Consumers Energy

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RATA Test Report

EUBOILER3

Consumers Energy Company
J.H. Campbell Generating Complex
17000 Croswell Street
West Olive, Michigan 49460
SRN: B2835
FRS: 110000411108
ORIS: 1710

October 19, 2023

Test Dates: September 18-20, 2023

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 41142205
Revision No.: 1.0

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 Sept. 18, 19, and 20, 2023

Facility Name: Consumers Energy J.H. Campbell Generating Complex

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

Equipment Tested: CO_2, NO_x, SO_2, and 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: Date: October 19, 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

The Regulatory Compliance Testing Section (RCTS) of Consumers Energy conducted continuous emission monitoring systems (CEMS) quality assurance (QA) audits associated with emission unit EUBOILER3 (Unit 3) operating at the J.H. Campbell Generating Complex in West Olive, Michigan.

The relative accuracy test audits (RATA) were conducted on September 18-20, 2023 to satisfy requirements in Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-B2835-2020b, United States Environmental Protection Agency (USEPA) Title 40, Code of Federal Regulations (40 CFR) Part 75, Appendices A and B, and 40 CFR 60, Appendices B and F. The Unit 3 40 CFR Part 75 monitoring plan designates EUBOILER3 as Unit/Stack 3.

A test protocol describing the USEPA sampling, calibration, and QA procedures in Reference Methods (RM) 1, 2, Conditional Test Method (CTM)-041, 3, 3A, 4, Alternative Test Method (ALT)-008, 6C, 7E, and 19, 40 CFR Part 60, Performance Specification (PS) 2 and 40 CFR 75, Appendices A and B was submitted on June 28, 2023 to the USEPA Region 5 and EGLE offices. The protocol was subsequently approved in a letter dated July 20, 2023, by EGLE representative Trevor Drost. No deviations, additions to, or exclusions from the test protocol were encountered except for a change in schedule from August 7-9 to September 18-20 due to conservative operation directives from the electrical grid operator. Representatives from USEPA or EGLE did not witness the test program.

The CEMS audits were performed by RCTS representatives Thomas Schmelter and David Kawasaki. Joe Mason, Senior Equipment Technician, and Kevin Starken, Supervisor of Engineering Support, at the Consumers Energy J.H. Campbell Generating Complex, coordinated the tests with applicable plant personnel and provided CEMS data.

RCTS operates as a self-accredited Air Emission Testing Body (AETB) as described in the AETB Letter of Certification contained in Appendix D1 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 representative Thomas Schmelter met these requirements and assumed the on-site lead QI roles for the duration of the Flow and Gas CEMS audits.

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

Table 1-1
Test Program Contact List

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, IL 60604
State Regulatory Administrator	Jeremy Howe Technical Programs Unit Supervisor Environmental Manager 231-878-6687 howej1@michigan.gov	EGLE Technical Programs Unit Constitution Hall, 2nd Floor S 525 W. Allegan Lansing, Michigan 48933
State Technical Programs Field Inspector	Trevor Drost Environmental Quality Analyst 517-245-5781 drostt@michigan.gov	EGLE Technical Programs Unit Constitution Hall, 2nd Floor S 525 W. Allegan Lansing, Michigan 48933
EGLE AQD Site Inspector	Heidi Hollenbach Air Quality Manager Grand Rapids District 616-540-1136 hollenbachh@michigan.gov	EGLE Grand Rapids District Office 350 Ottawa Avenue NW, Unit 10 Grand Rapids, Michigan 49503-2316
Responsible Official	Nathan J. Hoffman Plant Business Manager 616-738-5436 nathan.hoffman@cmsenergy.com	Consumers Energy J.H. Campbell Generating Complex 17000 Croswell Street West Olive, Michigan 49460
Site Environmental	Kevin Starken Supervisor – Engineering Support 616-738-3241 kevin.starken@cmsenergy.com	
CEMS Technician	Joe Mason Senior Equipment Technician 616-738-3278 joe.mason@cmsenergy.com	
Corporate Environmental Coordinator	Jason Prentice Principal Environmental Engineer 517-788-1467 jason.prentice@cmsenergy.com	Consumers Energy Company Parnall Office (P22-334) 1945 W. Parnall Road Jackson, Michigan 49201
Test Team Representative	Thomas Schmelter, QSTI Sr. Engineering Technical Analyst 616-738-3234 thomas.schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY AND DISCUSSION

The J.H. Campbell Generating Complex 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 annual RA frequency standards in 40 CFR 75, Appendix B. Further, as shown in Tables 2-1 through 2-5 of this report, the CEMS meet the applicable 40 CFR Part 60, Appendices B and F RATA requirements. Report appendices include RA equations and sample calculations as Appendix A, comprehensive test data as Appendix B, quality assurance data as Appendix C, and AETB certifications as Appendix D.

