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# Source Test Report for 2022 PEMS RAA Testing

## FG-BOILERSBLDG107 (EU-Boiler1-107, EU-Boiler2-107, EU-Boiler3-107)

## General Motors LLC Global Technical Center Warren, Michigan

**Prepared For:**

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**Document Number: MW049AS-015372-RT-1112**
**Test Date: October 19-20, 2022**
**Submittal Date: November 18, 2022**

MONTROSE AIR QUALITY SERVICES

STAC STACK TESTING ACCREDITATION COUNCIL

ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

# Review and Certification

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 / 16 / 2022

**Name:** Sean Wheeler **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:** robert j lisy jr **Date:** 11 / 18 / 2022

**Name:** Robert J. Lisy, Jr. **Title:** Reporting Hub Manager

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# 1.0 Introduction

## 1.1 Summary of Test Program

General Motors LLC-Global Technical Center (General Motors-Tech Center) (State Registration No.: B4049) contracted Montrose Air Quality Services, LLC (Montrose) to perform the Relative Accuracy Audit (RAA) for the Predictive Emission Monitoring Systems (PEMS) associated with FG-BOILERSBLDG107 (EU-Boiler1-107, EU-Boiler2-107, and EU-Boiler3-107) at the General Motors Global Technical Center facility located in Warren, Michigan. Testing was performed on October 19-20, 2022, for the purpose of satisfying the emission testing requirements pursuant to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operation Permit No. MI-ROP-B4049-2019a by evaluating the quality of the emissions data produced by General Motors-Tech Center's PEMS in accordance with 40 CFR Part 60, Appendices B and F.

The specific objectives were to:

- Verify the relative accuracy (RA) of the EU-Boiler1-107 PEMS for nitrogen oxides ($NO_x$) concentration (ppmvd) and oxygen ($O_2$) concentration in accordance with Performance Specification 16 (PS-16)
- Verify the relative accuracy (RA) of the EU-Boiler2-107 PEMS for nitrogen oxides ($NO_x$) concentration (ppmvd) and oxygen ($O_2$) concentration in accordance with Performance Specification 16 (PS-16)
- Verify the relative accuracy (RA) of the EU-Boiler3-107 PEMS for nitrogen oxides ($NO_x$) concentration (ppmvd) and oxygen ($O_2$) concentration in accordance with Performance Specification 16 (PS-16)
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

**Table 1-1**
**Summary of Test Program**

| Test Date(s) | Unit ID/ Source Name | Activity/Parameters | Test Methods | No. of Runs | Duration (Minutes) |
|---|---|---|---|---|---|
| 10/19/2022 | EU-Boiler1-107 | $O_2$ | EPA 3A | 3 | 30 |
| 10/19/2022 | EU-Boiler1-107 | $NO_x$ | EPA 7E | 3 | 30 |
| 10/19/2022 | EU-Boiler2-107 | $O_2$ | EPA 3A | 3 | 30 |
| 10/19/2022 | EU-Boiler2-107 | $NO_x$ | EPA 7E | 3 | 30 |
| 10/20/2022 | EU-Boiler3-107 | $O_2$ | EPA 3A | 3 | 30 |
| 10/20/2022 | EU-Boiler3-107 | $NO_x$ | EPA 7E | 3 | 30 |

To simplify this report, a list of Units and Abbreviations is included in Appendix C.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The RAA test results are summarized in Tables 1-2 through 1-4. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

**Table 1-2**
**Summary of Part 60 RAA Results – EU-Boiler1-107**

**October 19, 2022**

| Parameter/Units | Regulatory Reference | RA | Allowable |
|---|---|---|---|
| **Part 60** | | | |
| **Oxygen ($O_2$)** | | | |
| % volume dry | PS-16 | 0.49 | ≤ 1% as $O_2$ |
| **Nitrogen Oxides ($NO_x$)** | | | |
| ppmvd | PS-16 | 18.5 | ± 20% of RM |

**Table 1-3**
**Summary of Part 60 RAA Results – EU-Boiler2-107**

**October 19, 2022**

| Parameter/Units | Regulatory Reference | RA | Allowable |
|---|---|---|---|
| **Part 60** | | | |
| **Oxygen ($O_2$)** | | | |
| % volume dry | PS-16 | 0.059 | ≤ 1% as $O_2$ |
| **Nitrogen Oxides ($NO_x$)** | | | |
| ppmvd | PS-16 | 5.04 | ± 20% of RM |

**Table 1-4**
**Summary of Part 60 RAA Results – EU-Boiler3-107**

**October 20, 2022**

| Parameter/Units | Regulatory Reference | RA | Allowable |
|---|---|---|---|
| **Part 60** | | | |
| **Oxygen ($O_2$)** | | | |
| % volume dry | PS-16 | 0.46 | ≤ 1% as $O_2$ |
| **Nitrogen Oxides ($NO_x$)** | | | |
| ppmvd | PS-16 | -7.53 | ± 20% of RM |

