COMPLIANCE STACK EMISSION TEST REPORT

EXPANDED THERMOPLASTIC POLYURETHANE (E-TPU) PLANT

Determination of Volatile Organic Compound Destruction Efficiency

Utilizing US EPA Methods 1, 2, 3, 4, and 25A

Test Date(s): October 16, 2019
State Registration Number: M4777
Source Location: Wyandotte, Michigan
Permit: EGLE Permit-to-Install No. 88-17

Prepared For:

BASF Corporation - Wyandotte Facility
1609 Biddle Avenue • Wyandotte, MI 48192

Prepared By:

Montrose Air Quality Services, LLC
4949 Fernlee Avenue • Royal Oak, MI 48073
Phone: (248) 548-8070

Document Number: M049AS-579995-RT-207R0
Document Date: November 21, 2019
Test Plan: M049AS-579995-PP-27

STAC

ACCREDITED
TO ASTM D7036 ONLY
CERT #392501

MONTROSE
AIR QUALITY SERVICES

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

TEST RESULTS SUMMARY

Source Name:	**E-TPU Plant**	
Source ID Number:	**EUETPU**	
Control Device:	**Regenerative Thermal Oxidizer**	
Test Date:	**October 16, 2019**	
Sampling Locations:	**Inlet Duct**	**Exhaust Stack**
RTO Combustion Chamber Temperature (°F)	**1,550.17**	
RTO VOC Destruction Efficiency (%)	**-**	**98.8**
Permit Limit - Destruction Efficiency (%)	-	*98*
Compliance Acceptability Criteria Met (YES/NO)	-	*YES*
VOC Mass Emission Rate (lb/hr as propane)	**25.5**	**0.32**
Permit No.	**EGLE Permit-to-Install No. 88-17**	

* Production data was provided by BASF Corporation - Wyandotte Facility personnel.

REVIEW AND CERTIFICATION

The results of the Compliance Test conducted on October 16, 2019 are a product of the application of the United States Environmental Protection Agency (US EPA) Stationary Source Sampling Methods listed in 40 CFR Part 60, Appendix A, that were in effect at the time of this test.

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: _____ Date: 11-25-19

Name: Mason Sakshaug Title: Field Project Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: _____ Date: 11-25-19

Name: Randal Tysar Title: District Manager

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

The BASF Corporation (BASF) - Wyandotte Facility (State Registration Number: M4777), located at 1609 Biddle Avenue in Wyandotte, Michigan, contracted Montrose Air Quality Services, LLC (Montrose) of Detroit, Michigan, to conduct compliance stack emission testing for their Expanded Thermoplastic Polyurethane (E-TPU) Production Line 2 (EUETPUII). Testing was performed to satisfy the emissions testing requirements pursuant to Michigan Department of Environment, Great Lakes and Energy (EGLE) Permit-to-Install (PTI) No. 88-17. The testing was performed on October 16, 2019.

Simultaneous sampling was performed at the E-TPU Regenerative Thermal Oxidizer (RTO) Inlet Duct and RTO Exhaust Stack to determine the volatile organic compound (VOC) destruction efficiency (DE) of the RTO associated with E-TPU production. Testing was conducted during maximum achievable operations. During this test, emissions from the plant were controlled by an RTO.

The test methods that were conducted during this test were US EPA Methods 1, 2, 3, 4, and 25A.

1.2 KEY PERSONNEL

The key personnel who coordinated this test program (and their phone numbers) were:

- Tom Wharton, EHS Specialist, BASF Corporation, 734-324-5042
- Mark Dziadosz, Environmental Quality Analyst, Michigan Department of Environment, Great Lakes and Energy, 586-753-3745
- Todd Zynda, Environmental Engineer, Michigan Department of Environment, Great Lakes and Energy, 313-456-2761
- Mason Sakshaug QI, Field Project Manager, Montrose, 248-548-7980

2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

2.1 OBJECTIVES AND TEST MATRIX

The purpose of this test was to determine the VOC DE of the RTO. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE PTI No. 88-17.

The specific test objectives for this test were as follows:

- Simultaneously measure the concentration of total gaseous organics (TGO) at the RTO Inlet Duct and RTO Exhaust Stack.
- Measure the actual and dry standard volumetric flowrate of the stack gas at the RTO Inlet Duct and RTO Exhaust Stack.
- Utilize the above variables to determine the VOC DE of the RTO associated with E-TPU during normal operations.

Table 2.1 presents the sampling matrix log for this test.

2.2 FIELD TEST CHANGES AND PROBLEMS

2.2.1 E-TPU RTO Inlet Duct - US EPA Method 4

Run 3 moisture at the RTO Inlet Duct utilizes the average of the moisture measured during Runs 1 and 2 at the RTO Inlet duct. This approach was approved by on-site EGLE representative, Mark Dziadosz.

2.2.2 E-TPU RTO Exhaust Stack - US EPA Method 4

Run 3 moisture at the RTO Exhaust Stack utilizes the average of the moisture measured during Runs 1 and 2 at the RTO Exhaust Stack. This approach was approved by on-site EGLE representative, Mark Dziadosz.

