delta H_@$:	0.991 / 1.593
Test Team:	JL, AS	Sampling Box ID:	B-04
EPA Methods:	1-4	Probe Assembly ID:	PS P7-01 JML
D_s (in.):	73.5	D_n (in.):	N/A
% O_2	21.0	Assumed B_{ws}:	1%
% CO_2	0.0	P_{bar} (in. Hg):	29.12
Start Run:	1145	p_g (in. H_2O):	0.16
End Run:	1545	Minutes/Point:	40.0
Run Number:	1	K-Factor:	N/A

Point	Meter (dcf)	Inches H_2O Δp	Inches H_2O ΔH	Temperature Readings (°F) t_s	Probe	Filter Box	Last Impinger	t_m Inlet	t_m Outlet	Filter Exit (M5 or ~~CPM~~)	Vacuum (in. Hg)
1	982.937		1.593		250	252	68	110	110	245	1
2	↓		↓		250	259	60	112	112	246	1
3					251	257	58	118	118	245	1
4					250	256	60	120	120	246	1
5					252	255	61	119	119	243	1
6	↓		↓		251	254	62	120	120	244	1
7											
8											
9											
10											
11											
12											
Change Ports											
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
End	1162.393										

Moisture Collected (g)

	Initial	Final	Net
Body:	200.0	255.0	55.0
Silica Gel:	200.0	220.0	20.0
Gel Number:		Total:	75.0

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.000 @ 5"
Pitot A: ✓
Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.000 @ 5"
Pitot A: ✓
Pitot B: ✓

Silica Gel Desc. (initial): Blue
Silica Gel Desc. (final): Amber
Test Team Leader Review:
Data Entry Review: BOS

Reagent 1: Lot No:
Reagent 2: Lot No:

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD
Location:	Madison, GA
Source:	SYS 1 - Stack #1
Test Team:	JL, AS
EPA Methods:	1-4
Test Date:	6-30-2020
Console ID:	C-004
Probe Assembly ID:	P7-01

Measured values:

D_s (in.):	73.5
Y_m / $\Delta H_@$:	0.991 / 1.593
C_p:	0.84
t_{amb} (°F)	86
Assumed B_{ws} (%):	1%
O_2 (%):	21%
CO_2 (%):	0%

Start time:	1008	1530		
Stop time:	1056	1540		

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):	0.16		0.15					
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	0.045 ~~0.037~~	112	0.046	125				
2	0.042 ~~0.03~~	113	0.045	126				
3	0.040 ~~0.03~~	113	0.039	127				
4	0.037	113	0.035	126				
5	0.040	113	0.039	127				
6	0.041	113	0.040	126				
7	0.042	113	0.045	126				
8	0.043	113	0.044	127				
9	0.052	114	0.054	126				
10	0.030	113	0.029	127				
11	0.030	113	0.028	128				
12	0.070	113	0.032	128				
13	0.036	114	0.034	127				
14	0.035	113	0.035	127				
15	0.037	114	0.039	126				
16	0.042	114	0.041	125				
Average								

Test Team Leader Review: DPS

Data Entry Review:

Advanced Industrial Resources, Inc.

Source Description Sheets

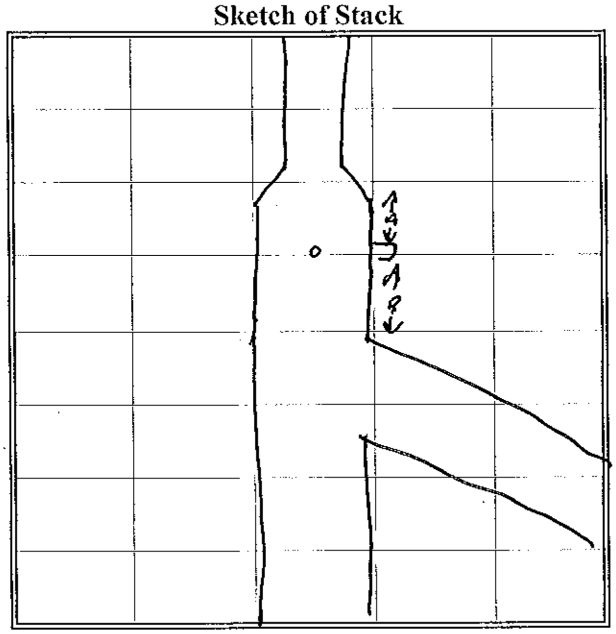
Client: BD
Location: Madison, GA
Source: SYS 1 - Stack #2

Date: 6-30-2020
Test Team: JL, AS

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	73.5
A_s (ft^2):	29.46
Length A (in.):	38.5
Length B (in.):	217
t_{amb} (°F):	85
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.12
P_g (in. H_2O):	0.16
% O_2:	21%
% CO_2:	0%
Console ID:	C-004
Y:	0.991
$\Delta H_@$:	1.593
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.045	112
2	0.042	113
3	0.040	113
4	0.037	113
5	0.040	113
6	0.041	113
7	0.042	113
8	0.043	113
9		
10		
11		
12		
Change Ports		
1	0.052	114
2	0.030	113
3	0.030	113
4	0.030	113
5	0.036	114
6	0.035	113
7	0.037	~~113~~ 114
8	0.042	114
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

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

Client: ~~Bard~~ BD
Location: Madison, GA
Source: Sys. 1 - Stack #1
Test Team: JL, AS
Probe ID: P7-01
C_p: 0.84

t_m (°F): 85
Console ID: C-004
Y_m: 0.991
$\Delta H_@$: 1.593
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): 73.5
A_s (ft^2): 29.46
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	5
7	0.0	5
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	4
4	0.0	5
5	0.0	5
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: ____________

System 1
Inlet

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client: ~~Bartt~~ BD 7ue
Location: Madison, GA
Source: SYS 2 - Inlet
Test Team: JL, AS
EPA Methods: 1-4
Test Date: 6-30-2020
Console ID: C-004
Probe Assembly ID: 16-01

Measured values:
D_s (in.): 58.0
Y_m / $\Delta H_@$: 0.991 / 1.593
C_p: 0.84
t_{amb} (°F): 85
Assumed B_{ws} (%): 1%
O_2 (%): 21.0
CO_2 (%): 0.0

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
Start time:	~~0901~~ 0915 7ue		1550					
Stop time:	~~0911~~ 0925 7ue		1600					
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):	-2.60		-2.60					
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	0.09	89	0.10	121				
2	0.09	89	0.09	120				
3	0.12	90	0.14	120				
4	0.13	90	0.15	120				
5	0.14	91	0.12	121				
6	0.09	91	0.10	121				
7	0.10	92	0.10	122				
8	0.11	92	0.08	121				
9	0.12	92	0.13	120				
10	0.10	92	0.14	120				
11	0.12	93	0.12	119				
12	0.14	92	0.16	120				
13	0.15	92	0.13	121				
14	0.15	91	0.13	120				
15	0.13	91	0.12	120				
16	0.11	91	0.12	121				
Average								

Wet Bulb 98°F
Dry Bulb 121°F

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

Pitot leak check PRE ✓ POST ✓

Advanced Industrial Resources, Inc.
Source Description Sheets

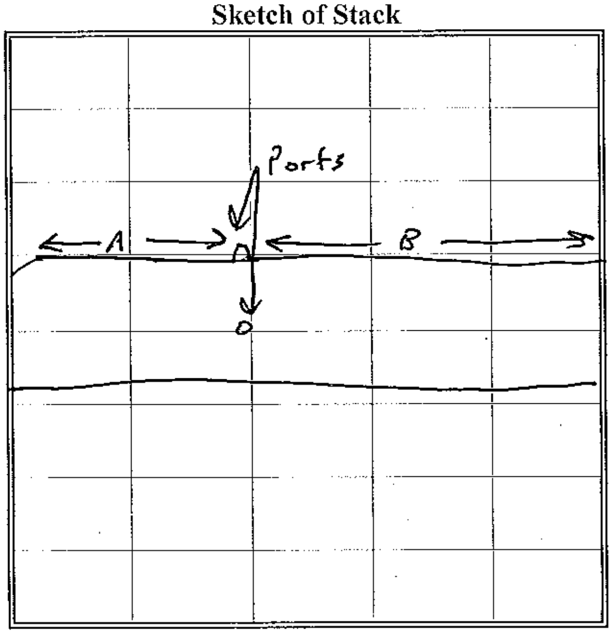
Client: BD
Date: 6-30-2020
Location: Madison, GA
Test Team: JL, AS
Source: SYS 1 Inlet

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 58.0
A_s (ft^2): 18.35
Length A (in.): 259
Length B (in.): 1200

t_{amb} (°F): 85
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): -2.60
% O_2: 21.0%
% CO_2: 0.0%
Console ID: C-004
Y: 0.991
$\Delta H_@$: 1.593
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.09	89
2	0.09	89
3	0.12	90
4	0.13	90
5	0.14	90
6	0.09	91
7	0.10	91
8	0.11	92
9		
10		
11		
12		
Change Ports		
1	0.12	92
2	0.10	92
3	0.12	93
4	0.14	92
5	0.15	92
6	0.15	91
7	0.13	91
8	0.11	91
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review:
Data Entry Review:

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: ~~Bard~~ BD Jm

Location: Madison, GA

Source: SYS 1 - Inlet

Test Team: JL, AJ

Probe ID: PG-01

C_p: 0.84

t_m (°F): 85

Console ID: C-004

Y_m: 0.991

$\Delta H_@$: 1.593

Assumed B_{ws}: 1%

P_{bar} (in. Hg): 29.12

Date: 6-30-2020

D_s (in.): 58.0

A_s (ft^2): 18.35

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	5
4	0.0	0
5	0.0	0
6	0.0	5
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: __________

SYSTEM 2
OUTLET

Advanced Industrial Resources, Inc.
Field Data Sheet

Client:	BD	Test Date:	6-30-2020
Location:	Madison, GA	Console ID:	C-018
Source:	SYS 2 - Stack #2	Y_m / $\Delta H_@$:	1.029 / 1.883
Test Team:	JL, CS	Sampling Box ID:	B-18
EPA Methods:	1-4	Probe Assembly ID:	PS-06
D_s (in.):	61.0	D_n (in.):	N/A
% O_2	21.0	Assumed B_{ws}:	1%
% CO_2	0.0	P_{bar} (in. Hg):	29.12
Start Run:	1145	p_g (in. H_2O):	0.30
End Run:	1545	Minutes/Point:	40
Run Number:	1	K-Factor:	N/A

Point	Meter (dcf)	Inches H_2O Δp	Inches H_2O ΔH	Temperature Readings (°F) t_s	Probe	Filter Box	Last Impinger	t_m Inlet	t_m Outlet	Filter Exit (M5 or CPM)	Vacuum (in. Hg)
1	0.000		1.883		261	260	68	92	92	250	3
2	↓		↓		260	262	60	94	94	251	3
3					261	260	56	106	106	250	3
4					260	262	59	109	109	251	3
5					259	260	60	110	110	250	3
6					260	260	61	109	109	249	3
7											
8											
9											
10											
11											
12											
Change Ports											
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
End	178.269										

Moisture Collected (g)

	Initial	Final	Net
Body:	200.0	246.0	46.0
Silica Gel:	200.0	221.0	21.0
Gel Number:		Total:	67.0

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.000 @ 5"
Pitot A: ✓
Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.000 @ 5"
Pitot A: ✓
Pitot B: ✓

Silica Gel Desc. (initial): Blue
Silica Gel Desc. (final): Amber
Test Team Leader Review:
Data Entry Review: DDS

Reagent 1: Lot No:
Reagent 2: Lot No:

REV021717

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	~~Bartd~~ BP JMR	**Measured values:**	
Location:	Madison, GA	D_s (in.):	61.0
Source:	SYS 2 - Stack #2	Y_m / $\Delta H_@$:	1.029 / 1.883
Test Team:	JL, LS	C_p:	0.84
EPA Methods:	1-4	t_{amb} (°F)	84
Test Date:	6-30-2020	Assumed B_{ws} (%):	1%
Console ID:	C-018	O_2 (%):	21%
Probe Assembly ID:	P5-06	CO_2 (%):	0%