## 1.2 Key Personnel

A list of project participants is included below:

**Facility Information**

| | |
|---|---|
| Source Location: | General Motors LLC<br>Global Technical Center<br>30001 Van Dyke Road<br>Warren, MI 48093 |
| Project Contact: | Hunter Lyons |
| Role: | Environmental Engineer |
| Company: | General Motors LLC |
| Telephone: | 586-506-4046 |
| Email: | hunter.1.lyons@gm.com |

**Testing Company Information**

| | | |
|---|---|---|
| Testing Firm: | Montrose Air Quality Services, LLC | |
| Contact: | Sean Wheeler | Robert J. Lisy, Jr. |
| Title: | Field Project Manager | Reporting Hub Manager |
| Telephone: | 630-860-4740 | 440-262-3760 |
| Email: | stwheeler@montrose-env.com | rlisy@montrose-env.com |

Test personnel and observers are summarized in Table 1-5.

**Table 1-5**
**Test Personnel and Observers**

| Name | Affiliation | Role/Responsibility |
|---|---|---|
| Sean Wheeler | Montrose | Project Manager, QI |
| Clayton DeRonne | Montrose | Field Technician |
| Hunter Lyons | General Motors LLC | Test Coordinator |

# 2.0 Plant and Sampling Location Descriptions

## 2.1 Process Description, Operation, and Control Equipment

General Motors LLC-Global Technical Center operates three natural gas fired boilers (EU-Boiler1-107, EU-Boiler2-107, and EU-Boiler3-107). Each boiler has an input capacity of 108 MMBtu/hr while firing natural gas (NG). Steam from each boiler utilized for process equipment at the facility. Low-$NO_x$ combustors and flue gas recirculation to minimize the emissions of nitrogen oxides from the boilers.

## 2.2 Facility PEMS and Reference Method (RM) CEMS Descriptions

The Facility PEMS information is presented in Tables 2-1 through 2-3, and the RM CEMS analyzer information is presented in Table 2-4.

**Table 2-1**
**Facility PEMS Information – EU-Boiler1-107**

| Analyzer Type | Manufacturer | Model No. | Serial No. |
|---|---|---|---|
| $O_2$ | CMC Solutions | SmartCEMS®-60 | GMBL122041 |
| $NO_x$ | CMC Solutions | SmartCEMS®-60 | GMBL122042 |

**Table 2-2**
**Facility PEMS Information – EU-Boiler2-107**

| Analyzer Type | Manufacturer | Model No. | Serial No. |
|---|---|---|---|
| $O_2$ | CMC Solutions | SmartCEMS®-60 | GMBL222041 |
| $NO_x$ | CMC Solutions | SmartCEMS®-60 | GMBL222042 |

**Table 2-3**
**Facility PEMS Information – EU-Boiler3-107**

| Analyzer Type | Manufacturer | Model No. | Serial No. |
|---|---|---|---|
| $O_2$ | CMC Solutions | SmartCEMS®-60 | GMBL322041 |
| $NO_x$ | CMC Solutions | SmartCEMS®-60 | GMBL322042 |

**Table 2-4**
**RM CEMS Information**

| Analyzer Type | Manufacturer | Model No. | Serial No. | Range |
|---|---|---|---|---|
| $O_2$ | Teledyne | T803 | 71 | 0-10.19% |
| $NO_x$ | Thermo | 42IQ | 12202615657 | 0-45.62 ppm |

## 2.3 Flue Gas Sampling Location

Information regarding the sampling location is presented in Table 2-5.

**Table 2-5**
**Sampling Location**

| Sampling Location | Stack Inside Diameter (in.) | Distance from Nearest Disturbance | | Number of Traverse Points |
|---|---|---|---|---|
| | | Downstream EPA "B" (in./dia.) | Upstream EPA "A" (in./dia.) | |
| EU-Boiler1-107 EXHAUST | 40 | 80.0 / 2.0 | 20.0 / 0.5 | Gaseous: 3 |
| EU-Boiler2-107 EXHAUST | 40 | 80.0 / 2.0 | 20.0 / 0.5 | Gaseous: 3 |
| EU-Boiler3-107 EXHAUST | 40 | 80.0 / 2.0 | 20.0 / 0.5 | Gaseous: 3 |

EPA Method 1 stack dimensions and traverse points for the boilers associated with FG-BOILERSBLDG107 are based on historical data. See General Motors-Tech Center personnel for more information.