2.3 PRESENTATION OF RESULTS

Two sampling trains were utilized during each run at the RTO Inlet Duct and RTO Exhaust Stack to determine the VOC DE of the RTO. At each location, one sampling train measured the gas stream moisture content while the second sampling train measured the gas stream concentration of TGO. Gas stream volumetric flowrates were measured during each concentration run. Grab samples of gas stream were collected during each sampling run for dry molecular weight determination.

Table 2.2 displays the VOC DE of the RTO associated with the E-TPU plant during normal operations.

The graphs that present the raw, uncorrected concentration data measured in the field by the US EPA Method 25A sampling systems at the RTO Inlet Duct and RTO Exhaust Stack are located in Appendix B of this report.

TABLE 2.1
SAMPLING MATRIX OF TEST METHODS UTILIZED

Date	Run No.	Sampling Location	US EPA METHODS 1/2 (Flow) Sampling Time / Duration (min)	US EPA METHOD 3 (Dry Molecular Wt.) Sampling Time / Duration (min)	US EPA METHOD 4 ($\%H_2O$) Sampling Time / Duration (min)	US EPA METHOD 25A (TGO) Sampling Time / Duration (min)
10/16/2019	1	E-TPU RTO Inlet Duct	10:31 - 10:42 / 11	9:35 - 9:46 / 3	9:40 - 10:10 / 30	9:33 - 10:37 / 60
10/16/2019	2	E-TPU RTO Inlet Duct	12:34 - 12:42 / 8	13:10 - 13:22 / 3	13:06 - 13:36 / 30	12:29 - 13:32 / 60
10/16/2019	3	E-TPU RTO Inlet Duct	15:06 - 15:11 / 5	15:10 - 15:20 / 3	-	15:04 - 16:10 / 60
10/16/2019	1	E-TPU RTO Exhaust Stack	9:50 - 10:03 / 13	10:15 - 10:30 / 3	10:25 - 10:36 / 30	9:33 - 10:37 / 60
10/16/2019	2	E-TPU RTO Exhaust Stack	12:44 - 12:55 / 11	12:34 - 12:52 / 3	12:32 - 13:02 / 30	12:29 - 13:32 / 60
10/16/2019	3	E-TPU RTO Exhaust Stack	15:58 - 16:06 / 8	15:45 - 15:58 / 3	-	15:04 - 16:10 / 60

All times are Eastern Daylight Time.

TABLE 2.2
EMISSION RESULTS

Parameter	E-TPU RTO Inlet Duct				E-TPU RTO Exhaust Stack			
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average
E-TPU RTO VOC Destruction Efficiency (%)	-	-	-	-	99.0	98.7	98.6	98.8
VOC Emissions (lb/hr as propane)	21.8	27.0	27.7	25.5	0.22	0.35	0.38	0.32
VOC Concentration (ppmvw as propane)	380	485	488	451	3.86	5.53	5.44	4.94
Stack Gas Average Flow Rate (acfm)	9,047	8,773	8,948	8,923	10,694	11,394	12,675	11,588
Stack Gas Average Flow Rate (scfm)	8,352	8,103	8,259	8,238	8,438	9,096	10,142	9,225
Stack Gas Average Flow Rate (dscfm)	8,068	7,826	7,978	7,957	8,167	8,821	9,825	8,938
Stack Gas Average Velocity (fpm)	1,316	1,276	1,302	1,298	987	1,052	1,170	1,070
Stack Gas Average Static Pressure (in-H_2O)	-0.86	-0.86	-0.86	-0.86	-0.02	-0.02	-0.02	-0.02
Stack Gas Average Temperature (°F)	93	93	93	93	188	180	179	182
Stack Gas Percent by Volume Moisture (%H_2O)	3.40	3.41	3.41*	3.41	3.22	3.02	3.12†	3.12
Measured Stack Inner Dimensions (in)§		35.5				30.0 X 52.0		
Percent by Volume Carbon Dioxide in Stack Gas (%-dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent by Volume Oxygen in Stack Gas (%-dry)	20.90	20.90	20.90	20.90	20.90	20.90	20.90	20.90
Percent by Volume Nitrogen in Stack Gas (%-dry)	79.10	79.10	79.10	79.10	79.10	79.10	79.10	79.10

* An average moisture content value was utilized for Run 3 at the EUETPUII RTO Inlet Duct. See Section 2.2.1 for details.
† An average moisture content value was utilized for Run 3 at the EUETPUII RTO Exhaust Stack. See Section 2.2.2 for details.
§ The EUETPUII RTO Exhaust Stack was rectangular in shape.

3.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

3.1 PROCESS DESCRIPTION AND OPERATION

The E-TPU plant specializes in the expansion of thermoplastic polyurethane pellets for use in consumer products. The process uses polyurethane resin and an expansion agent consisting of a mixture of n-butane and isobutane to produce the final product. This is a batch production with process steps at differing cycle times. This leads to an almost continuous butane concentration in the collected off-gas. The Line 2 was in operation during this test event. Production Line 1 is currently not in operation.

Figure 3.1 schematically depicts the sampling location.

3.2 CONTROL EQUIPMENT DESCRIPTION

During this test, emissions from the E-TPU plant were controlled by an RTO.

