City of Warren WWTP
SRN: B1792
Warren, Michigan

2024 NOX and CO Compliance Test Report
EU-Incinerator

Prepared For:
City of Warren WWTP
32360 Warkop Ave.
Warren, MI 48093

Prepared By:
Chase Young Environmental Testing Inc
28744 Groveland Street
Madison Heights, MI 48071

CYET Project Number: 241680
Test Date: June 11, 2024

EXECUTIVE SUMMARY

Chase Young Environmental Testing Inc (CYET) was retained by Tetra Tech, Inc. (Tetra Tech) to conduct a compliance emissions test program on the EU-Incinerator at the City of Warren Wastewater Treatment Plant (WWTP) [SRN: B1792] located in Warren, Michigan. The emissions test program was conducted on June 11, 2024, and was performed in accordance with CYET project number 241680 Emission Test Plan as well as the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) acceptance letter, dated May 24, 2024.

The emissions test program was conducted to determine compliance with permit number MI-ROP-B1792-2021 issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE). EU-Incinerator is subject to the emission limits of MI-ROP-B1792-2021 and 40 CFR Part 60, Subpart MMMM, and R336.1972.

Table 1
EU-Incinerator Overall Emission Summary
Test Date: June 11, 2024

Pollutant	Reporting Units	Test Result	Permit Limit	Percent of Limit
NOx	ppmvd @ 7% O_2	187	220	85
	lb/hr	7.7	-	-
CO	ppmvd @ 7% O_2	1,146	3,800	30.1
	lb/hr	28.9	-	-
Volumetric Flowrate	ACFM	8,132	-	-
Moisture	%	3.2	-	-

CYET ChaseYoung Environmental Testing

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1. Introduction

Chase Young Environmental Testing Inc (CYET) was retained by Tetra Tech, Inc. (Tetra Tech) to conduct a compliance emissions test program on the EU-Incinerator at the City of Warren Wastewater Treatment Plant (WWTP) [SRN: B1792] located in Warren, Michigan. The emissions test program was conducted on June 11, 2024, and was performed in accordance with CYET project number 241680 Emission Test Plan as well as the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) acceptance letter.

The emissions test program was conducted to determine compliance with permit number MI-ROP-B1792-2021 issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE). EU-Incinerator is subject to the emission limits of MI-ROP-B1792-2021 and 40 CFR Part 60, Subpart MMMM, and R336.1972.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on June 11, 2024 at the WWTP facility in Warren, Michigan.

Testing on EUINCINERATOR consisted of triplicate 84-minute test runs. A stratification test was performed on June 10, 2024.

1.b Purpose of Testing

The emissions test program was conducted to determine compliance with MI-ROP-B1792-2021 issued by the Michigan department of Environment, Great Lakes, and Energy (EGLE). EUINCINERATOR is subject to the emission limits of MI-ROP-B1792-2021 and 40 CFR Part 60, Subpart MMMM, and R336.1972. The NOx emission limit is 220 ppmvd@7%O_2, and the CO limit is 3,800 ppmvd@7%O_2.

1.c Source Description

The City of Warren operates under renewable operating permit MI-ROP-B1792-2021 which includes EU-Incinerator. The incinerator combusts natural gas and sewage sludge, a product of secondary and tertiary wastewater treatment processes, also known as biosolids. The incinerator exhaust gases are passed through a wet scrubber prior to discharge to atmosphere.

Figure1 presents the test ports and traverse/sampling point locations used.

