INITIAL DEMONSTRATION OF FUGITIVE EMISSIONS CONTROL SYSTEM PERFORMANCE

GLOBAL DISTRIBUTION CENTER

Becton, Dickinson and Company
14201 Lochridge Blvd.
Covington, GA 30014

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

February 2021

ENVIRONMENT
& HEALTH

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EXECUTIVE SUMMARY

In fulfillment of obligations first set in a Consent Order with the Georgia Environmental Protection Division on October 28, 2019, amended on January 15, 2020, Becton, Dickinson and Company has installed a dry bed fugitive emission control system at its Covington, Georgia, Global Distribution Center facility for the reduction of potential emissions of ethylene oxide.

In accordance with the Test Plan, approved by EPD on December 16, 2020, the system has been tested to assess its performance and effectiveness. The testing has found that the emissions to the atmosphere of ethylene oxide from the system are consistent with the levels expected from the dry bed system outlet. The emission rate measured from the system outlet on December 31, 2020 was 123.8 pounds-per-year, if annualized over 8,760 hours.

It should be noted that this is the first known instance of applying emission controls for the reduction of potential fugitive emissions of ethylene oxide from a facility solely engaged in warehousing and distribution activities.

1. BACKGROUND

Becton, Dickinson and Company (BD) operates a medical products warehouse facility, referred to as the Global Distribution Center (GDC) at 14201 Lochridge Boulevard in Covington, Georgia (see **Figure 1**). BD uses the nearly 600,000 square foot warehouse facility to store products sterilized with ethylene oxide (EO) prior to distribution to medical facilities.

As a condition of a Consent Order with the Georgia Environmental Protection Division (EPD) dated October 28, 2019, BD has installed a system for the capture and control potential fugitive emissions of EO that may exist in the GDC. The new equipment includes three discrete systems comprised of 50 Advanced Air Technologies Model DR490 "Dry Bed Scrubbers." Details regarding the dry bed scrubber system were presented in the air permit application for its installation that was submitted to the EPD on October 31, 2019.

BD developed a test plan for the fugitive emissions control system. **Appendix A** provides the test plan methodology. The testing for the overall system was conducted on December 31, 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 dry bed fugitive emission control system for fugitive releases captured in the warehouse facility was based on two primary elements:

1. Measurement of the airflow rate at three zones of the inlet ducts (Zone 2, Zone 3, and Zone 5) to the dry bed system and the stack outlet utilizing EPA standard methods 1, 2, and 4; and,

2. Measurement of the concentration of EO in three zones of the inlet ducts and the outlet stack.

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 analytical laboratory to be free of EO. The samples were analyzed for EO via EPA Method TO-15 modified to achieve sub-part-per-billion (ppb) 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 system stack outlet to allow for assessment of precision and repeatability of analyses. 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.

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 gas chromatography and mass spectrophotometer (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 the system stack 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 criteria 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>

The dry bed fugitive emission control system at the GDC facility captures and treats fugitive EO releases from the warehouse where products sterilized with EO are stored prior to distribution to medical facilities. Total fugitive emission concentrations from three zones of the inlet ducts (Zone 2, Zone 3, and Zone 5) in the warehouse area ranged between 110 micrograms per cubic meter ($\mu g/m^3$) to 1,100 $\mu g/m^3$. The exhaust mass rate from the system stack was only 0.014 pounds per hour (lb/hour), or 123.8 pounds per year (lb/year) if annualized over 8,760 hours.

As shown in **Table 3**, the system is achieving a control device effectiveness of 92.95 percent reduction in fugitive ethylene oxide emissions from the warehouse facility.

4. CONCLUSIONS

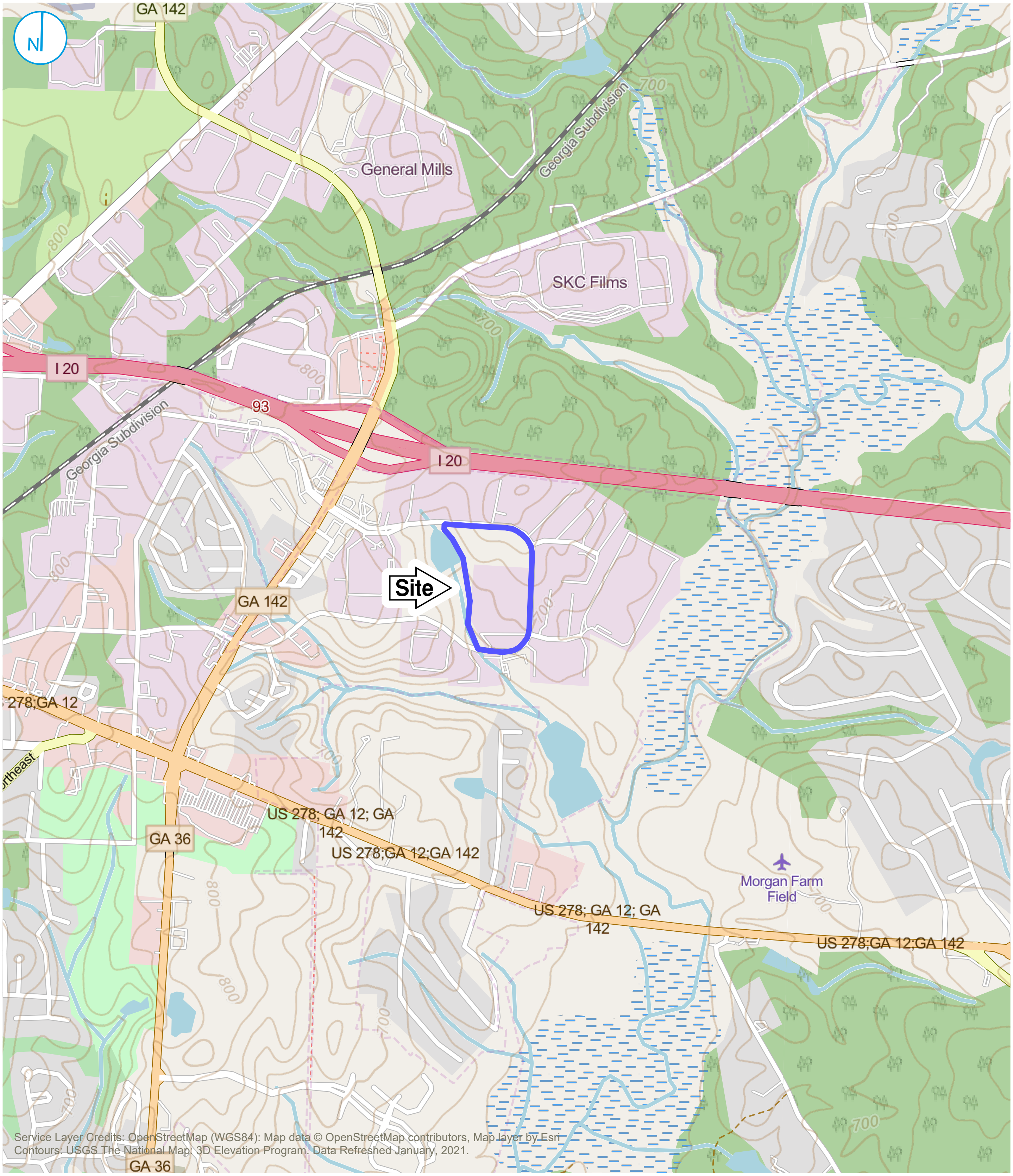
The following conclusions can be drawn from this testing as an initial assessment of the performance of the dry bed fugitive emission control system at the GDC Covington facility:

1. Post-control-device emissions of EO from the system are 0.014 lb/hour.

2. The system is reducing EO emissions from the warehouse facility at a control device efficiency of 92.95 percent.

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.

FIGURE



PROJECT: 169000XXXX | DATED: 1/26/2021 | DESIGNER: GMILES

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Map Scale: 1:24,000 | Map Center: 83°49'4"W 33°36'24"N

SITE LOCATION

FIGURE 1

0 1,000 2,000 Feet

BD BARD GLOBAL DISTRIBUTION FACILITY
14201 LOCHRIDGE BOULEVARD
COVINGTON, GEORGIA

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

TABLES

TABLE 1
System Air Flow Rates
Becton, Dickinson and Company
General Distribution Center
Covington, Georgia Facility

Sample ID	Sample Location	Pre-Test Flow Rate (dscfm)	Pre-Test Average Temperature (°F)	Post-Test Flow Rate (dscfm)	Post-Test Average Temperature (°F)	Average Flow Rate (dscfm)	Average Temperature (°F)
Emission Control System Testing - December 31, 2020							
SYS-S2 20201231	Zone 2 Inlet	44,496	63	44,729	64	44,613	64
SYS-S3 20201231	Zone 3 Inlet	33,275	63	34,237	63	33,756	63
SYS-S5 20201231	Zone 5 Inlet	14,717	71	14,464	71	14,591	71
SYS-STACK 20201231	SYS1 Out	104,347	68	102,327	72	103,337	70

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

TABLE 2
System Ethylene Oxide Sample Results
Becton, Dickinson and Company
General Distribution Center
Covington, Georgia Facility

Sample ID	Sample Location	Date	Start Time	Stop Time	Duration (hours)	Vacuum[1] Initial (In. Hg)	Vacuum[1] Final (In. Hg)	EO Concentration (µg/m^3)
Emission Control System Testing - December 31, 2020								
SYS-S2 20201231	Zone 2 Inlet	12/31/2020	9:52	13:52	4:00	28.0	8.3	210
SYS-S3 20201231	Zone 3 Inlet	12/31/2020	9:52	13:52	4:00	26.5	7.8	1100
SYS-S5 20201231	Zone 5 Inlet	12/31/2020	9:52	13:52	4:00	28.0	6.5	110
SYS-STACK 20201231[2]	SYS1 Out	12/31/2020	9:52	13:52	4:00	27.5	6.5	36.5

Notes:

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

[2]The listed EO concentration is the average of duplicate samples - SYS-STACK 20201231 (36 µg/m^3) & SYS-STACK DUP 20201231 (37 µg/m^3).

In. Hg - inches of mercury

µg/m^3 - micrograms per cubic meter

EO - Ethylene Oxide

TABLE 3
Performance Assessment
Becton, Dickinson and Company
General Distribution Center
Covington, Georgia Facility

Sample ID	Sample Location	EO Concentration ($\mu g/m^3$)	Duct Flow (dscfm)	EO Rate (lb/hr)
Emission Control System Testing - December 31, 2020				
SYS-S2 20201231	Zone 2 Inlet	210	44,613	0.035
SYS-S3 20201231	Zone 3 Inlet	1100	33,756	0.139
SYS-S5 20201231	Zone 5 Inlet	110	14,591	0.006
SYS-STACK 20201231	SYS1 Out	36.5	103,337	0.014
		Total Inlet	92,959	0.180
			Flow-weighted average inlet ($\mu g/m^3$)	517.49

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 Testing December 31, 2020
Annual EO Input to Treatment System (lb/yr)	**1579**
Annual Post-Treatment Emissions (lb/yr)	**123.8**
Concentration-based percent removal	92.95
Mass-based percent removal	92.16

APPENDIX A

STACK TESTING SCOPE

Test Plan

for the

Performance Testing of the Fugitive Emissions Control System

at

Becton, Dickinson and Company
Global Distribution Center
14201 Lochridge Boulevard
Covington, Georgia 30014

Proposed Test Date:
31 December 2020

Submitted By:

Becton, Dickinson and Company

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I. Introduction

Becton Dickinson (BD) is providing this test plan for the fugitive emissions control system proposed in the air permit application for the BD General Distribution Center (GDC) 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 February 14, 2020.

The 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 system into Summa canisters in accordance with EPA Method TO-15.

Testing is scheduled to be performed December 31, 2020 at the BD GDC facility in Covington, Georgia. The purpose of the testing is to determine removal efficiency of EO by the dry bed fugitive emissions control system.

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 warehousing distribution center facility where products that have been sterilized with EO are stored.

Testing for this equipment is specific to the emission control systems being installed to capture and treat fugitive emissions of EO. The new equipment to be tested includes a system comprised of multiple Advanced Air Technologies Model DR490 "Dry Bed Scrubbers." The collection system will capture potential emissions from three main zones of the facility where sterilized products are stored.

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.

A duplicate sample will be collected at the discharge stack from the combined duct of the 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.
- Three inlet sample locations from each of the three main ducts originating at three separate zones inside the facility.
- Outlet sample location at the discharge stack outside the facility.
- 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 based on the reduction in concentration of EO across the dry beds. Mass emission rate of EO (lb/hr) will be determined using the measured outlet concentration and airflow rate.

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

General safety rules must be adhered to when inside the GDC facility. Visitors must first sign in at the reception area at 14201 Lochridge Boulevard prior to admission to the GDC.

Entry to the GDC is restricted. John LaMontagne is responsible for this project. He can be reached at (770) 784-6186 (work) or (770) 652-2049 (cell).

APPENDIX B

TESTING SUBCONTRACTOR FINAL REPORT

DRY BED SYSTEM
INITIAL DEMONSTRATION
AT
BECTON, DICKINSON AND COMPANY
GLOBAL DISTRIBUTION CENTER
PROJECT ID: KR-10629

PREPARED FOR:

BECTON, DICKINSON AND COMPANY
14201 LOCHRIDGE BLVD
COVINGTON, GA 30014

PREPARED BY:

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

TEST DATE:
DECEMBER 31, 2020

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1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Becton, Dickinson and Company (BD) operates a medical products warehouse facility (Global Distribution Center (GDC)) located at 14201 Lochridge Blvd, Covington, GA 30014. Products already sterilized with ethylene oxide (EO) gas are shipped to this facility from various sterilization plants in preparation for distribution to medical facilities. The warehouse recently installed three (3) dry bed systems designed to control fugitive ethylene oxide emissions from the interior of the facility.