3.3 SAMPLING LOCATION(S)

3.3.1 E-TPU RTO Inlet Duct

The RTO Inlet Duct had a measured inner diameter of 35.5-inches, was oriented in the vertical plane, and was accessed utilizing a manlift. Two sampling ports were located 90° apart from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. During Run 1 of emissions sampling, the duct was traversed to verify the absence of cyclonic flow. An average yaw angle of 0.3° was measured. During emissions sampling, the duct was traversed for duct gas volumetric flowrate and TGO concentration determination. A single point in the duct measured moisture content. Grab samples were obtained for duct gas dry molecular weight determination.

3.3.2 E-TPU RTO Exhaust Stack

The RTO Exhaust Stack was rectangular in shape with a measured width of 52.0-inches and a measured depth of 30.0-inches. The stack was oriented in the vertical plane and was accessed utilizing a manlift. Five sampling ports were located equidistant from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. During Run 1 of emissions sampling, the stack was traversed to verify the absence of cyclonic flow. An average yaw angle of 1.0° was measured. During emissions sampling, the stack was traversed for stack gas volumetric flowrate. A single point, located within the central 10% of the stack cross-sectional area, was utilized for TGO concentration determination. A point in the stack measured moisture content. Grab samples were obtained for stack gas dry molecular weight determination.

Figures 3.2 to 3.4 schematically illustrate the traverse point and sample port locations utilized.

3.4 PROCESS SAMPLING LOCATION(S)

The US EPA Reference Test Methods performed did not specifically require that process samples were to be taken during the performance of this testing event. It is in the best knowledge of Montrose that no process samples were obtained and therefore no process sampling location was identified in this report.

FIGURE 3.1
E-TPU SAMPLING LOCATION SCHEMATIC

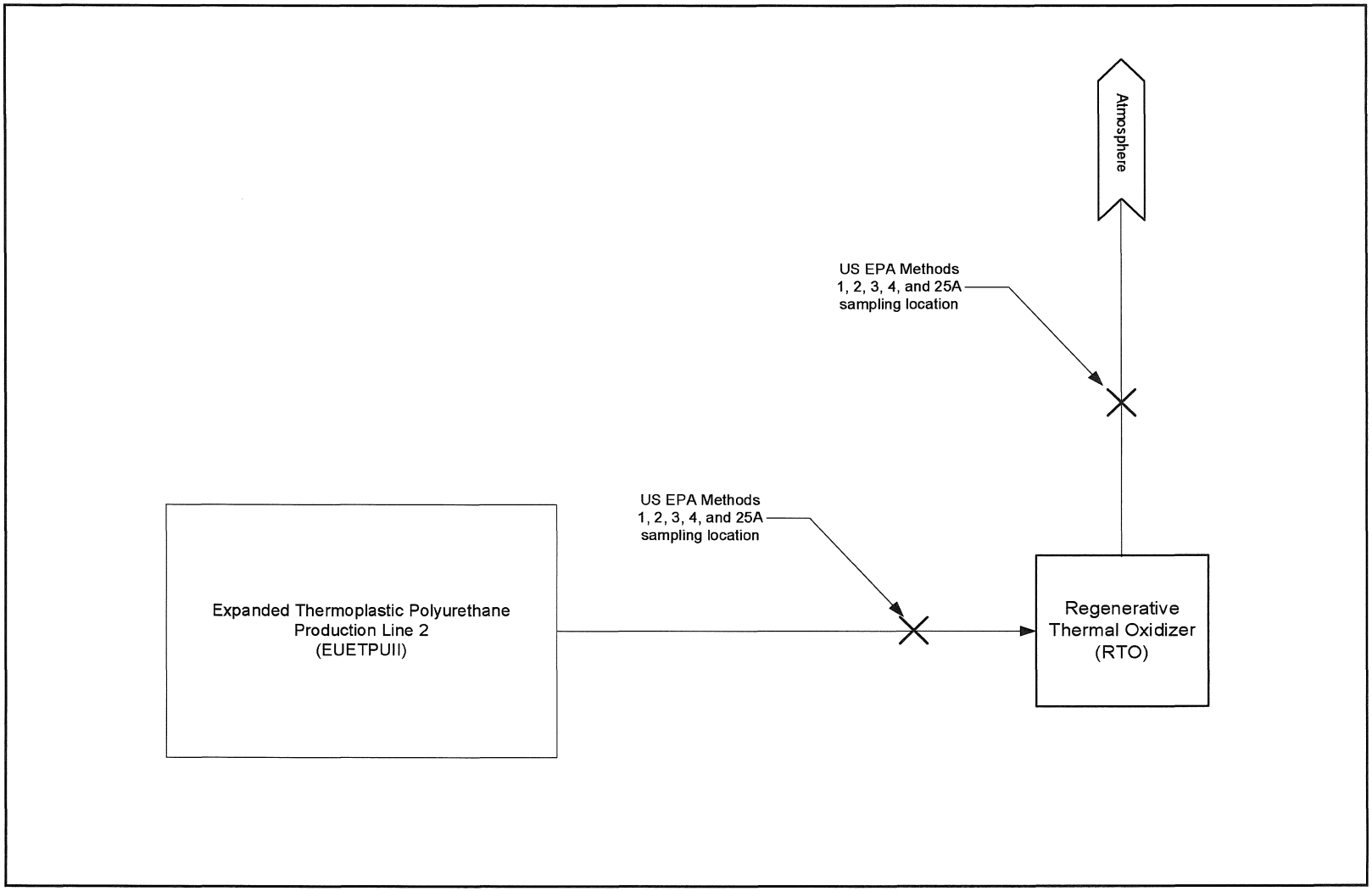
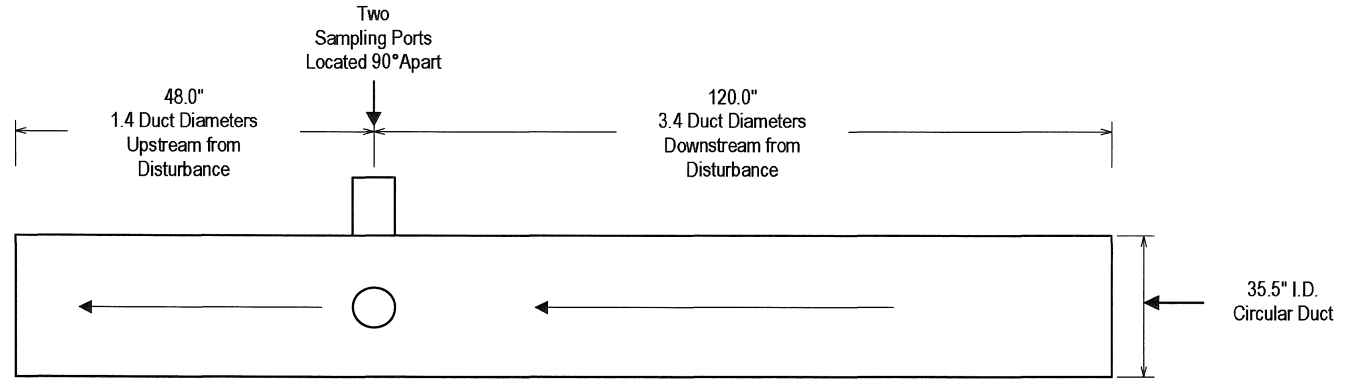
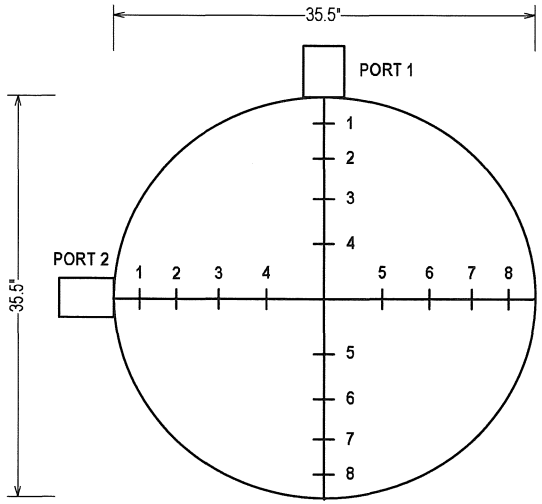