1.d Test Program Contacts

The contacts for the source and test report are:

City of Warren WWTP

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Division Head
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586-264-2530 ext. 8103
ddordeski@cityofwarren.org

Ted Bishop
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CYET

Matthew Young, QSTI
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Senior Environmental Engineer
248-506-0107
bchase@cyetinc.com

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

Table 2
Test Personnel

Name, Title, and Email	Affiliation	Telephone
Ms. Donna Dordeski Division Head ddordeski@cityofwarren.org	City of Warren WWTP 32360 Warkop Ave. Warren, Michigan 48093	(586) 264-2530 ext 8103
Mr. Ted Bishop Senior Project Manager ted.bishop@tetratech.com	Tetra Tech, Inc. 39395 W. 12 Mile Rd., Ste. 103 Farmington Hills, MI 48331	(248) 991-9702
Mr. Anthony Conigliaro Facilities Engineer aconigliaro@cityofwarren.org	City of Warren WWTP 32360 Warkop Ave. Warren, Michigan 48093	(586) 264-2530
Mr. Brandon Chase Senior Environmental Engineer bchase@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(248) 506-0107
Mr. Matthew Young Senior Project Manager myoung@cyetinc.com	CYET 28744 Groveland Street Madison Heights, MI 48071	(586) 744-9133
Mr. Robert Joseph Environmental Engineer Josephr4@michigan.gov	Air Quality Division – Warren District Office 27700 Donald Ct, Warren, MI 48092 Michigan Department of Environment, Great Lakes, and Energy	(586) 506-9564

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

Process data monitored during the emissions test program include:

- Sewage sludge feed rate,
- Moisture content of the grab samples of the sewage fed to incinerator,
- Operating Temperature of each hearth,
- Pressure drop across the scrubber,

- Scrubber liquid flow rate, and
- pH of scrubber liquid

Process operating data is included in Appendix F.

2.b Applicable Permit

The applicable permit for this emissions test program is MI-ROP-B1792-2021.

2.c Results

The overall results of the emission test program are summarized by Table 1 (see Section 5.a, and Appendix A). Emission limits are presented in section 1.b. Detailed emission results are presented in Table 3 in Appendix A.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

The City of Warren operates under renewable operating permit MI-ROP-B1792-2021 which includes EU-Incinerator. The incinerator combusts natural gas and sewage sludge, a product of secondary and tertiary wastewater treatment processes, also known as biosolids. The incinerator exhaust gases are passed through a wet scrubber prior to discharge to atmosphere.

3.b Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not necessary.

3.c Raw and Finished Materials

The process combusts dewatered biosolids which is fed to the incinerator at a maximum rate of 6.6 wet tons per hour, which is equivalent to an 85% feed rate of 5.6 wet tons per hour.

3.d Process Capacity

The rated capacity of the facility is 6.6 wet tons of biosolids per hour. Average production rate is typically 4 to 5.5 wet tons per hour.

3.e Process Instrumentation

Process data monitored during the emissions test program include:

- Sewage sludge feed rate,
- Moisture content of the grab samples of the sewage fed to incinerator,
- Operating Temperature of each hearth,
- Pressure drop across the scrubber,
- Scrubber liquid flow rate, and
- pH of scrubber liquid

Process operating data is included in Appendix F.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

Sampling and analysis procedures followed the methods codified at 40 CFR 60, Appendix A:

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"* was used to determine the sampling locations and the stack traverse points.
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"*
- Method 3 - *"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources"(Fyrite)*
- Method 3A – *"Determination of Oxygen and Carbon Dioxide Concentrations in emissions from stationary sources" (Instrumental Analyzer Procedure)* was used to determine the oxygen concentration of the exhaust gas.
- Method 4 - *"Determination of Moisture Content in Stack Gases"*
- Method 7E – "*Determination of Nitrogen Oxides Emissions from Stationary Sources"(Instrumental Analyzer Procedure)* was used to determine the nitrogen oxide concentration of the exhaust gas.
- Method 10 – "*Determination of Carbon Monoxide Emissions from Stationary Sources"* was used to determine the carbon monoxide concentration of the exhaust gas.

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2 (see Figure 1 for a schematic of the sampling location). An S-type pitot tube with thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of

the flow angle is greater than 20 degrees, cyclonic flow exists. The flow angle was determined to be less than 20 degrees at each sampling point.

Molecular weight was determined according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide content was analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the Method 4 sampling train and passed through the impinger configuration (see Figure 2). Exhaust gas moisture content was then determined gravimetrically.

