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40 CFR Part 75 CEMS Relative Accuracy Test Audit Report

EUBOILER1 and EUBOILER2

Consumers Energy Company
J.H. Campbell Plant
17000 Croswell Street
West Olive, Michigan 49460
SRN: B2835
ORIS: 1710

June 11, 2023

Test Dates: May 1 through 4, 2023

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 41142651

CERTIFICATION FOR 40 CFR PART 75 TEST REPORT

(To be completed by authorized AETB firm representative and included in source test report)

Facility ID: ORIS 1710; SRN B2835 Date(s) Tested May 1-4, 2023

Facility Name: J.H. Campbell Generating Complex Unit 1 and 2

Facility Address: 17000 Croswell Street, West Olive, MI 49460

Equipment Tested: EUBOILER1&2; SO2, NOx-Diluent, CO2, and Volumetric Flow CEMS

AETB Firm: CECo/RCTS AETB

Business Address: 135 W. Trail St., Jackson MI 49201

Phone: (616) 738-3234 Email: thomas.schmelter@cmsenergy.com

As the legally authorized representative of the RCTS AETB, I certify that I have reviewed this test report in conjunction with the relevant Quality Manual Appendix D checklist. Having checked each item, I believe the information provided in this test report is true, accurate, and complete.

Signature: Thomas Schmelter Digitally signed by Thomas Schmelter Date: 2023.06.11 07:53:42 -04'00' Date: June 11, 2023

Name: Thomas R. Schmelter Title: AETB Technical Director

Phone: (616) 738-3234 Email: thomas.schmelter@cmsenergy.com

RELATIVE ACCURACY TEST REPORT CHECKLIST

	Description (Typical location(s) in report) [ASTM D 7036-04 Section Reference]
☑	Title (Title Page) [15.3.1]
☑	AETB name & address (QM App. D pg. D-2) [15.3.2]
☑	Unique identification number on each page and a clear identification of the end of the report (Headers & Footers; "End of Report" page) [15.3.3]
☑	Name and address of the customer (Title Page; QM App. D pg. D-2) [15.3.4]
☑	Date(s) the testing was performed (Title page; Introduction; QM App. D pg. D-2) [15.3.10]
☑	Identification of the units tested (Title page; Introduction) [15.3.9]
☑	Identification of regulatory personnel that observed testing (Introduction; Appendix D1) [Note 13]
☑	Clear identification of the pollutants/parameters tested (Summary & Discussion) [15.3.5]
☑	Identification of the test methods used (Sampling and Analytical Procedures) [15.3.8]
☑	Identification of the sampling location, including diagrams, sketches, or photographs (Figures) [15.3.6]
☑	Detailed process description and process operations for each test run (Source and Monitor Description; Appendix B CEMS data sheets) [15.3.7]
☑	Reference to the test protocol and procedures used by the AETB (Introduction) [15.3.11]
☑	Test results and units of measure (Summary and Discussion) [15.3.12]
☑	Information on specific test conditions, including text description of process operations for each test run and description of any operational issues with the unit or the control device (Discussion of Test Results) [15.3.14]
☑	Discussion of the test results including the uncertainty associated with the test and discussion of possible errors or limiting conditions (Quality Assurance Procedures) [15.3.15]
☑	Reference Method analyzer calibrations for each RM gas RATA run. (Appendix B) [15.3.16]
☑	Raw plant CEMS data for each RATA run and each CEMS component (i.e. all gas analyzers, flow monitors). (Appendix B) [15.3.17]
☑	Raw Reference Method DAS data for each RM gas RATA run. (Appendix B) [15.3.17]
☑	CEMS "Operating Load Analysis" report. (Appendix C) [15.3.11]
☑	Meter box post-test calibration results (Appendix C) [15.3.16]
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☑	FRRS/manometer/Magnehelic gage calibration results (Appendix C) [15.3.16]
☑	Reference Method calibration gas certificates of analysis (Appendix C) [15.3.16]
☑	RATA field data sheets verified against spreadsheet data (Field data sheets in project file) [15.3.17]
☑	RCTS AETB Letter of Certification (Appendix D1) [15.3.19]
☐	Completed QM Appendix F – "AETB Field Test Signature Form" (Appendix D1) [3.1.3; 3.1.9; 3.1.14; 8.3; Note 14; 12.2; 12.3; 12.4; 14.1.1]
☑	Deviations from, additions to, or exclusions from the test protocol, test methods, or AETB Quality Manual entered on QM App. F pg. F-2 (Appendix D2) [15.3.13]
☑	Names, titles, and signatures of persons authorizing the test report – "QM App. D pg. D-2" (After Title Page) [15.3.18]
☑	QSTI certificates for Qualified Individuals overseeing/performing the test (Appendix D2)
☑	Table of Contents is correct (Report Body) [Neatness & professionalism]
☑	Report Headers & Footers are correct (Report Body) [Neatness & professionalism]
☑	RM and CEMS run data in correct order (Appendix B) [Neatness & professionalism]

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1.0 INTRODUCTION

Consumers Energy Company (CECo), Regulatory Compliance Testing Section (RCTS) conducted continuous emission monitoring systems (CEMS) quality assurance (QA) audits associated with emission units EUBOILER1 and EUBOILER2 operating at the J.H. Campbell Generating Complex located in West Olive, Michigan.

The relative accuracy test audits (RATA) conducted on May 1 through 4, 2023, satisfy requirements in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-B2835-2020b, Appendix 3, that incorporates requirements of United States Environmental Protection Agency (USEPA) Title 40, Code of Federal Regulations (40 CFR) Part 75, Appendices A and B. The 40 CFR Part 75 required monitoring plans designate EUBOILER1 as Unit/stack name: 1 and EUBOILER2 as Unit/stack name: 2.

A test protocol describing the sampling, calibration, and QA procedures in USEPA Reference Methods (RM) 1, 2, CTM-041, 3, 3A, ALT-008, 4, 6C, 7E, and 19, in conjunction with Performance Specifications (PS) 2 (for the SO_2 lb/mmBtu RATA) and 40 CFR 75, Appendices A and B, was submitted March 29, 2023 to the USEPA Region 5 and EGLE offices. The protocol was subsequently approved in a letter dated April 13, 2023, by EGLE representative Ms. Lindsey Wells.

The CEMS audits were performed by RCTS representatives Joe Gallagher, Dillon King and Thomas Schmelter. Mr. Kevin Starken, Supervisor - Engineering Support, and Mr. Roger Vargo, Senior Technician, with the J.H. Campbell Generating Complex coordinated the tests with applicable plant personnel and provided support. The field test was not witnessed by EGLE representatives.

RCTS operates as a self-accredited Air Emission Testing Body (AETB) as described in the AETB Letter of Certification contained in Appendix D of this report and is accordingly qualified to conduct 40 CFR Part 75 test programs. RCTS' AETB program is developed in accordance with the American Society for Testing and Materials (ASTM) D 7036-04, *Standard Practice for Competence of Air Emissions Testing Bodies*, in which the AETB is required during test projects to provide at least one qualified individual (QI), qualified in the specific methods for that project, to be on-site at all times. RCTS representatives Mr. King and Mr. Schmelter met these requirements and assumed the on-site lead QI roles for the duration of the Flow and Gas CEMS audits, respectively.

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Table 1-1 presents the test program organization, major lines of communication, and names of responsible individuals.