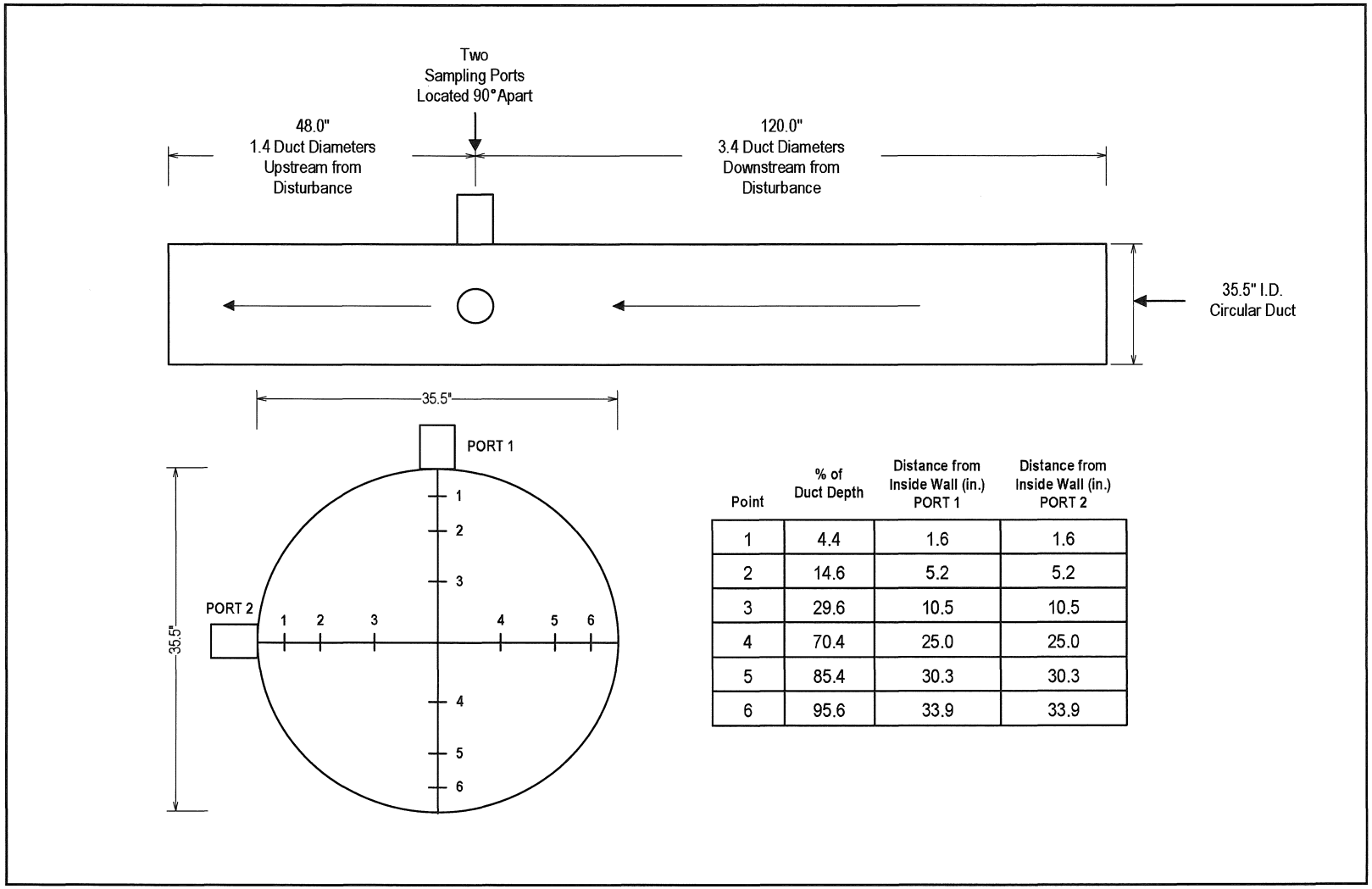
FIGURE 3.2
E-TPU RTO INLET FLOW TRAVERSE POINT LOCATION DRAWING