A performance test of the dry bed systems was conducted on December 31st, 2020 by Ramboll US Consulting, Inc. (Ramboll) and Advanced Industrial Resources, Inc. (AIR) in accordance with approved USEPA Methods (i.e., 40 CFR 60 Appendix A, Methods 1, 2, 4, and 18). The purpose of the 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

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

BD operates a medical products warehouse facility in Covington, Georgia. Products already sterilized with ethylene oxide (EO) gas are shipped to this facility from various sterilization plants in preparation for distribution to medical facilities around the country. The warehouse recently installed three (3) dry bed systems designed to control fugitive 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 ($\geq$ 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 (Ds)	Downstream flow disturbance distance (A)		Downstream flow disturbance distance (B)		Traverse Points (per port)
	inches	inches	equiv. diameter	inches	equiv. diameter	
Outlet	75.0	576	7.7	265	3.5	16 (8)
Zone 2 Inlet	68.0	48	0.7	140	2.1	24 (12)
Zone 3 Inlet	56.0	18.0	0.3	18.0	0.3	16 (8)
Zone 5 Inlet	37.5	85.0	2.3	72.0	1.3	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' EO removal efficiencies. Testing was conducted by quantifying the inlet loading of ethylene oxide to three separate dry bed systems and simultaneously quantifying the emission rate of ethylene oxide at the collective outlet of the combined system.

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% O_2, 0.0% CO_2).

- 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

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Summary

Dry Bed System									
Inlets					Outlet				
Source	**Pre**	**Post**	**Average**	**Units**	**Source**	**Pre**	**Post**	**Average**	**Units**
Zone 2 Inlet	44,496	44,729	44,612	**dscfm**	**Outlet**	104,347	102,327	103,337	**dscfm**
Zone 3 Inlet	33,275	34,237	33,756	**dscfm**	**Total**	**104,347**	**102,327**	**103,337**	**dscfm**
Zone 5 Inlet	14,717	14,464	14,591	**dscfm**					
Total	**92,488**	**93,430**	**92,959**	**dscfm**					

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) ($2.2046\text{x}10^{-6}$ lb./mg)

$E_{analyte} = c_{analyte}\ Q_{sd}$ (60 min/hr) ($2.2046\text{x}10^{-6}$ 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)

$K_I = [(2.0084\text{x}10^7\ \Delta H_{@}) A_n (1 - B_{ws})]^2 (M_d / M_s) (T_m / T_s) (P_s / P_m)$

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

$M_s = M_d (1 - B_{ws}) + M_w B_{ws}$

P = Qsd / F-Factor x 60 x $(20.9-O_2)$ / 20.9

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

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

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

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

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

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

$T_m = t_m + 460°$

$T_s = t_s + 460°$

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

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

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

NOMENCLATURE

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

NOMENCLATURE

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

NOMENCLATURE

Symbol	Units	Description
V_{lc}	mL	Total volume of liquid collected
V_m	dcf	Volume of gas sample as measured by the DGM
$V_{m(std)}$	dscf	Volume of gas sample as measured by the DGM, standardized
$V_{w(std)}$	scf	Volume of water vapor in the gas sample, standardized
v_s	ft./sec	Velocity of stack gas
Y_m	dimensionless	DGM calibration coefficient
Y_c	dimensionless	DGM calibration check value
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

Advanced Industrial Resources
Moisture Measurements & Calculations

<u>Input values:</u>

		Run Number			
		outlet	Inlet 2	Inlet 3	Inlet 5
T_{db}	F	68	63	63	71
T_{wb}	F	54	52	52	60
P_g	in H_20	0.71	0.00	0.00	1.30
P_{bar}	in Hg	20.9	20.9	20.9	20.9
O_2	%	20.9	20.9	20.9	20.9
CO_2	%	0.0	0.0	0.0	0.0

<u>Calculated values:</u>

P	in Hg	20.95	20.90	20.90	21.00
MW_{air}	lb/mol	28.84	28.84	28.84	28.84
p_{sat}	in Hg	0.42	0.39	0.39	0.52
p	in Hg	0.31	0.31	0.31	0.44
H	lb H_2O/lb air	0.0094	0.0093	0.0093	0.0132
$\mathbf{B_{ws}}$		**0.015**	**0.015**	**0.015**	**0.021**

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

Advanced Industrial Resources

BD Bard - Covington, Georgia

Moisture Measurements & Calculations

Outlet

Test Team:	JL, LS	**Measured values:**	
EPA Methods:	4	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2021	**p_g (in. H_2O):**	0.71
Console ID:	C-018	**Y_m**	1.029
		Probe Assembly ID:	

Moisture Run	Run #1
Used for flow runs:	1, 2 & 3
Water recovery (ml):	9
Start	0
Stop	172.795
Sample volume (cf):	172.795
Meter temperature (F):	63.0

Calculations:

Moisture volume, V_w =	**0.42**	**scf**	= ml x 0.04715
Sample volume, V_s =	**177.00**	**scf**	$=V_m \times Y_m \times \{528 / (T_m + 460)\} \times \{(P_{bar} + P_g / 13.6) / 29.92\}$
Moisture content, B_{ws} =	**0.24**	**%**	$=V_w / (V_w + V_s)$

OUTLET

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Outlet

Pre-Test

Test Team:	JL, LS	**D_s (in.):**	75.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.95
Test Date:	December 31, 2020	**p_g (in. H_2O):**	0.71
Console ID:	C-018	**O_2 (%):**	20.90
Y_m	1.029	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-02	**B_{ws}(%):**	2.4
Cp:	0.84	**Test Time:**	

(Right column heading: **Measured values:**)

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	1.50	1.225	68
2	1.55	1.245	69
3	1.40	1.183	68
4	1.40	1.183	69
5	1.20	1.095	68
6	1.10	1.049	68
7	0.88	0.938	69
8	0.86	0.927	69
9	0.84	0.917	68
10	0.84	0.917	67
11	0.82	0.906	67
12	0.81	0.900	68
13	1.40	1.183	68
14	1.55	1.245	67
15	1.45	1.204	67
16	1.20	1.095	68
17	1.00	1.000	68
18	0.90	0.949	69
19	0.87	0.933	69
20	0.85	0.922	68
21	0.86	0.927	67
22	0.84	0.917	67
23	0.83	0.911	67
24	0.80	0.894	68
Average	**1.07**	**1.028**	**68**

Calculations:

Molar weight, M_s =	**28.58**	**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 =	**57.91**	**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, $Q_{s,ds}$ =	**104,347**	**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, $Q_{s,act}$ =	**106,603**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**106,904**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Outlet

Post-Test

Test Team:	JL LS	**Measured values:**	
EPA Methods:	1, 2, 3A & 4	**D_s (in.):**	75.00
Test Date:	December 31, 2020	**P_{bar} (in. Hg):**	29.95
Console ID:	C-018	**p_g (in. H_2O):**	0.71
Y_m	1.029	**O_2 (%):**	20.90
Probe Assembly ID:	P7-02	**CO_2 (%):**	0.00
Cp:	0.84	**B_{ws}(%):**	2.4
		Test Time:	

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	1.35	1.162	71
2	1.30	1.140	71
3	1.40	1.183	72
4	1.15	1.072	72
5	1.10	1.049	72
6	0.97	0.985	71
7	0.90	0.949	72
8	0.86	0.927	72
9	0.84	0.917	72
10	0.85	0.922	72
11	0.82	0.906	72
12	0.81	0.900	72
13	1.35	1.162	71
14	1.50	1.225	71
15	1.40	1.183	72
16	1.25	1.118	72
17	1.05	1.025	72
18	0.94	0.970	71
19	0.86	0.927	71
20	0.85	0.922	72
21	0.84	0.917	72
22	0.83	0.911	71
23	0.81	0.900	71
24	0.81	0.900	71
Average	**1.04**	**1.011**	**72**

Calculations:

Molar weight, M_s =	**28.58**	**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 =	**57.18**	**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, $Q_{s,ds}$ =	**102,327**	**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, $Q_{s,act}$ =	**105,257**	**acfm**	$=v_s \pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**104,834**	**scfm**	$=v_s \pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources, Inc.
Field Data Sheet

Client:	Ramboll, GDC	Test Date:	12/31/20
Location:	Covington, GA	Console ID:	C-18
Source:	Outlet	Y_m / $\Delta H_@$:	1.029/1.883
Test Team:	SS	Sampling Box ID:	—
EPA Methods:	1, 2	Probe Assembly ID:	P7-02
D_s (in.):	75	D_n (in.):	—
% O_2	21	Assumed B_{ws}:	—
% CO_2	0	P_{bar} (in. Hg):	29.45
Start Run:	0915	p_g (in. H_2O):	0.71
End Run:	0928	Minutes/Point:	—
Run Number:	Pre-test	K-Factor:	—

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		1.50		68							
2		1.55		69							
3		1.40		68							
4		1.40		69							
5		1.20		69							
6		1.10		68							
7		0.88		68							
8		0.86		69							
9		0.84		69							
10		0.84		68							
11		0.82		67							
12		0.81		68							
Change Ports											
1		1.40		68							
2		1.55		67							
3		1.45		67							
4		1.20		68							
5		1.00		68							
6		0.90		69							
7		0.87		69							
8		0.85		68							
9		0.86		67							
10		0.84		67							
11		0.83		67							
12		0.80		68							
End											

Moisture Collected (g)

	Initial	Final	Net
Body:			
Silica Gel:	200.0		
Gel Number:		Total:	

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: ✓ @
Pitot A: ✓
Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: ✓ @
Pitot A: ✓
Pitot B: ✓

Silica Gel Desc. (initial): ______
Silica Gel Desc. (final): ______
Test Team Leader Review: ______
Data Entry Review: [signature]

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

REV021717

Advanced Industrial Resources, Inc.

Field Data Sheet

Client:	Ramboll - GDC	Test Date:	12/31/20
Location:	Covington, GA	Console ID:	C-18
Source:	Outlet	Y_m / $\Delta H_@$:	1.029 / 1.883
Test Team:	SS	Sampling Box ID:	—
EPA Methods:	1, 2	Probe Assembly ID:	P7-02
D_s (in.):	75	D_n (in.):	—
% O_2	21	Assumed B_{ws}:	—
% CO_2	0	P_{bar} (in. Hg):	29.45
Start Run:	1355	p_g (in. H_2O):	0.72
End Run:	1405	Minutes/Point:	—
Run Number:	Post-test	K-Factor:	—

		Inches H_2O		Temperature Readings (°F)							
Point	Meter (dcf)	Δp	ΔH	t_s	Probe	Filter Box	Last Impinger	t_m Inlet	t_m Outlet	Filter Exit (M5 or CPM)	Vacuum (in. Hg)
1		1.35		71							
2		1.30		71							
3		1.40		72							
4		1.15		72							
5		1.10		72							
6		0.97		71							
7		0.90		72							
8		0.86		72							
9		0.84		72							
10		0.85		72							
11		0.82		72							
12		0.81		72							
Change Ports											
1		1.35		71							
2		1.50		71							
3		1.40		72							
4		1.25		72							
5		1.05		72							
6		0.94		71							
7		0.86		71							
8		0.85		72							
9		0.84		72							
10		0.83		71							
11		0.81		71							
12		0.81		71							
End											

Moisture Collected (g)

	Initial	Final	Net
Body:			
Silica Gel:	200.0		
Gel Number:		**Total:**	

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: @

Pitot A: ✓

Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: @

Pitot A: ✓

Pitot B: ✓

Silica Gel Desc. (initial):

Silica Gel Desc. (final):

Test Team Leader Review:

Data Entry Review: [signature]

Reagent 1: Lot No:

Reagent 2: Lot No:

Advanced Industrial Resources, Inc.
Field Data Sheet

Client:	Ramboll - GDC	Test Date:	12/31/20
Location:	Covington, GA	Console ID:	C-18
Source:	Outlet	Y_m / $\Delta H_@$:	1.029 / 1.883
Test Team:	SS	Sampling Box ID:	—
EPA Methods:	1-4	Probe Assembly ID:	—
D_s (in.):	75	D_n (in.):	—
% O_2	21	Assumed B_{ws}:	—
% CO_2	0	P_{bar} (in. Hg):	29.45
Start Run:	0952	p_g (in. H_2O):	0.71
End Run:	1352	Minutes/Point:	10
Run Number:	①	K-Factor:	—

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		1.88		N/A	N/A	40	46	46	N/A	3
2	7.18						41	48	48		3
3	14.35						41	52	52		3
4	21.58						41	55	55		3
5	28.83						42	57	57		3
6	36.04						42	59	59		3
7	43.21						43	61	61		3
8	50.44						43	61	61		3
9	57.56						43	62	62		3
10	64.92						43	63	63		3
11	72.05						44	63	63		3
12	79.23						44	63	63		3
Change Ports											
1	86.40						44	63	63		3
2	93.64						44	63	63		3
3	100.81						45	63	63		3
4	108.10						45	63	63		3
5	115.23						45	64	64		3
6	122.41						46	64	64		3
7	129.66						46	64	64		3
8	136.83						46	64	64		3
9	144.05						45	64	64		3
10	151.26						45	64	64		3
11	158.52						45	64	64		3
12	165.61		↓		↓	↓	45	64	64	↓	3
End	172.795										

Moisture Collected (g)

	Initial	Final	Net
Body:	200	206	6
Silica Gel:	200.0	203	3
Gel Number:		Total:	9

Pre-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.003 @ 8"
Pitot A: ✓
Pitot B: ✓

Post-Run Leak Checks (dcfm @ "Hg)

Sampling Line: 0.003 @ 8"
Pitot A: ✓
Pitot B: ✓

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

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

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client:	Ramboll - GDC
Location:	Covington, GA
Source:	Outlet
Test Team:	SS
Probe ID:	P7-02
C_p:	0.84

Date:	12/31/20
D_s (in.):	75
A_s (ft^2):	30.68
D_n (in.):	—
A_n (ft^2):	—

t_m (°F):	50
Console ID:	C-18
Y_m:	1.029
$\Delta H_@$:	1.883
Assumed B_{ws}:	—
P_{bar} (in. Hg):	29.45