## 2.4 Operating Conditions and Process Data

Emission tests were performed while the boilers and low-$NO_x$ burners were operating at the conditions required by the permit. The boilers were tested when operating at normal (>50%) capacity.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The PEMS and process data that was provided is presented in Appendix B. Data collected includes the following parameters for each boiler:

- PEMS data for each 30-minute RAA run
- $NO_x$, lb/MMBtu
- Steam Load, klbs/hr

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# 3.0 Sampling and Analytical Procedures

## 3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

### 3.1.1 EPA Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 3A is an instrumental test method used to measure the concentration of $O_2$ and $CO_2$ in stack gas. The effluent gas is continuously or intermittently sampled and conveyed to analyzers that measure the concentration of $O_2$ and $CO_2$. The performance requirements of the method must be met to validate data.

The typical sampling system is detailed in Figure 3-1.

### 3.1.2 EPA Method 7E, Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)

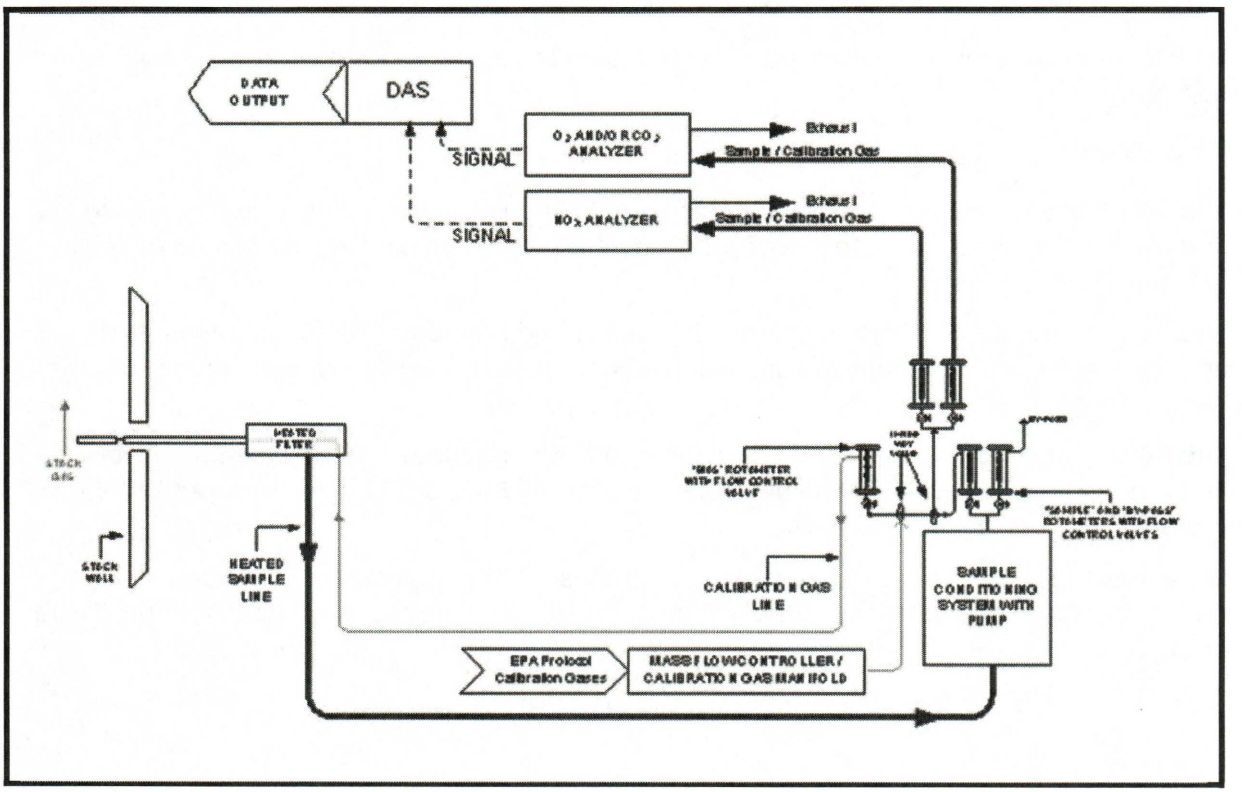
EPA Method 7E is an instrumental test method used to continuously measure emissions of $NO_x$ as $NO_2$. Conditioned gas is sent to an analyzer to measure the concentration of $NO_x$. NO and $NO_2$ can be measured separately or simultaneously together but, for the purposes of this method, $NO_x$ is the sum of NO and $NO_2$. The performance requirements of the method must be met to validate the data.

The typical sampling system is detailed in Figure 3-1.