USEPA Method 1 was utilized to determine the necessary sampling points in which to collect the air pollutants. Twelve sampling points were used for the stratification test which was performed on June 10, 2024. It was determined that the stack was not stratified, and the sampling for the test program was conducted at a single sampling point located at the center of the stack.

The NOx and O_2 content of the gas stream was measured using a Teledyne API 200EH NOx and O_2 gas analyzer. The CO content of the gas stream was measured via a Thermo Electron 48C CO gas analyzer. The gas stream was drawn through a stainless-steel probe with a heated in-line filter to remove any particulate, a heated Teflon® sample line, through a refrigerated Teflon® sample conditioner to remove the moisture from the sample before it entered the analyzer. Data was recorded on a PC equipped with data acquisition software. Recorded NOx, O_2, and CO concentrations were averaged and reported for the duration of each test (as drift corrected per Method 7E). A drawing of the sampling train used for the testing program is presented as Figure 3.

In accordance with Method 7E, a 3-point (zero, mid, and high) bias check and calibration check was performed on the analyzers prior to initiating the test program. Following each test run, a 2-point (zero and high) calibration drift check was performed. The NOx/O_2 analyzer was operated at the 0-25% range for O_2 and 0-500 ppm range for NOx. The CO analyzer was operated in the 0-5000 ppm range.

Prior to the field test, a NO_2 to NO conversion efficiency test was performed.

For the analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consists of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. A field quality assurance check of the system was performed pursuant to Method 205 by setting the diluted concentration to a value identical to a Protocol 1 calibration gas and then verifying that the analyzer response is the same with the diluted gas as with the Protocol 1 gas.

4.b Recovery and Analytical Procedures

This test program did not include laboratory samples, consequently, sample recovery and analysis are not applicable to this test program.

4.c Sampling Ports

A diagram of the stack indicating traverse point and sampling locations and stack dimensions is included as Figure 1.

4.d Traverse Points

A diagram of the stack indicating traverse point and sampling locations and stack dimensions is included as Figure 1.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 1. Detailed results for the emissions test program are summarized by Table 3 in Appendix A.

Table 1
EU-Incinerator Overall Emission Summary
Test Date: June 11, 2024

Pollutant	Reporting Units	Test Result	Permit Limit	Percent of Limit
NOx	ppmvd @ 7% O_2	187	220	85
	lb/hr	7.7	-	-
CO	ppmvd @ 7% O_2	1,146	3,800	30.1
	lb/hr	28.9	-	-
Volumetric Flowrate	ACFM	8,132	-	-
Moisture	%	3.2	-	-

5.b Discussion of Results

All test results are in compliance with permit limits.

5.c Sampling Procedure Variations

There were no sampling procedure variations for the test program.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

There was no control equipment maintenance performed during the emissions test program.

5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix D.

5.i Sample Calculations

Sample calculations are provided in Appendix E.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix C. Computer Generated raw data files can be downloaded from https://cyetinc.myusa.cloud/index.php/s/wwtp-241680

5.k Laboratory Data

There are no laboratory results for this test program.

MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, CYET personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, CYET personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

REPORT SIGNATURES

CYET operated in conformance with the requirements of ASTM D7036-04 during this emissions test project and this emissions test report:

This report was prepared by: Brandon Chase

Brandon Chase
Senior Environmental Engineer

This report was reviewed by: M Young

Matthew Young
Senior Project Manager

Appendix A – Emission Results Tables

Table 3
EUINCINERATOR NOx and CO Emission Rates
City of Warren WWTP
Warren, MI
CYET Project No. 241680
Sampling Date: June 11, 2024