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

Test Team Leader Review: __________

Data Entry Review: __________

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: Ramboll - GDC

Location: Covington, GA

Source: Outlet

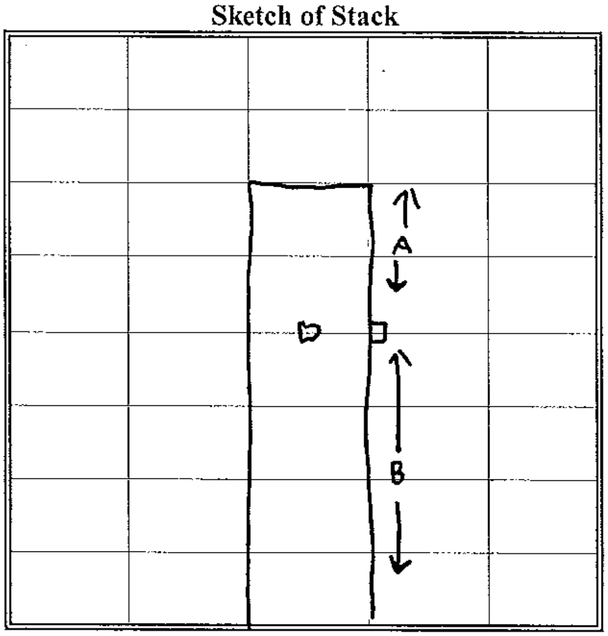
Date: 12/31/20

Test Team: SS,

D_n (in.):	—
A_n (ft^2):	—
D_s (in.):	75
A_s (ft^2):	30.68
Length A (in.):	576
Length B (in.):	265
t_{amb} (°F):	50
Assumed B_{ws}:	—
P_{bar} (in. Hg):	29.45
P_g (in. H_2O):	0.71
% O_2:	21
% CO_2:	0
Console ID:	C-18
Y:	1.029
$\Delta H_@$:	1.883
C_p:	0.84
K-Factor:	—

Point	Δp (in. H_2O)	t_s (°F)
1	1.60	68
2	1.55	69
3	1.40	68
4	1.40	69
5	1.20	69
6	1.10	68
7	0.88	68
8	0.86	69
9	0.84	69
10	0.84	68
11	0.82	67
12	0.81	68
Change Ports		
1	1.40	68
2	1.55	67
3	1.45	67
4	1.20	68
5	1.00	68
6	0.90	69
7	0.87	69
8	0.85	68
9	0.86	67
10	0.84	67
11	0.83	67
12	0.80	68

Sketch of Stack



Test Team Leader Review: ________

Data Entry Review: ________

ZONE 2

INLET

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 2 Inlet

Pre-Test

			Measured values:	
Test Team:	GE/ RB		**D_s (in.):**	68.00
EPA Methods:	1,2		**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020		**p_g (in. H_2O):**	-2.60
Console ID:	C-02		**O_2 (%):**	21.00
Y_m	0.999		**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01		**B_{ws}(%):**	1.46
Cp:	0.84		**Test Time:**	9:40

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.26	0.510	63
2	0.33	0.574	63
3	0.35	0.592	63
4	0.35	0.592	63
5	0.33	0.574	63
6	0.25	0.500	63
7	0.21	0.458	63
8	0.24	0.490	63
9	0.20	0.447	63
10	0.20	0.447	63
11	0.27	0.520	63
12	0.23	0.480	63
13	0.44	0.663	63
14	0.25	0.500	63
15	0.24	0.490	63
16	0.22	0.469	63
17	0.23	0.480	63
18	0.23	0.480	63
19	0.35	0.592	63
20	0.37	0.608	63
21	0.37	0.608	63
22	0.34	0.583	63
23	0.33	0.574	63
24	0.32	0.566	63
Average	**0.29**	**0.533**	**63**

Calculations:

Molar weight, M_s =	**28.68 lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**30.23 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, $Q_{s,ds}$ =	**44,496 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, $Q_{s,act}$ =	**45,739 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**45,156 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 2 Inlet
Post-Test

		Measured values:	
Test Team:	GE/ RB	**D_s (in.):**	68.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020	**p_g (in. H_2O):**	-2.60
Console ID:	C-002	**O_2 (%):**	21.00
Y_m	0.999	**CO_2 (%):**	0.00
Probe Assembly ID:	P7-01	**B_{ws}(%):**	1.46
Cp:	0.84	**Test Time:**	13:55

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.22	0.469	64
2	0.20	0.447	64
3	0.30	0.548	64
4	0.34	0.583	64
5	0.33	0.574	64
6	0.27	0.520	64
7	0.26	0.510	64
8	0.26	0.510	64
9	0.28	0.529	64
10	0.30	0.548	64
11	0.34	0.583	64
12	0.33	0.574	64
13	0.22	0.469	63
14	0.31	0.557	63
15	0.39	0.624	63
16	0.40	0.632	63
17	0.37	0.608	63
18	0.36	0.600	63
19	0.31	0.557	63
20	0.27	0.520	63
21	0.25	0.500	63
22	0.23	0.480	63
23	0.21	0.458	63
24	0.22	0.469	63
Average	**0.29**	**0.536**	**64**

Calculations:

Molar weight, M_s =	**28.68**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**30.41**	**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, $Q_{s,ds}$ =	**44,729**	**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, $Q_{s,act}$ =	**46,022**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**45,392**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

Duct Velocity & Flow Calculation Sheet

Client:	Ramboll - GDC	**Measured values:**	
Location:	Covington, GA.	D_s (in.):	68
Source:	System 2	P_{bar} (in. Hg):	29.45
Test Team:	GE / RB	p_g (in. H_2O):	-2.6
EPA Methods:	1, 2	t_{amb} (°F)	63
Test Date:	12-31-2020	Assumed B_{ws} (%):	1
Console ID:	C-02	O_2 (%):	21
Y_m / $\Delta H_@$:	0.999 / 1.594	CO_2 (%):	0
Probe Assembly ID:	P7-01	Pre-Time:	9:40
Cp:	0.84	Post-Time:	13:55

	Pre		Post		Average	
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.26	63	0.27	64		
2	0.33	63	0.28	64		
3	0.35	63	0.30	64		
4	0.35	63	0.34	64		
5	0.33	63	0.33	64		
6	0.25	63	0.27	64		
7	0.21	63	0.26	64		
8	0.24	63	0.24	64		
9	0.20	63	0.28	64		
10	0.20	63	0.30	64		
11	0.27	63	0.34	64		
12	0.23	63	0.33	64		
13	0.44	63	0.22	63		
14	0.25	63	0.31	63		
15	0.24	63	0.39	63		
16	0.22	63	0.40	63		
17	0.23	63	0.37	63		
18	0.23	63	0.36	63		
19	0.35	63	0.31	63		
20	0.37	63	0.27	63		
21	0.37	63	0.25	63		
22	0.34	63	0.23	63		
23	0.33	63	0.21	63		
24	0.32	63	0.22	63		
Average						

Side port (points 1–12); bottom port (points 13–24)

	Pre	Post
Pitot A	ok	ok
Pitot B	ok	ok

Can 6L1220	
9:52	28.5
10:27	26.0
10:53	23.5
11:23	21.0
11:52	18.0
12:20	15.5
12:52	13.0
13:21	11.0
13:52	8.25

Calculations:

Molar weight, M_s =	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 =	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, $Q_{s,ds}$ =	dscfm	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$
Flow Rate, $Q_{s,act}$ =	acfm	$=v_s\pi D_s^2/4/144 \times 60$

Wet Bulb 52

Test Team Leader Review: [signature]

Data Entry Review:

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: Ramboll - GDC
Location: Covington, GA.
Source: System 2
Test Team: GE SW
Probe ID: P7-01
C_p: 0.84

~~C-02~~ t_m (°F):
Console ID: C-02
Y_m: 0.999
$\Delta H_@$: 1.594
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.45

Date: 12-31-2020
D_s (in.): 68
A_s (ft^2): 25.22
D_n (in.):
A_n (ft^2):

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	0
10	0.0	0
11	0.0	0
12	0.0	0
Change Ports		
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	2
7	0.0	0
8	0.0	0
9	0.0	0
10	0.0	0
11	0.0	0
12	0.0	0

Test Team Leader Review: __________
Data Entry Review: __________

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: Ramboll GDC
Location: Covington GA
Source: System 2

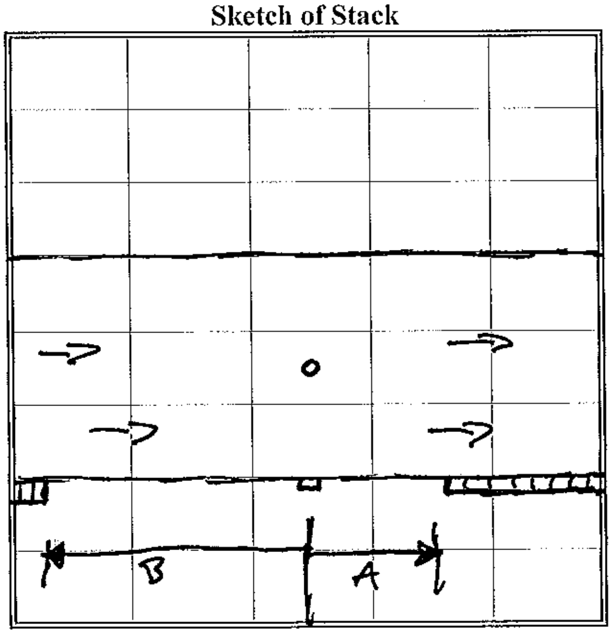
Date: 12-31-2020
Test Team: GE/RB

D_n (in.): NA
A_n (ft^2): NA
D_s (in.): 68
A_s (ft^2): 25.22
Length A (in.): 48
Length B (in.): 140

t_{amb} (°F): 63
Assumed B_{ws}: 1%
P_{bar} (in. Hg): 29.45
P_g (in. H_2O): -2.6
% O_2: 21
% CO_2: 0
Console ID: C-02
Y: 0.999
$\Delta H_@$: 1.594
C_p: 0.84
K-Factor: NA

Point	Δp (in. H_2O)	t_s (°F)
1	0.26	63
2	0.33	63
3	0.35	63
4	0.35	63
5	0.33	63
6	0.25	63
7	0.21	63
8	0.24	63
9	0.20	63
10	0.20	63
11	0.20	63
12	0.27	63
Change Ports		
1	0.23	63
2	0.34	63
3	0.25	~~64~~ 63
4	0.24	63
5	0.25	63
6	0.24	63
7	0.23	63
8	0.37	63
9	0.37	63
10	0.34	63
11	0.33	63
12	0.32	63

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

ZONE 3

INLET

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 3 Inlet

Pre-Test

Test Team:	LS KF	**D_s (in.):**	56.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020	**p_g (in. H_2O):**	-2.00
Console ID:	C-014	**O_2 (%):**	20.90
Y_m	1.010	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-04	**B_{ws}(%):**	1.5
Cp:	0.84	**Test Time:**	9:20

Measured values: (right column)

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.34	0.583	63
2	0.36	0.600	63
3	0.35	0.592	63
4	0.34	0.583	63
5	0.41	0.640	63
6	0.40	0.632	63
7	0.41	0.640	63
8	0.42	0.648	63
9	0.42	0.648	63
10	0.32	0.566	63
11	0.31	0.557	63
12	0.26	0.510	63
13	0.30	0.548	63
14	0.30	0.548	63
15	0.32	0.566	63
16	0.29	0.539	63
Average	**0.35**	**0.587**	**63**

Calculations:

Molar weight, M_s =	**28.68**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**33.28**	**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, $Q_{s,ds}$ =	**33,275**	**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, $Q_{s,act}$ =	**34,153**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**33,768**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 3 Inlet

Post-Test

Measured values:

Test Team:	LS KF	**D_s (in.):**	56.00
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020	**p_g (in. H_2O):**	-2.00
Console ID:	C-014	**O_2 (%):**	20.90
Y_m	1.01	**CO_2 (%):**	0.00
Probe Assembly ID:	P5-04	**B_{ws}(%):**	1.5
Cp:	0.84	**Test Time:**	14:06

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.29	0.539	63
2	0.34	0.583	63
3	0.36	0.600	63
4	0.35	0.592	63
5	0.38	0.616	63
6	0.40	0.632	63
7	0.41	0.640	63
8	0.42	0.648	63
9	0.33	0.574	63
10	0.39	0.620	63
11	0.41	0.640	63
12	0.42	0.648	63
13	0.39	0.624	63
14	0.37	0.608	63
15	0.32	0.566	63
16	0.29	0.539	63
Average	**0.37**	**0.604**	**63**

Calculations:

Molar weight, M_s =	**28.68 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 =	**34.24 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, $Q_{s,ds}$ =	**34,237 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, $Q_{s,act}$ =	**35,140 acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**34,745 scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	Ramboll - GDC	**Measured values:**	
Location:	Covington, GA	D_s (in.):	56.0
Source:	System 3 Inlet	Y_m / $\Delta H_@$:	N/A
Test Team:	RB / GE	C_p:	0.84
EPA Methods:	1, 2, 3, 4	t_{amb} (°F):	63
Test Date:	12/31/2020	Assumed B_{ws} (%):	1
Console ID:	C-14	O_2 (%):	21
Probe Assembly ID:	PS-04	CO_2 (%):	0

Start time: 9:20	Start time: 14:06	Start time:	Start time:
Stop time:	Stop time: 14:12	Stop time:	Stop time:

Test #	Pre test		Post TEST					
P_{bar} (in. Hg):								
p_g (in. H_2O):	-2.0		-2.0					
Traverse Point	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)	Δp (" H_2O)	t_s (°F)
1	0.34	63	0.29	63				
2	0.36	63	0.34	63				
3	0.35	63	0.36	63				
4	0.34	63	0.35	63				
5	0.41	63	0.38	63				
6	0.40	63	0.40	63				
7	0.41	63	0.41	63				
8	0.42	63	0.42	63				
9	0.42	63	0.33	63				
10	0.32	63	0.38	63				
11	0.31	63	0.41	63				
12	0.26	63	0.42	63				
13	0.30	63	0.39	63				
14	0.30	63	0.37	63				
15	0.32	63	0.32	63				
16	0.29	63	0.29	63				
Average								

Wet bulb = 52°F
Wet bulb = 52°F

Test Team Leader Review: ____________

Data Entry Review: [signature]

Advanced Industrial Resources, Inc.

Cyclonic Flow Absence Verification Field Data

EPA Method 1

Client: Ramboll - GDC
Location: Covington, GA
Source: System 3 Inlet
Test Team: RB / GE
Probe ID: PS-04
C_p: 0.84

Date: 12/31/2020
D_s (in.): 56.0
A_s (ft^2): 17.10
D_n (in.): N/A
A_n (ft^2): N/A

t_m (°F): 63
Console ID: C-14
Y_m: N/A
$\Delta H_{@}$: N/A
Assumed B_{ws}:
P_{bar} (in. Hg):

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:

Advanced Industrial Resources, Inc.