2.1 Wall Adjustment Factor

In August 2016, USEPA CTM-041, *Determination of Volumetric Gas Flow in Rectangular Ducts or Stacks Taking into Account Velocity Decay near the Stack or Duct Walls*, was performed prior to conducting volumetric flowrate RATAs to evaluate the magnitude of velocity decay near the duct rectangular walls and calculate a site-specific wall effect adjustment factor (WAF). This measurement yielded a calculated WAF of 0.9740 (dimensionless) which was applied to the Unit 3 duct area and CEMS volumetric flow rate.

CTM-041 rectangular duct criteria allow application of a single operating load WAF to all operating loads and subsequent tests, unless the affected ductwork configuration was changed. The Unit 3 ductwork configuration remains unchanged; thus, the 0.9740 WAF is valid and no additional WAF tests were necessary.

2.2 Volumetric Flowrate

Two ultrasonic volumetric airflow monitors, identified as components F01 and F02, are installed in an X-pattern within the duct. The monitors operate in tandem as the primary flow monitoring system, with volumetric flowrate and continuous emission rates calculated and reported based on the average of both. The monitors also act as individual redundant backups to the primary system and are assigned to data acquisition and handling system (DAHS) channels BK1 and BK2, respectively.

On September 18 and 19, as allowed in 40 CFR 75.20(b)(3)(vii)(E), trial flow RATA runs were completed at High-load, Low-load, and Mid-load, where the primary (3FLOW) and both redundant backup (3FLOWBK1 and 3FLOWBK2) CEMS differed from the reference method (RM) by <10% for all individual runs. To meet the reduced testing frequency incentive, the flow CEMS were subsequently adjusted and recalibrated prior to a full three-load RATA test.

The trial flow RATA runs and the CEMS velocity data were used to create new Look Up Table (LUT) data to optimize the flow CEMS performance. After entering the new LUT values into F01 and F02, the flow monitors were forced into a probationary calibration as allowed by Part 75. Refer to Section 6.1 for additional details.

After passing the probationary calibration, flow RATA runs were completed at the High-, Mid-, and Low-load levels. The three-load flow RATA results presented in Table 2-1 met the 40 CFR 75, Appendix A §3.3.4(a) ≤10.0% criterion and 40 CFR 75, Appendix B §2.3.1.2(c) ≤7.5% annual test frequency incentives. Refer to Section 6.1 for further details.

Table 2-1
Summary of Volumetric Airflow RATA Results

CEMS Make/ Model	CEMS Duct Location & Serial Number	RATA Criteria	Required RATA Performance	Actual RATA Performance		
				Primary (F01 & F02)	F01 Monitor	F02 Monitor
Teledyne Monitor Labs Model 150	Unit 3 F01 Monitor SN 1500470 F02 Monitor SN 1500471	High-Load	≤10% of mean RM	2.66%	2.08%	3.15%
		Mid-Load		0.42%	0.56%	0.45%
		Low-Load		4.34%	1.86%	6.77%
		Bias†	|d| ≤ |CC| = Pass	1.020	1.015	1.024

|d| average absolute difference between the RM and CEMS
|CC| confidence coefficient
† highest bias measured at normal (high) or second most frequently used load level (low) is presented

2.3 SO_2 GAS RATA

The Unit 3 SO_2 CEMS concentrations (ppm) are used for 40 CFR Part 75 Acid Rain Program and Cross-state Air Pollution Rule (CSAPR) reporting, while lb/mmBtu emission rates are used to evaluate compliance with 40 CFR Part 60, Subpart D and MATS emission limits. The average RM SO_2 lb/mmBtu emission rate measured was <50% of the 1.2 lb/mmBtu emission limit under Subpart D; therefore, RA was calculated using the emission limit in the equation denominator as specified in 40 CFR Part 60, Appendix B, PS 2, §13.2.

The SO_2 RA presented in Table 2-2 met the 40 CFR 75, Appendix A §3.3.1(b) ±15 ppm specification and the 40 CFR 75, Appendix B §2.3.1.2(e) ±12 ppm annual test frequency incentive. The SO_2 lb/mmBtu RATA results met the ≤10% RA criterion, when the emission limit is used as the RA equation denominator, as required by 40 CFR 60, Appendices B and F.