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	6/11/2024	6/11/2024	6/11/2024	
Test Run Time	1055-1219	1240-1404	1435-1559	
Outlet Flowrate (acfm)	8,374	7,496	8,527	**8,132**
Outlet Flowrate (dscfm)	7,705	6,886	7,782	**7,458**
Outlet Flowrate (scfm)	7,943	7,114	8,047	**7,701**
Moisture (%)	3.0	3.2	3.3	**3.2**
Oxygen Concentration (%, drift corrected as per USEPA 7E)	10.7	9.5	10.0	**10.1**
Carbon Dioxide Concentration (%, per fyrite)	8.0	8.0	8.0	**8.0**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	138.4	145.4	152.0	**145.3**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**7.6**	**7.1**	**8.4**	**7.7**
Outlet NOx Concentration (ppmv, corrected to 7% O_2)	**189**	**177**	**194**	**187**
NOx Permit Limit (ppmv, corrected to 7% O2)				**220**
Percent of Limit				**85%**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	858.6	861.0	949.2	**889.6**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**28.8**	**25.8**	**32.1**	**28.9**
Outlet CO Concentration (ppmv, corrected to 7% O_2)	**1,175**	**1,050**	**1,213**	**1,146**
CO Permit Limit (ppmv, corrected to 7% O2)				**3,800**
Percent of Limit				**30%**

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NOx = 46.01)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@7\%O2}$ = Conc * (20.9 -7)/(20.9 - $\%O_2$)

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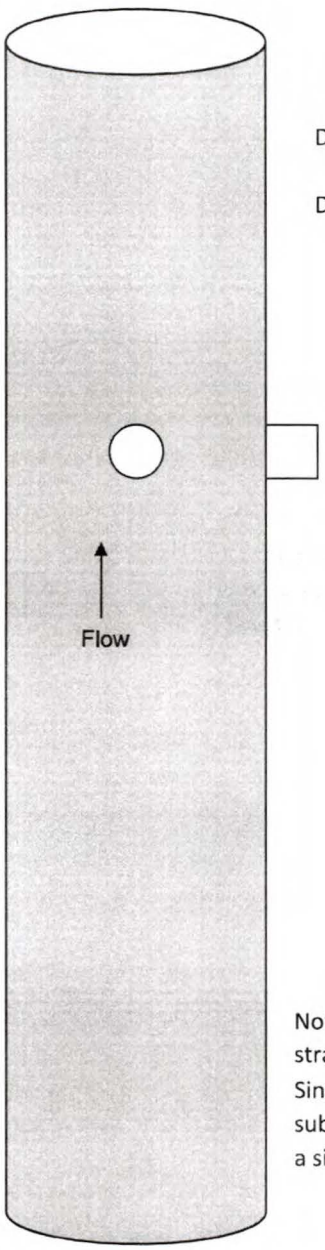
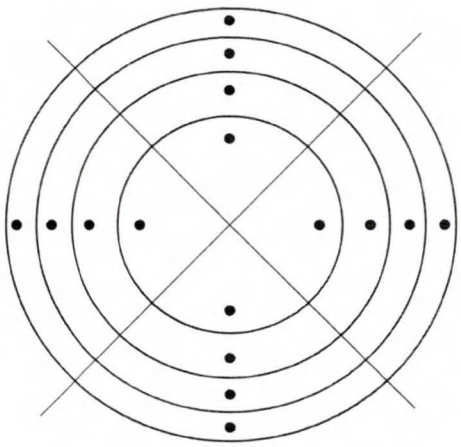
Appendix B – Figures

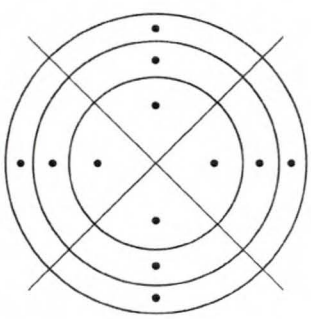


Diameter	47.25 inches
Upstream	360 inches
Downstream	144 inches
Upstream	7.6 diameters
Downstream	3.0 diameters



Flow Traverse Point #	Distance (inches)
1	1.51
2	4.96
3	9.17
4	15.26
5	31.99
6	38.08
7	42.29
8	45.74

CEM Traverse Point #	Distance (inches)
1	2.1
2	6.9
3	14.0
4	33.3
5	40.4
6	45.2



Note: CEMS points are for stratification test.
Since the stack was not stratified subsequent sampling was conducted at a single point near the centroid