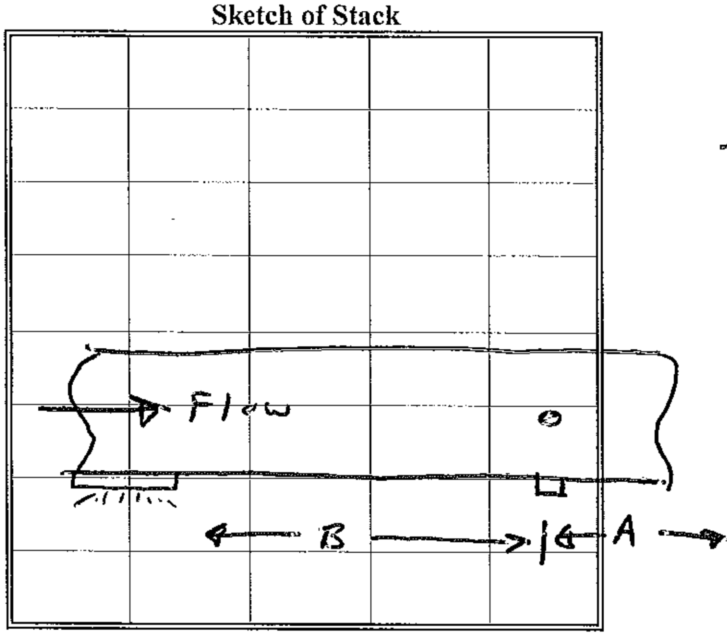
Source Description Sheets

Client: Ramboll - GDC
Date: 12/31/2020
Location: Covington, GA
Test Team: RB / GE
Source: System 3 Inlet

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	56.0
A_s (ft^2):	17.10
Length A (in.):	180
Length B (in.):	130
t_{amb} (°F):	63
Assumed B_{ws}:	1
P_{bar} (in. Hg):	
P_g (in. H_2O):	-2.0
% O_2:	21
% CO_2:	0
Console ID:	C-14
Y:	N/A
$\Delta H_@$:	N/A
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.34	63
2	0.36	63
3	0.35	63
4	0.34	63
5	0.41	63
6	0.40	63
7	0.41	63
8	0.42	63
~~9~~		
~~10~~		
~~11~~		
~~12~~		
Change Ports		
1	0.42	63
2	0.32	63
3	0.31	63
4	0.26	63
5	0.30	63
6	0.30	63
7	0.32	63
8	0.29	63
~~9~~		
~~10~~		
~~11~~		
~~12~~		

Sketch of Stack



Test Team Leader Review: ____________

Data Entry Review: ____________

ZONE 5

INLET

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 5 Inlet

Pre-Test

Test Team:	RB GE	**D_s (in.):**	37.50
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020	**p_g (in. H_2O):**	-1.30
Console ID:	C-003	**O_2 (%):**	20.90
Y_m	0.938	**CO_2 (%):**	0.00
Probe Assembly ID:	FP-04	**B_{ws}(%):**	2.1
Cp:	0.84	**Test Time:**	9:22

Measured values:

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.32	0.566	71
2	0.36	0.600	71
3	0.35	0.592	71
4	0.39	0.624	71
5	0.34	0.583	71
6	0.33	0.574	71
7	0.33	0.574	71
8	0.30	0.548	71
9	0.26	0.510	71
10	0.29	0.539	71
11	0.32	0.566	71
12	0.35	0.592	71
13	0.41	0.640	71
14	0.40	0.632	71
15	0.39	0.624	71
16	0.38	0.616	71
Average	**0.35**	**0.586**	**71**

Calculations:

Molar weight, M_s =	**28.61**	**lb/mol**	$=\{(\%O_2 \times 32)+(\%CO_2 \times 44)+(\%N_2 \times 28)\} \times (1-B_{ws}/100))/100+B_{ws}/100*18$
Velocity, v_s =	**33.48**	**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, $Q_{s,ds}$ =	**14,717**	**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, $Q_{s,act}$ =	**15,406**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**15,029**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources

BD Bard - Covington, Georgia

Flow Measurements & Calculations

Zone 5 Inlet

Post-Test

Test Team:	RB GE	**D_s (in.):**	37.50
EPA Methods:	1,2	**P_{bar} (in. Hg):**	29.45
Test Date:	December 31, 2020	**p_g (in. H_2O):**	-1.30
Console ID:	C-003	**O_2 (%):**	20.90
Y_m	0.938	**CO_2 (%):**	0.00
Probe Assembly ID:	FP-04	**B_{ws}(%):**	2.1
Cp:	0.84	**Test Time:**	13:24

Measured values:

Point	Δp (" H_2O)	$(\Delta p)^{1/2}$	t_s (°F)
1	0.29	0.539	71
2	0.37	0.608	71
3	0.35	0.592	71
4	0.33	0.574	71
5	0.33	0.574	71
6	0.31	0.557	71
7	0.30	0.548	71
8	0.27	0.520	71
9	0.27	0.520	71
10	0.31	0.557	71
11	0.34	0.583	71
12	0.38	0.616	71
13	0.39	0.624	71
14	0.39	0.624	71
15	0.35	0.592	71
16	0.35	0.592	71
Average	**0.33**	**0.576**	**71**

Calculations:

Molar weight, M_s =	**28.61**	**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 =	**32.90**	**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, $Q_{s,ds}$ =	**14,464**	**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, $Q_{s,act}$ =	**15,141**	**acfm**	$=v_s\pi D_s^2/4/144 \times 60$
Flow Rate, $Q_{s,std}$ =	**14,771**	**scfm**	$=v_s\pi D_s^2/4/144 \times 60 \times (t_{std}+460)/(t_s+460) \times (P_{bar}+p_g/13.6)/29.92$

Advanced Industrial Resources
Duct Velocity & Flow Calculation Sheet

Client:	Ramboll GDC	**Measured values:**	
Location:	Covington, GA	D_s (in.):	37.5
Source:	S-5	Y_m / $\Delta H_@$:	0.938/1.807
Test Team:	LS, KF	C_p:	0.84
EPA Methods:	1+2	t_{amb} (°F)	69
Test Date:	12/31/20	Assumed B_{ws} (%):	1%
Console ID:	C-03	O_2 (%):	21%
Probe Assembly ID:	FP-04	CO_2 (%):	0%

	Pre-1 LS		Post-1; Pre-2		Post-2; Pre-3		Post-3	
	Start time: 0922		Start time: 13:24		Start time:		Start time:	
	Stop time: 0929		Stop time: 13:28		Stop time:		Stop time:	
P_{bar} (in. Hg):	~~29.34~~ 29.45		29.45					
p_g (in. H_2O):	-1.30		-1.30					
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	71	0.29	71				
2	0.36	71	0.37	71				
3	0.35	71	0.35	71				
4	0.39	71	0.33	71				
5	0.34	71	0.33	71				
6	0.33	71	0.31	71				
7	0.33	71	0.30	71				
8	0.30	71	0.27	71				
9	0.26	71	0.27	71				
10	0.29	71	0.31	71				
11	0.32	71	0.34	71				
12	0.35	71	0.38	71				
13	0.41	71	0.39	71				
14	0.40	71	0.39	71				
15	0.39	71	0.35	71				
16	0.38	71	0.35	71				
Average								

	Pre-1	Post-1; Pre-2
Wet	60	59
Dry	71	71

Pre Pitot Leak Check - o.k.

Static = 1.30

Can No. 6L1647

Test Team Leader Review: [signature]

Data Entry Review: [signature]

Advanced Industrial Resources, Inc.

Source Description Sheets

Client: ~~BD Bard~~ Ramboll GDC **Date:** 12-31-20

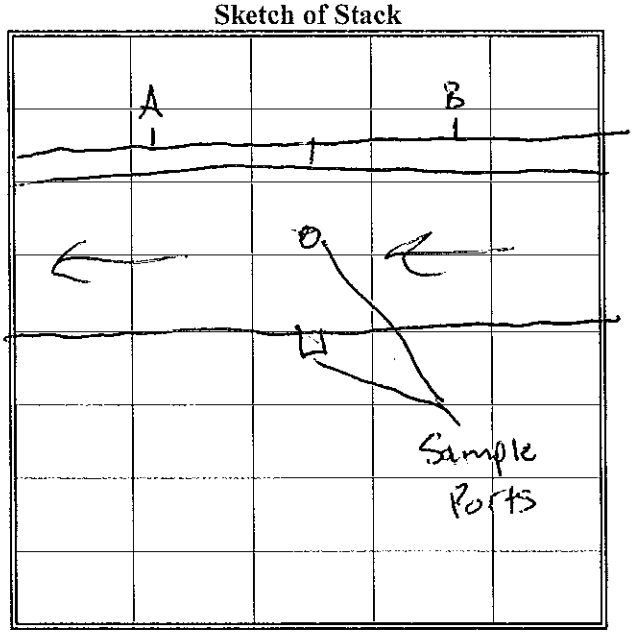
Location: COVINGTON LS **Test Team:** LS - KF

Source: S-5 INLET

D_n (in.):	N/A
A_n (ft^2):	N/A
D_s (in.):	~~38~~ 37.5 LS
A_s (ft^2):	~~7.88~~ 7.67 LS
Length A (in.):	85
Length B (in.):	> 72
t_{amb} (°F):	45
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.34
P_g (in. H_2O):	- 1.30
% O_2:	21
% CO_2:	0
Console ID:	C03
Y:	0.938
$\Delta H_@$:	1.807
C_p:	0.84
K-Factor:	N/A

Point	Δp (in. H_2O)	t_s (°F)
1	0.32	71
2	0.36	71
3	0.35	71
4	0.39	71
5	0.34	71
6	0.33	71
7	0.30	71
8	0.33	71
9		
10		
11		
12		
Change Ports		
1	0.26	71
2	0.29	71
3	0.32	71
4	0.35	71
5	0.41	71
6	0.40	71
7	0.39	71
8	0.38	71
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:	~~BD Bard~~ Ramboll - GDC LS	Date:	12/31/20
Location:	Covington, GA	D_s (in.):	37.5
Source:	S-5	A_s (ft^2):	7.67
Test Team:	LS, KF	D_n (in.):	N/A
Probe ID:	FP-04	A_n (ft^2):	N/A
C_p:	0.84		

t_m (°F):	66
Console ID:	C-03
Y_m:	~~0.999~~ 0.938 LS
$\Delta H_@$:	1.807
Assumed B_{ws}:	1%
P_{bar} (in. Hg):	29.34

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

APPENDIX D

CALIBRATION DATA

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-02
Serial Number:	

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

Date: 07/24/20

Barometric Pressure, P_b (in. Hg): 29.15

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.)
3.0	0.50	5.205	5.276	72	66.0	76.0	71.0	11.90
3.0	1.00	5.009	5.066	73	77.0	84.0	80.5	8.40
3.0	2.00	6.468	6.537	74	85.0	89.0	87.0	7.75
3.0	3.00	5.283	5.324	74	88.0	90.0	89.0	5.10
3.0	4.00	7.217	7.365	74	90.0	92.0	91.0	6.10

Calculations

ΔH (inches H_2O)	Y_m (dimensionless)	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.981	-0.018	**PASS**	1.521	-0.073	**PASS**
1.00	0.998	-0.001	**PASS**	1.614	0.020	**PASS**
2.00	1.006	0.007	**PASS**	1.634	0.040	**PASS**
3.00	1.010	0.011	**PASS**	1.586	-0.008	**PASS**
4.00	0.999	0.000	**PASS**	1.615	0.021	**PASS**
Averages:	**0.999**	**PASS**		**1.594**	**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.

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

$\mathbf{\Delta H_@}$ 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.

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

Advanced Industrial Resources, Inc.

Dry Gas Meter Calibration Data

Dry Gas Meter	
Console ID:	C-002
Serial Number:	

Reference Meter	
Meter ID:	MSRFM #1
Calibration Factor, Y_w:	0.9980

Date:	01/05/21	**Accepted Y_m:**	0.999
Barometric Pressure, P_b (in. Hg):	29.80	**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	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
5.0	3.00	6.287	6.314	74	94	96	95.0	6.00
5.0	3.00	6.262	6.316	75	96	97	96.5	6.00
5.0	3.00	6.209	6.274	75	97	98	97.5	6.00

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
3.00	1.025	0.0024	**PASS**	1.499	-0.017	**PASS**
3.00	1.022	-0.0012	**PASS**	1.513	-0.003	**PASS**
3.00	1.022	-0.0012	**PASS**	1.536	0.020	**PASS**
Averages:	**1.023**	**PASS**		**1.516**	**PASS**	

Calculations

**Note	Low Tolerance	High Tolerance	% diff	Pass or Fail?
****Note:** Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	**0.949**	**1.049**	**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-003
Serial Number:	

Reference Meter	
Meter ID:	M5 RFM #1
Calibration Factor, Y_w:	0.998

Date: 12/11/20

Barometric Pressure, P_b (in. Hg): 29.27

Performed By: JML

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	5.949	6.130	72	61.0	59.0	60.0	14.50
5.0	1.00	5.772	5.970	72	58.0	60.0	59.0	10.00
5.0	2.00	6.029	6.269	72	60.0	62.0	61.0	7.50
5.0	3.00	5.894	6.143	72	62.0	65.0	63.5	6.00
5.0	4.00	5.637	5.878	72	65.0	67.0	66.0	5.00

Calculations

ΔH (inches H_2O)	Y_m (dimensionless)	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.945	0.007		1.758	-0.049	
1.00	0.939	0.001		1.780	-0.027	
2.00	0.935	-0.003		1.828	0.021	
3.00	0.935	-0.003		1.828	0.021	
4.00	0.937	-0.001		1.841	0.034	
Averages:	**0.938**			**1.807**		

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-003
Serial Number:	

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

Date:	01/05/21	**Accepted Y_m:**	0.938
Barometric Pressure, P_b (in. Hg):	29.27	**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	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
5.0	3.00	5.895	6.164	72	64	65	64.5	6.00
5.0	3.00	5.905	6.177	72	65	66	65.5	6.00
5.0	3.00	5.894	6.186	72	66	68	67.0	6.00