	Start time	Stop time
Pre-1	0954	~~09~~ 1004
Post-1; Pre-2	1516	1526
Post-2; Pre-3		
Post-3		

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):	0.30		0.31					
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	0.52	86	0.54	98				
2	0.63	86	0.65	99				
3	~~0.66~~ 0.69 JMR	86	0.70	99				
4	0.73	86	0.72	98				
5	0.66	86	0.67	98				
6	0.64	87	0.62	97				
7	0.75	87	0.79	98				
8	0.78	87	0.82	98				
9	0.72	86	0.70	96				
10	0.74	87	0.71	97				
11	0.76	87	0.76	97				
12	0.60	87	0.59	98				
13	0.56	87	0.53	98				
14	0.61	87	0.59	99				
15	0.70	85	0.73	98				
16	0.71	85	0.74	98				
Average								

Test Team Leader Review: ____________

Data Entry Review: OOS

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BP
Location: Madison, GA
Source: SYS 2 - Stack #2

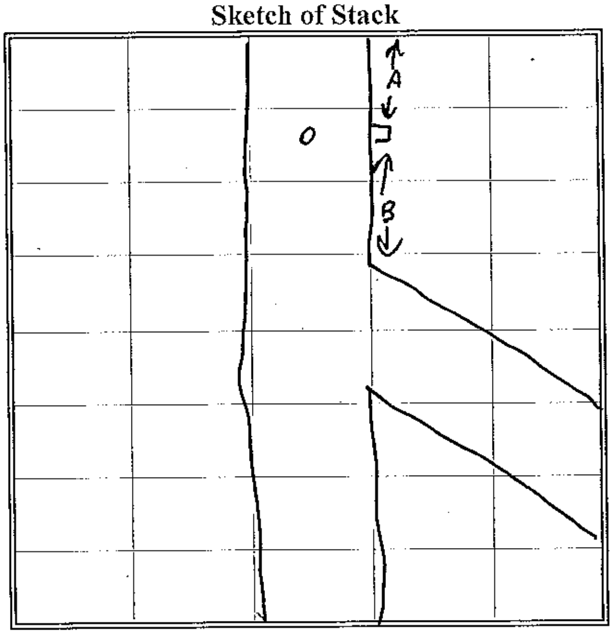
Date: 6-30-2020
Test Team: JL, LS

D_n (in.): N/A
A_n (ft^2): N/A
D_s (in.): 61.0
A_s (ft^2): 20.29
Length A (in.): 255
Length B (in.): 170

t_{amb} (°F): 82
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): 0.30
% O_2: 21%
% CO_2: 0.0%
Console ID: C-018
Y: 1.029
$\Delta H_@$: 1.883
C_p: 0.84
K-Factor: N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.52	86
2	0.63	86
3	0.69	86
4	0.73	86
5	0.66	86
6	0.64	87
7	0.75	87
8	0.78	87
9		
10		
11		
12		
Change Ports		
1	0.72	86
2	0.74	87
3	0.76	87
4	0.60	87
5	0.56	87
6	0.61	87
7	0.70	85
8	0.71	85
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ________
Data Entry Review: ________

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

Client:	~~Baird~~ BD 7M	Date:	6-30-2020
Location:	Madison GA	D_s (in.):	61.0
Source:	SYS 2 - stack #2	A_s (ft^2):	20.29
Test Team:	JL, LS	D_n (in.):	N/A
Probe ID:	~~P7-01~~ P5-06 JML	A_n (ft^2):	N/A
C_p:	0.84		

t_m (°F):	82
Console ID:	C-018
Y_m:	1.029
$\Delta H_@$:	1.883
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.12

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: __________

SYSTEM 2
INLET

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD	**Measured values:**	
Location:	Madison, GA	D_s (in.):	34
Source:	SVS2 INI	Y_m / $\Delta H_@$:	0.907 / 1.808
Test Team:	GE SSW JH	C_p:	0.84
EPA Methods:	1, 2	t_{amb} (°F)	80
Test Date:	6-30-2020	Assumed B_{ws} (%):	2%
Console ID:	C-13	O_2 (%):	21
Probe Assembly ID:	Flow probe S-02	CO_2 (%):	0

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
Start time:	9:30		16:50					
Stop time:	9:41		16:58					
P_{bar} (in. Hg):	29.12							
p_g (in. H_2O):								
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	0.31	80	0.30	85				
2	0.31	80	0.30	85				
3	0.31	80	0.30	85				
4	0.31	90	0.32	85				
5	0.31	80	0.32	85				
6	0.29	80	0.30	85				
7	0.30	82	0.30	86				
8	0.31	82	0.30	86				
9	0.32	88	0.30	85				
10	0.37	88	0.35	85				
11	0.37	87	0.36	85				
12	0.37	87	0.37	85				
13	0.34	88	0.35	85				
14	0.32	86	0.32	85				
15	0.30	86	0.30	86				
16	0.28	86	0.30	86				
Average								

Pg - -1.1

Pitot leak check Pre ✓ Post ✓

Test Team Leader Review: AR

Data Entry Review: AR

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

Client: BD
Location: Madison, GA
Source: SYS 2 - IN1
Test Team: GE SSW JH
Probe ID: FP5-02
C_p: 0.84

Date: 6-30-2020
D_s (in.): 34
A_s (ft^2): 6.305
D_n (in.): NA
A_n (ft^2): NA

t_m (°F): 81
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Point	Δp (in. H_2O)	α (degrees)
1	0.0	2
2	0.0	2
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	2
2	0.0	2
3	0.0	2
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	

Test Team Leader Review: __________
Data Entry Review: __________

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD
Location: Madison GA
Source: SYS 2 IN 1

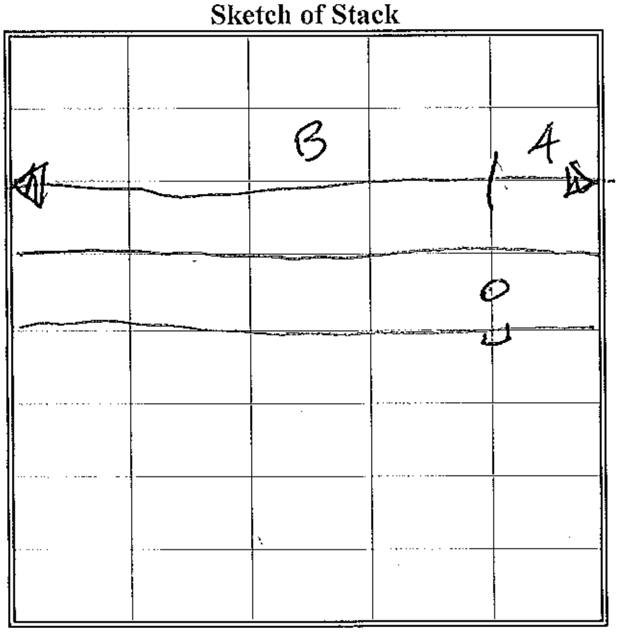
Date: 6-30-2020
Test Team: GE SSW JH

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 34
A_s (ft^2): 6.305
Length A (in.): 96
Length B (in.): 498

t_{amb} (°F): 88
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): -1.1
% O_2: 21
% CO_2: 0
Console ID: C-13
Y: 0.907
$\Delta H_@$: 1.808
C_p: 0.84
K-Factor: NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.30	85
2	0.30	85
3	0.30	85
4	0.32	85
5	0.32	85
6	0.30	86
7	0.30	86
8	0.30	86
9		
10		
11		
12		
Change Ports		
1	0.30	86
2	0.35	85
3	0.36	85
4	0.37	86
5	0.35	85
6	0.32	85
7	0.30	86
8	0.30	86
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client: BD
Location: Madison, GA
Source: Sys 2 - IN2
Test Team: GE SSW JH
EPA Methods: 1, 2
Test Date: 6-30-2020
Console ID: C-13
Probe Assembly ID: Flow probe 5-02

Measured values:
D_s (in.): 34
Y_m / $\Delta H_@$: 0.907 / 1.808
C_p: 0.84
t_{amb} (°F): 78
Assumed B_{ws} (%): 2%
O_2 (%): 21
CO_2 (%): 0

	Start time: 9:19	Stop time: 9:27	Start time: 16:41	Stop time: 16:49	Start time:	Stop time:	Start time:	Stop time:
	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):								
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	85	0.26	86				
2	0.30	84	0.30	86				
3	0.31	84	0.30	86				
4	0.31	85	0.32	87				
5	0.32	85	0.32	87				
6	0.33	85	0.32	87				
7	0.31	84	0.32	87				
8	0.32	82	0.32	87				
9	0.32	85	0.32	87				
10	0.29	85	0.30	86				
11	0.29	85	0.30	86				
12	0.31	85	0.30	86				
13	0.31	85	0.30	86				
14	0.31	86	0.30	87				
15	0.30	84	0.30	87				
16	0.31	84	0.30	87				
Average		R						

Pg - -0.80

Leak check
pre ✓
post ✓

Test Team Leader Review:
Data Entry Review: DMS

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

Client: BD
Location: ~~W~~ ~~ST~~ Madison, GA.
Source: SYS 2 - W2
Test Team: GE SSW JH
Probe ID: Flow probe 5.02
C_p: 0.84

Date: 6-30-2020
D_s (in.): 34
A_s (ft^2): 6.305
D_n (in.): N/A
A_n (ft^2): N/A

t_m (°F): 80
Console ID: C-13
Y_m: 0.S07
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

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

Test Team Leader Review: ____________

Data Entry Review: ____________

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD
Location: Madison, GA
Source: SYS 2 IN 2

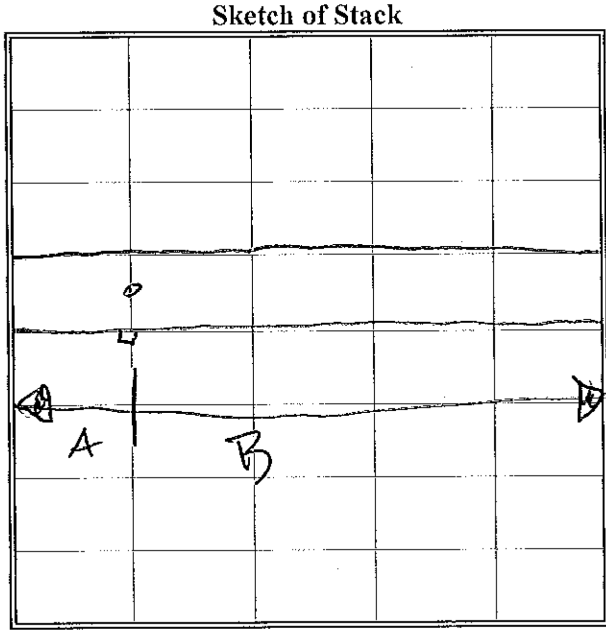
Date: 6-30-2020
Test Team: GE SSW JH

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 34
A_s (ft^2): 6.305
Length A (in.): 96
Length B (in.): 462

t_{amb} (°F): 88
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): −0.80
% O_2: 21
% CO_2: 0
Console ID: C-13
Y: 0.907
$\Delta H_@$: 1.808
C_p: 0.84
K-Factor: NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.26	86
2	0.30	86
3	0.30	86
4	0.32	87
5	0.32	87
6	0.32	86
7	0.32	87
8	0.32	87
9		
10		
11		
12		
Change Ports		
1	0.30	87
2	0.30	86
3	0.30	86
4	0.30	86
5	0.30	86
6	0.30	87
7	0.30	87
8	0.30	87
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD	Measured values:	
Location:	Madison GA	D_s (in.):	30
Source:	SYS2 IN3	Y_m / $\Delta H_@$:	0.907/1.808
Test Team:	GE SSW & JH (initials)	C_p:	0.84
EPA Methods:	1, 2	t_{amb} (°F)	88
Test Date:	6-30-2020	Assumed B_{ws} (%):	2%
Console ID:	C-13	O_2 (%):	21
Probe Assembly ID:	FPS-02	CO_2 (%):	0