Table 1-1
Contact Information

Program Role	Contact	Address
EPA Regional Contact	Michael Compher 312-886-5745 compher.michael@epa.gov	USEPA Region 5 77 W. Jackson Blvd. (AR-18J) Chicago, Illinois 60604
EGLE AQD Emissions Measurement Representative	Mr. Jeremy Howe Technical Programs Unit Environmental Manager 231-878-6687 howej1@michigan.gov	EGLE Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933-1502
EGLE AQD Site Inspector	Mr. Michael Cox Environmental Quality Analyst 616-240-3607 coxm9@michigan.gov	EGLE Grand Rapids District Office 350 Ottawa Avenue NW, Unit 10 Grand Rapids, Michigan 49503-2316
Responsible Official	Mr. Nathan J. Hoffman Director of Plant Operations 616-738-5436 nathan.hoffman@cmsenergy.com	Consumers Energy Company J.H. Campbell Power Plant 17000 Croswell Street West Olive, Michigan 49460
Site Environmental	Mr. Kevin Starken Supervisor – Engineering Support 616-738-3241 kevin.starken@cmsenergy.com	
CEMS Technician	Mr. Roger Vargo Sr. Technician 616-738-3270 roger.vargo@cmsenergy.com	
Test Team Representative	Mr. Joseph Gallagher, QSTI Engineering Technical Analyst 989-450-9420 joseph.gallagher@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460
	Mr. Dillon King, QSTI Sr. Engineering Technical Analyst 989-891-5585 dillon.king@cmsenergy.com	Consumers Energy Company Saginaw Service Center 2400 Weiss St Saginaw, Michigan 48602

2.0 SUMMARY AND DISCUSSION

The J.H. Campbell EUBOILER1 and EUBOILER2 volumetric airflow, carbon dioxide (CO_2), oxides of nitrogen (NO_x), and sulfur dioxide (SO_2) CEMS relative accuracy (RA) results indicate the CEMS meet the semi-annual RA frequency standards in 40 CFR 75, Appendix A and the annual reduced RA test frequency incentives in 40 CFR 75, Appendix B. In addition, the CEMS RA results comply with the Appendix 3 Monitoring Requirements in EGLE ROP MI-ROP-B2835-2020b. Results are presented in Tables 2-1 through 2-4 and Appendix B of this report.

RA equations and other applicable sample calculations are presented in Appendix A. Comprehensive test data are presented in Appendix B.

2.1 Wall Adjustment Factor

Prior to performing the May 2016 volumetric flowrate RATAs, the magnitude of flue gas velocity decay near the rectangular duct walls was determined using USEPA CTM-041, *Determination of Volumetric Gas Flow in Rectangular Ducts or Stacks Taking into Account Velocity Decay near the Stack or Duct Walls* to evaluate and calculate a site-specific wall effect adjustment factor (WAF). The results of those tests yielded a Unit 1 WAF of 0.9804 and Unit 2 WAF of 0.9547, which when applied to the CEMS flow monitors, adjusts the duct area accordingly when calculating volumetric flow rates.

CTM-041 rectangular duct criteria allow a single operating load WAF to be applied for all operating loads and subsequent tests, unless the affected ductwork configuration was changed. As there have been no Unit 1 and Unit 2 ductwork changes, the previously established WAFs continue to be utilized.

Accordingly, when reviewing the Appendix B RM 2 volumetric flow data, note the flue duct length and width dimensions measured in feet vs. calculated square foot area do not directly align. Specifically, the "Flue Duct Dimensions (ft.)" entry represents the physical inner flue duct dimensions, while the "Flue Area (ft^2)" entry represents the WAF adjusted flow area. For example, Unit 2 measures 9.5 feet by 28.4271 feet, or an actual physical area of 270.06 ft^2, which when multiplied by the respective 0.9547 WAF yields an area of 257.82 ft^2.

2.2 Volumetric Flowrate

The flow monitoring system on each duct consists of two ultrasonic volumetric air flow monitors configured in an X-pattern. These monitors are referred to as Unit 1 A Monitor (monitoring plan system identification 141, component identification F01), Unit 1 B Monitor (142, F02), Unit 2 A Monitor (241, F01), and Unit 2 B Monitor (242, F02). In this configuration, the dual monitor data is averaged to report primary volumetric flow (Unit 1 = System 140; Unit 2 = System 240) and calculate continuous emissions, while each individual flow monitor also operates as a redundant backup. The data acquisition and handling system (DAHS) assigns the individual monitors for Unit 1 as FLO1ABAK and FLO1BBAK, with the average of both as primary flow U1FLOW and for Unit 2 as FLO2ABAK and FLO2BBAK, with the average of both as primary flow U2FLOW. Relative accuracy test audits were performed on the primary system and each individual redundant backup system.

Volumetric flowrate RA was determined at two distinct operating loads, High and Mid at Unit 2. Volumetric flowrate RA was determined at three load levels at Unit 1 to fulfill the requirements of 40 CFR 75, Appendix B, §2.3.1.3(c)(4), *A 3-load Flow RATA…shall be performed at least once every 20 consecutive calendar quarters…* The most recent Unit 1, 3-load flow RATA was performed during the 2nd quarter of 2018. Trial runs evaluated the need to optimize, if necessary, the primary and both individual redundant backup flow CEMS, as allowed in 40 CFR 75, Appendix B §2.3.2(b)(2). All trial flow run results differed by no more than ±10% of the average RM value, which met the trial run RA criterion in 40 CFR 75.20(b)(3)(vii)(E)(2), thereby allowing the trial runs to be incorporated into the 12-run flow RATA result at each operating load.

The flow RATA results for each CEMS system met the annual reduced test frequency incentive standard of ≤7.5% in 40 CFR 75, Appendix B §2.3.1.2(c). Table 2-1 summarizes the volumetric airflow RATA results.

Table 2-1
Summary of Volumetric Air Flow RATA Results

CEMS Make/ Model	CEMS Duct Location & Serial Number	RATA Criteria	Required RATA Performance	Actual RATA Performance		
				Primary (A & B)	A Monitor	B Monitor
Teledyne Monitor Labs Model 150	Unit 1 A Monitor SN 1501592 B Monitor SN 1501571	Low Load	≤ 10% of mean RM	0.90%	1.43%	2.77%
		Mid Load		2.52%	2.67%	2.41%
		High Load		3.24%	4.80%	1.69%
		Bias†	|d| ≤ |CC| = Pass	1.023	1.042	Pass
Teledyne Monitor Labs Model 150	Unit 2 A Monitor SN 1501593 B Monitor SN 1501572	Mid Load	≤ 10% of mean RM	4.72%	3.03%	6.35%
		High Load		5.54%	3.83%	7.25%
		Bias†	|d| ≤ |CC| = Pass	Pass	Pass	Pass

|d| average absolute difference between the RM and CEMS
|CC| confidence coefficient
† highest bias measured at normal or second load level is presented

2.3 SO_2 Gas RATA

The facility operates SO_2 dilution in-stack pulsed fluorescence CEMS at the exhaust duct of each unit to report continuous emissions. The SO_2 concentrations (ppm) are used in conjunction with flow data to support 40 CFR Part 75 mass emissions reporting and assess compliance with rolling SO_2 emission limits. The lb/mmBtu emission rates are used to evaluate compliance with the R 336.1401(3) SO_2 emission limits. Because the R 336.1401(3) SO_2 emission standard is greater than 0.30 lb/mmBtu and the reference method measured less than 50% of emission standard at both units, the 1.67 lb SO_2/mmBtu rolling average emission limit was used as the denominator in calculation of CEMS relative accuracy.