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$ΔH_@$ (inches H_2O)	Variation (dimensionless)	
3.00	0.934	-0.0008	**PASS**	1.824	0.006	**PASS**
3.00	0.935	0.0006	**PASS**	1.814	-0.004	**PASS**
3.00	0.935	0.0002	**PASS**	1.815	-0.002	**PASS**
Averages:	**0.935**	**PASS**		**1.818**	**PASS**	

Calculations

****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	Low Tolerance	High Tolerance	% diff	Pass or Fail?
	0.891	**0.985**	**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-14
Serial Number:	28554

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

Date: 01/23/20 **Performed By:** LS

Barometric Pressure, P_b (in. Hg): 29.30 **Reviewed By:**

Data								
				Temperatures (°F)				Time Elapsed
Vacuum (in. Hg)	ΔH (in. H_2O)	Reference Meter Volume V_w (ft^3)	Dry Gas Meter Volume V_m (ft^3)	Reference Meter t_w	Dry Gas Meter init. t_i	final t_f	avg. t_m	θ (min.)
5.0	0.50	5.170	5.334	51	65.0	70.0	67.5	12.75
5.0	0.75	5.082	5.264	53	71.0	76.0	73.5	10.50
5.0	1.00	5.021	5.132	53	71.0	74.0	72.5	9.10
5.0	1.20	5.038	5.113	54	75.0	77.0	76.0	8.50
5.0	1.50	5.025	5.111	55	75.0	77.0	76.0	7.50

Calculations						
ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
0.50	0.997	-0.012	**PASS**	1.635	-0.113	**PASS**
0.75	1.000	-0.010	**PASS**	1.716	-0.032	**PASS**
1.00	1.011	0.001	**PASS**	1.763	0.016	**PASS**
1.20	1.022	0.013	**PASS**	1.829	0.081	**PASS**
1.50	1.017	0.008	**PASS**	1.796	0.048	**PASS**
Averages:	**1.010**	**PASS**		**1.748**	**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-014
Serial Number:	

Reference Meter	
Meter ID:	MSRFM #1
Calibration Factor, Y_w:	0.9980

Date:	01/05/21	**Accepted Y_m:**	1.010
Barometric Pressure, P_b (in. Hg):	29.05	**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	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
5.0	3.00	6.035	6.098	74	88	94	91.0	6.00
5.0	3.00	6.166	6.249	74	94	100	97.0	6.17
5.0	3.00	5.986	6.091	74	100	106	103.0	6.00

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
3.00	1.011	-0.0076	**PASS**	1.681	0.002	**PASS**
3.00	1.019	0.0004	**PASS**	1.685	0.005	**PASS**
3.00	1.026	0.0072	**PASS**	1.673	-0.007	**PASS**
Averages:	**1.019**	**PASS**		**1.680**	**PASS**	

Calculations

	Low Tolerance	High Tolerance	% diff	Pass or Fail?
****Note: Avg Y_m cannot be (< or >) 5% of the Accepted Y_M**	**0.960**	**1.061**	**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.

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

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 Elapsed
		Reference Meter Volume	Dry Gas Meter Volume	Reference Meter	Dry Gas Meter			
Vacuum (in. Hg)	ΔH (in. H_2O)	V_w (ft^3)	V_m (ft^3)	t_w	init. t_i	final t_f	avg. t_m	θ (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)		$ΔH_@$ (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-18
Serial Number:	1604006

Reference Meter	
Meter ID:	M5RFM1
Calibration Factor, Y_w:	0.9980

Date:	01/05/21	**Accepted Y_m:**	1.029
Barometric Pressure, P_b (in. Hg):	29.15	**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	Dry Gas Meter final t_f	Dry Gas Meter avg. t_m	Time Elapsed θ (min.)
4.0	1.80	5.293	5.072	74	64	64	64.0	7.25
4.0	1.80	5.241	5.029	74	64	65	64.5	7.20
4.0	1.80	5.271	5.061	74	65	66	65.5	7.25

Calculations

ΔH (inches H_2O)	Y_m	Variation (dimensionless)		$\Delta H_@$ (inches H_2O)	Variation (dimensionless)	
1.80	1.017	-0.0002	**PASS**	2.007	-0.007	**PASS**
1.80	1.017	-0.0006	**PASS**	2.017	0.003	**PASS**
1.80	1.018	0.0007	**PASS**	2.018	0.004	**PASS**
Averages:	**1.018**	**PASS**		**2.014**	**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 DGM Model: T-110
Customer: Advanced Industrial Resources DGM S/N: 27979
Reference Prover: Cert.# A-610 Tape # 26727

Pb: 29.89 in Hg

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

AVERAGE Y_{ds} **0.992**

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

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

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

Signature

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

AVERAGE Y_{ds} 0.998

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

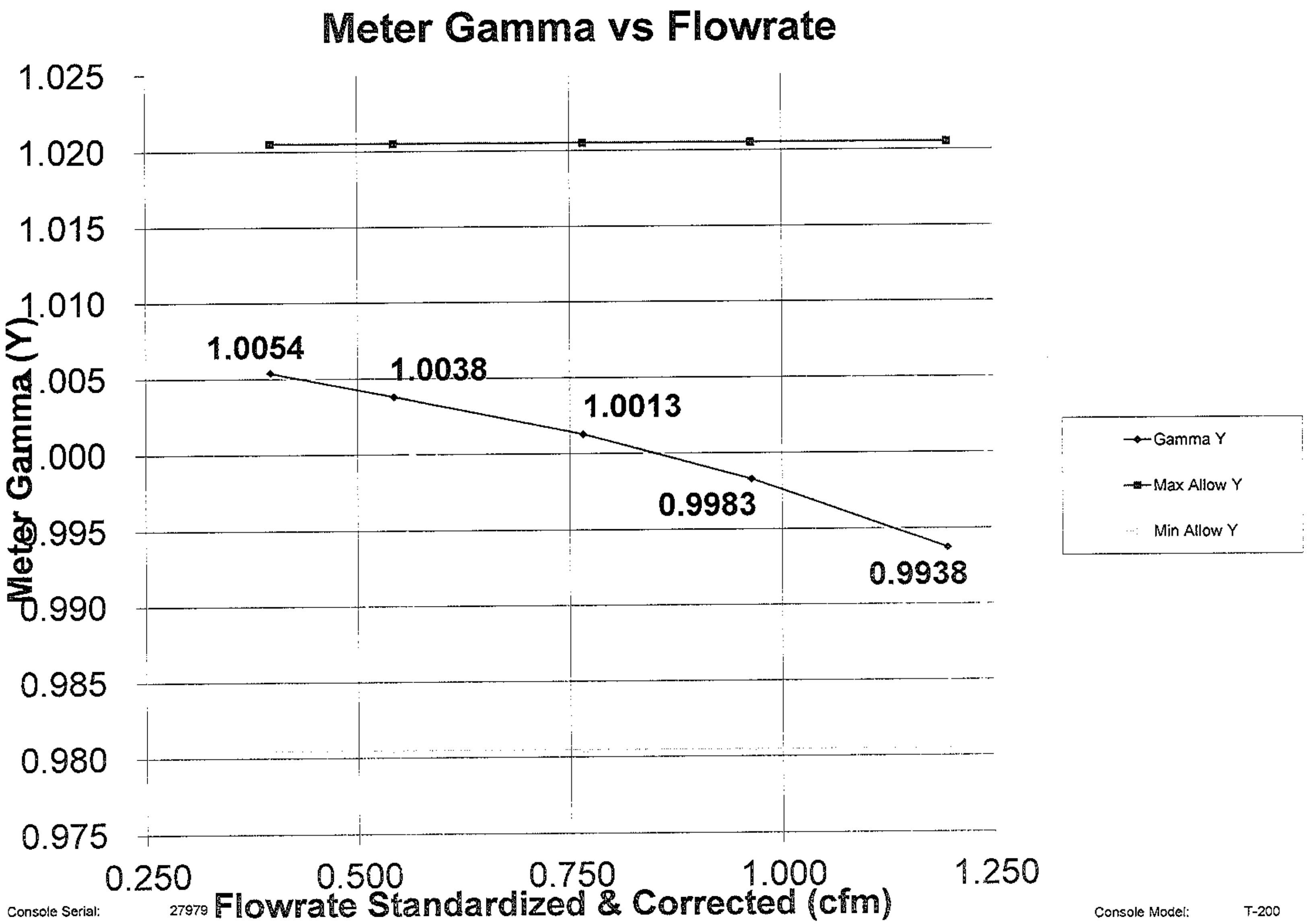
$$Q = 17.64 \frac{P_{bar}}{(t_w + t_{std})} \frac{V_w}{\Phi}$$

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

Signature

Calibration Date: 10-10-2017

Calibration Technician: EW

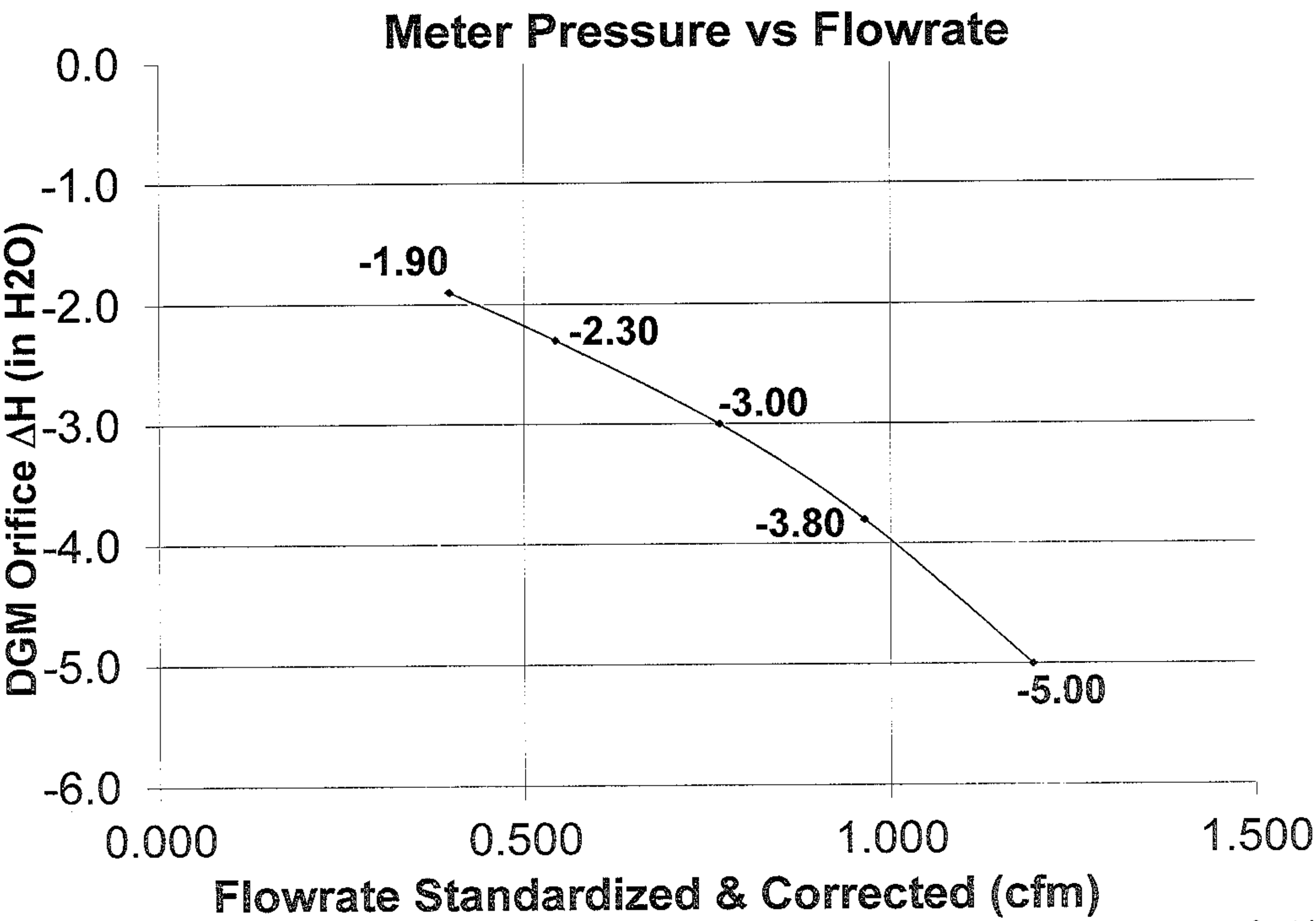


Console Serial: 27979

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:** 01/04/21

Bias: 0 **Performed By:** SS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P7-02	Stack Temp.	32	492	33	493	0.2
P7-02	Stack Temp.	210	670	211	671	0.1
B-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	33	493	0.2
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	33	493	0.2
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
P7-02	Probe Temp.	32	492	33	493	0.2
P7-02	Probe Temp.	210	670	210	670	0.0

Thermocouple Calibration Procedure

A. References

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

B. Measurement

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

Advanced Industrial Resources, Inc.

Thermocouple Calibration Data

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

Bias: 0 **Performed By:** SS

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-02	Filter Temp.	32	492	33	493	0.2
B-02	Filter Temp.	210	670	211	671	0.1
B-02	Exit Imp. Temp.	32	492	33	493	0.2
B-02	Exit Imp. Temp.	210	670	211	671	0.1
C-002	Meter In Temp.	32	492	32	492	0.0
C-002	Meter In Temp.	210	670	210	670	0.0
C-002	Meter Out Temp.	32	492	32	492	0.0
C-002	Meter Out Temp.	210	670	211	671	0.1
B-02	Filter Exit Temp.	32	492	33	493	0.2
B-02	Filter Exit Temp.	210	670	210	670	0.0
P7-01	Probe Temp.	32	492	33	493	0.2
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:** 01/04/21

Bias: 0 **Performed By:** SS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P5-04	Stack Temp.	32	492	33	493	0.2
P5-04	Stack Temp.	210	670	210	670	0.0
B-14	Filter Temp.	32	492	33	493	0.2
B-14	Filter Temp.	210	670	210	670	0.0
B-14	Exit Imp. Temp.	32	492	33	493	0.2
B-14	Exit Imp. Temp.	210	670	211	671	0.1
C-014	Meter In Temp.	32	492	32	492	0.0
C-014	Meter In Temp.	210	670	211	671	0.1
C-014	Meter Out Temp.	32	492	32	492	0.0
C-014	Meter Out Temp.	210	670	210	670	0.0
B-14	Filter Exit Temp.	32	492	33	493	0.2
B-14	Filter Exit Temp.	210	670	210	670	0.0
P5-04	Probe Temp.	32	492	33	493	0.2
P5-04	Probe Temp.	210	670	211	671	0.1

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:** 01/04/21

Bias: 0 **Performed By:** SS

Apparatus ID	Apparatus Description	Reference Temperature Reading		Indicated Temperature		Relative Variation
		°F	°R	°F	°R	%
P4-01	Stack Temp.	32	492	33	493	0.2
P4-01	Stack Temp.	210	670	210	670	0.0
B-14	Filter Temp.	32	492	32	492	0.0
B-14	Filter Temp.	210	670	211	671	0.1
B-14	Exit Imp. Temp.	32	492	33	493	0.2
B-14	Exit Imp. Temp.	210	670	210	670	0.0
C-003	Meter In Temp.	32	492	33	493	0.2
C-003	Meter In Temp.	210	670	210	670	0.0
C-003	Meter Out Temp.	32	492	32	492	0.0
C-003	Meter Out Temp.	210	670	210	670	0.0
B-14	Filter Exit Temp.	32	492	33	493	0.2
B-14	Filter Exit Temp.	210	670	210	670	0.0
P4-01	Probe Temp.	32	492	32	492	0.0
P4-01	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.