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 3 SN 0706120983	ppm	≤10% of mean RM or ±15.0 ppm RM-CEMS difference	16.23%
				-2.144 ppm
		Bias (ppm)	|d|≤|CC|=Pass	Pass
		lb/mmBtu[1]	≤10% of emission limit[2]	0.21%

[1] SO_2 lb/mmBtu RA is reported to comply with 40 CFR Part 60.43(a)(2) and EGLE Air Pollution Control (APC) Rule, R 336.2150, *Performance Specifications for Continuous Emission Monitoring Systems*, Rule 1150(1)(c).
[2] The average Unit 3 RM SO_2 lb/mmBtu emission rate was <50% of the 1.2 lb/mmBtu emission limit; therefore, the emission limit was used in the RA equation denominator to calculate RA as specified in 40 CFR Part 60, Appendix B, PS 2, §13.2.

2.4 NO_x GAS RATA

The Unit 3 lb/mmBtu NO_x emission rate CEMS are used for 40 CFR Part 75 Acid Rain Program and CSAPR reporting. The NO_x lb/mmBtu RA presented in Table 2-3 met the ±0.020 lb/mmBtu specification in 40 CFR 75, Appendix A §3.3.2(b) and the ±0.015 lb/mmBtu reduced RATA test frequency incentive in 40 CFR 75, Appendix B §2.3.1.2(f).

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 NOx Model 42i	Unit 3 SN 0801820985	lb/mmBtu	≤10% of mean RM or ±0.020 lb/mmBtu RM-CEMS Difference	15.68%
				0.006 lb/mmBtu
		Bias	|d|≤|CC|=Pass	1.111[1]

[1] The calculated bias is 1.169, but the default of 1.111 is used consistent with 40 CFR Part 75, Appendix A, Section 7.6.5(b); the average reference method NOx emission rate was 0.045 lb/mmBtu, below 0.200 lb/mmBtu qualification threshold for the default bias adjustment factor.

2.5 CO_2 GAS RATA

The Unit 3 CO_2 dilution out-of-stack non-dispersive infrared CEMS evaluated during this test program is used to calculate lb/mmBtu emission rates and report CO_2 mass emissions under 40 CFR Part 75. The CO_2 RA presented in Table 2-4 met the 40 CFR 75, Appendix A §3.3.3 ≤10% RA specification.

Table 2-4
Summary of CO_2 RATA Results (September 19, 2023)

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required Performance Criteria	Actual RATA Performance
Thermo CO_2 410i	Unit 3 SN 0801820987	%	≤10% of mean RM or	9.60%
			±1.0% CO_2 RM-CEMS difference	-1.056%

Because the CO_2 CEMS RATA result met just the semi-annual test criteria, an additional RATA was performed on September 20, 2023 in an attempt to meet the reduced test frequency incentive. After the required daily calibration on September 20, 2023, a routine calibration adjustment was performed, with no other corrective maintenance, repair, re-linearization or reprogramming of the monitor. An additional daily calibration was initiated and a subsequent RATA of the Unit 3 CO_2 CEMS was performed. The CO_2 RA results presented in Table 2-5, met the 40 CFR 75, Appendix A §3.3.3 ≤10% RA, the ±1.0% CO_2 mean difference specification, and the 40 CFR 75, Appendix B §2.3.1.2(a) and (h) reduced test frequency incentive where the RA is ≤7.5% or the mean difference does not exceed ±0.7% CO_2, respectively.

Table 2-5
Summary of CO_2 RATA Results (September 20, 2023)

CEMS Make and Model	CEMS Location & Serial Number	RATA Performance Criteria	Required Performance Criteria	Actual RATA Performance
Thermo CO_2 410i	Unit 3 SN 0801820987	%	≤10% of mean RM or	3.85%
			±1.0% CO_2 RM-CEMS difference	-0.400%

3.0 SOURCE AND MONITOR DESCRIPTION

The J.H. Campbell Generating Complex operates under State of Michigan Registration Number (SRN) B2835 in accordance with air permit MI-ROP-B2835-2020b, within which EUBOILER3 is identified as a designated emission unit. The permit incorporates various applicable federal regulations, including requirements for monitoring gas flow, SO_2, CO_2, and

NO_x emissions using CEMS installed, maintained, and operated in accordance with 40 CFR 75 provisions.

EUBOILER3 is a pulverized coal-fired 8,240 mmBtu per hour dry bottom, wall-fired boiler with fuel oil startup capability. High pressure steam from the boiler turns a turbine connected to a generator to produce electricity. The boiler is fired with pulverized coal and is rated to produce an electricity output of approximately 910 MW gross.

Unit 3 emissions are minimized or controlled using low-NO_x burners (LNB), over-fire air (OFA), and selective catalytic reduction (SCR) for NO_x, activated carbon injection (ACI) for mercury (Hg), spray dry absorbers (SDAs) for acid gases [e.g., sulfur oxides (SO_x), hydrogen chloride (HCl)], and a low pressure/high volume pulse jet fabric filter (PJFF) baghouse system for particulate matter control.