The SO_2 ppm RATA results met the ≤10% RA specification in 40 CFR 75, Appendix A §3.3.1(a) and the reduced RATA test frequency incentive standard of ≤7.5% RA in 40 CFR 75, Appendix B §2.3.1.2(a). The SO_2 lb/mmBtu RATA results met the ≤10% RA criterion, when the emission limit is used as the denominator in the RA calculation, as required by 40 CFR 60, Appendices B and F. Table 2-2 summarizes the SO_2 RATA results.

Table 2-2
Summary of SO_2 RATA Results

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required RATA Performance	Actual RATA Performance
Thermo SO_2 Model 43i	Unit 1 SN 1153170023	ppm	≤10% of mean RM or ±15.0 ppm RM-CEMS difference	1.05%
				-0.122 ppm
		Bias (ppm)	|d|≤|CC|=Pass	Pass
		lb/mmBtu[1, 2]	≤10% of emission limit	0.64%

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required RATA Performance	Actual RATA Performance
Thermo SO_2 Model 43i	Unit 2 SN 1153170027	ppm	≤10% of mean RM or ±15.0 ppm RM-CEMS difference	2.96%
				-0.833 ppm
		Bias (ppm)	$\lvert d \rvert \leq \lvert CC \rvert$=Pass	Pass
		lb/mmBtu[1, 2]	≤10% of emission limit	0.74%

|d| average absolute difference between the RM and CEMS
|CC| confidence coefficient
[1] SO_2 pound per million British thermal unit (lb/mmBtu) RA is reported to comply with the EGLE Air Pollution Control (APC) Rules, Part 4, R336.1401, *Emissions of Sulfur Dioxide from Power Plants*.
[2] As the SO_2 lb/mmBtu emission limit is greater than 0.30 lb/mmBtu, and the average emissions for the test were less than 50% of the 1.67 lb/mmBtu SO_2 emission standard, the limit was used in the denominator of the percent RA calculation in lieu of the average RM value per §13.2 of 40 CFR Part 60, Appendix B, Performance Specification 2.

2.4 NO_x Gas RATA

The facility operates NO_x dilution in-stack chemiluminescence CEMS at the exhaust ducts to report continuous emissions. The NO_x emission rates (lb/mmBtu) are used in conjunction with heat input determinations (mmBtu/hr) to support 40 CFR Part 75 mass emissions reporting and to evaluate compliance with rolling NO_x emission limits.

The NO_x-diluent CEMS RA met the ≤10% RA or the ±0.020 lb/mmBtu mean difference criteria where the RM measured NO_x average emission rate is ≤0.200 lb/mmBtu of 40 CFR Part 75, App A, § 3.3.2. The NO_x-diluent CEMS also met the reduced test frequency incentives of ≤7.5% RA or ±0.015 lb/mmBtu mean difference criteria in 40 CFR Part 75, App. B §2.3.1.2(f). Table 2-3 summarizes the NO_x RATA results.

Table 2-3
Summary of NO_x RATA Results

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required RATA Performance	Actual RATA Performance
Thermo NO_x Model 42i	Unit 1 SN 0801820990	lb/mmBtu	≤10% of mean RM or ±0.020 lb/mmBtu RM-CEMS difference	2.81%
				-0.004 lb/mmBtu
		Bias	$\lvert d \rvert \leq \lvert CC \rvert$=Pass	Pass
Thermo NO_x Model 42i	Unit 2 SN 0801820991	lb/mmBtu	≤10% of mean RM or ±0.020 lb/mmBtu RM-CEMS difference	2.20%
				-0.001 lb/mmBtu
		Bias (ppm)	$\lvert d \rvert \leq \lvert CC \rvert$=Pass	Pass

|d| average absolute difference between the RM and CEMS
|CC| confidence coefficient

2.5 CO_2 GAS RATA

The facility operates CO_2 dilution in-stack non-dispersive infrared CEMS at the exhaust ducts that were evaluated during this test program. The CO_2 concentrations are used to calculate heat input and pollutant lb/mmBtu emission rates. The CO_2 RATA results met the ≤10% RA and the mean difference of no greater than ±1.0% CO_2 specifications in 40 CFR 75, Appendix A §3.3.3 and the reduced RATA test frequency incentive standard in 40 CFR 75, Appendix B §2.3.1.2(a) and (h) where the RA is ≤7.5% or the mean difference does not exceed ±0.7% CO_2, respectively. Table 2-4 summarizes the CO_2 RATA results.

Table 2-4
Summary of CO_2 RATA Results

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required Performance Criteria	Actual RATA Performance
Thermo CO_2 410i	Unit 1 SN 0801820993	%	≤10% of mean RM or ±1.0% CO_2 RM-CEMS difference	3.45%
		%		-0.378%
	Unit 2 SN 0801820994	%	≤10% of mean RM or ±1.0% CO_2 RM-CEMS difference	4.61%
		%		-0.411%

3.0 SOURCE AND MONITOR DESCRIPTION

The J.H. Campbell Plant operates one 3,237 mmBtu/hr dry bottom, tangential-fired boiler designated as EUBOILER1 (Unit 1) and one 4,270 mmBtu/hr wall-fired (converted from cell burner) boiler designated as EUBOILER2 (Unit 2). High-pressure steam from the boilers turn turbines connected to generators to produce electricity. The boilers are fired with low sulfur western sub-bituminous pulverized coal and rated to produce a maximum sustainable electricity output of 300 MW gross for Unit 1 and 400 MW for Unit 2. Unit 2 has the capability to fire a blended fuel that includes up to approximately 50% bituminous coal, and electrical output is limited to approximately 300 MW gross when firing 100% western sub-bituminous pulverized coal.

Both units use a Pulse Jet Fabric Filter, or PJFF (i.e., Baghouse), to control particulate emissions, and a Dry Sorbent Injection (DSI) system to control SO_2 and acid gas emissions. In addition, both units are equipped with low NO_x burners, including overfire air for Unit 1. A Selective Catalytic Reduction (SCR) system is used to control NO_x emissions from Unit 2.

CO_2, SO_2, NO_x, and airflow CEMS are installed in each boiler's exhaust duct. The CEMS interface with a data acquisition and handling system (DAHS) manufactured by ESC Spectrum (ESC), responsible for recording data that includes exhaust gas flow rate, concentrations, emission rates, and operating parameters. Figures 1 and 2 illustrate the CEMS locations, duct dimensions and approximate RM sampling locations.

The CEMS systems quality assured during this test program are summarized in Table 3-1.

Table 3-1
CEMS Information

Make and Model	System ID	Component ID	Span	Serial Number
EUBOILER1				
Flow Teledyne Monitor Labs Model 150	140 141 142	F01 / F02 F01 F02	58,000 KSCFH	A Monitor SN 1501592 B Monitor SN 1501571
SO_2 Thermo Model 43i	110	S01	300 ppm	1153170023
NO_x Thermo Model 42i	121	N01	280 ppm	0801820990
CO_2 Thermo Model 410i	130	C01	20%	0801820993
EUBOILER2				
Flow Teledyne Monitor Labs Model 150	240 241 242	F01 / F02 F01 F02	74,000 KSCFH	A Monitor SN 1501593 B Monitor SN 1501572
SO_2 Thermo Model 43i	210	S02	L= 300 ppm H = 500 ppm	SN 1153170027
NO_x Thermo Model 42i	221	N02	L =100 ppm H = 400 ppm	0801820991
CO_2 Thermo Model 410i	230	C02	20%	0801820994

In preparation for the testing, an Operating Load Analysis was obtained for both sources encompassing a period of April 1, 2022 through March 31, 2023. Based on these four quarters of representative historical operating data, the first (i.e., normal) and second most frequently used load levels were determined to ensure the appropriate load levels were selected during the RATAs.