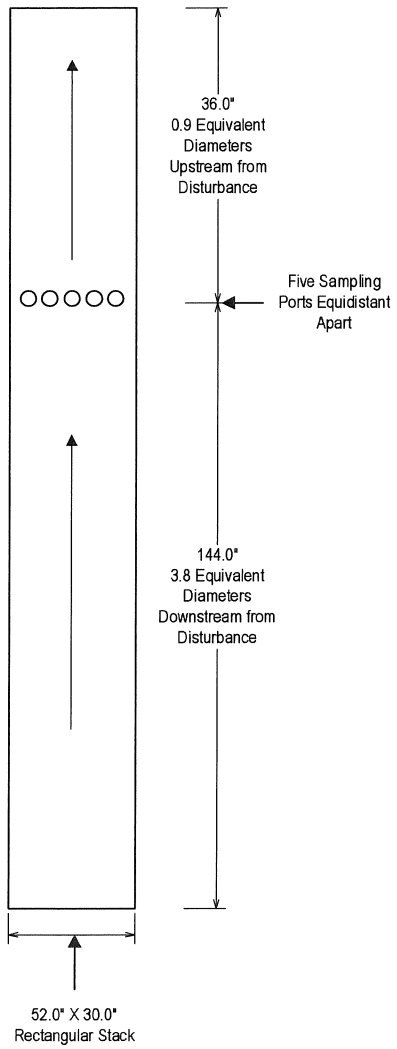
Point	% of Duct Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	3.2	1.1	1.1
2	10.5	3.7	3.7
3	19.4	6.9	6.9
4	32.3	11.5	11.5
5	67.7	24.0	24.0
6	80.6	28.6	28.6
7	89.5	31.8	31.8
8	96.8	34.4	34.4

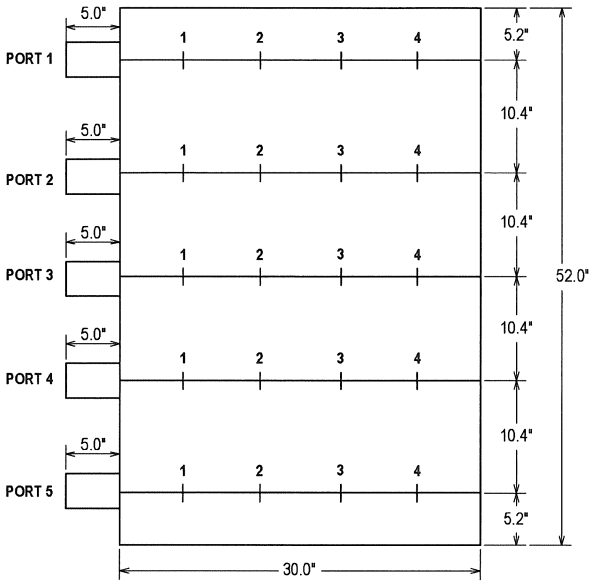
FIGURE 3.3
E-TPU RTO INLET CEMS TRAVERSE POINT LOCATION DRAWING



Point	% of Duct Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	4.4	1.6	1.6
2	14.6	5.2	5.2
3	29.6	10.5	10.5
4	70.4	25.0	25.0
5	85.4	30.3	30.3
6	95.6	33.9	33.9