Thermo Environmental dilution-extractive CO_2, SO_2, NO_x, and Teledyne ultrasonic air flow CEMS are installed in the common exhaust duct, upstream of the discharge stack, to measure exhaust gas concentrations and velocity on a wet basis. Mercury (Hg) and particulate matter (PM) CEMS are also installed in this proximity. The CEMS are designed to interface with a data acquisition handling system (DAHS) manufactured by ESC Spectrum (ESC). The DAHS records various data including exhaust gas flow rates, concentrations, mass emissions, and unit operating parameters.

Figure 1, *J.H. Campbell Unit 3 Test Port Location*, Figure 2, *J.H. Campbell Unit 3 Duct Cross Section and Flow Traverse Point Detail*, and Figure 3, *J.H. Campbell Unit 3 Duct Cross Section and Gas Sample Port Detail* illustrate the in-duct RM test port locations. Although not presented via diagram, the upstream flow disturbance relative to the RM test ports consists of a silencer/change in duct size, while the downstream disturbance consists of a 90-degree duct bend/change in duct size entering the base of the exhaust stack.

In preparation for the testing, a Unit 3 Operating Load Analysis (OLA) was obtained encompassing the July 1, 2022 through June 30, 2023 period. 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. The OLA revealed High-load Level was most frequently used, with Low-load the second most frequently used load level.

Within the 40 CFR Part 75 Monitoring Plan, Unit 3 designates the normal operating level as High, and Low is designated as the 2nd most frequently used operation level. For this test event, the unit was operated at the High (normal) load level for the gas RATA, with High, Mid, and Low operating load levels used for the flow RATA.

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, 4, ALT-008, 6C, 7E, and 19 were followed in conjunction with Part 75 Appendices A and B to conduct a minimum of 10 runs and to 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.

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 equal areas based on the location of existing airflow disturbances.

The equivalent diameter of the duct is 28.54 feet, and the flow and gas test ports are located approximately 107.5 feet downstream and 23.1 feet upstream of a flow disturbance. Thus, the test ports are located approximately 3.8 duct diameters downstream and 0.8 duct diameters upstream from flow disturbances.

Because the sampling location at the exhaust duct is at least 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance, gas concentrations were measured for approximately 7-minutes at each of three traverse points located at 0.4, 1.2, and 2.0 meters from the duct wall (the short reference method measurement line). 20 traverse points (4 traverse points in each of the five test ports) were selected and traversed to measure flue gas velocity and temperature to calculate volumetric flowrate. Refer to Figures 1, 2, and 3 for illustrations of the exhaust duct configuration, flow, and gas sampling locations.

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 were used to calculate exhaust gas velocity and volumetric flowrate. Refer to Figure 4 for an illustration of the volumetric flow RM apparatus.

The RM flow data incorporates a wall effect adjustment factor (WAF) of 0.9740 (See Section 2.1), derived 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.* CTM-041 results are shown in Appendix B1.

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

During the gaseous 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),* further described in Section 4.5.

Oxygen (O_2) and CO_2 concentrations were also measured using calibrated Fyrite gas analyzers during the flow RATA to calculate flue gas composition via USEPA Method 3, *Gas Analysis for the Determination of Dry Molecular Weight*. Triplicate grab samples were captured in absorbing fluid resulting in a proportional fluid rise to the gas concentration absorbed. After reading each sample concentration on the instrument scale, the calculated dry molecular weight is 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 Method 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 (Figure 5), which was subsequently measured gravimetrically to calculate moisture content.

Flow RATA moisture content was determined using USEPA ALT-008, *Alternative Moisture Measurement Method Midget Impingers*. The sample apparatus (Figure 5) 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.

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

During the gaseous RATAs, CO_2, NO_x, and SO_2 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 apart from the analyzers and analytical technique for each. Components of the extractive gaseous RM system (Figure 6) 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.

Data collected from the RM analyzers were averaged for each run with NO_x and SO_2 concentrations measured as ppm by volume, on a dry basis (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.

$$E = C_d F_c \frac{100}{\%CO_{2d}}$$ USEPA Method 19, Equation 19-6

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, (1,840 scf CO_2/mmBtu for subbituminous coal from 40 CFR 75, Appendix F, Table 1)
$\%CO_{2d}$	=	Concentration of carbon dioxide on a dry basis (%, dry)

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-1, 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 the absolute measured temperature, considering 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 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 sheets.

