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The Dow Chemical Company, Michigan Operations

CISWI Compliance Testing
1130 Building Specialty Monomers, EU95-S1 Tar Incinerator

MI-ROP-A4033

February 1, 2019

Quality information

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1. Introduction

1.1 Summary of Test Program

AECOM Technical Services Inc. (AECOM) was contracted by Dow Chemical (Dow) in Midland Michigan, Specialty Monomers (Spec Mono) Plant to conduct Performance testing on their Tar Incinerator (EU95). Testing was performed the week of July 16th, 2018 and consisted of measurements for nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), filterable particulate matter (PM), polychlorinated dibenzodioxins and dibenzofurans (D/F) (total mass basis and TEQ basis), hydrogen chloride (HCl) and metals, specifically lead (Pb), cadmium (Cd), and mercury (Hg). The test report was presented to the Michigan Department of Environmental Quality (MDEQ) on September 19, 2018. After additional work with the vendor and on the unit to improve NO_x reduction performance, Dow proposed to retest the unit at a higher tar flow rate to demonstrate the current performance of the unit. It was noted in the test plan for this re-test, the results for metals, HCl, SO_2, PM and D/F were all at or near the detection limit, indicating that they are not present in the feed material. Hence, the re-test was conducted on December 5th, 2018 for only for nitrogen oxides (NO_x), carbon monoxide (CO) and Oxygen (O_2). The following sections present the regulatory background, objectives, description, and schedule of the testing program.

Table 7 of the CISWI Guidelines Rule (40 CFR 60 Subpart DDDD) requires that observations for fugitive ash be conducted during performance testing. The Tar Incinerator does not create ash or have an ash handling system; therefore, in an email dated June 28, 2018 from Kathy Brewer of the Michigan Department of Environmental Quality (MDEQ) – Air Quality Division the agency agreed this condition is not applicable to the unit. Instead a qualitative visual observation of the unit was completed to confirm there were no fugitive emissions.

The results of testing are presented in Table 1-1. Table 3-2 contains more details on each of the three test runs and additional details supporting these data are presented in this report.

Table 1-1 Emission Testing Results

Sample Type	Test Method	Sampling Time (min/run)	Allowable Emission	Actual Emission
NO_x	EPA Method 7E	60 min	76 ppmv @ 7% O_2	61 ppmv @ 7% O_2
CO	EPA Method 10	60 min	35 ppmv @ 7% O_2	<0.3 ppmv @ 7% O_2 [1]

[1] Actual results are below zero. <0.3 is based on the proxy of 1% of the analyzer span.

1.2 Regulatory Background

On March 21, 2011, in parallel with publication of the Boiler National Emission Standard for Hazardous Air Pollutants (NESHAP) rules and the Non-Hazardous Secondary Material (NHSM) rule, EPA promulgated the final updates to the New Source Performance Standards (NSPS) and Emission Guidelines (EG) for Existing CISWI Units, collectively referred to as the "2011 CISWI Rules." The 2011 CISWI Rules impact any facility that owns an emission unit that "combusts, or has combusted in the preceding six months, any solid waste as that term is defined in 40 CFR Part 241.2." The CISWI rules were then reconsidered and amended in 2013. The final version of the CISWI Rules/Guidelines were published in the Federal Register on February 7, 2013. The final rule is titled: Subpart DDDD—Emissions Guidelines and Compliance Times for Commercial and Industrial Solid Waste Incineration Units.

In accordance with the requirements of 40 CFR 60 Subpart DDDD, each affected unit must conduct an annual performance test. The requirements of that testing is outlined in 40 CFR 60.2690 and in tables 2 or 6-9, depending on the specific mechanism by the unit is affected.

The following table summarizes the pertinent data for this compliance test:

Responsible Groups	• The Dow Chemical Company • Michigan Department of Environmental Quality (MDEQ) • Environmental Protection Agency (EPA)
Applicable Regulations	• MI-ROP-A4033 • 40 CFR Part 60 Commercial and Industrial Solid Waste Incineration Units MACT (Subpart DDDD) • "MDEQ Air Quality Division Part 9, Rule 336.1974"
Industry/Plant	• Specialty Monomers, 1130 Building
Plant Location	• The Dow Chemical Company Midland, Michigan 48667
Unit Initial Start-up	• 1990
Air Pollution Control Equipment	• N/A
Emission Points	• EU-95 Tar Incinerator (EU95-S1)
Pollutants/Diluent Measure	• Nitrogen Oxides (NO_x) • Carbon Monoxide (CO) • Oxygen (O_2)
Test Date	• December 5th, 2018

1.3 Key Personnel

The key personnel coordinating this test program were:

- Cody Lindemulder, Laura Allington and Katie Frankowski provided support as the Process Focal Point(s). The Process Focal Point is responsible for coordinating the plant operation during the test and ensuring the unit is operating at the agreed upon conditions in the test plan. They also serve as the key contact for collecting any process data required and providing all technical support related to process operation.