### 3.1.3 EPA Performance Specification 16, Specifications and Test Procedures for Predictive Emission Monitoring Systems in Stationary Sources

EPA Performance Specification 16 is a specification used to evaluate the acceptability of Predictive Emission Monitoring Systems (PEMS) to show compliance with an emission limitation under 40 CFR 60, 61, or 63. These procedures are used to certify a PEMS after initial installation and periodically thereafter to ensure the system is operating properly and meets the requirements of all applicable regulations. Ongoing QA/QC tests include sensor evaluation, bias correction, quarterly Relative Accuracy Audits (RAA), and annual Relative Accuracy Test Audits (RATA).

**Figure 3-1**
**EPA Method 3A and 7E Sampling Train**




## 3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

# 4.0 Test Discussion and Results

## 4.1 Field Test Deviations and Exceptions

No field deviations or exceptions from the test plan or test methods occurred during this test program.

## 4.2 Presentation of Results

The RA results for EU-Boiler1-107 are compared to the regulatory requirements in Table 1-2 and the results of individual test runs performed at EU-Boiler1-107 are presented in Tables 4-1 and 4-2.

The RA results for EU-Boiler2-107 are compared to the regulatory requirements in Table 1-3 and the results of individual test runs performed at EU-Boiler2-107 are presented in Tables 4-3 and 4-4.

The RA results for EU-Boiler3-107 are compared to the regulatory requirements in Table 1-4 and the results of individual test runs performed at EU-Boiler3-107 are presented in Tables 4-5 and 4-6.

Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

**Table 4-1**
**$NO_x$ (ppmvd) RAA Results -**
**EU-Boiler1-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/19/2022 | 10:57-11:27 | 20.567 | 23.800 | 3.233 | 68.49 |
| 2 | 10/19/2022 | 11:41-12:11 | 19.830 | 23.820 | 3.990 | 69.68 |
| 3 | 10/19/2022 | 12:26-12:56 | 19.955 | 23.870 | 3.915 | 69.05 |
| Averages | | | 20.117 | 23.830 | 3.713 | 69.07 |
| Unit Load | | | Normal | | | |
| RA based on mean RM value | | | 18.5 | % | | |

**Table 4-2**
**$O_2$ (%-Dry) RAA Results -**
**EU-Boiler1-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/19/2022 | 10:57-11:27 | 3.870 | 3.400 | -0.470 | 68.49 |
| 2 | 10/19/2022 | 11:41-12:11 | 3.891 | 3.400 | -0.491 | 69.68 |
| 3 | 10/19/2022 | 12:26-12:56 | 3.900 | 3.400 | -0.500 | 69.05 |
| Averages | | | 3.887 | 3.400 | -0.487 | 69.07 |
| Unit Load | | | Normal | | | |
| RA based on \| mean difference \| | | | 0.49 | % as $O_2$ | | |

**Table 4-3**
**$NO_x$ (ppmvd) RAA Results -**
**EU-Boiler2-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/19/2022 | 14:59-15:29 | 24.652 | 25.920 | 1.268 | 73.62 |
| 2 | 10/19/2022 | 15:45-16:15 | 24.653 | 25.910 | 1.257 | 74.05 |
| 3 | 10/19/2022 | 16:27-16:57 | 24.857 | 26.070 | 1.213 | 72.98 |
| Averages | | | 24.721 | 25.967 | 1.246 | 73.55 |
| Unit Load | | | Normal | | | |
| RA based on mean RM value | | | 5.04 | % | | |

**Table 4-4**
**$O_2$ (%-Dry) RAA Results -**
**EU-Boiler2-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/19/2022 | 14:59-15:29 | 3.680 | 3.700 | 0.020 | 73.62 |
| 2 | 10/19/2022 | 15:45-16:15 | 3.605 | 3.700 | 0.095 | 74.05 |
| 3 | 10/19/2022 | 16:27-16:57 | 3.636 | 3.700 | 0.064 | 72.98 |
| Averages | | | 3.641 | 3.700 | 0.059 | 73.55 |
| Unit Load | | | Normal | | | |
| RA based on \| mean difference \| | | | 0.059 | % as $O_2$ | | |

**Table 4-5**
**$NO_x$ (ppmvd) RAA Results -**
**EU-Boiler3-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/20/2022 | 10:37-11:07 | 36.688 | 34.080 | -2.608 | 74.58 |
| 2 | 10/20/2022 | 11:20-11:50 | 37.249 | 34.150 | -3.099 | 72.59 |
| 3 | 10/20/2022 | 12:03-12:33 | 36.781 | 34.150 | -2.631 | 72.44 |
| Averages | | | 36.906 | 34.127 | -2.779 | 73.20 |
| Unit Load | | | Normal | | | |
| RA based on mean RM value | | | -7.53 | % | | |