5.2 Dry Gas Metering Console

The ALT-008 dry gas metering (DGM) consoles and pumps for measuring exhaust gas moisture content were 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. Refer to Appendix C for DGM console calibration data.

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 Yqa 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 gaseous 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 Appendix B indicate the CEMS operating at J.H. Campbell Generating Complex Unit 3 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. Further, where applicable, the CEMS meet the RATA requirements of 40 CFR Part 60, Appendices B and F. 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 QI in attendance and criteria specified in the applicable Reference Methods and the agency-approved Test Protocol were followed.

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 Appendix B5. AETB certifications and signature forms are provided in Appendices D1 and D2.

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.

6.1 Flow RATA Trial Runs

The trial flow RATA runs are considered passed partial RATA(s) and successful trial runs that do not impact data validation and will be maintained on site per part 75 Appendix B paragraph 2.3.2(h). Following these measurements and subsequent flow monitor F01 and F02 LUT adjustments, a probationary calibration was performed on both flow monitors.

The probationary calibration established the flow monitor system data output as a "conditionally valid" reporting condition, pending successful completion of the subsequent 3-Load RATA without further flow monitor adjustments. Because no further adjustments to the flow monitors were made and a subsequent 3-load flow RATA was passed, the "conditionally valid" data output from the time of the calibration became valid.

6.2 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 3 Test Port Location

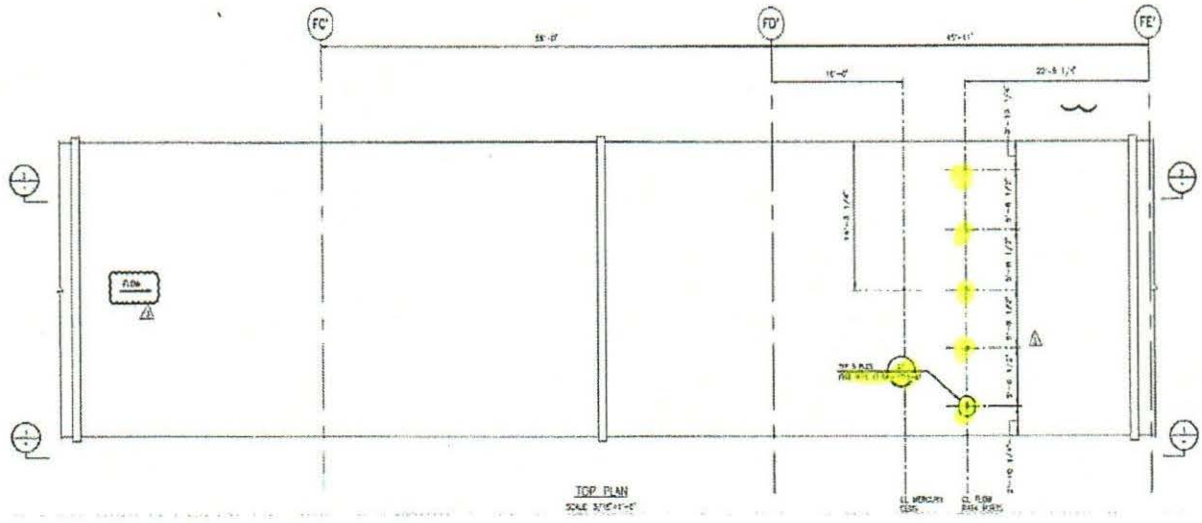


Figure 2 – J.H. Campbell Unit 3 Duct Cross Section and Flow Traverse Point Detail