According to the Part 75 Monitoring Plan and the Operating Load Analysis reviewed for Unit 1, High (224.1 – 300 MW) and Low (110.0 – 167.0 MW) are the most frequently used load levels, with High designated as the normal operating level and Low as the second most frequently used operating level. Therefore, the gas RATAs were conducted at High Load, while the flow RATAs were performed at Low, Mid and High load conditions, to satisfy the requirements of 40 CFR 75, Appendix B, §2.3.1.3(c)(4).

At Unit 2, the most frequently used load levels were High (284.1 – 400 MW) and Mid (197.1 – 284 MW). High operating load is designated as the normal operating level and Mid the second most frequently used operating level. Therefore, the gas RATAs were conducted at High Load, while the flow RATAs were performed at High and Mid operating load conditions.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Specific test procedures detailed in 40 CFR Part 60, Appendix A, Reference Methods 1, 2, CTM-041, 3, 3A, ALT-008, 4, 6C, 7E, and 19 were followed in conjunction with Part 75 Appendices A and B to conduct 10 to 12 runs and calculate CEMS RA. CO_2, NO_x, and SO_2 concentrations were measured for 21-minutes during each gas RATA run. Flue gas velocity and temperature were measured for a minimum of 5-minutes during each flow RATA test run. The following sections provide the sampling and analytical procedures employed.

4.1 Traverse Points (USEPA Method 1)

The number and location of traverse points used for determining exhaust gas velocity and flow RA was determined in accordance with USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources*. The exhaust duct area was calculated, and the cross-section divided into traverse points of equal area based on the location of existing airflow disturbances.

At Unit 1, 20 traverse points (4 traverse points in each of the 5 test ports) were selected as illustrated in Figure 3. At Unit 2, 16 traverse points (4 traverse points in each of 4 test ports) were selected as illustrated in Figure 4.

Because the sampling locations are at least 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance, and the ducts are greater than 7.8 feet in equivalent diameter, CO_2, SO_2, and NO_x concentrations were measured for 7-minutes at each of three traverse points located at 15.7, 47.2, and 78.7 inches from the stack wall of the duct dimension parallel to the port during each gas RATA test.

4.2 Velocity and Volumetric Flow (USEPA Method 2 and CTM-041)

The exhaust gas velocity and temperature measurements were conducted in accordance with USEPA Method 2, *Determination of Stack Gas Velocity and Volumetric Flow Rate*. The pressure differential across the positive and negative openings of an S-type Pitot tube connected to a pressure transducer was used to calculate exhaust gas velocity and volumetric flowrate. Refer to Figure 5 for an illustration of the volumetric flow RM apparatus.

As described in Section 2.1 above, the RM volumetric flow data incorporates the applicable WAF for Units 1 and 2 as previously determined in accordance with USEPA Method CTM-041, *Determination of Volumetric Gas Flow in Rectangular Ducts or Stacks Taking into Account Velocity Decay near the Stack or Duct Walls.*

4.3 Diluent/Molecular Weight (USEPA Method 3 and 3A)

During the gas RATAs, CO_2 diluent concentrations were measured using a non-dispersive infrared (NDIR) analyzer following guidelines in USEPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from a Stationary Source (Instrumental Analyzer Procedure)*. Section 4.5 describes the sample apparatus configuration.

Oxygen (O_2) and CO_2 concentrations were measured to calculate flue gas composition during the flow RATA using USEPA Method 3, *Gas Analysis for the Determination of Dry Molecular Weight* using calibrated Fyrite gas analyzers. Triplicate grab samples were captured in absorbing fluid resulting in a proportional fluid rise to the gas concentration absorbed. Each sample concentration is read on the instrument scale, and the calculated dry molecular weight verified to not differ from the triplicate sample mean by more than 0.3 g/g-mole (0.3 lb/lb-mole), with the average result reported to the nearest 0.1 g/g-mole (0.1 lb/lb-mole).

4.4 Moisture Content (USEPA Methods 4 and ALT-008)

Gas RATA moisture content was determined using USEPA Method 4, *Determination of Moisture in Stack Gases*. Exhaust gas was drawn at a constant rate through a series of impingers immersed in an ice bath to condense moisture, which was subsequently measured gravimetrically to calculate moisture content. Refer to Figure 6 for a drawing of the RM4 Moisture Apparatus.

Flow RATA moisture content was determined using USEPA ALT-008, *Alternative Moisture Measurement Method Midget Impingers*. The sample apparatus follows the general guidelines contained in Figure 4-2 and § 8.2 of USEPA Method 4, *Determination of Moisture Content in Stack Gases,* and ALT-008 Figure 1 or 2. Exhaust gas was drawn at a constant rate through a series of midget impingers immersed in an ice bath to remove moisture, which was subsequently measured gravimetrically to calculate moisture content. The Alt-008 Moisture Sample Apparatus is shown in Figure 7.

4.5 CO_2, SO_2, and NO_x Concentrations (USEPA Methods 3A, 6C, and 7E)

Carbon dioxide, sulfur dioxide, and nitrogen oxides concentrations were measured using the following sampling and analytical procedures:

- USEPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure),*
- USEPA Method 6C, *Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure), and*
- USEPA Method 7E, *Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)*

The sampling procedures of the methods are similar except for the analyzers and analytical technique used to quantify the parameters of interest. Components of the extractive gaseous RM system in contact with flue gas are constructed of Type 316 stainless steel and Teflon. Exhaust gas was extracted from the duct through a steel tube probe, heated Teflon® tubing, and a gas conditioning system to remove water and dry the sample before entering a pump, manifold, and the gas analyzers. The output signal from each analyzer was connected to a data acquisition system (DAS). The RM analyzers were calibrated with USEPA Protocol calibration gases and operated to ensure that zero drift, calibration gas drift, bias and calibration error met the specified method requirements. Refer to Figure 8 for a drawing of the reference method gaseous RATA sample apparatus.

Data collected from the RM analyzers were averaged for each run with NO_x and SO_2 concentrations measured in ppmvd. CO_2 concentrations were measured as percent by volume on a dry basis. Equation 19-6 from 40 CFR Part 60, Appendix A, Method 19 was used to calculate NO_x and SO_2 lb/mmBtu emission rates.

4.6 Emission Rates (USEPA Method 19)

USEPA Method 19, *Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*, was used to calculate lb/mmBtu emission rates. Measured CO_2 and pollutant concentrations and F factors (ratios of combustion gas volume to heat input) were used to calculate emission rates using equation 19-6 from the method.

USEPA Method 19 Equation 19-6:

$$E = C_d F_c \frac{100}{\%CO_{2d}}$$

Where:

E	=	Pollutant emission rate (lb/mmBtu)
C_d	=	Pollutant concentration, dry basis (lb/dscf)
F_c	=	Volumes of combustion components per unit of heat content, (scf CO_2/mmBtu)
$\%CO_{2d}$	=	Concentration of carbon dioxide on a dry basis (%, dry)

An F_c factor of 1840 scf CO_2/mmBtu for sub-bituminous coal was used to calculate RM lb/mmBtu emissions and calculate CEMS relative accuracy. Refer to Appendix A for RATA calculation summary presenting the calculations used in this report.