**Table 4-6**
**$O_2$ (%-Dry) RAA Results -**
**EU-Boiler3-107**

| Run # | Date | Time | RM | PEMS | Difference | Heat Input Rate (MMBtu/hr) |
|---|---|---|---|---|---|---|
| 1 | 10/20/2022 | 10:37-11:07 | 3.646 | 4.100 | 0.454 | 74.58 |
| 2 | 10/20/2022 | 11:20-11:50 | 3.621 | 4.100 | 0.479 | 72.59 |
| 3 | 10/20/2022 | 12:03-12:33 | 3.647 | 4.100 | 0.453 | 72.44 |
| Averages | | | 3.638 | 4.100 | 0.462 | 73.20 |
| Unit Load | | | Normal | | | |
| RA based on \| mean difference \| | | | 0.46 | % as $O_2$ | | |

# 5.0 Internal QA/QC Activities

## 5.1 QA/QC Audits

Table 5-1 presents a summary of the gas cylinder information.

**Table 5-1**
**Part 60 Gas Cylinder Information**

| Gas Type | Gas Concentrations | Cylinder ID | Expiration Date |
|---|---|---|---|
| Zero Gas, $N_2$ | 0.0000% | CC234306 | 9/9/2030 |
| $O_2$, Balance $N_2$ | 5.123% | EB0108808 | 8/27/2027 |
| $O_2$, Balance $N_2$ | 10.19% | SG9174965BAL | 11/10/2029 |
| $NO_x$, Balance $N_2$ | 24.63 ppmv | CC232884 | 1/25/2024 |
| $NO_x$, Balance $N_2$ | 45.62 ppmv | SG9133711BAL | 7/22/2025 |
| $NO_2$, Balance Air | 51.54 ppmv | CC521692 | 8/1/2025 |

EPA Method 3A and 7E calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

The $NO_2$ to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiency met the criteria.

## 5.2 QA/QC Discussion

All QA/QC criteria were met during this test program.