VERIFICATION OF CONSTRUCTION SPECIFICATIONS FOR THE TYPE-S PITOT TUBE

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

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

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

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

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

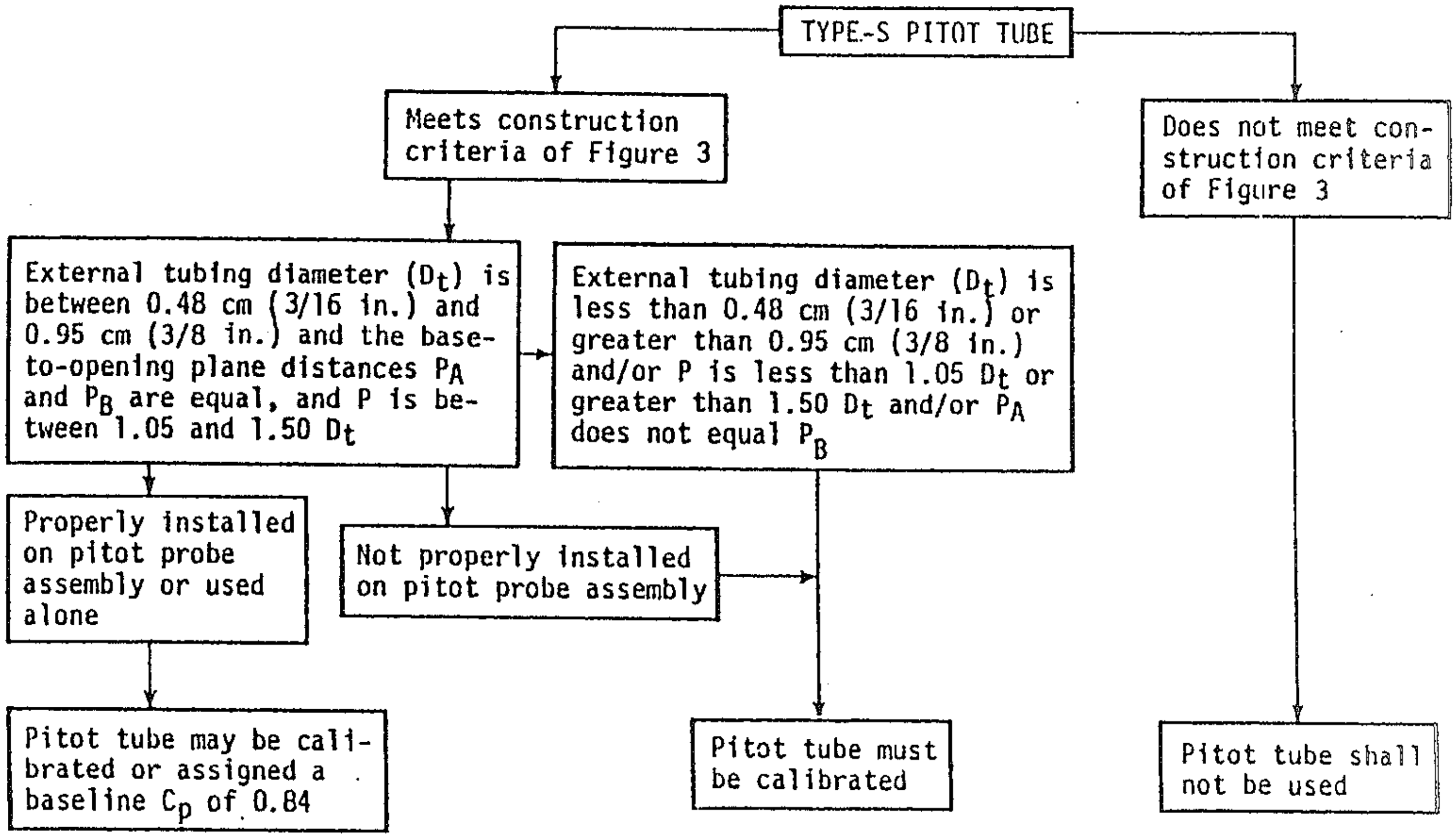


Figure 1. Procedures for determining the calibration coefficients of Type-S pitot tubes.

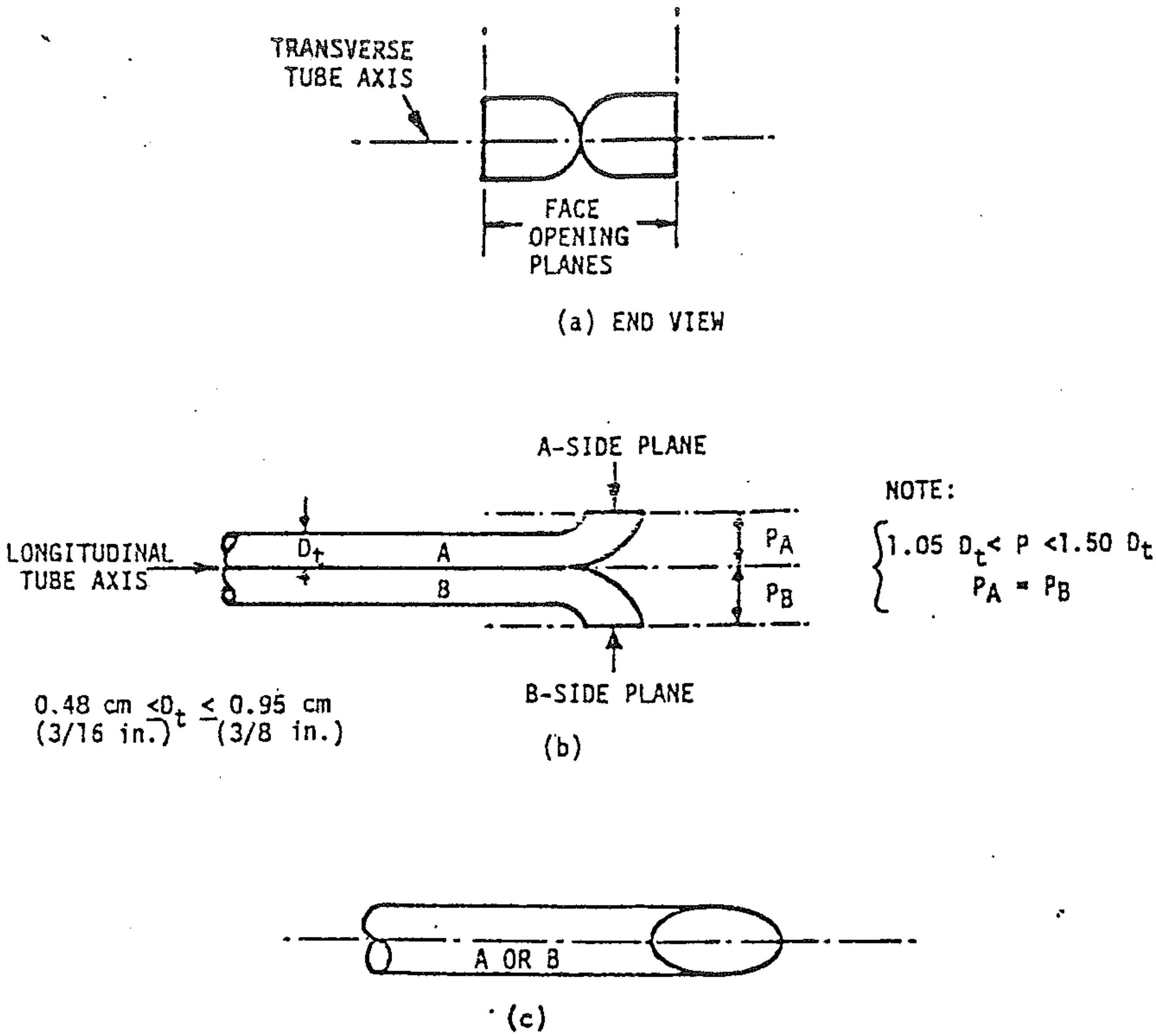


Figure 2. Properly constructed Type-S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening plans parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient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

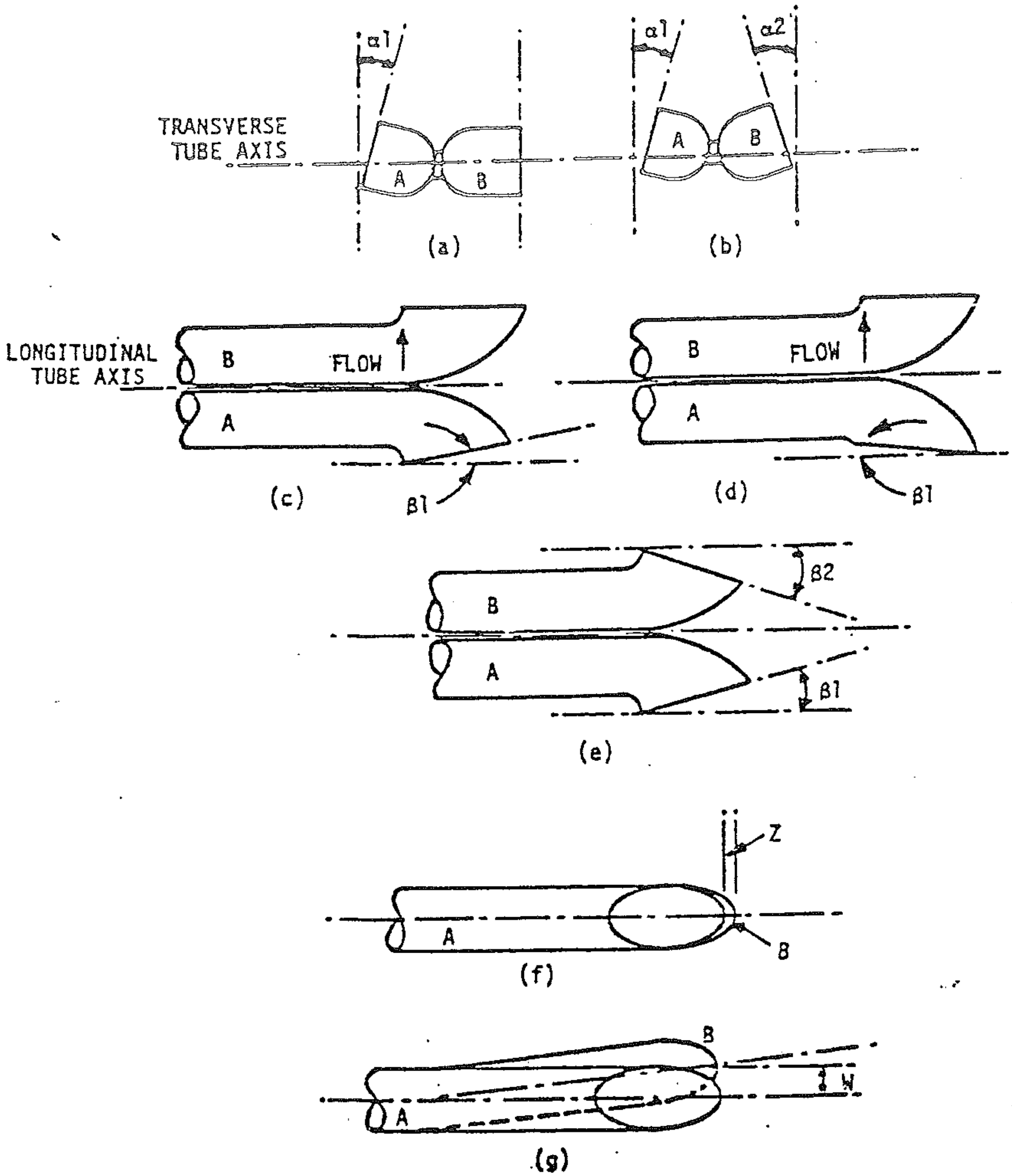


Figure 3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp as long as a_1 and a_2 <10°, β_2 <5°, z <0.32 cm (1/8 in.) and w <0.08 cm (1/32 in.).