Figure 1

EU-Incinerator Exhaust Stack Traverse Point Diagram

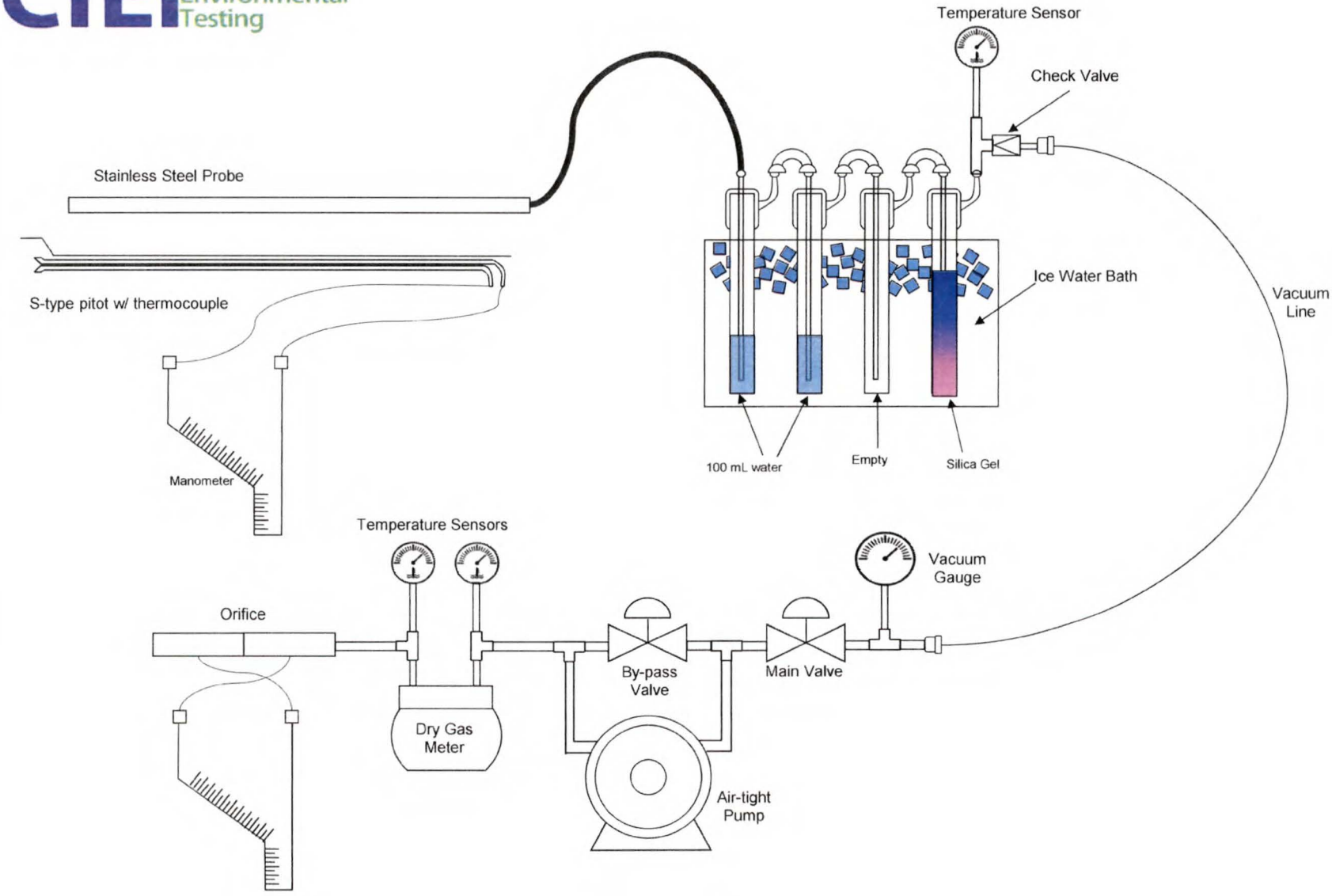


Figure 2