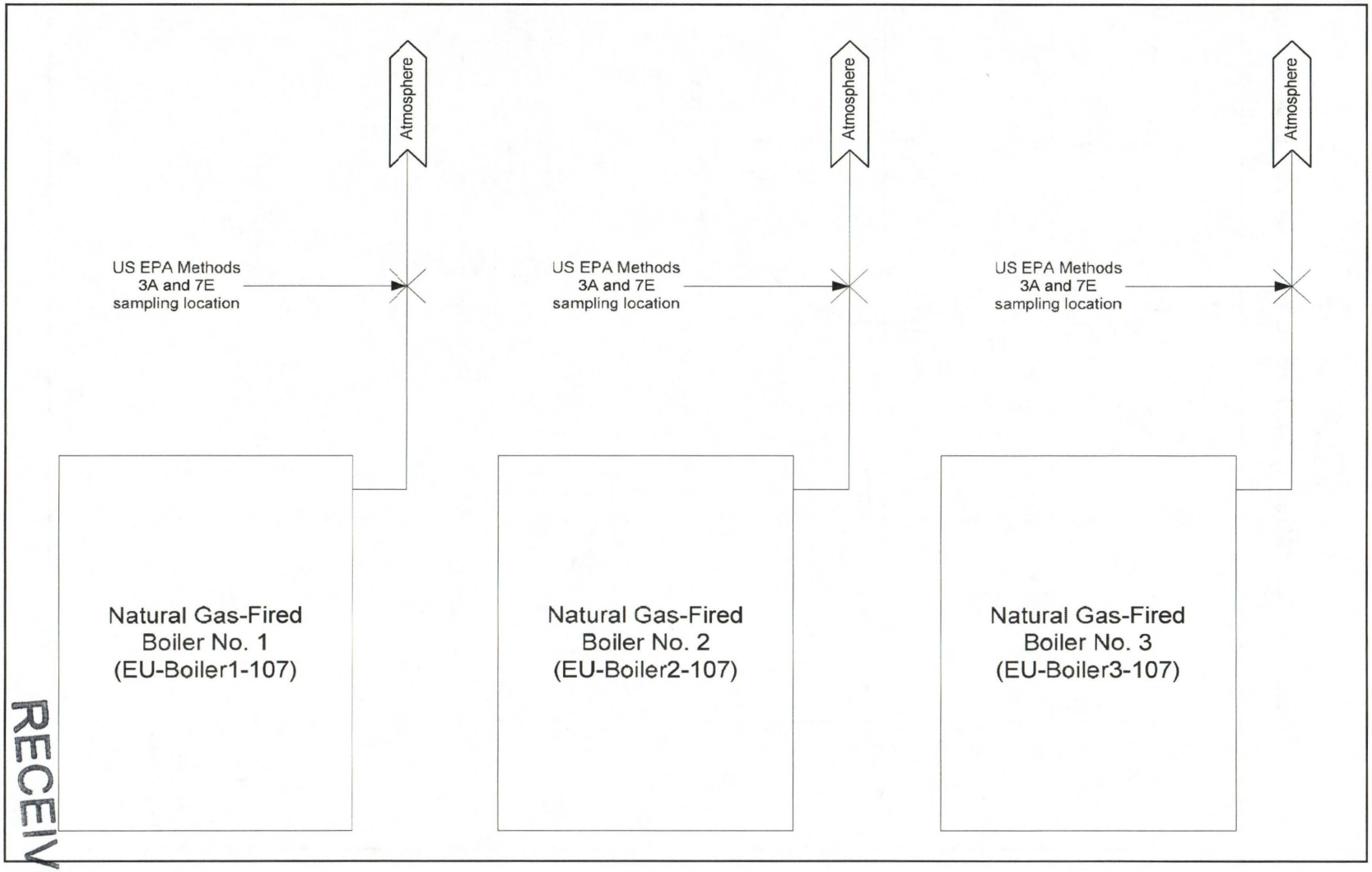
## 5.3 Quality Statement

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 included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