5.0 QUALITY ASSURANCE PROCEDURES

The objective of a Quality Assurance (QA) program is to produce data that are complete, representative, and of known precision and accuracy. Within the RATA test program, completeness can be defined as the percentage of the required field measurements and associated documentation achieved. Representativeness, defined as the "when," "how," and "how many" measurements taken, is typically specified within the regulations governing the source to be tested as well as the Test Protocol submitted to the regulatory agency prior to the test event. Precision and accuracy are measures of data quality and exist by design within each of the USEPA reference test methods and procedures incorporated during the RATA.

RCTS addresses these QA goals by operating within a Quality System in compliance with ASTM D 7036-04, Standard Practice for Competence of Air Emissions Testing Bodies; a practice specifying the general competence requirements applicable to all AETB staff engaged in air emission testing at stationary sources, regardless of testing scope. By employing these requirements in conjunction with the precision and accuracy standards in each reference method, RCTS is better able to ensure consistently accurate data quality from an individual and AETB perspective. RCTS' AETB Letter of Accreditation and individual QSTI Certificates are contained in Appendix D.

5.1 Pitot Tube, Thermocouple, and Pressure Equipment

The Pitot tube-thermocouple assembly for measuring exhaust gas volumetric flow was inspected and/or calibrated according to procedures in RCTS' AETB Standard Operating Procedure 3-5 and Appendix O, USEPA RM 2, and Approved Alternative Method (ALT-011).

A Pitot tube inspection occurred before the field test to confirm there was no gross damage or excess misalignment of the Pitot openings. A post-test Pitot tube inspection and certification is performed to evaluate if the Pitot face openings are still aligned within acceptable tolerances.

ALT-011 describes the inherent accuracy and precision of a thermocouple within ±1.3°F in the range of -32°F and 2,500°F and states that a system performing accurately at one temperature is expected to behave similarly at other temperatures. Therefore, a single point thermocouple calibration procedure to verify accuracy within ±1.0 percent of absolute temperature, taking into account the presence of disconnected wire junctions or a potential miscalibrated temperature display, was performed. After the test event, the accuracy of the thermocouple system was checked at ambient temperature, or other temperature, within the range specified by the manufacturer, using a reference thermometer. The temperatures of the thermocouple and reference thermometer(s) shall agree within ±2°F.

The differential pressure transmitters and/or gauges used with Method 2 were calibrated in accordance with §6.2.1 of the method and RCTS AETB Standard Operating Procedure Appendix J-4. Refer to Appendix C for Pitot tube, thermocouple, differential pressure and barometer calibration or inspection records.

5.2 Dry Gas Metering Console

The ALT-008 dry gas metering (DGM) console and pump for measuring exhaust gas moisture content was calibrated against a DGM calibration standard as described in Method 5, §16.1, using the procedures in Method 5, §10.3.2 and RCTS AETB Standard Operating Procedure 3-4.

The RM 4 DGM post-test calibration was performed in the field using Alternative Method 5 Post-Test Calibration (ALT-009) which incorporates the optional pretest orifice meter coefficient check principle of Method 5, § 9.2.1.1. Instead of determining the pretest DGM calibration check value Yc, ALT-009 calculates a quality assured average lYqa after three or more test runs are conducted, with that value required to be within 5 percent of the pre-test DGM calibration factor (Y). Note that field metering system and pump to console leak checks were performed per ALT-009 requirements.

5.3 USEPA Protocol Gas Standards

USEPA Protocol gas standards used by RCTS were purchased from an outside vendor participating in the USEPA Protocol Gas Verification Program (PGVP) calibration gas audit program described 40 CFR Part 75 § 75.21(g) following RCTS AETB Standard Operating Procedure 2-10. The standards are certified to have a total relative uncertainty of no greater than ±2.0 percent according to the *USEPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; EPA – 600/R-97/121; September 1997* or the current version of the traceability protocol (*EPA – 600/R-12/531; May 2012*). Appendix C contains a summary of the PGVP calibration gas standards used during this test program.

5.4 Analyzer Calibrations

The gaseous RM instruments were calibrated on-site, and operated following manufacturer's specifications and the applicable reference method based in part on the quality assurance and quality control requirements contained in USEPA Methods 3A, 6C, and 7E.

Before beginning the gas RATA, a three-point analyzer calibration error (ACE) check was conducted on each RM analyzer by injecting zero-, mid-, and high-level calibration gases directly into the instruments and measuring the responses. The instrument response must be within ±2.0% of the respective analyzer span or within ±0.5 ppmv or ±0.5% for CO_2 absolute difference to be acceptable. An initial system bias check was then performed by measuring the instrument response while introducing zero- and mid- or high-level (upscale) calibration gases at the probe, upstream of all sample conditioning components, and drawing it through the various sample components in the same manner as flue gas. The initial system bias check is acceptable if the instrument response at the zero and upscale calibration is within ±5.0% of the calibration span or ±0.5 ppmv or ±0.5% for CO_2 absolute difference.

A NO_x analyzer nitrogen dioxide (NO_2) to nitric oxide (NO) conversion efficiency (CE) test was conducted to verify the analyzer's ability to convert NO_2 to NO and accurately measure NO_x by chemiluminescence. Refer to Appendix C for this CE documentation.

After each gas RATA run, post-test zero and upscale system bias checks were performed to quantify and compensate for RM analyzer drift and bias. The RM system bias is acceptable if those values remain within ±5.0% of the calibration span or ±0.5 ppmv or ±0.5% for CO_2 absolute difference. The RM drift is acceptable if the zero and upscale values are within ±3.0% of the calibration span. System response times were documented during the initial system bias tests. Calibration gas flow rates were maintained at the target sample rate, with each subsequent run started after twice the system response time elapsed. Analyzer bias and drift data is presented in Appendix B, while calibration data is in Appendix C.

6.0 DISCUSSION OF TEST RESULTS

The CEMS RATA results presented in Tables 2-1 through 2-4 and Appendix B indicate the CEMS operating at J.H. Campbell EUBOILER1 and EUBOILER2 exhaust ducts meet the performance specifications in 40 CFR 75, Appendix A, and the annual reduced RATA test frequency incentive standards in 40 CFR 75, Appendix B. These data indicate compliance with the CEMS monitoring and recordkeeping requirements of the facility's air permit MI-ROP-B2835-2020b.

During the test event, no deviations were observed by the QIs in attendance. The criteria specified in the applicable Reference Methods and the agency-approved Test Protocol were followed. Hard copy and/or electronic field data were completed in the field and upon return to the office, verified for data precision and accuracy, further ensuring the appropriate AETB and Reference Method quality measures were met.

Quality Assurance data, such as protocol gas certificates of analysis, analyzer calibration error and system response time, NO_2 to NO CE check and instrument interference information are presented in Appendix C. Gas RATA instrument system bias/drift data is presented in Appendices B4 and B8. AETB certifications and signature forms are provided in Appendices D1 and D2.

6.1 Clock Time Synchronization

The electronic timestamps recorded for RM RATA runs are on military time basis and synchronized to the CEMS DAHS, which is in Eastern Standard Time (EST).