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
	Start time: 10:35	Stop time: 10:44	Start time: 16:12	Stop time: 16:21	Start time:	Stop time:	Start time:	Stop time:
P_{bar} (in. Hg):	29.12							
p_g (in. H_2O):								
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	0.41	86	0.40	88				
2	0.42	86	0.40	88				
3	0.44	86	0.43	88				
4	0.43	86	0.43	88				
5	0.43	88	0.43	88				
6	0.40	88	0.40	88				
7	0.35	89	0.36	88				
8	0.27	88	0.30	89				
9	0.33	88	0.32	87				
10	0.37	88	0.35	88				
11	0.42	89	0.40	88				
12	0.43	88	0.44	87				
13	0.40	88	0.42	87				
14	0.38	88	0.37	87				
15	0.36	88	0.37	87				
16	0.31	88	0.30	87				
Average								

Pg - -1.1

Leak check
Pre ✓
Post ✓

Test Team Leader Review: ______

Data Entry Review: ADS

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

Client: BD
Location: Madison GA
Source: SYS 2 1&3
Test Team: GE SSW JH
Probe ID: FPS-02
C_p: 0.84

t_m (°F): 80
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): 30
A_s (ft^2): 4.909
D_n (in.): NA
A_n (ft^2): NA

Point	Δp (in. H_2O)	α (degrees)
1	0.0	2
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	2
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	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	

Test Team Leader Review: ____________
Data Entry Review: ____________

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD
Location: Madison, GA
Source: 5YS2 IN3

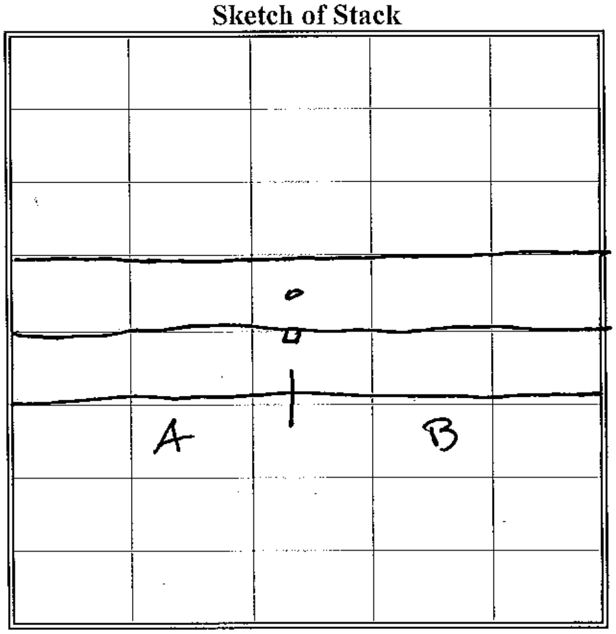
Date: 6-30-2020
Test Team: GE SSW JH

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 30
A_s (ft^2): 4.909
Length A (in.): 255
Length B (in.): 770

t_{amb} (°F): 88
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): -1.1
% O_2: 21
% CO_2: 0
Console ID: C-13
Y: 0.907
$\Delta H_@$: 1.808
C_p: 0.84
K-Factor: NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.40	88
2	0.40	88
3	0.43	88
4	0.43	88
5	0.43	88
6	0.40	88
7	0.36	88
8	0.30	88
9		
10		
11		
12		
Change Ports		
1	0.32	87
2	0.35	88
3	0.40	88
4	0.44	87
5	0.42	87
6	0.37	87
7	0.37	87
8	0.30	87
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD	**Measured values:**	
Location:	Madison, GA	D_s (in.):	30
Source:	Sys 2 IN4	Y_m / $\Delta H_@$:	0.907 / 1.808
Test Team:	GE SSW JH	C_p:	0.84
EPA Methods:	1, 2	t_{amb} (°F)	88
Test Date:	6-30-2020	Assumed B_{ws} (%):	2%
Console ID:	C-13	O_2 (%):	21
Probe Assembly ID:	FP5-02	CO_2 (%):	0

	Start time	Stop time
Pre-1	10:51	11:00
Post-1; Pre-2	16:22	16:30
Post-2; Pre-3		
Post-3		

29.12

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	~~10:51~~							
p_g (in. H_2O):	~~11:00~~							
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	0.35	85	0.33	87				
2	0.37	85	0.35	87				
3	0.37	85	0.35	87				
4	0.38	85	0.36	88				
5	0.40	85	0.37	88				
6	0.40	85	0.40	88				
7	0.41	85	0.40	88				
8	0.41	85	0.40	88				
9	0.44	86	0.41	88				
10	0.45	86	0.44	89				
11	0.44	86	0.44	89				
12	0.40	86	0.40	88				
13	0.40	86	0.37	88				
14	0.40	86	0.39	88				
15	0.40	86	0.40	88				
16	0.40	86	0.39	88				
Average								

Pg - -0.91

Leak check
Pre ✓
Post ✓

Test Team Leader Review: ___________

Data Entry Review: ___________

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD
Location: Madison GA
Source: SYS 2 1H4
Test Team: GE SSW JH
Probe ID: FP5-02
C_p: 0.84

t_m (°F): 81
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): 30
A_s (ft^2): 4.909
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	2
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	0
4	0.0	2
5	0.0	2
6	0.0	2
7	0.0	2
8	0.0	2
9	0.0	
10	0.0	
11	0.0	
12	0.0	

Test Team Leader Review: ________________
Data Entry Review: ________________

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

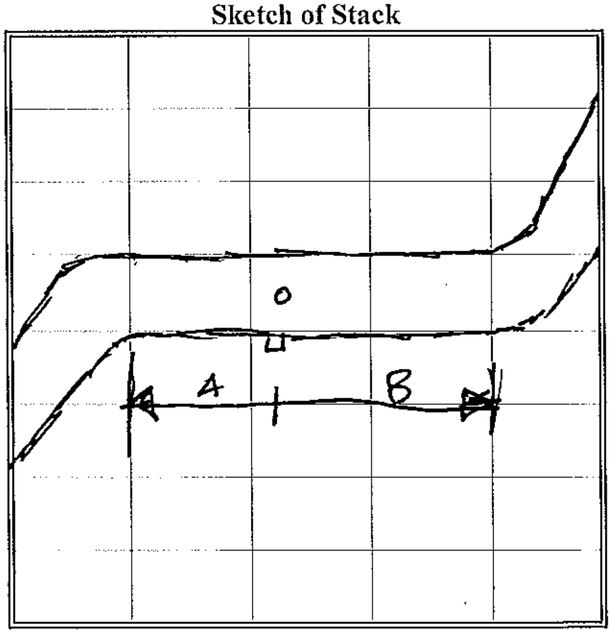
Client: BD
Location: Madison, GA.
Source: SYS2 IN4

Date: 6-30-2020
Test Team: GE SSW JH

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	30
A_s (ft^2):	4.909
Length A (in.):	60
Length B (in.):	60
t_{amb} (°F):	88
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.12
P_g (in. H_2O):	-0.91
% O_2:	21
% CO_2:	0
Console ID:	C-13
Y:	0.907
$\Delta H_@$:	1.808
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.33	87
2	0.35	87
3	0.35	87
4	0.36	88
5	0.37	88
6	0.40	88
7	0.40	88
8	0.40	88
9		
10		
11		
12		
Change Ports		
1	0.41	88
2	0.44	88
3	0.44	89
4	0.40	89
5	0.37	88
6	0.39	88
7	0.40	88
8	0.39	88
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD	**Measured values:**	
Location:	Madison GA	D_s (in.):	26
Source:	SYS 2 1&5	Y_m / $\Delta H_@$:	0.907 / 1.808
Test Team:	GE SSW JH	C_p:	0.84
EPA Methods:	1, 2	t_{amb} (°F):	89
Test Date:	6-30-2020	Assumed B_{ws} (%):	2%
Console ID:	C-13	O_2 (%):	21
Probe Assembly ID:	FP5-02	CO_2 (%):	0

Start time: 11:07 Start time: 16:32 Start time: ____ Start time: ____
Stop time: 11:16 Stop time: 16:39 Stop time: ____ Stop time: ____

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):								
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	0.18	86	0.17	87				
2	0.18	86	0.18	87				
3	0.19	86	0.18	87				
4	0.20	86	0.20	87				
5	0.20	86	0.20	88				
6	0.24	86	0.24	88				
7	0.24	86	0.25	88				
8	0.23	86	0.25	88				
9	0.16	86	0.15	87				
10	0.22	86	0.20	87				
11	0.26	86	0.25	88				
12	0.27	86	0.27	87				
13	0.26	86	0.28	87				
14	0.23	86	0.25	87				
15	0.21	86	0.20	87				
16	0.23	86	0.24	87				
Average								

Pg – ~~-0.94~~ -0.74

leak check
Pre ✓
Post ✓

Test Team Leader Review: ________
Data Entry Review: ADS

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

Client: BD
Location: Madison, GA
Source: SVS2 INS
Test Team: GE SSW JH
Probe ID: FPS-02
C_p: 0.84

t_m (°F): 81
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): 26
A_s (ft^2): 3.687
D_n (in.): N/A
A_n (ft^2): N/A

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

Test Team Leader Review: ____________

Data Entry Review: ____________

REV021717

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD
Location: Madison, GA.
Source: SYS2 INS

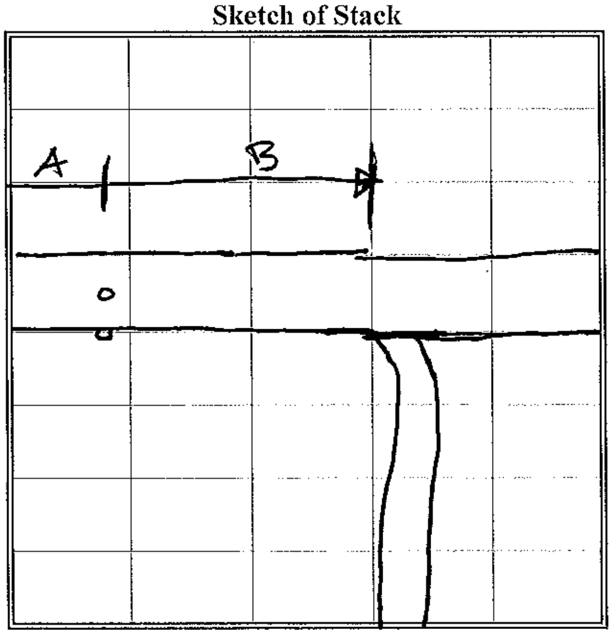
Date: 6-30-2020
Test Team: GE SSW JH

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 26
A_s (ft^2): 3.687
Length A (in.): 24
Length B (in.): 56

t_{amb} (°F): 88
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.12
P_g (in. H_2O): -0.74
% O_2: 21
% CO_2: 0
Console ID: C-13
Y: 0.907
$\Delta H_@$: 1.808
C_p: 0.84
K-Factor: NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.17	87
2	0.18	87
3	0.18	86
4	0.20	87
5	0.20	88
6	0.24	88
7	0.25	88
8	0.25	88
9		
10		
11		
12		
Change Ports		
1	0.15	87
2	0.20	87
3	0.25	87
4	0.27	87
5	0.28	87
6	0.25	88
7	0.20	88
8	0.24	88
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	BD	**Measured values:**	
Location:	Madison GA	D_s (in.):	22
Source:	Sys 2 ING	Y_m / $\Delta H_@$:	0.907 / 1.808
Test Team:	GE SSW JH	C_p:	0.84
EPA Methods:	1, 2	t_{amb} (°F)	80
Test Date:	6-30-2020	Assumed B_{ws} (%):	2%
Console ID:	C-13	O_2 (%):	21
Probe Assembly ID:	FP 5-02	CO_2 (%):	0

Start time: 10:01 Stop time: 10:10 | Start time: 16:07 Stop time: 16:16 | Start time: Stop time: | Start time: Stop time:

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):								
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	0.12	86	0.13	90				
2	0.16	86	0.15	91				
3	0.18	86	0.18	91				
4	0.21	86	0.20	91				
5	0.21	86	0.20	91				
6	0.21	86	0.21	91				
7	0.21	86	0.22	91				
8	0.22	86	0.22	91				
9	0.20	86	0.21	91				
10	0.22	86	0.21	91				
11	0.22	86	0.22	91				
12	0.23	86	0.23	91				
13	0.23	86	0.22	91				
14	0.23	86	0.22	91				
15	0.22	86	0.22	91				
16	0.22	86	0.20	91				
Average								