FIGURE 3.4
E-TPU RTO EXHAUST FLOW TRAVERSE POINT LOCATION DRAWING





Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2	Distance from Inside Wall (in.) PORT 3
1	12.5	3.8	3.8	3.8
2	37.5	11.3	11.3	11.3
3	62.5	18.8	18.8	18.8
4	87.5	26.3	26.3	26.3

Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 4	Distance from Inside Wall (in.) PORT 5
1	12.5	3.8	3.8
2	37.5	11.3	11.3
3	62.5	18.8	18.8
4	87.5	26.3	26.3

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

4.1.1 US EPA Method 1: "Sample and Velocity Traverses for Stationary Sources"

Principle: To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.2 US EPA Method 2: "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"

Principle: The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.3 US EPA Method 3: "Gas Analysis for the Determination of Dry Molecular Weight"

Principle: A gas sample is extracted from a stack by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent CO_2, percent O_2, and if necessary, for percent CO. For dry molecular weight determination, either an Orsat or a Fyrite analyzer may be used for the analysis. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.4 US EPA Method 4: "Determination of Moisture Content in Stack Gases"

Principle: A gas sample is extracted at a constant rate from the source; moisture is removed from the sample stream and determined either volumetrically or gravimetrically. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.5 US EPA Method 25A: "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

Principle: A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents. Performance specifications and test procedures are provided to ensure reliable data. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

The sampling trains utilized during this testing project are depicted in Figures 4.1 and 4.2.

4.2 PROCEDURES FOR OBTAINING PROCESS DATA

Process data was recorded by BASF personnel utilizing their typical record keeping procedures. Recorded process data was provided to Montrose personnel at the conclusion of this test event. The process data is located in Appendix A of this report.