Figures

Figure 1 – J.H. Campbell Unit 1 Test Port Location

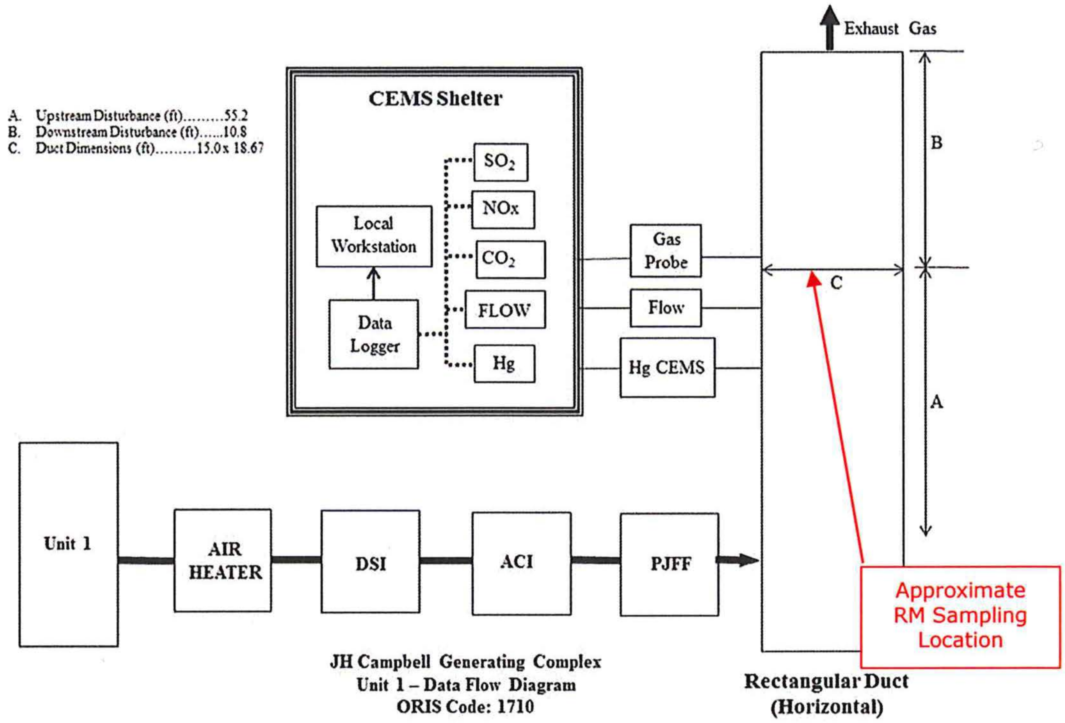


Figure 2 – J.H. Campbell Unit 2 Test Port Location

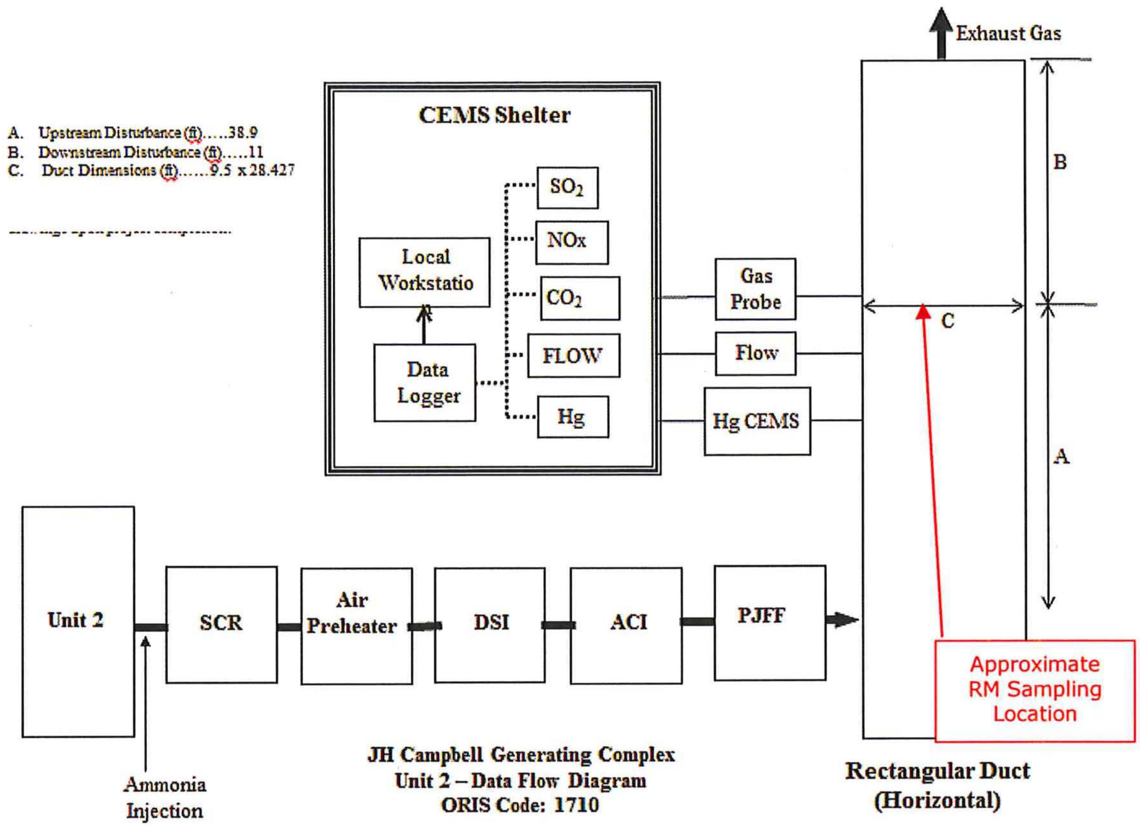


Figure 3 – J.H. Campbell Unit 1 Duct Cross Section and Test Port / Traverse Point Detail