Pg — -0.65

Leak check
pre ✓
post ✓

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

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

Client: BD
Location: Madison, GA.
Source: SYS 2 INC
Test Team: GE SSW JH
Probe ID: FP5-02
C_p: 0.84

t_m (°F): 81
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): ~~22~~ 22
A_s (ft^2): 2.64
D_n (in.): NA
A_n (ft^2): NA

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

Test Team Leader Review: ____________

Data Entry Review: ____________

REV021717

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client: BD
Location: Madison GA
Source: SYS2 IN7
Test Team: GE SSW
EPA Methods: 1, 2
Test Date: 6-30-2020
Console ID: C-13
Probe Assembly ID: FP5-02

Measured values:
D_s (in.): 30.0
Y_m / $\Delta H_@$: 0.907 / 1.808
C_p: 0.84
t_{amb} (°F): 82
Assumed B_{ws} (%): 2%
O_2 (%): 21
CO_2 (%): 0

Start time: 10:11 Start time: 15:58 Start time: Start time:
Stop time: 10:20 Stop time: 16:06 Stop time: Stop time:

	Pre-1		Post-1; Pre-2		Post-2; Pre-3		Post-3	
P_{bar} (in. Hg):	29.12		29.12					
p_g (in. H_2O):								
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	0.32	85	0.30	92				
2	0.35	85	0.35	92				
3	0.36	85	0.35	92				
4	0.36	85	0.36	92				
5	0.37	84	0.38	92				
6	0.37	84	0.38	92				
7	0.39	84	0.38	92				
8	0.39	84	0.40	92				
9	0.35	86	0.33	91				
10	0.37	86	0.36	91				
11	0.35	86	0.36	91				
12	0.38	86	0.40	91				
13	0.40	86	0.40	91				
14	0.36	86	0.35	91				
15	0.40	86	0.38	91				
16	0.39	86	0.39	91				
Average								

Pg - -0.92

Leak check
Pre ✓
Post ✓

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

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: BD
Location: Madison, GA.
Source: SYS 2 W7
Test Team: GE SSW SH
Probe ID: FP5-02
C_p: 0.84

t_m (°F): 81
Console ID: C-13
Y_m: 0.907
$\Delta H_@$: 1.808
Assumed B_{ws}: 2%
P_{bar} (in. Hg): 29.12

Date: 6-30-2020
D_s (in.): 30
A_s (ft^2): 4.909
D_n (in.): NA
A_n (ft^2): NA

Point	Δp (in. H_2O)	α (degrees)
1	0.0	2
2	0.0	2
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	2
4	0.0	2
5	0.0	2
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: ______

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: BD

Location: Madison, GA

Source: SYS 2 IN#7

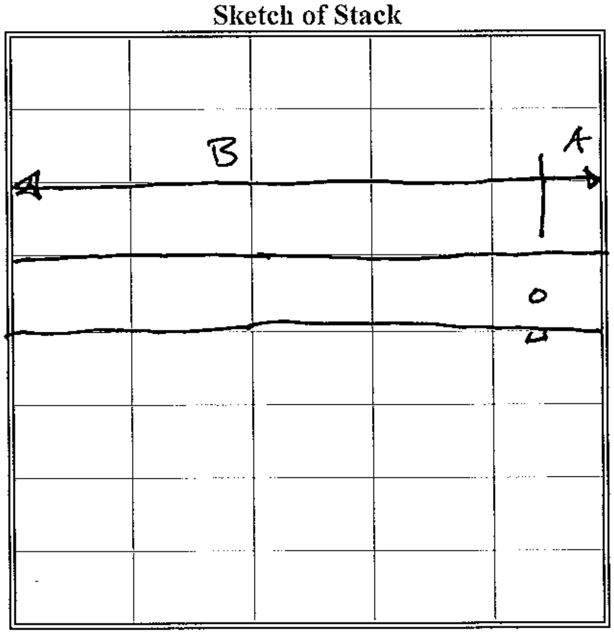
Date: 6-30-2020

Test Team: GE SSW JH

D_n (in.):	NA
A_n (ft^2):	NA
D_s (in.):	30
A_s (ft^2):	4.909
Length A (in.):	30
Length B (in.):	288
t_{amb} (°F):	88
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.12
P_g (in. H_2O):	-0.65
% O_2:	21
% CO_2:	0
Console ID:	C-13
Y:	0.907
$\Delta H_@$:	1.808
C_p:	0.84
K-Factor:	NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.30	92
2	0.35	92
3	0.35	92
4	0.36	92
5	0.38	92
6	0.38	92
7	0.38	92
8	0.40	92
9		
10		
11		
12		
Change Ports		
1	0.33	91
2	0.36	91
3	0.36	91
4	0.40	91
5	0.40	91
6	0.35	91
7	0.38	91
8	0.39	91
9		
10		
11		
12		

Sketch of Stack



Test Team Leader Review: ________

Data Entry Review: ________

APPENDIX D

CALIBRATION DATA

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-004
Serial Number:	

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

Date: 05/06/20

Barometric Pressure, P_b (in. Hg): 28.95

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.)
5.0	0.50	5.254	5.118	73	96.0	97.0	96.5	11.80
5.0	1.00	5.517	5.455	73	97.0	98.0	97.5	9.00
5.0	2.00	5.707	5.684	73	98.0	###	99.0	6.80
5.0	3.00	5.149	5.127	73	####	###	####	5.10
5.0	4.00	7.644	7.646	74	####	###	####	6.60

Calculations

ΔH (inches H_2O)	Y_m (dimensionless)	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	1.068	0.017	**PASS**	1.415	-0.143	**PASS**
1.00	1.053	0.002	**PASS**	1.491	-0.068	**PASS**
2.00	1.046	-0.005	**PASS**	1.586	0.028	**PASS**
3.00	1.047	-0.004	**PASS**	1.639	0.080	**PASS**
4.00	1.040	-0.010	**PASS**	1.662	0.103	**PASS**
Averages:	**1.051**	**PASS**		**1.559**	**PASS**	

Where:

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

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

$\mathbf{\Delta H_@}$ 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-004
Serial Number:	

Reference Meter	
Meter ID:	MSRFM
Calibration Factor, Y_w:	0.9980

Date:	07/01/20	**Accepted Y_m:**	0.991
Barometric Pressure, P_b (in. Hg):	28.90	**Performed By:**	WB

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.)
1.0	1.60	6.304	6.248	77	77	78	77.5	8.15
1.0	1.60	6.275	6.189	77	78	79	78.5	8.15
1.0	1.60	6.379	6.189	77	79	80	79.5	8.15

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
1.60	1.004	-0.0107	**PASS**	1.580	0.010	**PASS**
1.60	1.011	-0.0040	**PASS**	1.592	0.022	**PASS**
1.60	1.029	0.0147	**PASS**	1.537	-0.032	**PASS**
Averages:	**1.015**	**PASS**		**1.570**	**PASS**	

Calculations

	Low Tolerance	High Tolerance	% diff	Pass or Fail?
****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	**0.941**	**1.041**	**2%**	**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-13
Serial Number:	1109045

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

Date: 12/17/19

Barometric Pressure, P_b (in. Hg): 28.78

Performed By: SS

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.)
5.0	0.50	6.020	6.587	62	62.0	63.0	62.5	15.50
5.0	1.00	5.576	6.102	62	63.0	63.0	63.0	10.00
5.0	2.00	5.662	6.215	63	63.0	64.0	63.5	7.00
5.0	3.00	5.462	6.010	63	64.0	65.0	64.5	5.50
5.0	4.00	5.730	6.304	64	66.0	67.0	66.5	5.00

Calculations

ΔH (inches H_2O)	Y_m (dimensionless)	Variation (dimensionless)		$ΔH_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.912	0.005	**PASS**	1.912	0.103	**PASS**
1.00	0.911	0.005	**PASS**	1.853	0.045	**PASS**
2.00	0.905	-0.001	**PASS**	1.766	-0.042	**PASS**
3.00	0.903	-0.004	**PASS**	1.754	-0.054	**PASS**
4.00	0.902	-0.004	**PASS**	1.757	-0.052	**PASS**
Averages:	**0.907**	**PASS**		**1.808**	**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-13
Serial Number:	1109045

Reference Meter	
Meter ID:	MSRFM1
Calibration Factor, Y_w:	0.9980

Date:	07/30/20	**Accepted Y_m:**	0.907
Barometric Pressure, P_b (in. Hg):	29.83	**Performed By:**	SS

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	6.239	6.838	82	81	84	82.5	6.00
5.0	3.00	6.229	6.812	85	84	87	85.5	6.00
5.0	3.00	6.749	7.408	88	87	89	88.0	6.50

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
3.00	0.905	0.0001	**PASS**	1.603	-0.013	**PASS**
3.00	0.907	0.0021	**PASS**	1.617	0.001	**PASS**
3.00	0.903	-0.0021	**PASS**	1.627	0.011	**PASS**
Averages:	**0.905**	**PASS**		**1.616**	**PASS**	

Calculations

****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	Low Tolerance	High Tolerance	% diff	Pass or Fail?
	0.862	**0.952**	**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-18
Serial Number:	1604009

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

Date: 04/15/20

Barometric Pressure, P_b (in. Hg): 28.95

Performed By: LS

Reviewed By:

Data								
				Temperatures (°F)				Time
		Reference	Dry Gas	Reference	Dry Gas Meter			Elapsed
Vacuum	ΔH	Meter Volume	Meter Volume	Meter	init.	final	avg.	θ
(in. Hg)	(in. H_2O)	V_w (ft^3)	V_m (ft^3)	t_w	t_i	t_f	t_m	(min.)
5.0	0.50	8.531	8.056	73	60.0	63.0	61.5	21.60
5.0	1.00	7.771	7.485	73	64.0	67.0	65.5	14.00
5.0	2.00	8.095	7.712	74	67.0	71.0	69.0	10.20
5.0	3.00	5.764	5.508	74	71.0	72.0	71.5	5.90
5.0	4.00	6.619	6.319	74	72.0	72.0	72.0	5.83

Calculations						
ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	1.033	0.003	**PASS**	1.920	0.037	**PASS**
1.00	1.019	-0.010	**PASS**	1.929	0.046	**PASS**
2.00	1.033	0.003	**PASS**	1.882	-0.001	**PASS**
3.00	1.032	0.002	**PASS**	1.854	-0.029	**PASS**
4.00	1.031	0.002	**PASS**	1.829	-0.054	**PASS**
Averages:	**1.029**	**PASS**		**1.883**	**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-018
Serial Number:	1604006

Reference Meter	
Meter ID:	MSRFM1
Calibration Factor, Y_w:	0.9980

Date:	07/01/20	**Accepted Y_m:**	1.029
Barometric Pressure, P_b (in. Hg):	28.90	**Performed By:**	LS

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	final t_f	avg. t_m	Time Elapsed θ (min.)
4.0	1.90	5.639	5.358	74	67	72	69.5	7.25
4.0	1.90	6.028	5.738	74	72	74	73.0	7.75
4.0	1.90	5.360	5.138	75	74	78	76.0	7.00

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
1.90	1.036	-0.0022	**PASS**	1.863	-0.010	**PASS**
1.90	1.041	0.0028	**PASS**	1.850	-0.023	**PASS**
1.90	1.038	-0.0006	**PASS**	1.906	0.033	**PASS**
Averages:	**1.039**	**PASS**		**1.873**	**PASS**	

Calculations

**Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M	Low Tolerance	High Tolerance	% diff	Pass or Fail?
	0.978	**1.080**	**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
Customer: Advanced Industrial Resources
DGM Model: T-110
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