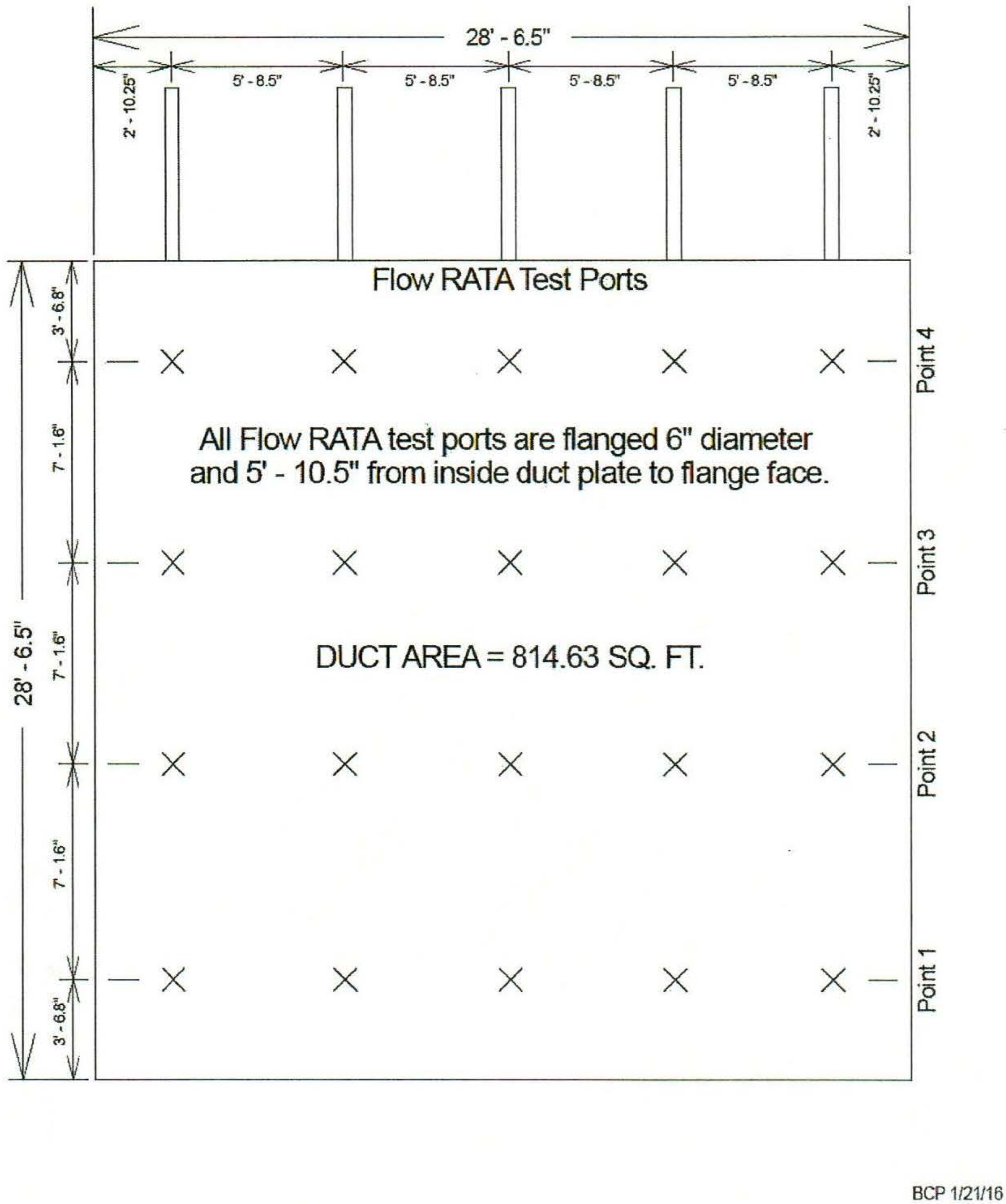


Figure 3 – J.H. Campbell Unit 3 Duct Cross Section and Gas Sample Port Detail

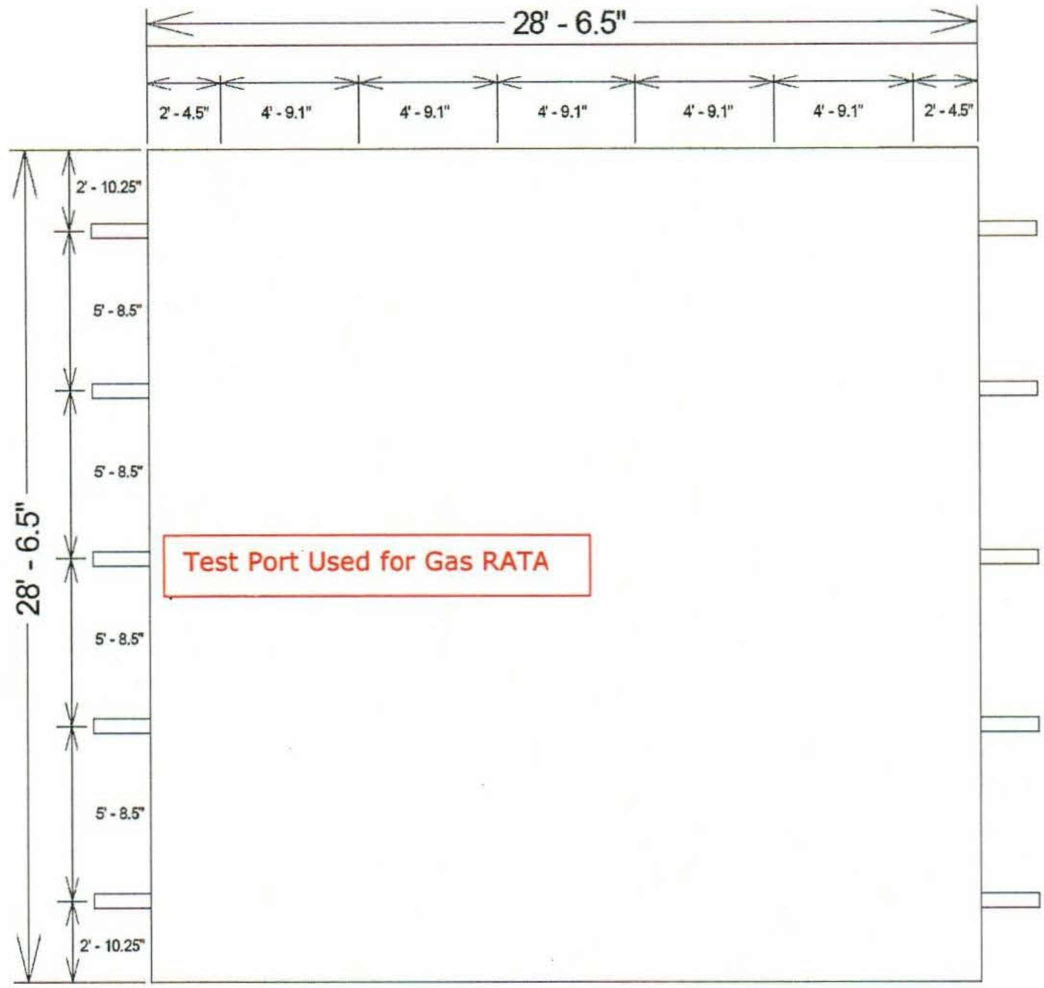