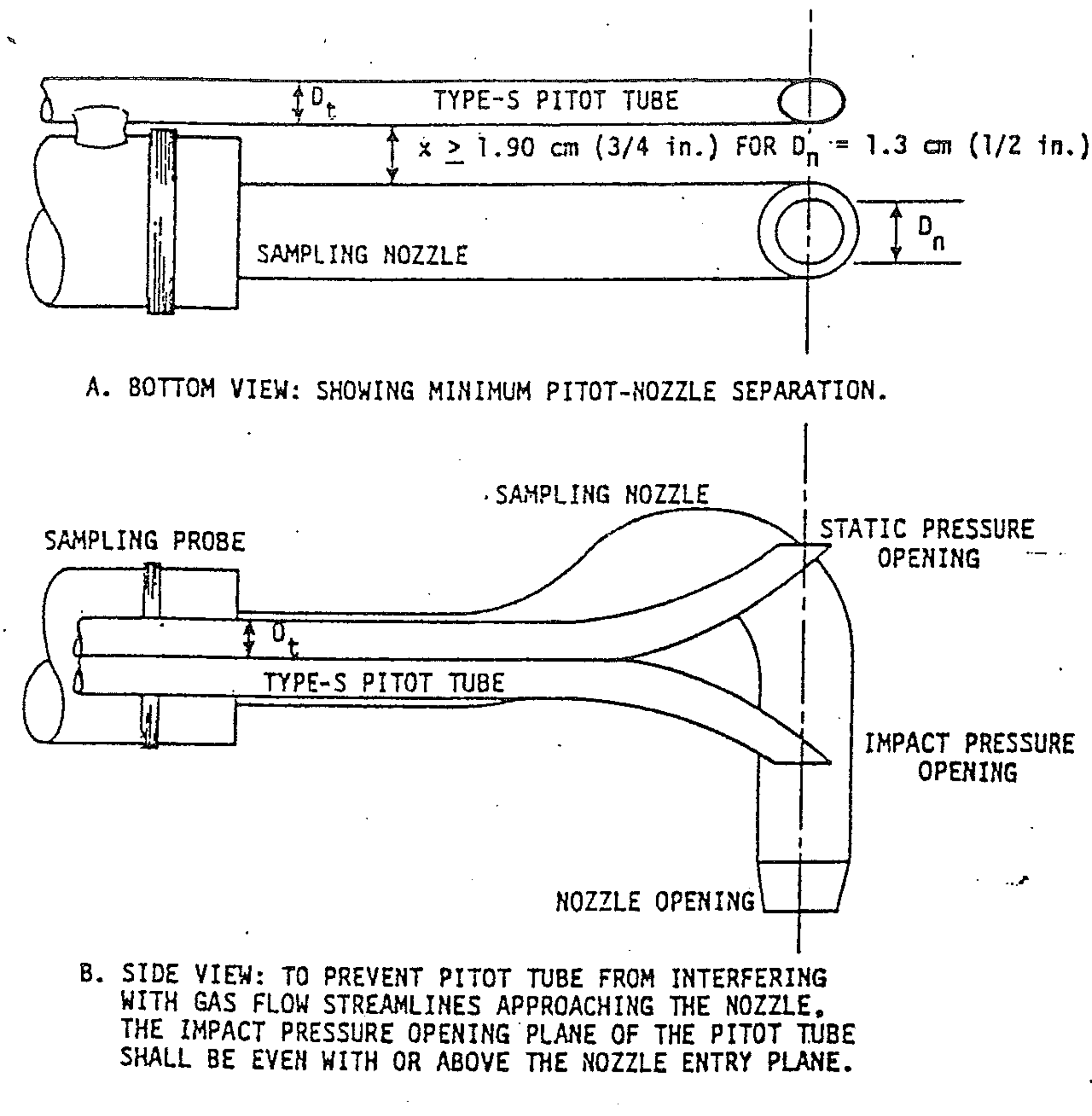


Figure 4. Required pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

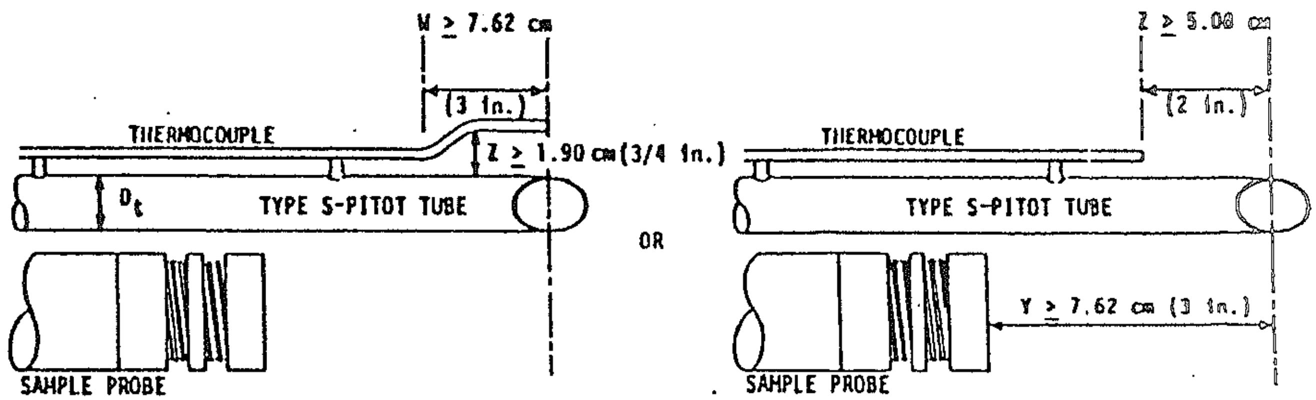


Figure 5. Required thermocouple and probe placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

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

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

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

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

4. Measure distances P_A and P_B with a micrometer.

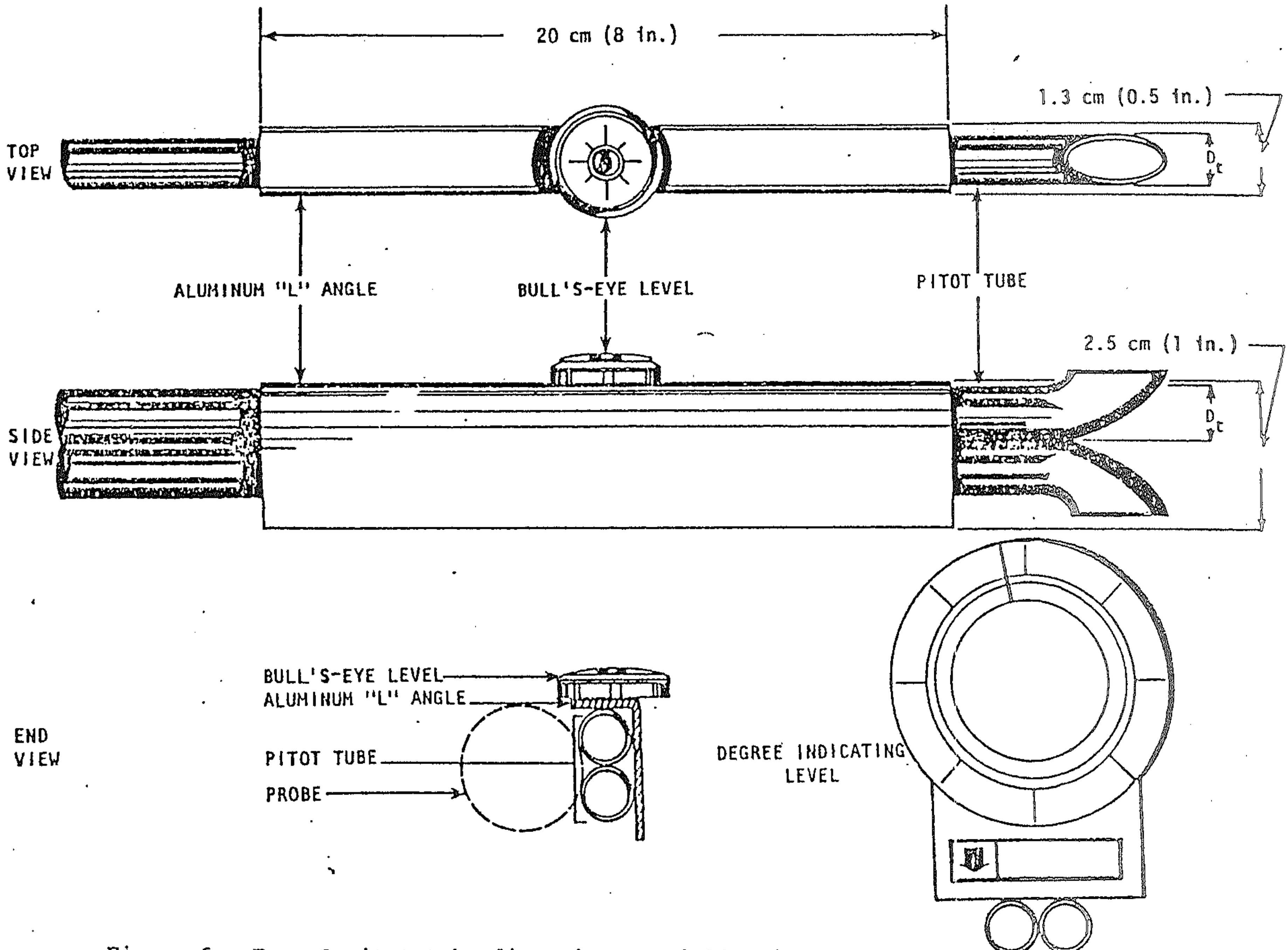


Figure 6. Type S pitot tube dimension specialization measurements.

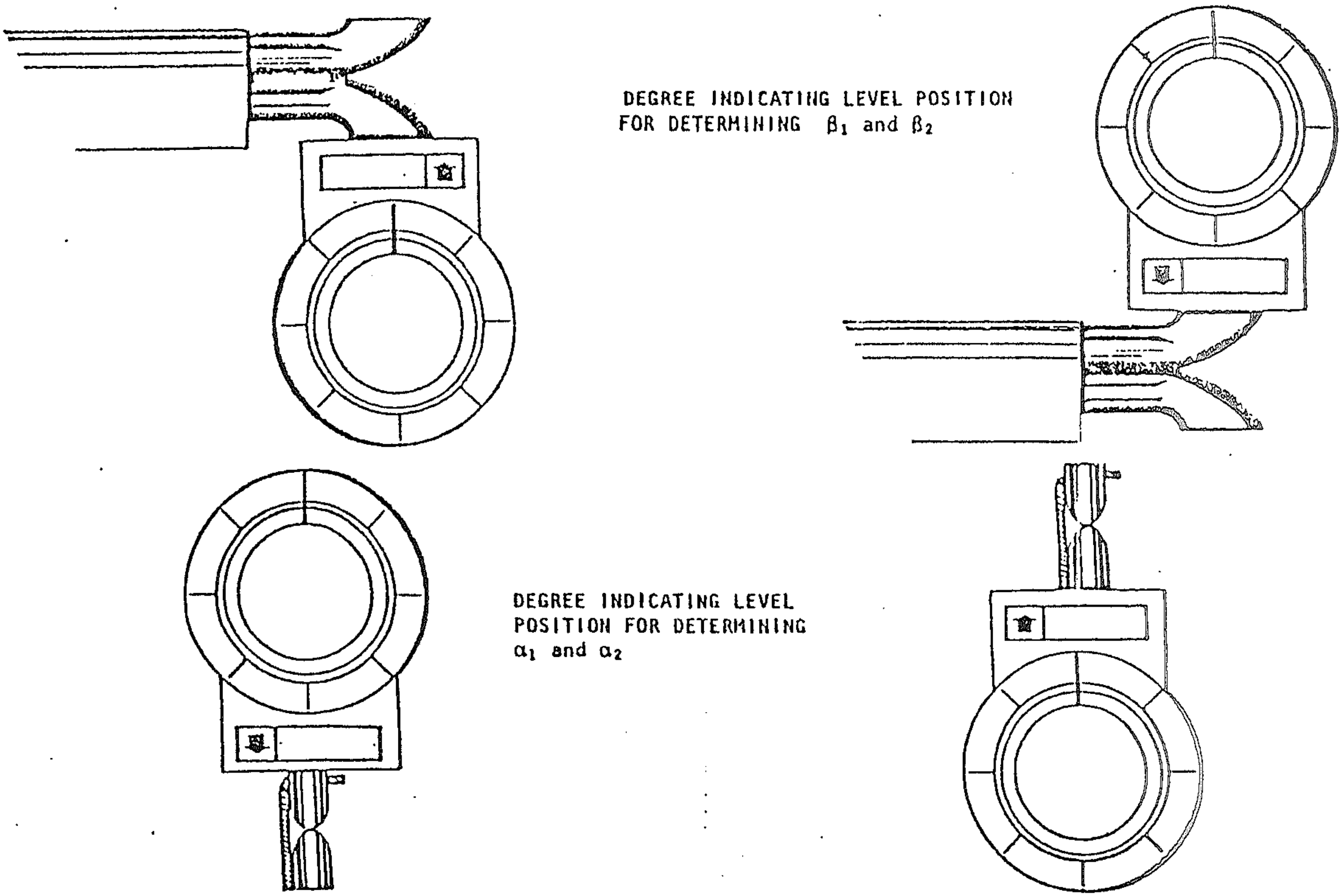
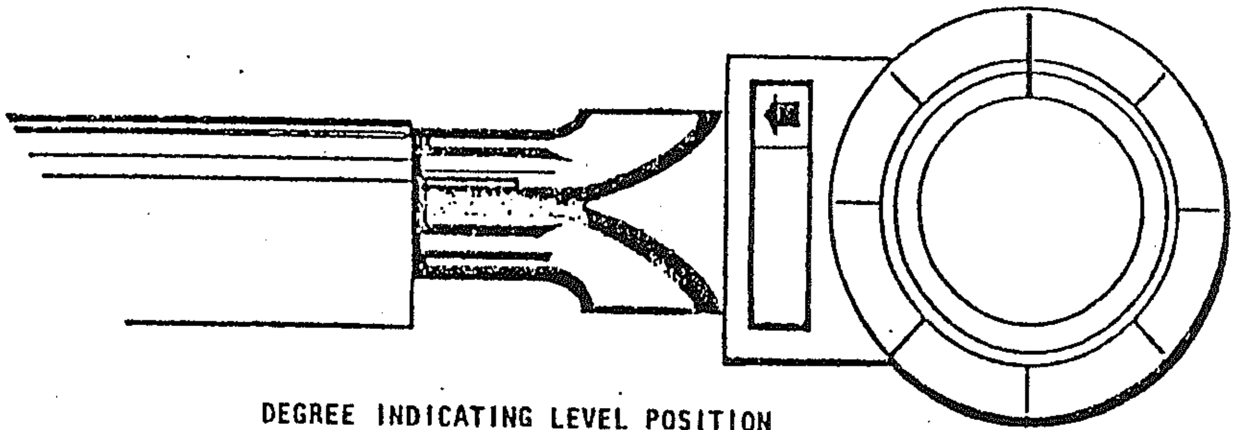


Figure 7. Position of dimension measurement.