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

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

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

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

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

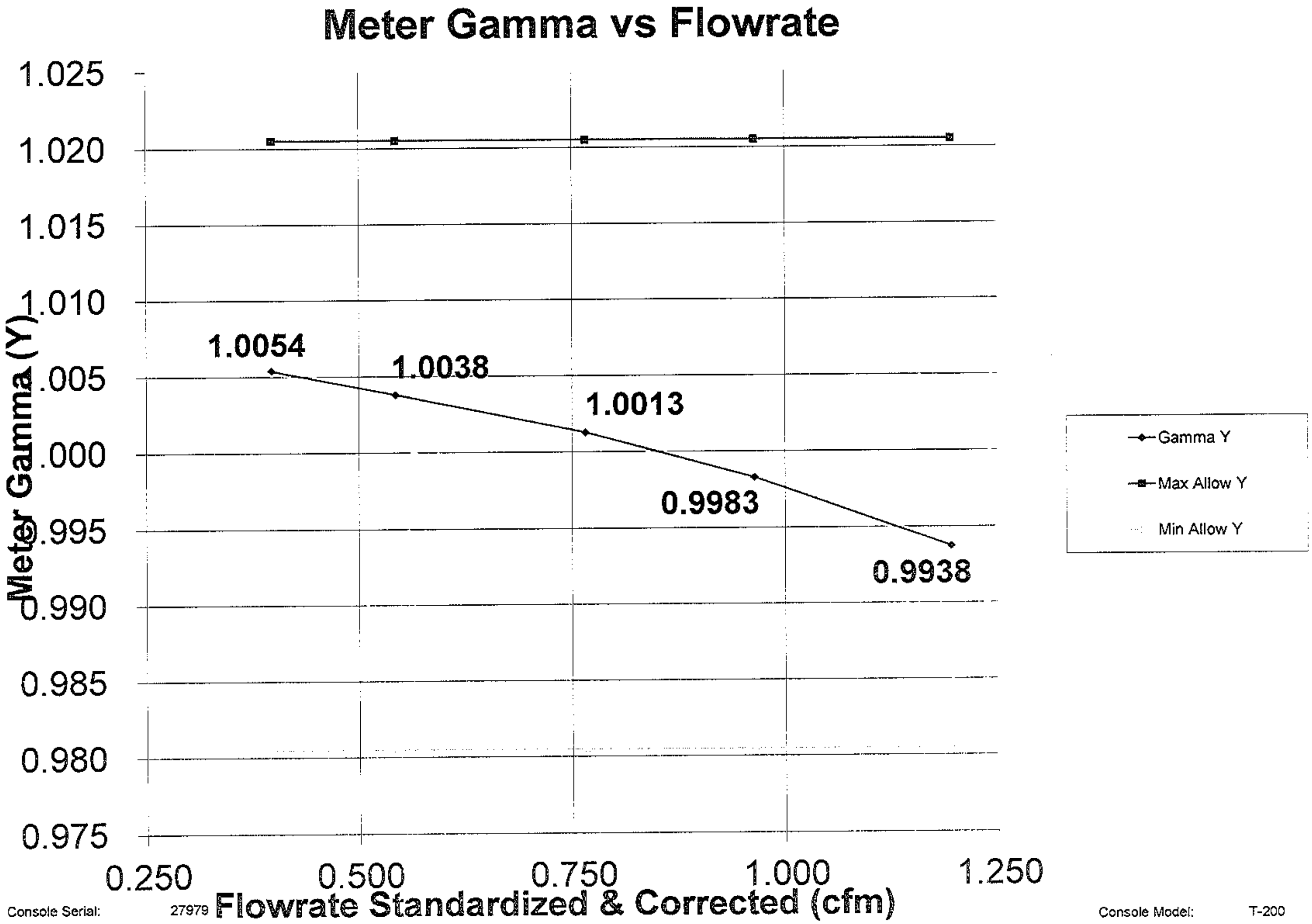
$$Q = 17.64 \frac{P_{bar}}{(t_w + t_{std})} \frac{V_w}{\Phi}$$

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

Calibration Date: 10-10-2017

Calibration Technician: EW

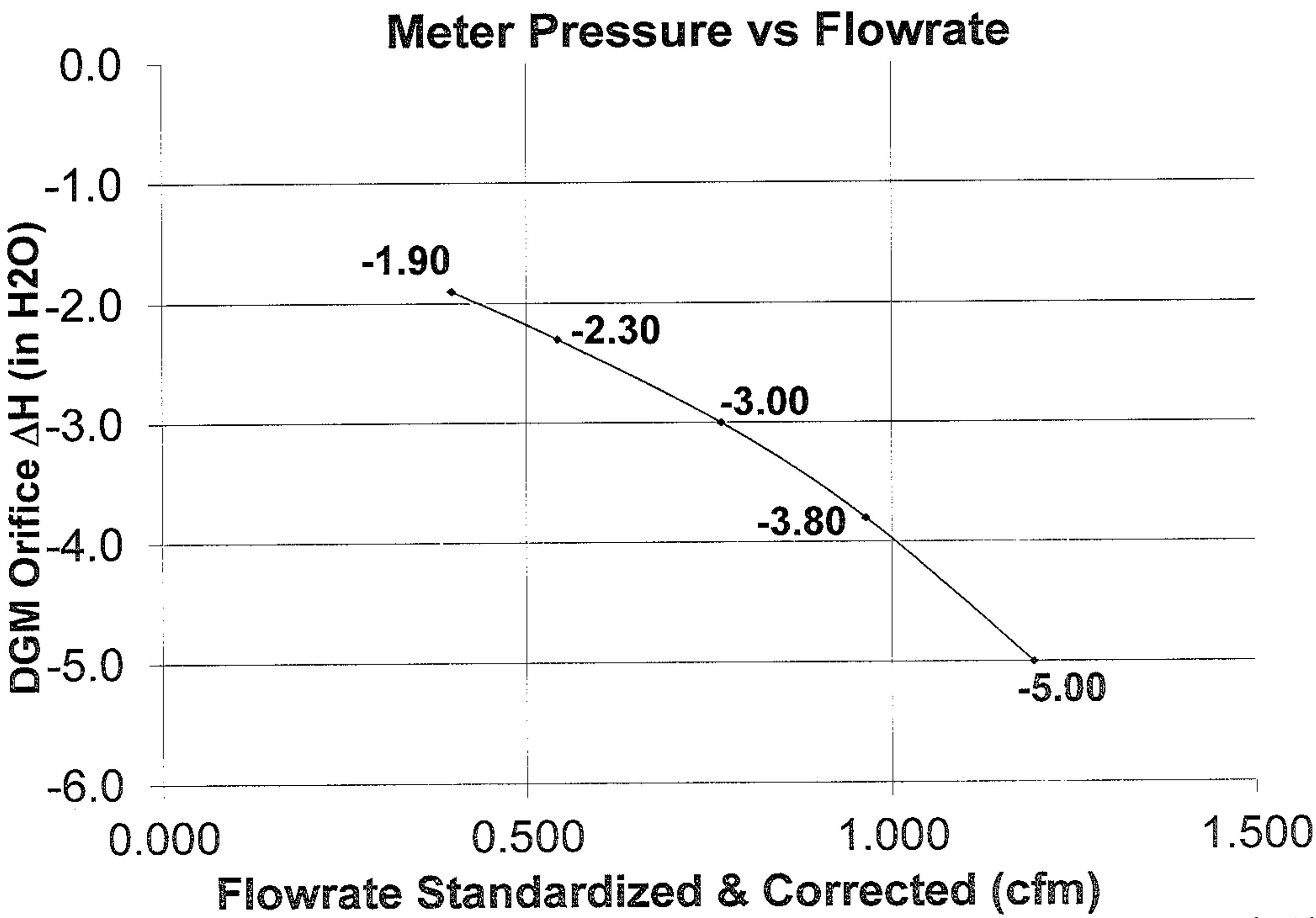


Console Serial: 27979

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:** 07/02/20

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	32	492	0.0
P7-01	Stack Temp.	210	670	211	671	0.1
B-04	Filter Temp.	32	492	32	492	0.0
B-04	Filter Temp.	210	670	210	670	0.0
B-04	Exit Imp. Temp.	32	492	32	492	0.0
B-04	Exit Imp. Temp.	210	670	210	670	0.0
C-004	Meter In Temp.	32	492	32	492	0.0
C-004	Meter In Temp.	210	670	211	671	0.1
C-004	Meter Out Temp.	32	492	33	493	0.2
C-004	Meter Out Temp.	210	670	211	671	0.1
B-04	Filter Exit Temp.	32	492	32	492	0.0
B-04	Filter Exit Temp.	210	670	210	670	0.0
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:** 07/02/20

Bias: 0 **Performed By:** SS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P5-06	Stack Temp.	32	492	33	493	0.2
P5-06	Stack Temp.	210	670	212	672	0.3
B-18	Filter Temp.	32	492	32	492	0.0
B-18	Filter Temp.	210	670	210	670	0.0
B-18	Exit Imp. Temp.	32	492	32	492	0.0
B-18	Exit Imp. Temp.	210	670	210	670	0.0
C-018	Meter In Temp.	32	492	33	493	0.2
C-018	Meter In Temp.	210	670	211	671	0.1
C-018	Meter Out Temp.	32	492	32	492	0.0
C-018	Meter Out Temp.	210	670	210	670	0.0
B-18	Filter Exit Temp.	32	492	33	493	0.2
B-18	Filter Exit Temp.	210	670	210	670	0.0
P5-06	Probe Temp.	32	492	32	492	0.0
P5-06	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:** 07/30/20

Bias: 0 **Performed By:** LS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P5-02	Stack Temp.	32	492	33	493	0.2
P5-02	Stack Temp.	210	670	211	671	0.1
B-13	Filter Temp.	32	492	32	492	0.0
B-13	Filter Temp.	210	670	210	670	0.0
B-13	Exit Imp. Temp.	32	492	33	493	0.2
B-13	Exit Imp. Temp.	210	670	211	671	0.1
C-013	Meter In Temp.	32	492	32	492	0.0
C-013	Meter In Temp.	210	670	210	670	0.0
C-013	Meter Out Temp.	32	492	33	493	0.2
C-013	Meter Out Temp.	210	670	211	671	0.1
B-13	Filter Exit Temp.	32	492	32	492	0.0
B-13	Filter Exit Temp.	210	670	211	671	0.1
P5-02	Probe Temp.	32	492	33	493	0.2
P5-02	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.