# Appendix A
# Field Data and Calculations

# Appendix A.1
# Sampling Locations

## FG-BOILERSBLDG107 SAMPLING LOCATIONS SCHEMATIC

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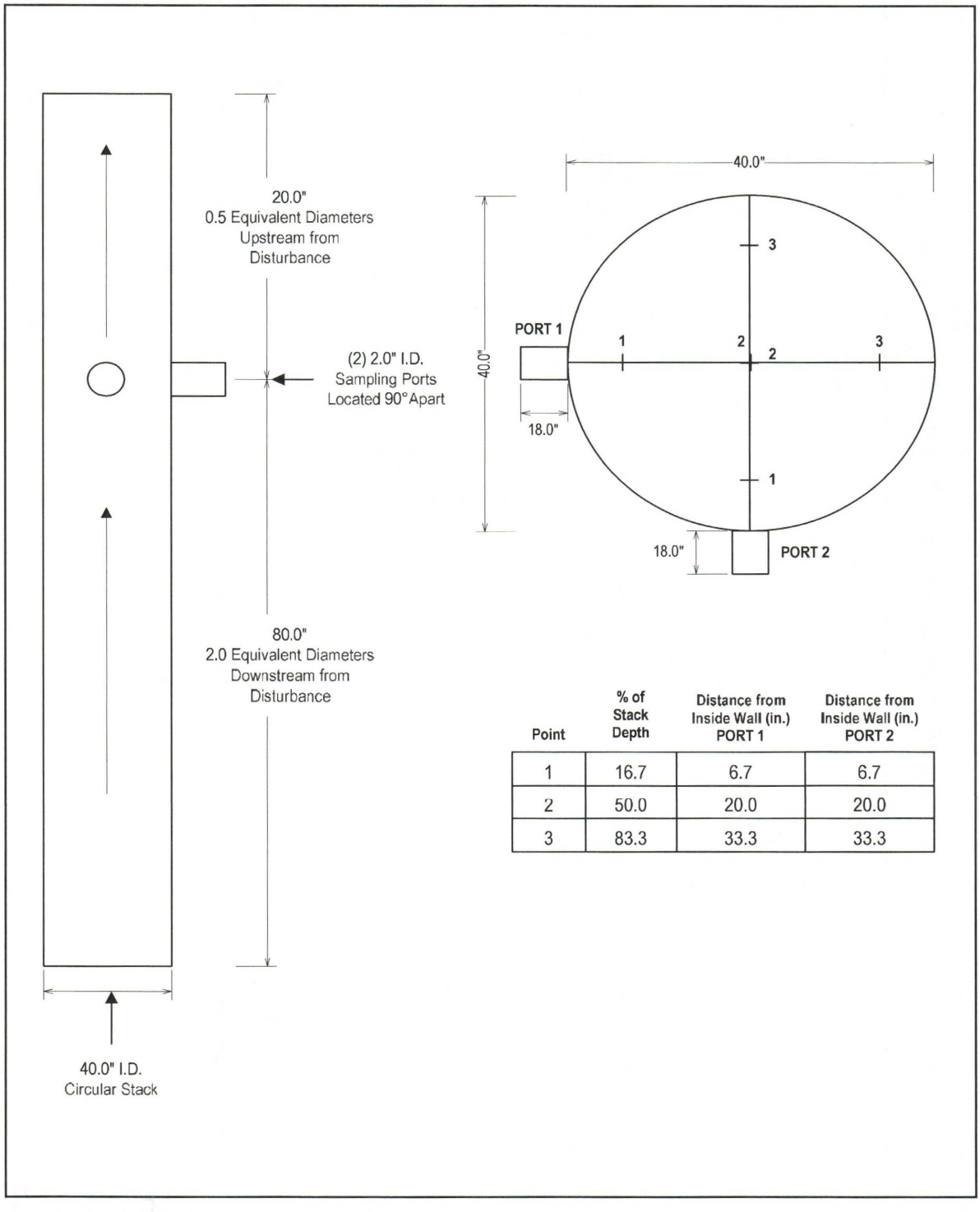
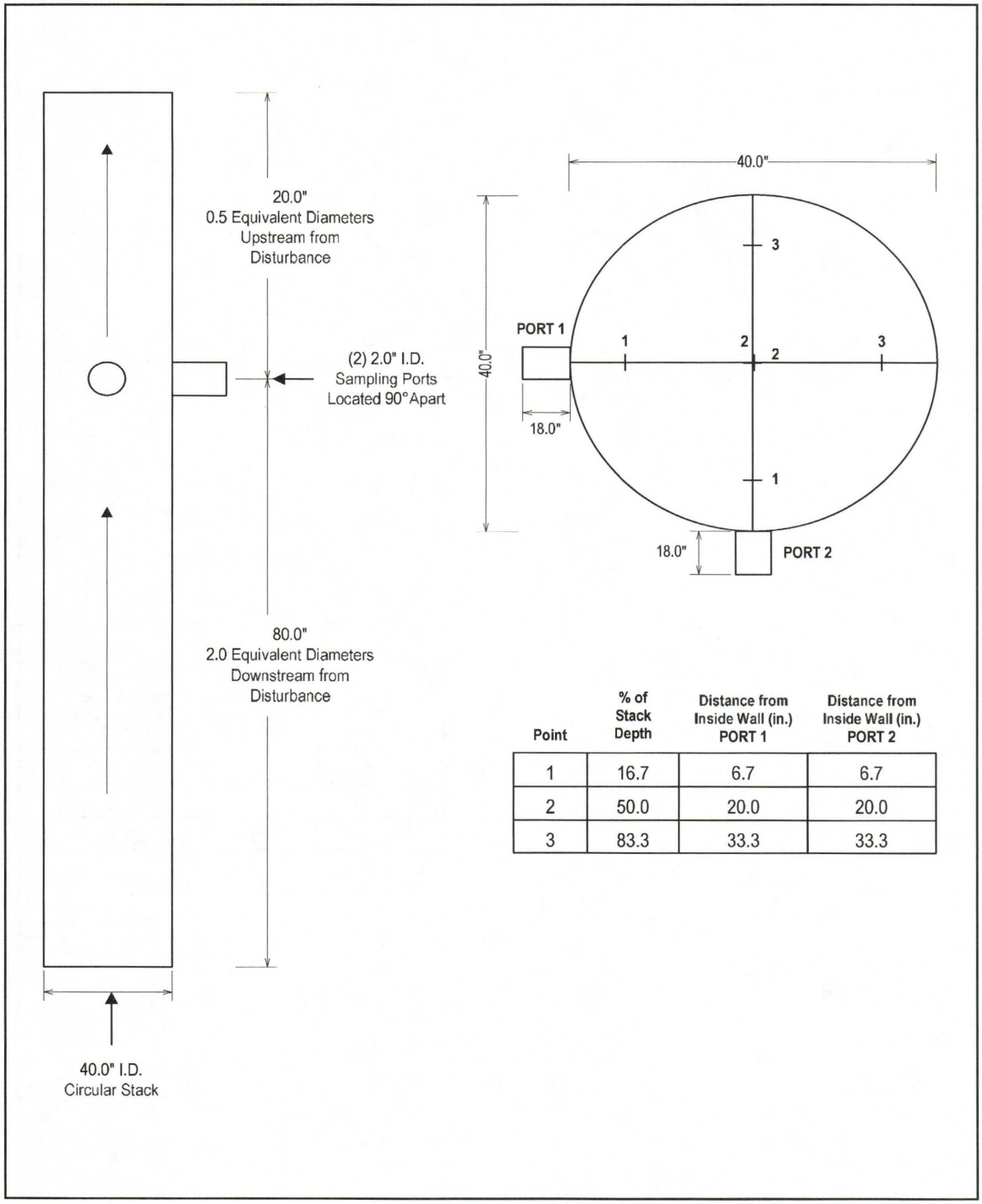
## EU-Boiler1-107 EXHAUST TRAVERSE POINT LOCATION DRAWING