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

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

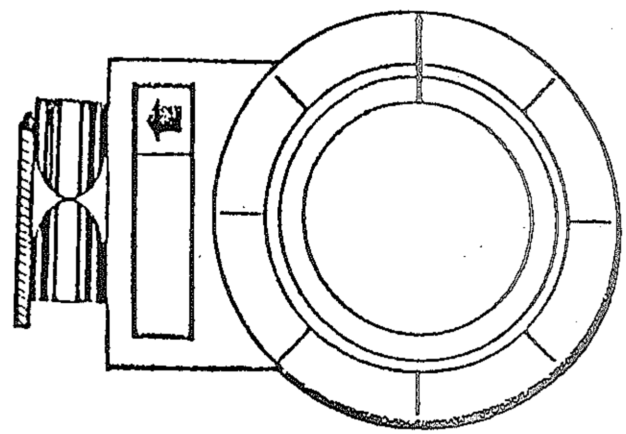


Figure 8. Position of dimension measurement.

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

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

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

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

where,

w = alignment dimension, cm (in.)

z = alignment dimension, cm (in.)

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

θ = angle in degrees

γ = angle in degrees.

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

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

References

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

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

Date: 1/5/2021

Pitot Tube Assembly: P5-04 Caliper ID: CP-02

Performed by: SS

Pitot tube assembly level? x yes ___ no

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

α_1 = 0 °(<10°) β_1 = 2 °(<5°)

α_2 = 0 °(<10°) β_2 = 1 °(<5°)

γ = 2 ° θ = 0 ° A = 0.92 in.

z = A sin γ = 0.0321 in. <1/8 in. (0.125 in.)

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

P_A = 0.460 in. **P_B =** 0.460 in.

D_t = 0.375 cm (in.) **P / D_t =** 1.23 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 1 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 3.31 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.65 (>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: 1/5/2021

Pitot Tube Assembly: P4-01 Caliper ID: CP-02

Performed by: SS

Pitot tube assembly level? X yes ____ no

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

α_1= 2 ^{o}(<10^o) β_1= 1 ^{o}(<5^o)

α_2= 2 ^{o}(<10^o) β_2= 2 ^{o}(<5^o)

γ = 2 1 ^{o} A= 0.97 in.

z = A sin γ = 0.0338 in. <1/8 in. (0.125 in.)

w = A sin θ = 0.0169 in. <1/32 in. (0.03125 in.)

P_A= 0.485 in. P_B= 0.485 in.

D_t = 0.385 cm (in.) **P / D_t =** 1.26 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 1.1 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 3.52 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.27 (>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: 1/5/2021

Pitot Tube Assembly: P7-01 Caliper ID: CP-02

Performed by: SS

Pitot tube assembly level? x yes ____ no

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

α_1 = 1 °(<10°) β_1 = 0 °(<5°)

α_2 = 0 °(<10°) β_2 = 0 °(<5°)

γ = 1 ° θ = 0 ° A= 0.93 in.

z = A sin γ = 0.0162 in. <1/8 in. (0.125 in.)

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

P_A= 0.465 in. **P_B=** 0.465 in.

D_t = 0.375 cm (in.) **P / D_t =** 1.24 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 1.11 (>0.75 in.) (Dist. between pitot and nozzle)

Y = 3.71 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)

Z = 2.03 (>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: 1/5/2021

Pitot Tube Assembly: P7-02 Caliper ID: CP-02

Performed by: SS

Pitot tube assembly level? x yes ____ no

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

α_1= 0 ^{o}(<10^o) β_1= 1 ^{o}(<5^o)

α_2= 1 ^{o}(<10^o) β_2= 0 ^{o}(<5^o)

γ = 1 ^{o} θ = 1 ^{o} A= 1 in.

z = A sin γ = 0.0174 in. <1/8 in. (0.125 in.)

w = A sin θ = 0.0174 in. <1/32 in. (0.03125 in.)

P_A= 0.500 in. **P_B=** 0.500 in.

D_t = 0.375 cm (in.) **P / D_t =** 1.33 (1.05 </= and </= 1.50)

$P_a = P_b = P$

X = 1.57 (>0.75 in.) (Dist. between pitot and nozzle)
Y = 3.75 (>3.0 in.) (Dist. from nozzle union to pitot tube openings)
Z = 1.2 (>0.75 in.) (Dist. between pitot and stack thermocouple)

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

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

APPENDIX C

LABORATORY ANALYTICAL REPORT

eurofins | Air Toxics

1/11/2021
Mr. Robert DeMott
Ramboll Environ
10150 Highland Manor Drive
Suite 440
Tampa FL 33610

Project Name: K&S Bard
Project #: 1690014483
Workorder #: 2101012

Dear Mr. Robert DeMott

The following report includes the data for the above referenced project for sample(s) received on 1/4/2021 at Eurofins Air Toxics LLC.

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

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

Regards,

Brian Whittaker

Brian Whittaker
Project Manager

eurofins | Air Toxics

WORK ORDER #: 2101012

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. #**	
FAX:	813-628-4983	**PROJECT #**	1690014483 K&S Bard
DATE RECEIVED:	01/04/2021	**CONTACT:**	Brian Whittaker
DATE COMPLETED:	01/11/2021		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	SYS-S2 20201231	Modified TO-15 SIM	8.5 "Hg	5 psi
02A	SYS-S3 20201231	Modified TO-15 SIM	7.5 "Hg	5 psi
03A	SYS-S5 20201231	Modified TO-15 SIM	7.5 "Hg	5 psi
04A	SYS-STACK 20201231	Modified TO-15 SIM	6.5 "Hg	5 psi
05A	SYS-STACK DUP 20201231	Modified TO-15 SIM	6.0 "Hg	5 psi
05AA	SYS-STACK DUP 20201231 Lab Duplicate	Modified TO-15 SIM	6.0 "Hg	5 psi
06A	Lab Blank	Modified TO-15 SIM	NA	NA
07A	CCV	Modified TO-15 SIM	NA	NA
08A	LCS	Modified TO-15 SIM	NA	NA
08AA	LCSD	Modified TO-15 SIM	NA	NA

CERTIFIED BY: Heidi Hayes DATE: 01/11/21

Technical Director

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

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

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LABORATORY NARRATIVE
EPA TO-15 Ethylene oxide (SIM)
Ramboll Environ
Workorder# 2101012

Five 6 Liter Summa Canister (EO) samples were received on January 04, 2021. The laboratory performed analysis via EPA Method TO-15 using GC/MS in the SIM acquisition mode for the measurement of Ethylene oxide in ambient air.

Receiving Notes

There were no receiving discrepancies.

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 half the Reporting Limit for Ethylene Oxide. Concentrations that are below the level at which the canister was certified may be false positives.

Dilution was performed on samples SYS-S2 20201231, SYS-S3 20201231 and SYS-S5 20201231 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:	SYS-S2 20201231		
Lab ID:	2101012-01A	**Date/Time Analyzed:**	1/6/21 07:07 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	7.48
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010614sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.14	D	0.67	210

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:	SYS-S3 20201231		
Lab ID:	2101012-02A	**Date/Time Analyzed:**	1/6/21 07:39 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	7.15
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010615sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.13	D	0.64	1100

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS-S5 20201231		
Lab ID:	2101012-03A	**Date/Time Analyzed:**	1/6/21 08:10 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	7.15
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010616sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.13	D	0.64	110

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS-STACK 20201231		
Lab ID:	2101012-04A	**Date/Time Analyzed:**	1/6/21 06:35 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	1.71
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010613sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.032	D	0.15	36

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	SYS-STACK DUP 20201231		
Lab ID:	2101012-05A	**Date/Time Analyzed:**	1/6/21 05:25 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	1.68
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010611sim

Compound	CAS#	MDL (ug/m3)	LOD (ug/m3)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethylene Oxide	75-21-8	0.031	D	0.15	37

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:	SYS-STACK DUP 20201231 Lab Duplicate		
Lab ID:	2101012-05AA	**Date/Time Analyzed:**	1/6/21 06:00 PM
Date/Time Collected:	12/31/20 01:52 PM	**Dilution Factor:**	1.68
Media:	6 Liter Summa Canister (EO)	**Instrument/Filename:**	msd30.i / 30010612sim

Compound	**CAS#**	**MDL (ug/m3)**	**LOD (ug/m3)**	**Rpt. Limit (ug/m3)**	**Amount (ug/m3)**
Ethylene Oxide	75-21-8	0.031	D	0.15	37

D: Analyte not within the DoD scope of accreditation.

MODIFIED EPA METHOD TO-15 GC/MS SIM
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Client ID:	Lab Blank		
Lab ID:	2101012-06A	**Date/Time Analyzed:**	1/6/21 12:08 PM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30010605sim

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

D: Analyte not within the DoD scope of accreditation.

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

Client ID:	CCV		
Lab ID:	2101012-07A	**Date/Time Analyzed:**	1/6/21 10:29 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30010602sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	108

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:	2101012-08A	**Date/Time Analyzed:**	1/6/21 11:01 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30010603sim

Compound	CAS#	%Recovery
Ethylene Oxide	75-21-8	92

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:	2101012-08AA	**Date/Time Analyzed:**	1/6/21 11:33 AM
Date/Time Collected:	NA - Not Applicable	**Dilution Factor:**	1.00
Media:	NA - Not Applicable	**Instrument/Filename:**	msd30.i / 30010604sim

Compound	**CAS#**	**%Recovery**
Ethylene Oxide	75-21-8	91

D: Analyte not within the DoD scope of accreditation.

* % Recovery is calculated using unrounded analytical results.

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Analysis Request /Canister Chain of Custody

For Laboratory Use Only

PID: ______ Workorder #: 2101012

180 Blue Ravine Rd. Suite B, Folsom, CA 95630
Phone (800) 985-5955; Fax (916) 351-8279

Click links below to view:
Canister Sampling Guide
Helium Shroud Video

Client: Ramboll PID:
Project Name: K&S Bard
Project Manager: Robert DeMott P.O.# 1690014483
Sampler: K. Cole / K Hitchcock
Site Name: K&S Bard

Special Instructions/Notes:

Turnaround Time (Rush surcharges may apply): RUSH

Lab ID	Sample Identification	Can #	Flow Controller #	Start Sampling Information Date	Start Sampling Information Time	Stop Sampling Information Date	Stop Sampling Information Time	Canister Vacuum/Pressure Initial (in Hg)	Canister Vacuum/Pressure Final (in Hg)	Lab Use Only Receipt	Lab Use Only Final (psig) Gas: N_2 / He	Requested Analyses: Ethylene Oxide	Requested Analyses: 2,5-Dimethyl Furan		
01A	SYS-S2 20201231	6L1220	23990	12/31/2020	0952	12/31/2020	1352	28	8.25			X			
02A	SYS-S3 20201231	6L1496	23997	12/31/2020	0952	12/31/2020	1352	26.5	7.8			X			
03A	SYS-S5 20201231	6L1647	23991	12/31/2020	0952	12/31/2020	1352	28	6.5			X			
04A	SYS-STACK 20201231	6L0559	23992	12/31/2020	0952	12/31/2020	1352	27.5	6.5			X			
05A	SYS-STACK DUP 20201231	6L0979	23746	12/31/2020	0952	12/31/2020	1352	28	5.5			X			

Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
[signature]	12-31-2020	1740	[signature]	1/4/21	1020

Lab Use Only

Shipper Name: FedEx | Custody Seals Intact? Yes No None (circled) | Good

Sample Transportation Notice: Relinquishing signature on this document indicates that samples are shipped in compliance with all applicable local, State, Federal, and international laws, regulations, and ordinances of any kind. Relinquishing signature also indicates agreement to hold harmless, defend, and indemnify Eurofins Air Toxics against any claim, demand, or action, of any kind, related to the collection, handling, of shipping of samples. D.O.T Hotline (800) 467-4922

LABSAMPID	LABCODE	MATRIX	METHOD	CLIENTSAMPID	SAMPDATET	ANALDATE	ANALTIME	LABCTLID	DILUTION	REPLMT	UNITS	RESULTS	DATAFLAGS	REPLMT (ug/m	UNITS (ug/n	RESULTS (ug/n	DATAFLAGS	COMPOUND NAME	CASNUM	COMMENTS
2101012-01A	ATL	AIR	TO-15	SYS-S2 20201231	12/31/2020	01/06/2021	1907	msd3006JAN21	7.48	0.67	UG/M3	210		0.67	UG/M3	210		Ethylene Oxide	75-21-8	
2101012-02A	ATL	AIR	TO-15	SYS-S3 20201231	12/31/2020	01/06/2021	1939	msd3006JAN21	7.15	0.64	UG/M3	1100		0.64	UG/M3	1100		Ethylene Oxide	75-21-8	
2101012-03A	ATL	AIR	TO-15	SYS-S5 20201231	12/31/2020	01/06/2021	2010	msd3006JAN21	7.15	0.64	UG/M3	110		0.64	UG/M3	110		Ethylene Oxide	75-21-8	
2101012-04A	ATL	AIR	TO-15	SYS-STACK 20201231	12/31/2020	01/06/2021	1835	msd3006JAN21	1.71	0.15	UG/M3	36		0.15	UG/M3	36		Ethylene Oxide	75-21-8	
2101012-05A	ATL	AIR	TO-15	SYS-STACK DUP 20201231	12/31/2020	01/06/2021	1725	msd3006JAN21	1.68	0.15	UG/M3	37		0.15	UG/M3	37		Ethylene Oxide	75-21-8	
2101012-05AA	ATL	AIR	TO-15	SYS-STACK DUP 20201231 Lab	12/31/2020	01/06/2021	1800	msd3006JAN21	1.68	0.15	UG/M3	37		0.15	UG/M3	37		Ethylene Oxide	75-21-8	
2101012-06A	ATL	AIR	TO-15	Lab Blank	00:00	01/06/2021	1208	msd3006JAN21	1.00	0.090	UG/M3		ND	0.090	UG/M3		ND	Ethylene Oxide	75-21-8	
2101012-07A	ATL	AIR	TO-15	CCV	00:00	01/06/2021	1029	msd3006JAN21	1.00		%R	108			%R	108		Ethylene Oxide	75-21-8	
2101012-08A	ATL	AIR	TO-15	LCS	00:00	01/06/2021	1101	msd3006JAN21	1.00		%R	92			%R	92		Ethylene Oxide	75-21-8	
2101012-08AA	ATL	AIR	TO-15	LCSD	00:00	01/06/2021	1133	msd3006JAN21	1.00		%R	91			%R	91		Ethylene Oxide	75-21-8	