Figure 4 – Volumetric Air Flow RATA Sample Apparatus

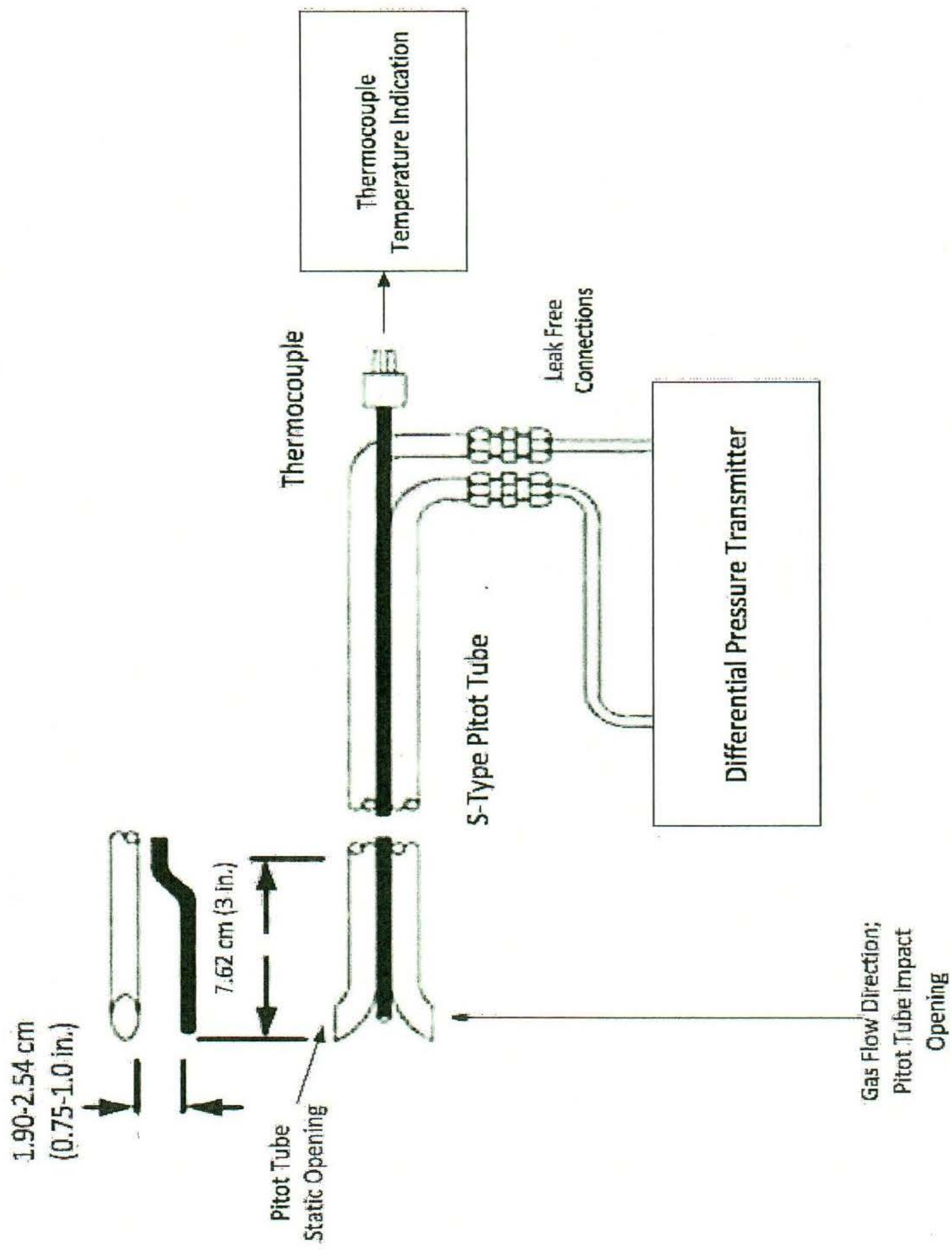
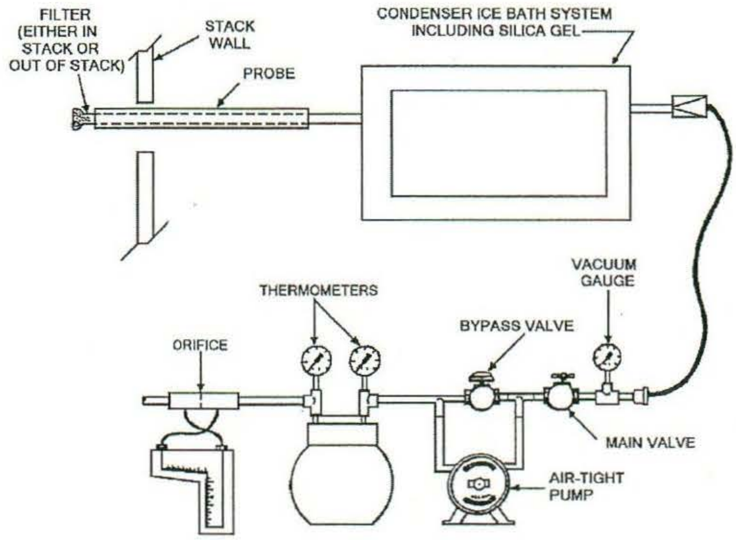
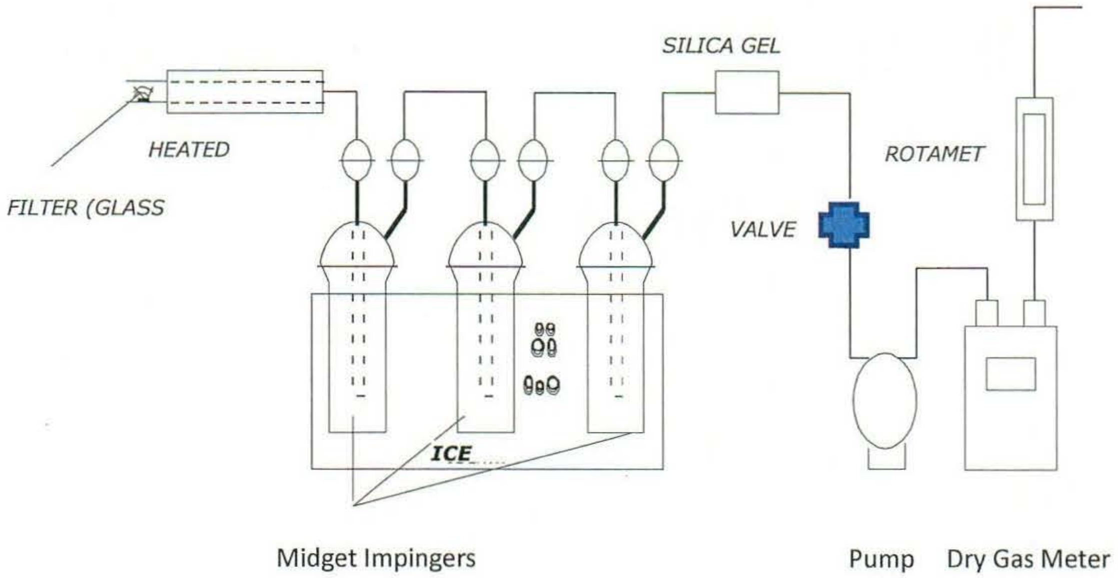


Figure 5 – Method 4 and Alternative Method 008 Moisture Sample Apparatus

Method 4:



Method ALT-008:



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 6 – USEPA Reference Method Gaseous RATA Sample Apparatus