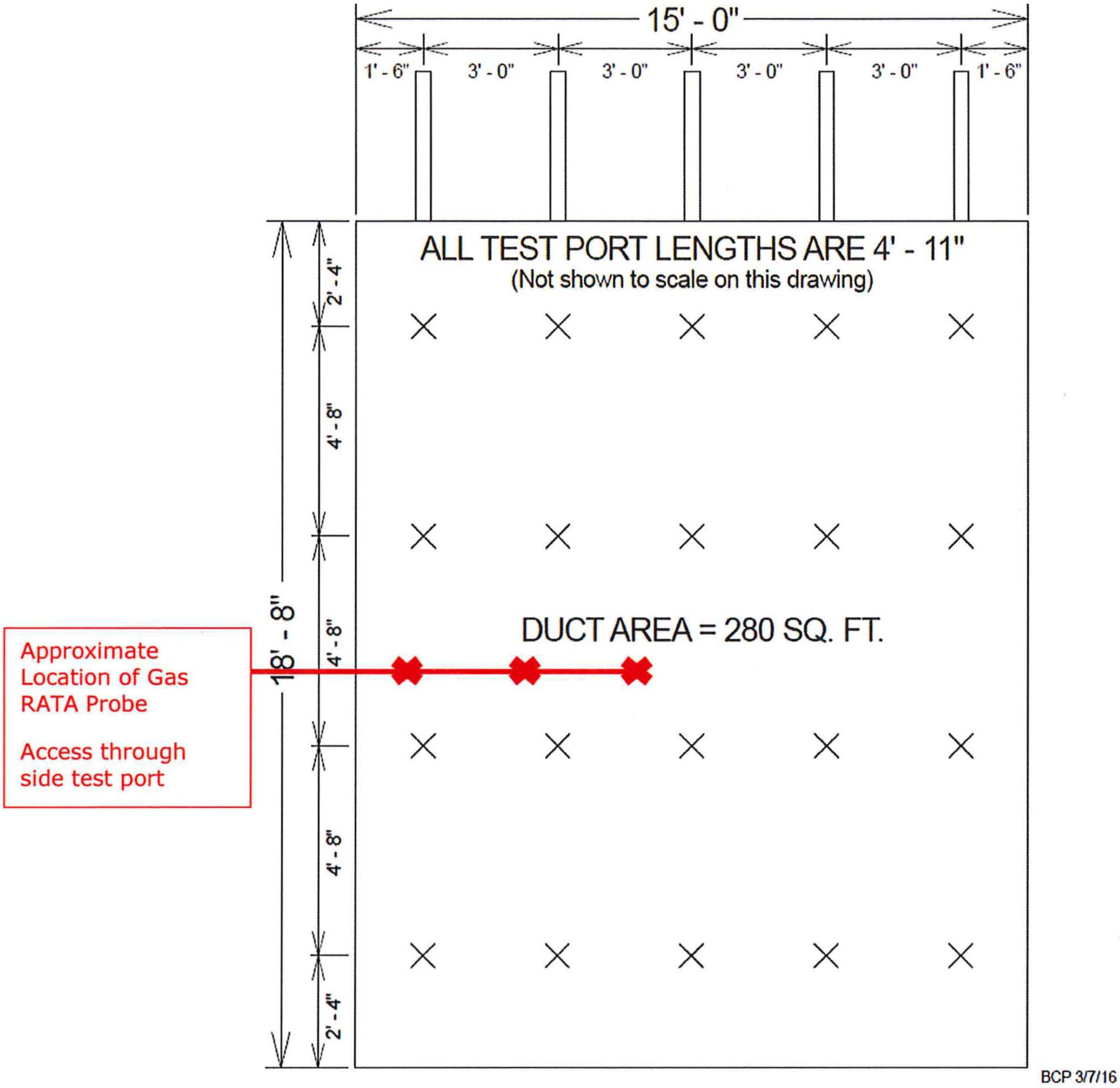


Figure 4 – J.H. Campbell Unit 2 Duct Cross Section and Test Port / Traverse Point Detail