FIGURE 4.1
US EPA METHOD 4 SAMPLING TRAIN SCHEMATIC

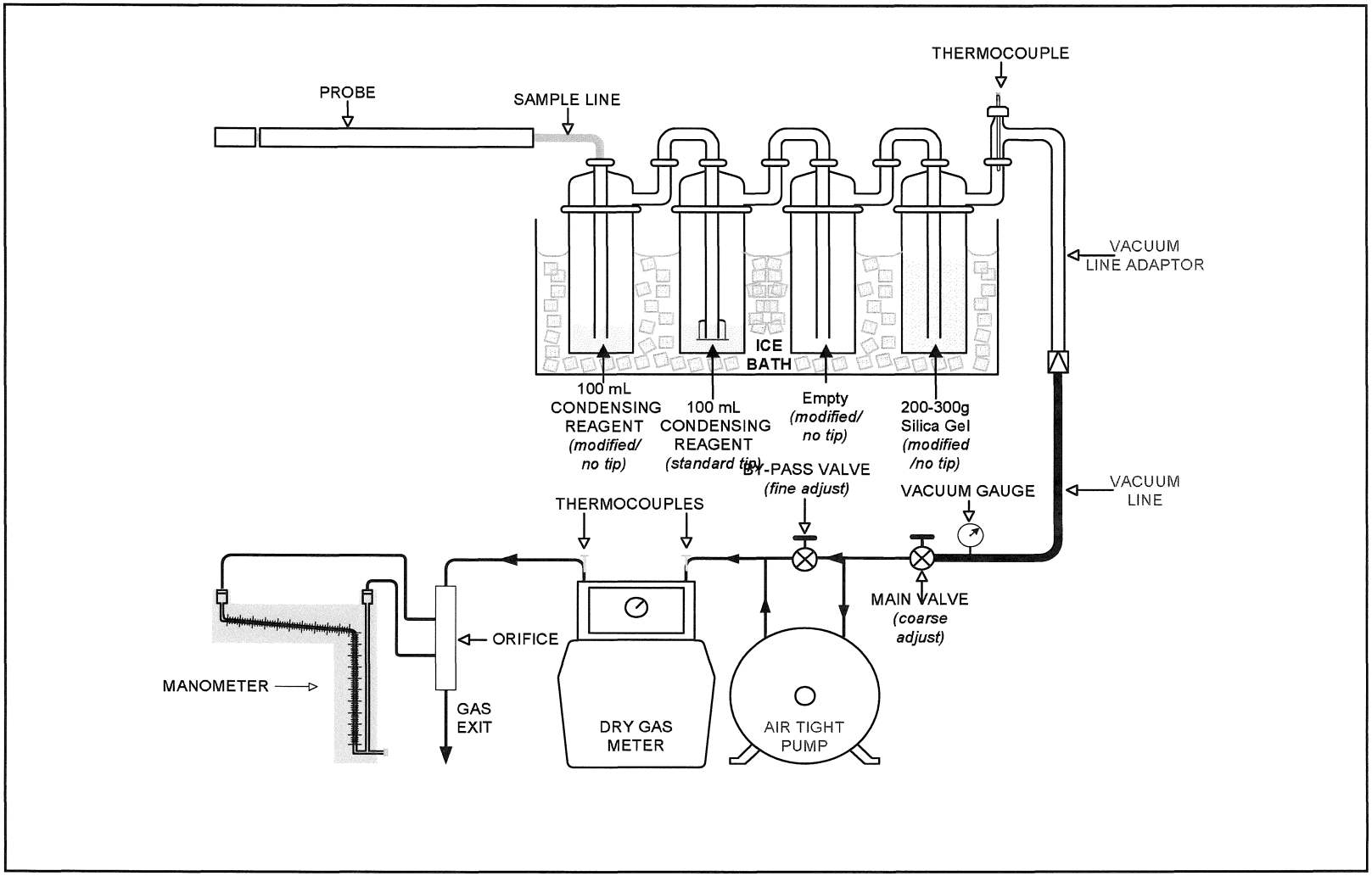
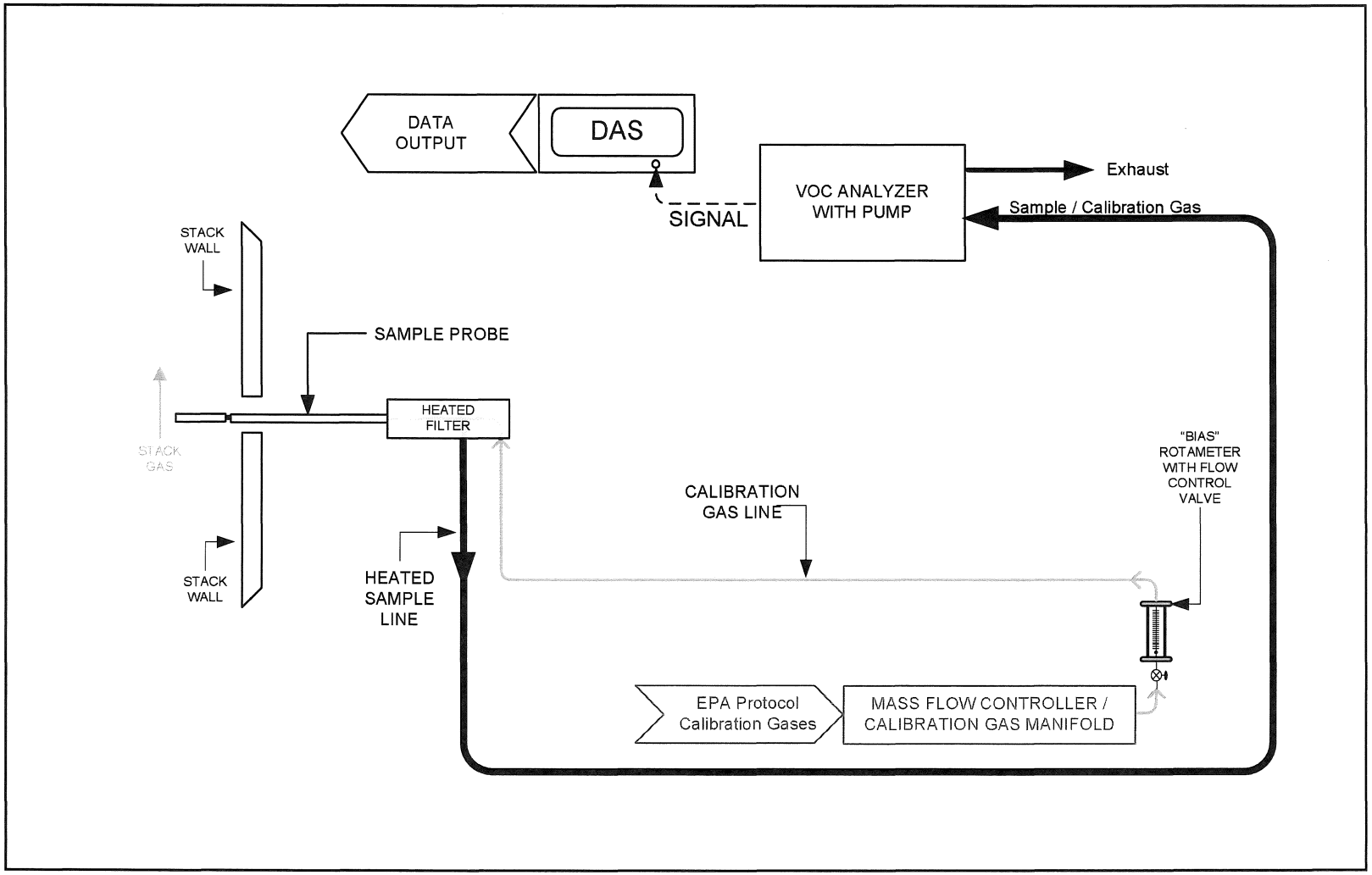


FIGURE 4.2
US EPA METHOD 25A SAMPLING TRAIN SCHEMATIC



5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA AUDITS

Tables 5.1 to 5.5 illustrate the QA audits that were performed during this test.

The meter box and sampling trains used during sampling performed within the requirements of their respective methods as is shown in Tables 5.1 and 5.2. All post-test leak checks were well below the applicable limit. Minimum metered volumes were also met where applicable.

Table 5.3 displays the US EPA Method 3 Fyrite Audits which were performed on August 30, 2019 in accordance with US EPA Method 3, Section 10.1 requirements. As shown, all Fyrite analyzer results were within ±0.5% of the respective Audit Gas concentrations.