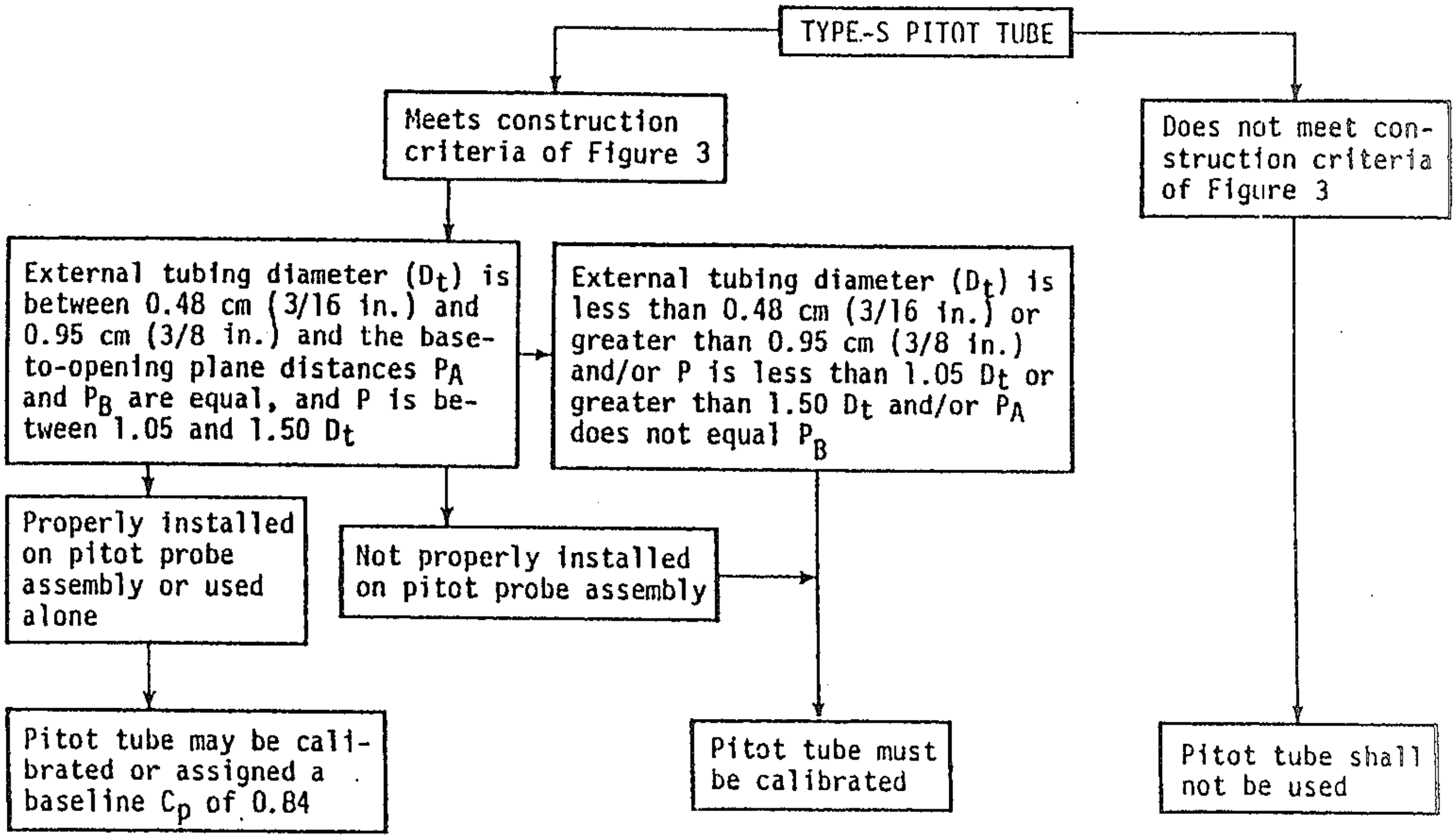


Figure 1. Procedures for determining the calibration coefficients of Type-S pitot tubes.

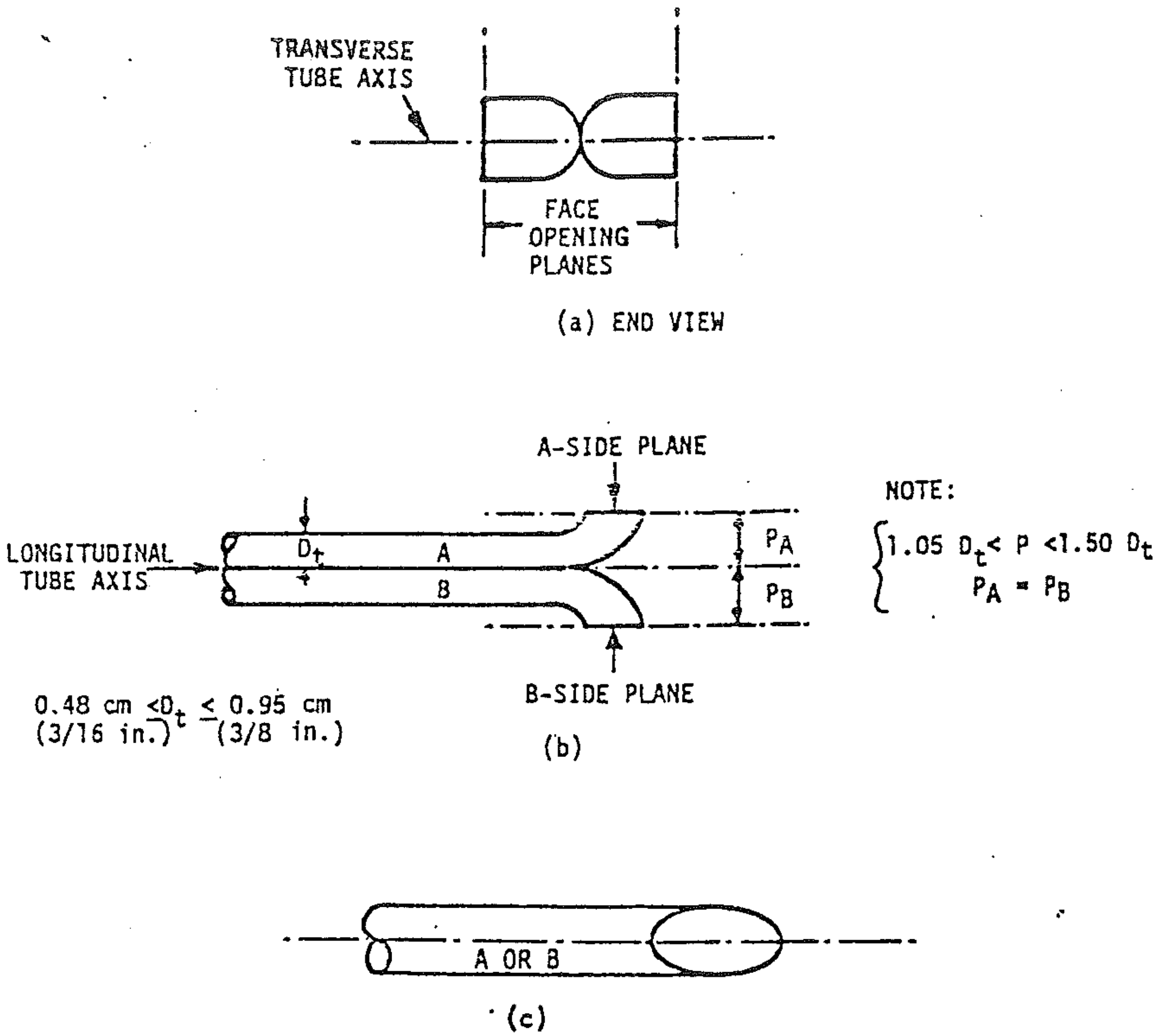


Figure 2. Properly constructed Type-S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening plans parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient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

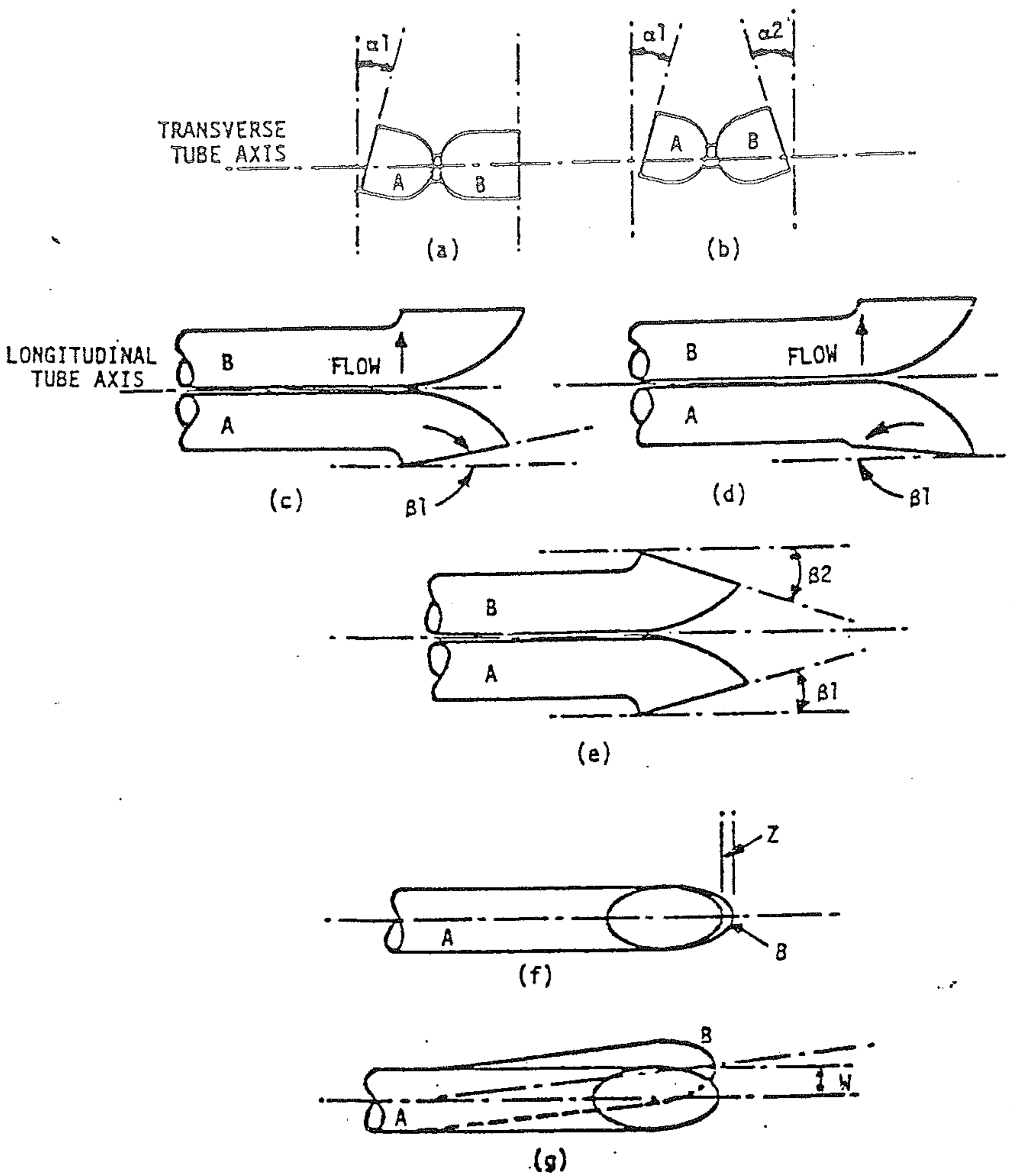


Figure 3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp as long as a_1 and a_2 <10°, β_2 <5°, z <0.32 cm (1/8 in.) and w <0.08 cm (1/32 in.).