USEPA Method 4 Sampling Train

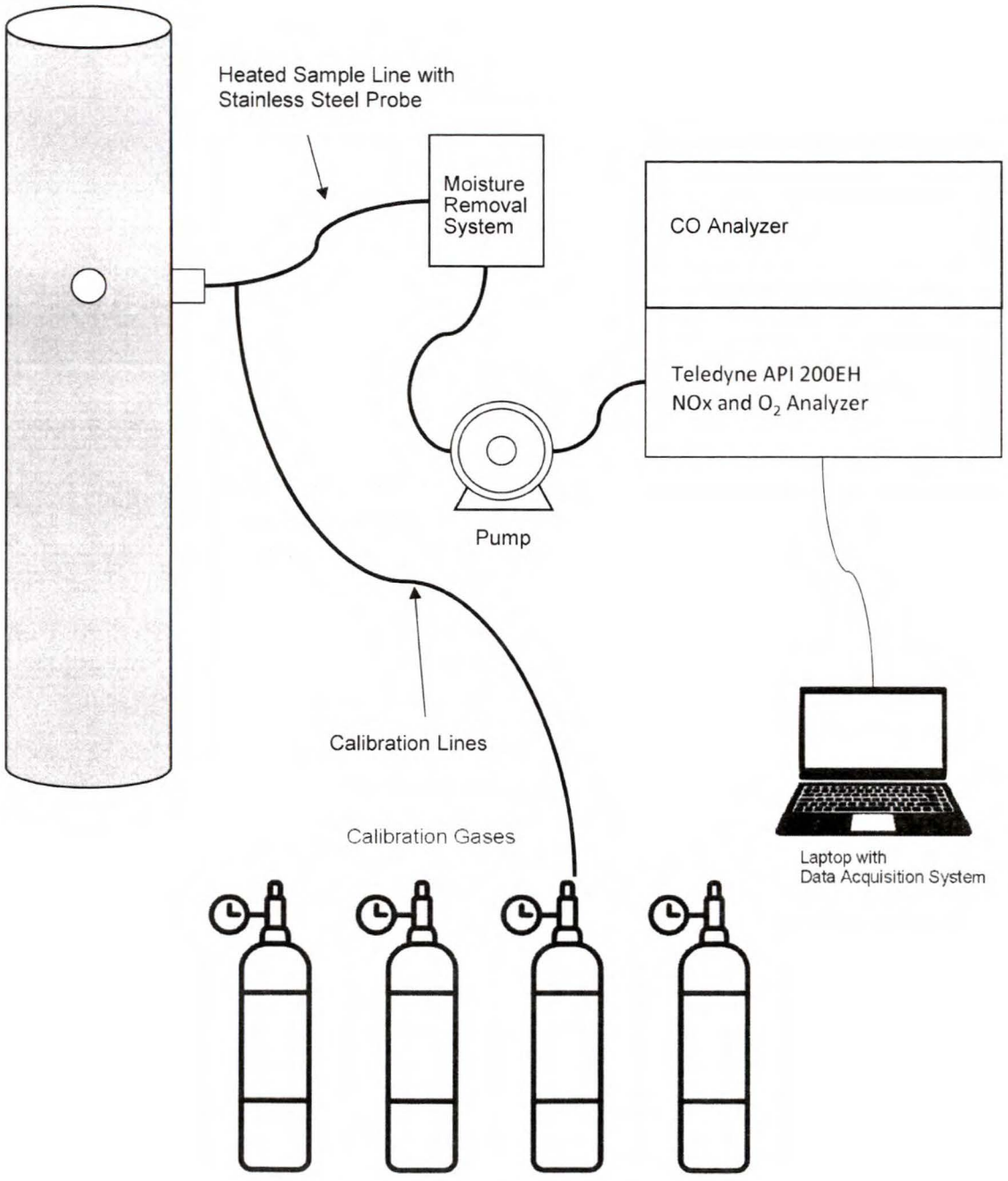


Figure 3

USEPA Method 3A/7E/10 Sampling Train