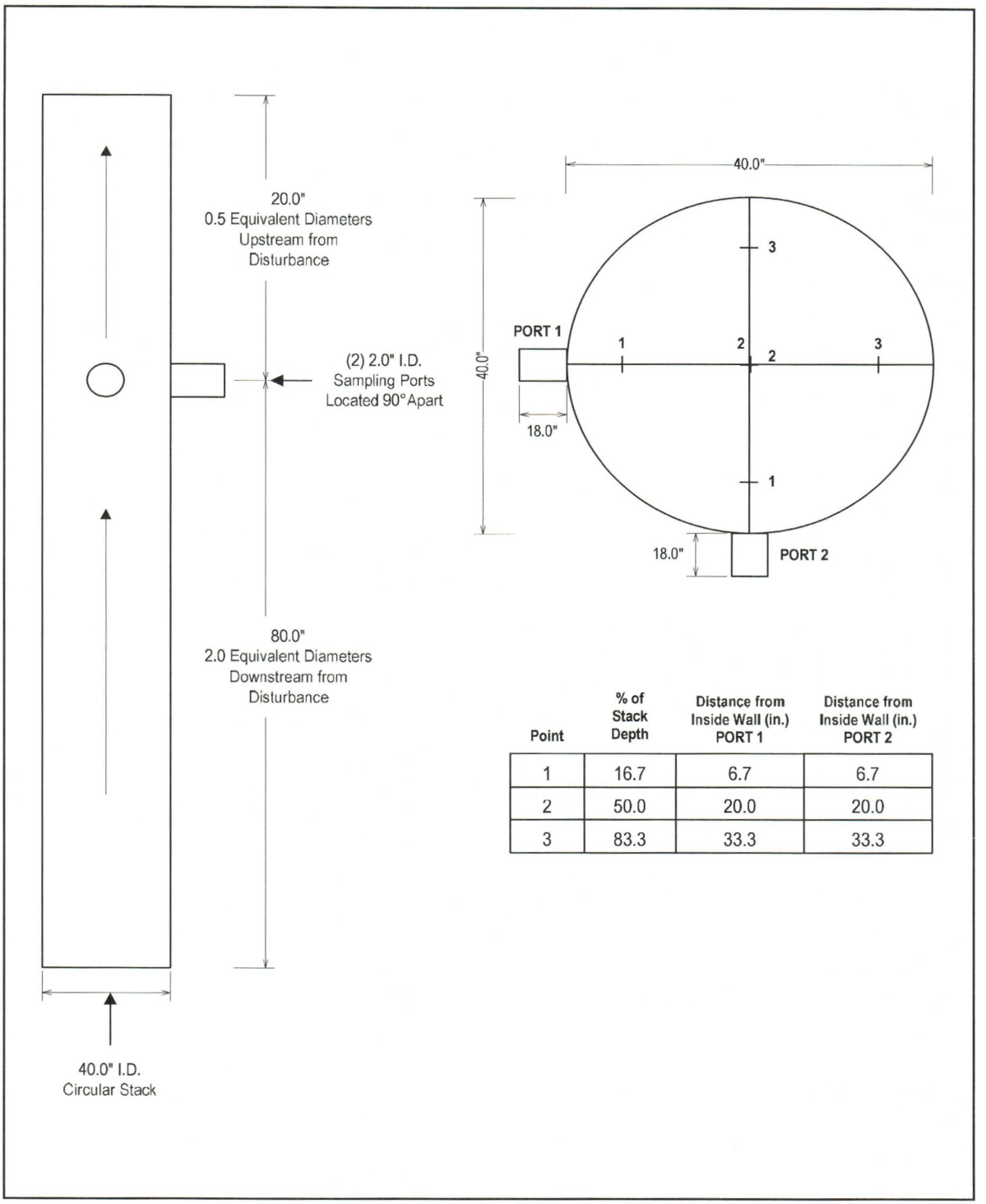

| Point | % of Stack Depth | Distance from Inside Wall (in.) PORT 1 | Distance from Inside Wall (in.) PORT 2 |
|---|---|---|---|
| 1 | 16.7 | 6.7 | 6.7 |
| 2 | 50.0 | 20.0 | 20.0 |
| 3 | 83.3 | 33.3 | 33.3 |

## EU-Boiler2-107 EXHAUST TRAVERSE POINT LOCATION DRAWING




| Point | % of Stack Depth | Distance from Inside Wall (in.) PORT 1 | Distance from Inside Wall (in.) PORT 2 |
|---|---|---|---|
| 1 | 16.7 | 6.7 | 6.7 |
| 2 | 50.0 | 20.0 | 20.0 |
| 3 | 83.3 | 33.3 | 33.3 |

## EU-Boiler3-107 EXHAUST TRAVERSE POINT LOCATION DRAWING




| Point | % of Stack Depth | Distance from Inside Wall (in.) PORT 1 | Distance from Inside Wall (in.) PORT 2 |
|---|---|---|---|
| 1 | 16.7 | 6.7 | 6.7 |
| 2 | 50.0 | 20.0 | 20.0 |
| 3 | 83.3 | 33.3 | 33.3 |