Table 5.4 illustrates the FIA calibration audits which were performed during this test (and integral to performing US EPA Method 25A correctly) were within the Measurement System Performance Specifications of ±3% of span for the Zero and Calibration Drift Checks, and ±5% of the respective cylinder concentrations for the Calibration Error Checks.

Table 5.5 displays the US EPA Method 205 field evaluation of the calibration gas dilution system utilized during this test event. As shown, the average concentration output at each dilution level was within ±2% of the predicted value. The average concentration output of the direct inject gas was also within ±2% of the certified concentration.

5.2 QA/QC PROBLEMS

No QA/QC problems occurred during this test event.

5.3 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is presented in the report appendices.

TABLE 5.1
US EPA METHOD 4 SAMPLING TRAIN AUDIT RESULTS

Parameter	Run 1	Run 2
Sampling Location	**E-TPU RTO Inlet Duct**	
Post-Test Leak Rate Observed (cfm)	0.000	0.000
Applicable Method Allowable Leak Rate (cfm)	0.020	0.020
Acceptable	Yes	Yes
Volume of Dry Gas Collected (dscf)	22.754	22.679
Recommended Volume of Dry Gas Collected (dscf)	21.000	21.000
Acceptable	Yes	Yes
Sampling Location	**E-TPU RTO Exhaust Stack**	
Post-Test Leak Rate Observed (cfm)	0.000	0.000
Applicable Method Allowable Leak Rate (cfm)	0.020	0.020
Acceptable	Yes	Yes
Volume of Dry Gas Collected (dscf)	22.681	22.709
Recommended Volume of Dry Gas Collected (dscf)	21.000	21.000
Acceptable	Yes	Yes

TABLE 5.2
US EPA METHOD 4 DRY GAS METER AUDIT RESULTS

Sampling Location	Pre-Test Dry Gas Meter Calibration Factor (Y)	Average Post-Test Dry Gas Meter Calibration Check Value (Yqa)	Post Test Dry Gas Meter Calibration Check Value Difference From Pre-Test Calibration Factor (%)	Applicable Method Allowable Difference (%)	Acceptable
E-TPU RTO Inlet Duct	1.0170	1.0314	-1.42%	5.00%	Yes
E-TPU RTO Exhaust Stack	1.0170	1.0310	-1.38%	5.00%	Yes

TABLE 5.3
US EPA METHOD 3 FYRITE AUDIT

Audit Date	August 30, 2019	
Audit Gas	**%CO_2**	**%O_2**
Audit Gas Concentration (%)	**10.0**	**10.1**
Fyrite Response 1 (%)	10.0	10.0
Fyrite Response 2 (%)	10.0	10.0
Fyrite Response 3 (%)	10.0	10.0
Average (%)	10.0	10.0
Average Within ±0.5%	Yes	Yes

Audit Gas Cylinder Number: EB0024944

TABLE 5.4
US EPA METHOD 25A ANALYZER CALIBRATION AND QA

	E-TPU RTO Inlet Duct					
FIA ANALYZER	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (ppmv as propane)	1,000	YES	1,000	YES	1,000	YES
Average Stack Gas Concentration (ppmv as propane)	388.4	YES	493.1	YES	486.2	YES
Zero Drift (% of Span)	2.04	YES	-0.20	YES	-0.92	YES
Calibration Drift for Mid-Level Gas (% of Span)	1.78	YES	-1.70	YES	-0.31	YES
Calibration Error for Low-Level Gas (% of Cal. Gas Tag Value)	-0.42	YES	-0.42	YES	-0.42	YES
Calibration Error for Mid-Level Gas (% of Cal. Gas Tag Value)	0.30	YES	0.30	YES	0.30	YES

	E-TPU RTO Exhaust Stack					
FIA ANALYZER	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (ppmv as propane)	100.0	YES	100.0	YES	100.0	YES
Average Stack Gas Concentration (ppmv as propane)	3.57	YES	4.93	YES	4.79	YES
Zero Drift (% of Span)	-0.54	YES	0.19	YES	-0.06	YES
Calibration Drift for Mid-Level Gas (% of Span)	-1.61	YES	-1.88	YES	-0.08	YES
Calibration Error for Low-Level Gas (% of Cal. Gas Tag Value)	-2.88	YES	-2.88	YES	-2.88	YES
Calibration Error for Mid-Level Gas (% of Cal. Gas Tag Value)	-3.19	YES	-3.19	YES	-3.19	YES

TABLE 5.5
US EPA METHOD 205 GAS DILUTION SYSTEM QA

Analyzer ID/SN: JUM 109A
Dilution System ID/SN: 6014
CGD Mass Flow Controllers Used: 1 and 2

	Dilution Level 1	Dilution Level 2	Direct Inject Gas
Calibration Tag Value (ppm):	905.4	905.4	90.33
Dilution Ratio:	18.108	10.06	-
Predicted Diluted Value (ppm):	50.00	90.00	-
Injection 1 Response (ppm):	49.81	89.36	90.78
Injection 2 Response (ppm):	49.50	90.24	90.67
Injection 3 Response (ppm):	49.64	90.20	90.67
Average Response (ppm):	49.65	89.93	90.71
Difference From Predicted (%):	0.70	0.07	-0.42
Acceptable (YES/NO):	YES	YES	YES