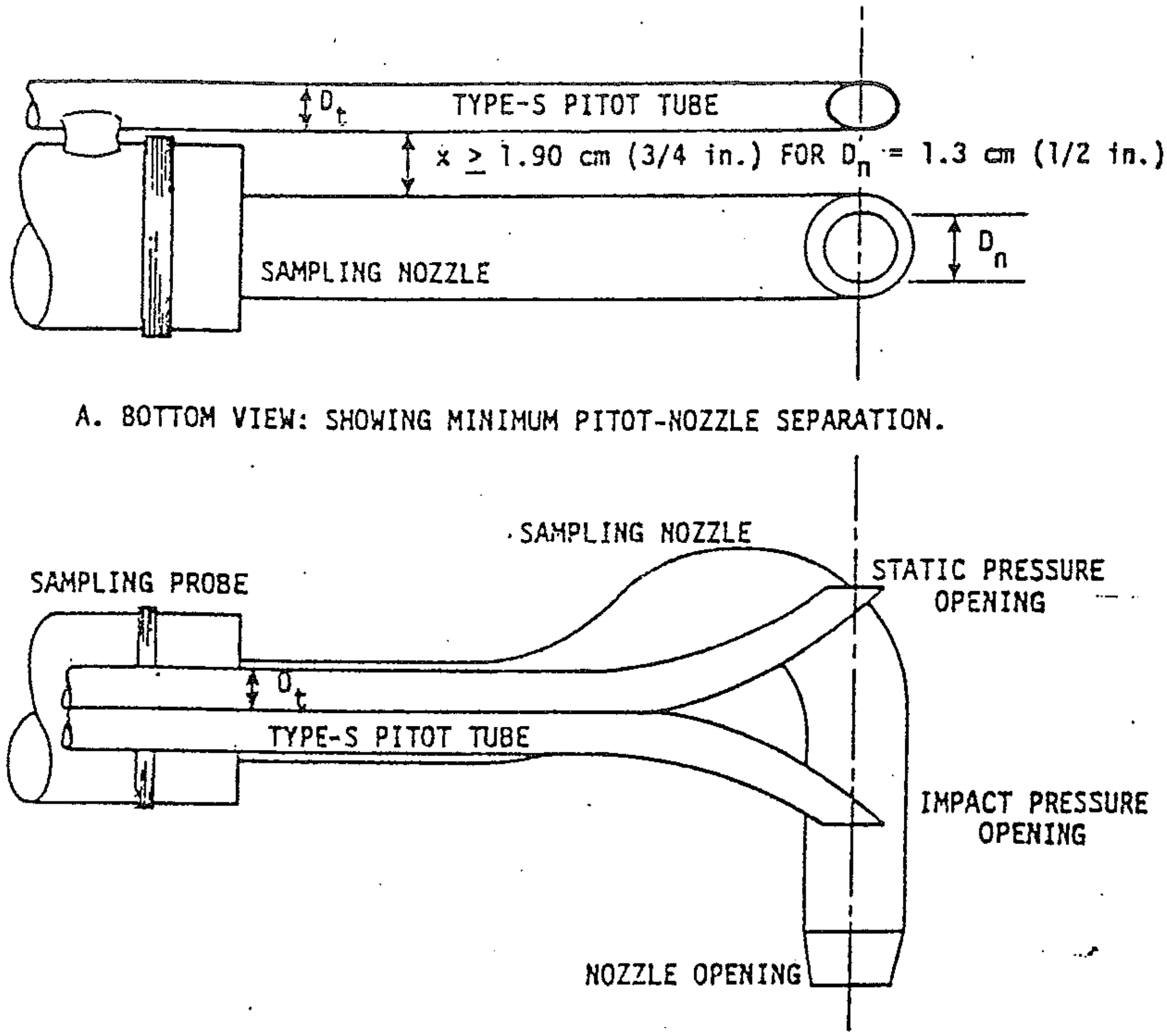


Figure 4. Required pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

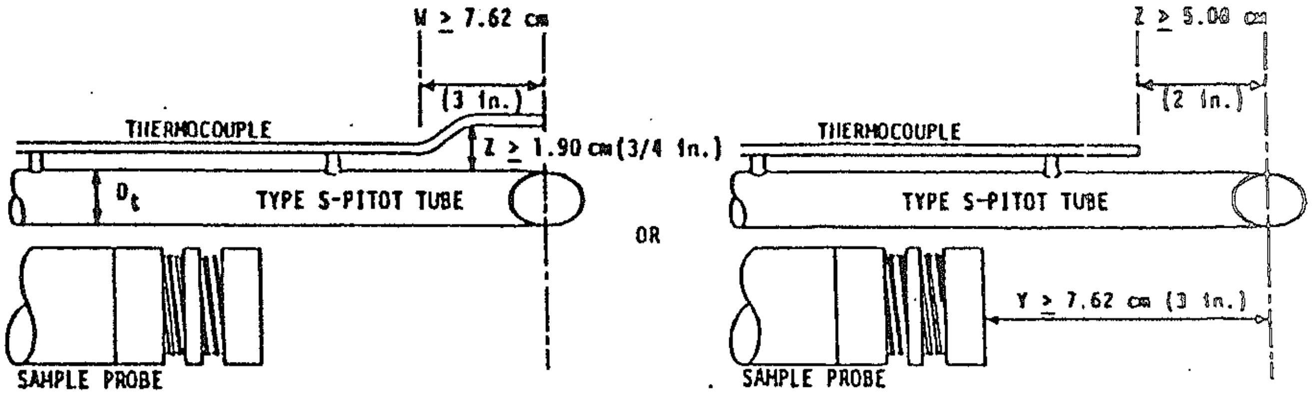


Figure 5. Required thermocouple and probe placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

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 $\pm$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. <u>Note</u>: 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.

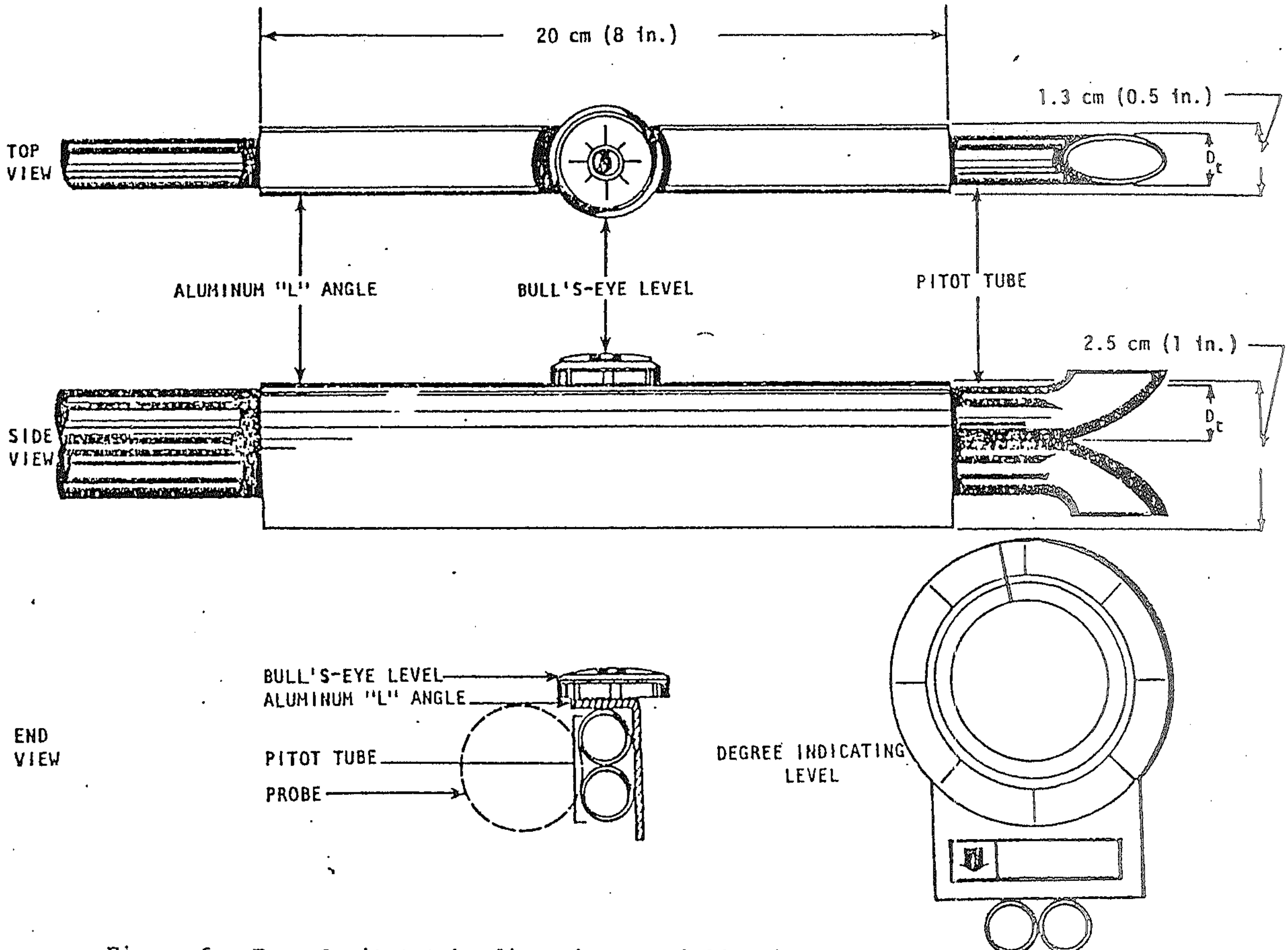


Figure 6. Type S pitot tube dimension specialization measurements.

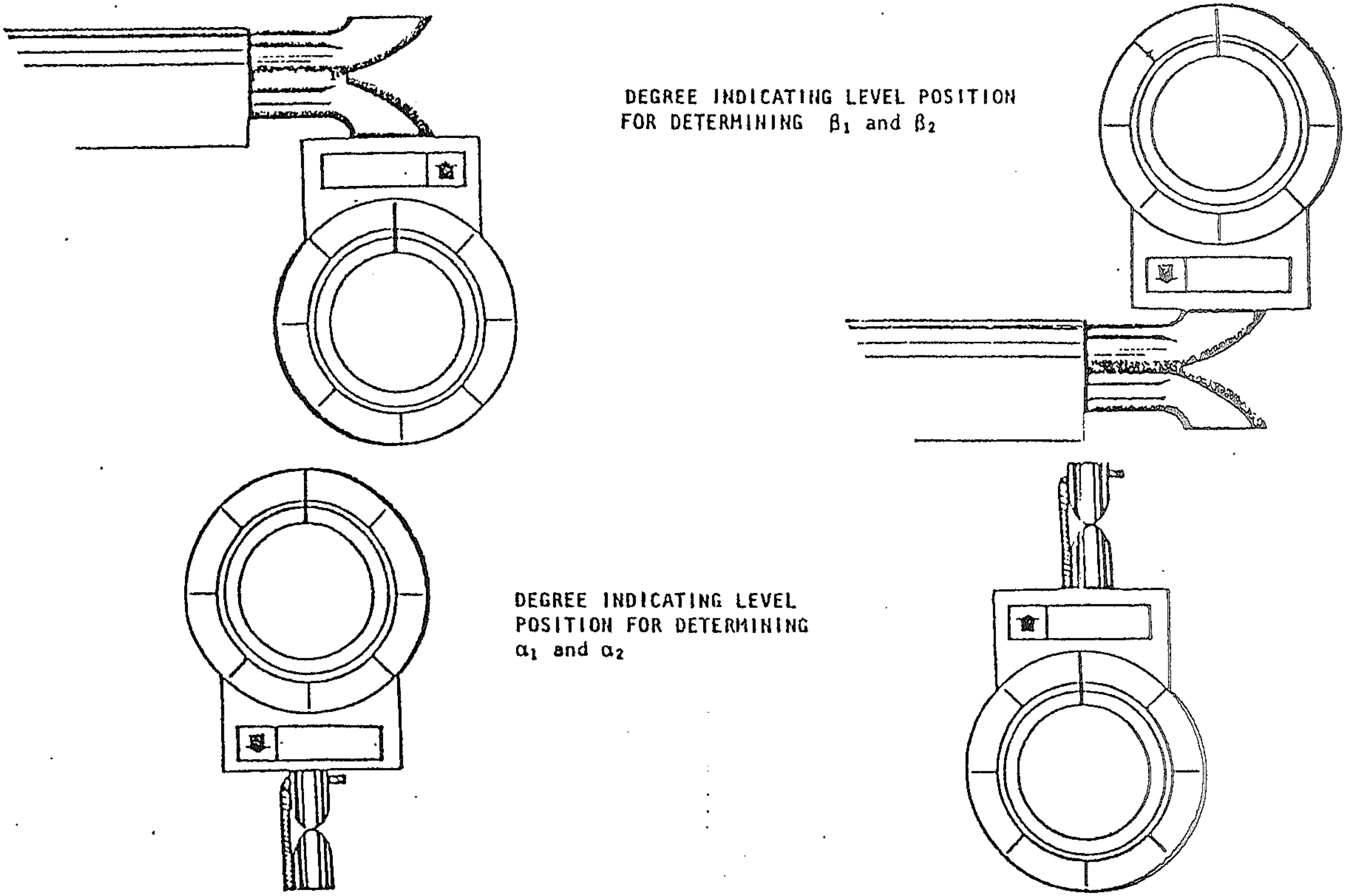
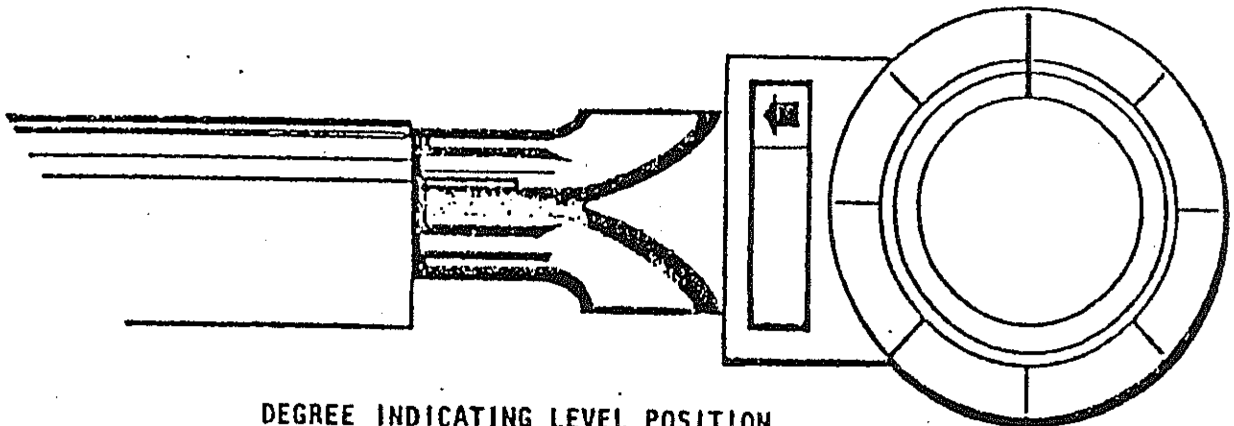


Figure 7. Position of dimension measurement.