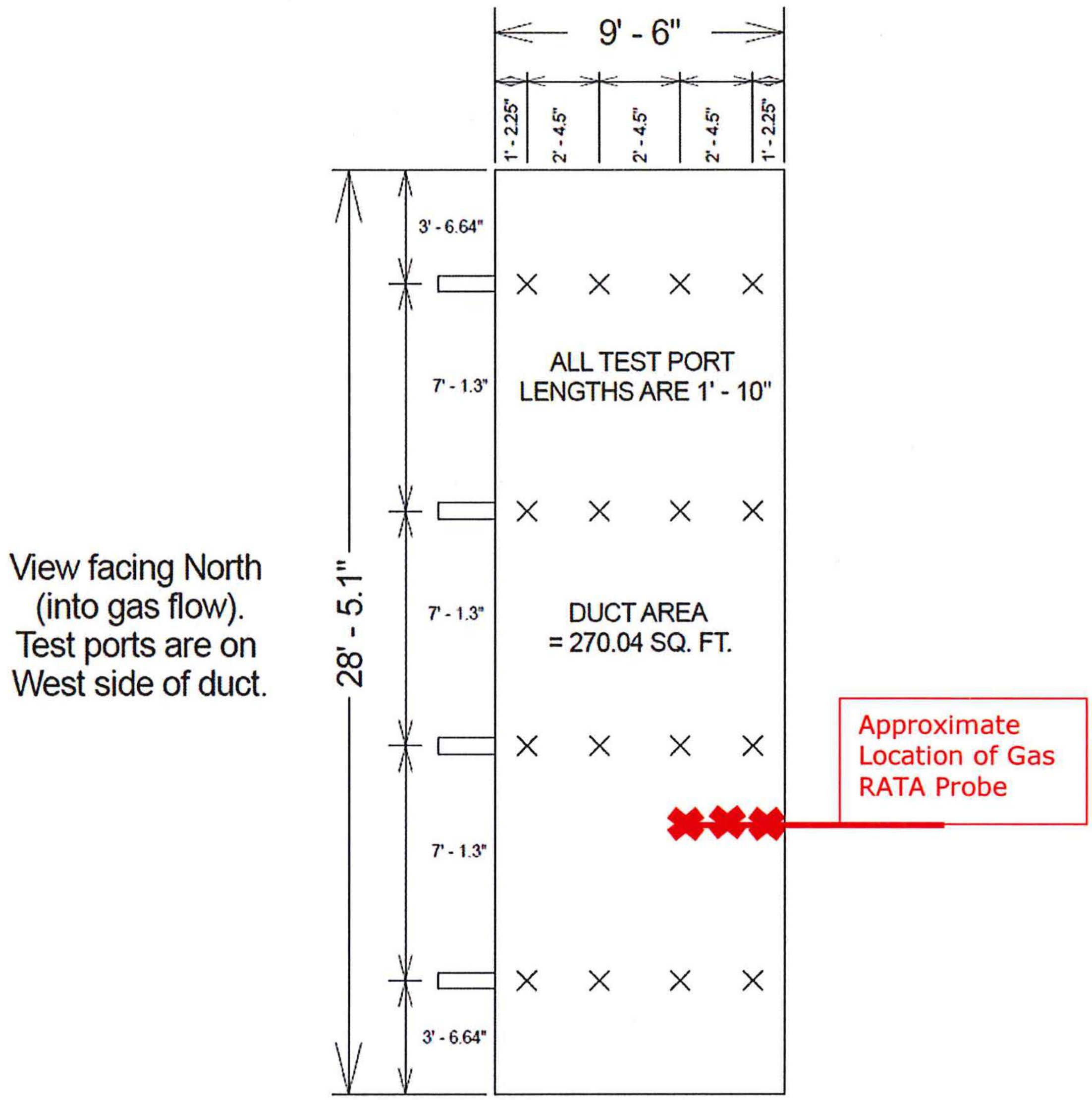


Figure 5 – Volumetric Airflow RATA Sample Apparatus

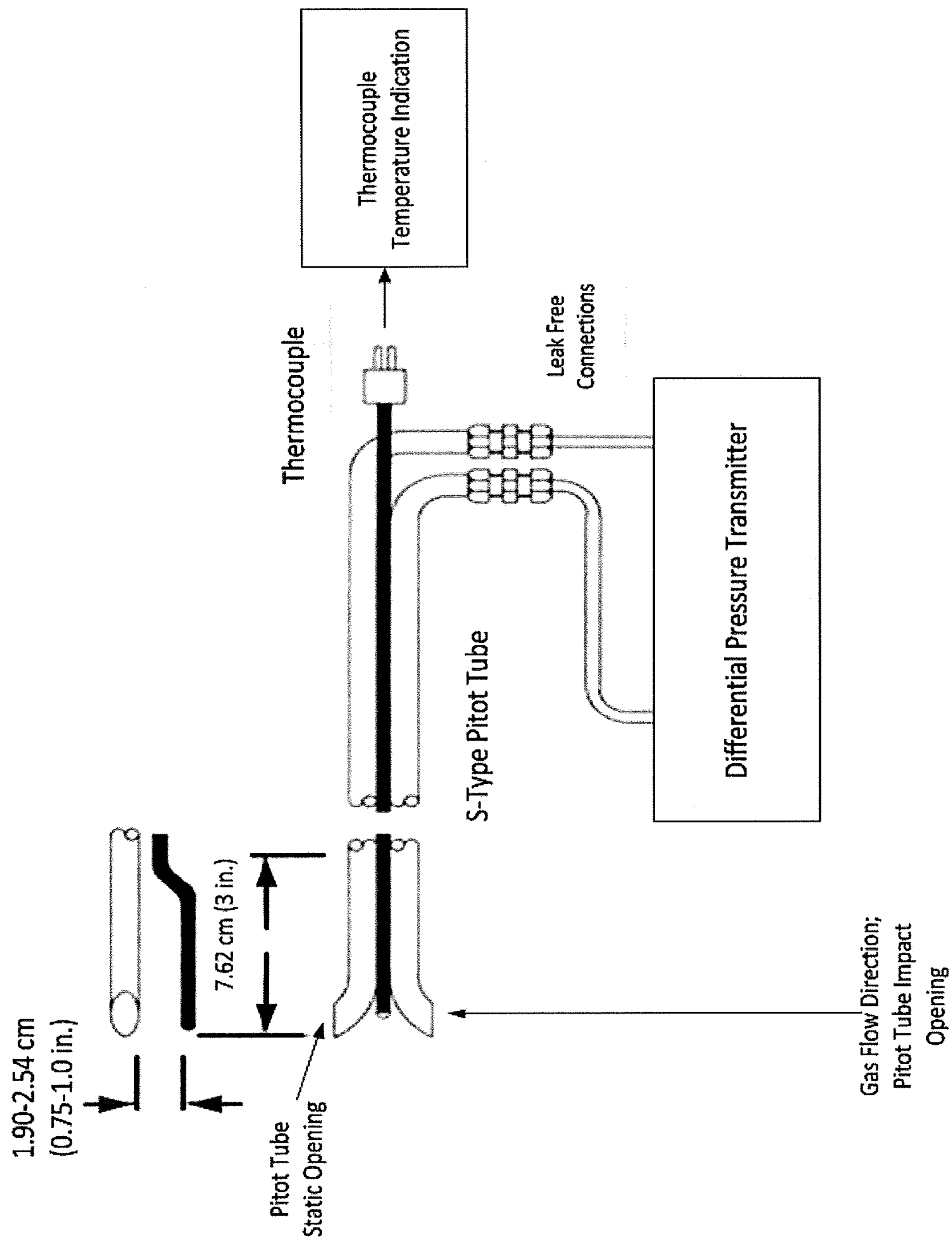


Figure 6 – Reference Method 4 Moisture Apparatus

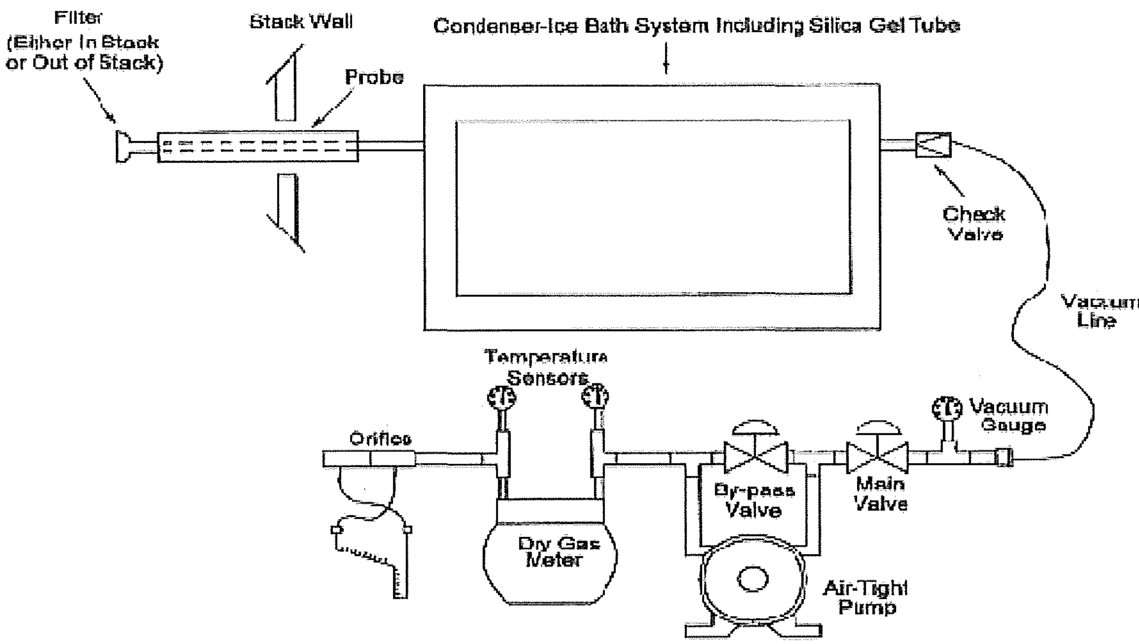
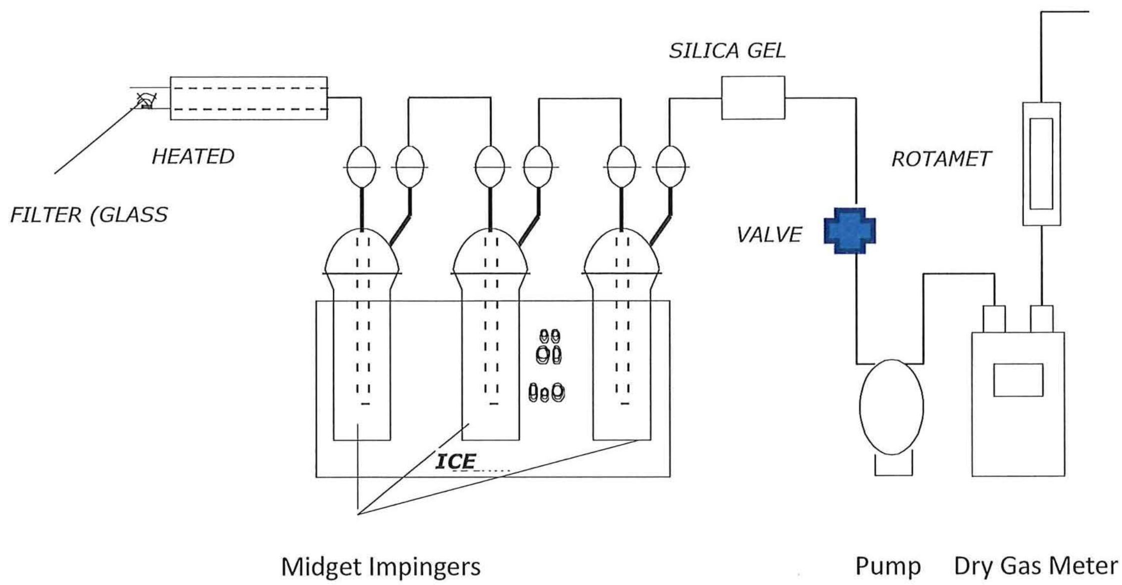


Figure 7 – ALT-008 Moisture Sample Apparatus



The silica gel tube depicted in this figure was replaced with a midget impinger (bubbler) with a straight tube insert, as allowed in ALT-008, §1

Figure 8 – Reference Method Gaseous RATA Sample Apparatus