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

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

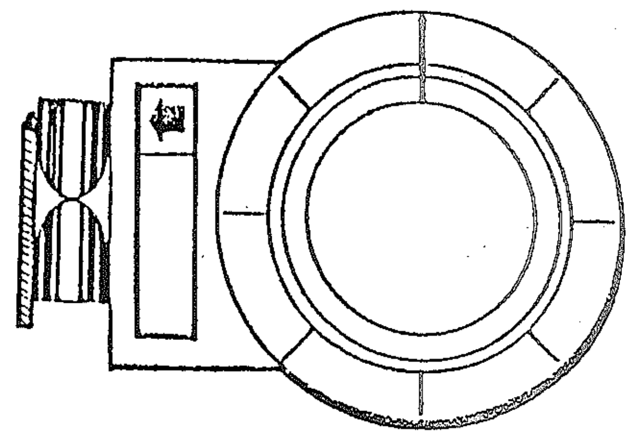


Figure 8. Position of dimension measurement.

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: 7/3/2020
Pitot Tube Assembly: P5-02 Caliper ID: CL-04
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= 2 °(<5°)

α_2= 2 °(<10°) β_2= 2 °(<5°)

γ = 2 ° θ = 0 ° A= 0.9375 in.

z = A sin γ = 0.0327 in. <1/8 in. (0.125 in.)

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

P_A= 0.469 in. **P_B=** 0.469 in.

D_t = 0.375 in. **P / D_t =** 1.25 (1.05 </= and </= 1.50)
$P_a = P_b = P$

X = 1.5 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 4.25 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.25 (>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: 7/3/2020

Pitot Tube Assembly: P5-6 Caliper ID: CL-04

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= 2 ^{o}(<10^o) β_2= 0 ^{o}(<5^o)

γ = 0 ^{o} θ = 2 ^{o} A= 0.875 in.

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

w = A sin θ = 0.0305 in. <1/32 in. (0.03125 in.)

P_A= 0.438 in. **P_B=** 0.438 in.

D_t = 0.375 cm (in.) **P / D_t =** 1.16667 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 0.8125 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 4.25 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.625 (>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.

Type-S Pitot Tube Assembly Inspection Data Sheet

Date: 7/3/2020

Pitot Tube Assembly: P7-01 Caliper ID: CL-04

Performed by: LS

Pitot tube assembly level? X yes ____ no

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

α_1= 1 °(<10°) β_1= 2 °(<5°)

α_2= 0 °(<10°) β_2= 2 °(<5°)

γ = 1 ° θ = 0 ° A= 0.9375 in.

z = A sin γ = 0.0164 in. <1/8 in. (0.125 in.)

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

P_A= 0.469 in. **P_B=** 0.469 in.

D_t = 0.375 in. **P / D_t =** 1.25 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 0.875 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 4.25 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.75 (>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

eurofins | Air Toxics

7/10/2020
Mr. Robert DeMott
Ramboll Environ
10150 Highland Manor Drive
Suite 440
Tampa FL 33610

Project Name: K&S Bard
Project #:
Workorder #: 2007028

Dear Mr. Robert DeMott

The following report includes the data for the above referenced project for sample(s) received on 7/2/2020 at Air Toxics Ltd.

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 Inc. 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
Project Manager

eurofins | Air Toxics

WORK ORDER #: 2007028

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:	07/02/2020	**CONTACT:**	Brian Whittaker
DATE COMPLETED:	07/10/2020		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	SYS1-IN 20200630	Modified TO-15 SIM	9.5 "Hg	5 psi
02A	SYS2-IN1 20200630	Modified TO-15 SIM	10.0 "Hg	5 psi
03A	SYS2-IN2 20200630	Modified TO-15 SIM	25.0 "Hg	5 psi
04A	SYS2-IN3 20200630	Modified TO-15 SIM	7.5 "Hg	5 psi
04AA	SYS2-IN3 20200630 Lab Duplicate	Modified TO-15 SIM	7.5 "Hg	5 psi
05A	SYS2-IN4 20200630	Modified TO-15 SIM	8.5 "Hg	5 psi
06A	SYS2-IN5 20200630	Modified TO-15 SIM	9.0 "Hg	5 psi
07A	SYS2-IN6 20200630	Modified TO-15 SIM	9.0 "Hg	5 psi
08A	SYS2-IN7 20200630	Modified TO-15 SIM	10.5 "Hg	5 psi
09A	SYS1-STACK 20200630	Modified TO-15 SIM	9.5 "Hg	5 psi
10A	SYS1-STACK DUP 20200630	Modified TO-15 SIM	9.0 "Hg	5 psi
11A	SYS2-STACK 20200630	Modified TO-15 SIM	9.0 "Hg	5 psi
12A	SYS2-STACK DUP 20200630	Modified TO-15 SIM	8.0 "Hg	5 psi
13A	SYS2-IN2R 20200630	Modified TO-15 SIM	12.0 "Hg	5 psi
14A	Lab Blank	Modified TO-15 SIM	NA	NA
14B	Lab Blank	Modified TO-15 SIM	NA	NA
15A	CCV	Modified TO-15 SIM	NA	NA
15B	CCV	Modified TO-15 SIM	NA	NA
16A	LCS	Modified TO-15 SIM	NA	NA
16AA	LCSD	Modified TO-15 SIM	NA	NA
16B	LCS	Modified TO-15 SIM	NA	NA
16BB	LCSD	Modified TO-15 SIM	NA	NA

CERTIFIED BY: Heidi Hayes DATE: 07/10/20

Technical Director

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

eurofins | Air Toxics

LABORATORY NARRATIVE
EPA TO-15 Ethylene oxide (SIM)
Ramboll Environ
Workorder# 2007028

Thirteen 6 Liter Summa Canister (EO) samples were received on July 02, 2020. 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

Sample SYS2-IN2 20200630 was received with significant vacuum remaining in the canister. The residual canister vacuum resulted in elevated reporting limits.

Analytical Notes

Ethylene Oxide is not included on the laboratory's NELAP scope of accreditation for TO-15 SIM. However, TO-15 method and NELAP quality requirements were met.

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 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 SYS1-IN 20200630, SYS2-IN1 20200630, SYS2-IN2 20200630, SYS2-IN3 20200630, SYS2-IN3 20200630 Lab Duplicate, SYS2-IN4 20200630, SYS2-IN5 20200630, SYS2-IN6 20200630, SYS2-IN7 20200630 and SYS2-IN2R 20200630 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

Client ID:	SYS1-IN 20200630		
Lab ID:	2007028-01A	**Date/Time Analyzed:**	7/3/20 02:12 AM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	3.92
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070223sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.10	D	0.35	180

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:	SYS2-IN1 20200630		
Lab ID:	2007028-02A	**Date/Time Analyzed:**	7/3/20 02:49 AM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	4.02
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070224sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.11	D	0.36	400

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS2-IN2 20200630		
Lab ID:	2007028-03A	**Date/Time Analyzed:**	7/3/20 03:27 AM
Date/Time Collected:	6/30/20 12:20 PM	**Dilution Factor:**	16.1
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070225sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.43	D	1.4	520

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS2-IN3 20200630		
Lab ID:	2007028-04A	**Date/Time Analyzed:**	7/6/20 03:47 PM
Date/Time Collected:	6/30/20 03:59 PM	**Dilution Factor:**	14.3
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070609sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.38	D	1.3	1000

D: Analyte not within the DoD scope of accreditation.

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

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Client ID:	SYS2-IN3 20200630 Lab Duplicate		
Lab ID:	2007028-04AA	**Date/Time Analyzed:**	7/6/20 04:23 PM
Date/Time Collected:	6/30/20 03:59 PM	**Dilution Factor:**	14.3
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070610sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.38	D	1.3	960

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS2-IN4 20200630		
Lab ID:	2007028-05A	**Date/Time Analyzed:**	7/6/20 04:58 PM
Date/Time Collected:	6/30/20 03:47 PM	**Dilution Factor:**	15.0
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070611sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.40	D	1.4	990

D: Analyte not within the DoD scope of accreditation.

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

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Client ID:	SYS2-IN5 20200630		
Lab ID:	2007028-06A	**Date/Time Analyzed:**	7/6/20 05:36 PM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	3.83
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070612sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.10	D	0.34	710

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-IN6 20200630		
Lab ID:	2007028-07A	**Date/Time Analyzed:**	7/6/20 09:25 PM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	7.66
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070618sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.20	D	0.69	670

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-IN7 20200630		
Lab ID:	2007028-08A	**Date/Time Analyzed:**	7/6/20 06:51 PM
Date/Time Collected:	6/30/20 03:47 PM	**Dilution Factor:**	4.12
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070614sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.11	D	0.37	390

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 20200630		
Lab ID:	2007028-09A	**Date/Time Analyzed:**	7/2/20 11:34 PM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	1.96
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070219sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.052	D	0.18	0.36

D: Analyte not within the DoD scope of accreditation.

eurofins | Air Toxics

Client ID:	SYS1-STACK DUP 20200630		
Lab ID:	2007028-10A	**Date/Time Analyzed:**	7/3/20 12:14 AM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	1.91
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070220sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.051	D	0.17	0.24

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 20200630		
Lab ID:	2007028-11A	**Date/Time Analyzed:**	7/3/20 12:54 AM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	1.91
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070221sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.051	D	0.17	0.23

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 20200630		
Lab ID:	2007028-12A	**Date/Time Analyzed:**	7/3/20 01:35 AM
Date/Time Collected:	6/30/20 03:45 PM	**Dilution Factor:**	1.83
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070222sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.049	D	0.16	0.25

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-IN2R 20200630		
Lab ID:	2007028-13A	**Date/Time Analyzed:**	7/6/20 07:29 PM
Date/Time Collected:	6/30/20 03:46 PM	**Dilution Factor:**	4.47
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30070615sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.12	D	0.40	730

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:	2007028-14A	**Date/Time Analyzed:**	7/2/20 12:01 PM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070206sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.027	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:	2007028-14B	**Date/Time Analyzed:**	7/6/20 12:56 PM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070607sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.027	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:	2007028-15A	**Date/Time Analyzed:**	7/2/20 09:11 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070202sim

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

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:	CCV		
Lab ID:	2007028-15B	**Date/Time Analyzed:**	7/6/20 10:04 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070603sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	89

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	LCS		
Lab ID:	2007028-16A	**Date/Time Analyzed:**	7/2/20 09:49 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070203sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	94

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:	2007028-16AA	**Date/Time Analyzed:**	7/2/20 10:27 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070204sim

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:	LCS		
Lab ID:	2007028-16B	**Date/Time Analyzed:**	7/6/20 10:59 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070604sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	107

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:	LCSD		
Lab ID:	2007028-16BB	**Date/Time Analyzed:**	7/6/20 11:38 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30070605sim

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.

APPENDIX D

SYSTEM 1 PROCESS LOG

Becton, Dickinson and Company
Madison Georgia Facility
June 30, 2020 - Activity Log

Time	Activity
11:55	Vent #1 Vessel
12:24	Finish unloading Vessel #1 into Post A
12:45	Start Drum Change 7A
13:01	Finish Drum Change 7A
13:25	Start Vent #3 Vessel
13:52	End Vent #3 Vessel
14:00	Change (start) Drum Change 1A
14:16	End Drum Change 1A