- Jennifer Kraut, Sara Bennett and Colleen Rosenbrock provided support as the Environmental Focal Point for this test. The Environmental Focal Point is responsible for ensuring that all regulatory requirements and citations are reviewed and considered for the testing. All agency communication will be completed through this role.

- Daniel J Nuñez served as the Test Plan Coordinator. The Test Plan Coordinator is responsible for the overall leadership of the sampling program. They also develop the overall testing plan and determine the correct sample methods.

- Eugene Youngerman provided support as a technical reviewer of the test data.

- James Edmister served as the Sample Team Leader. The Sample Team Leader is responsible for ensuring the data generated meets the quality assurance objectives of the plan. Kyle Kennedy and Randy Reinke also assisted as sampling technicians.

2. Plant and Sampling Location Descriptions

2.1 Facility Description

The Dow Chemical Company (DOW) operates a Tar Incinerator (EU95-S1) at its Midland, Michigan chemical manufacturing facility. EU95-S1 is a boiler that produces steam from the heat input of natural gas and process tars. The process tars contain distillation heavies from the 1130 building process and process aids from the distillation process. The boiler is rated for 48 MMBtu/hr while the burner is rated for 15 MMBtu/hr. EU95-S1 must meet the requirements of the Commercial and Industrial Solid Waste Incineration (CISWI) rule promulgated under 40 CFR Part 60 Subpart DDDD, and is regulated as an Energy Recovery Unit under the rule.

2.2 Performance Test Operations

The performance test was conducted at one operating condition to demonstrate the system performance with respect to the emission standards listed in this report. During each test run CMS parameters were monitored and stack gas emissions were measured. The following sections briefly summarize these activities associated with the performance test.

2.2.1 Unit Process Data

Process monitoring information pertinent to establishing that the unit is operating at normal conditions was recorded during the test by the EU-95 Tar Incinerator data acquisition system. One-minute average data was obtained from the process control system for each operating parameter specified in the test plan for each test run. For each operating parameter, an average value was calculated for each test run.

Figure 1 EU95 Tar Incinerator Process Schematic

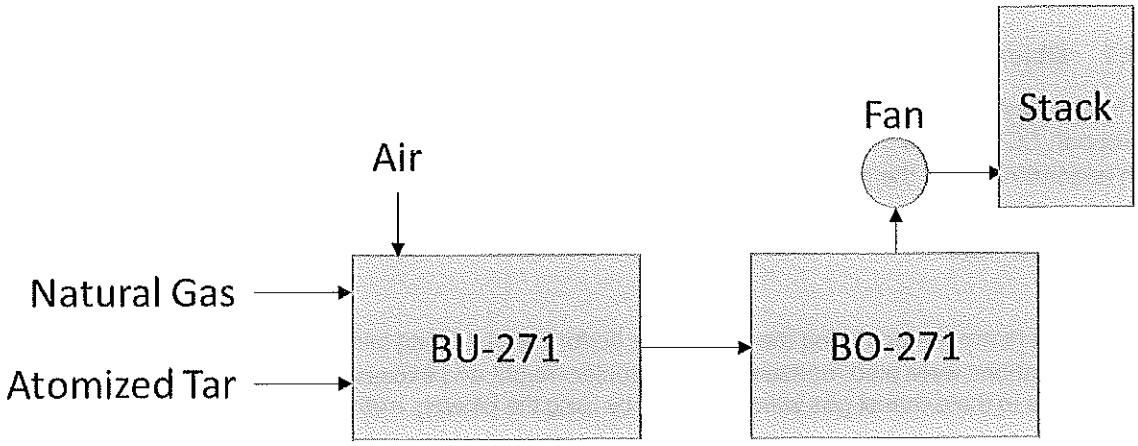


Table 2-1 Manufacturer's Name and Model Number

Equipment	Manufacturer	Model Number
BU-271	Bloom	S-1610-022
BO-271	Johnston	509 Series

3. Summary and Discussion of Test Plan

3.1 Objectives and Test Matrix

The primary objective of this testing was to demonstrate compliance with the requirements of 40 CFR 60 Subpart DDDD. The performance testing of the Incinerator Stack NO_x and CO emissions was performed in accordance with the procedures specified in 40 CFR 60, Appendix A. This test report describes the instrumental procedures performed on the Incinerator Stack located within the Dow Chemical Specialty Monomers Plant.

Parameters measured during the December performance testing included NO_x and CO. O_2 and CO_2 concentrations were also measured for molecular weight and excess air correction. The concentrations of pollutants in the exhaust gas were measured by using the following methods and procedures:

O_2/CO_2

- EPA Method 3A, *"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources.";*

NO_X

- EPA Method 7E, "*Determination of Nitrogen Oxides Emission from Stationary Sources.*";

CO

- EPA Method 10, "*Determination of Carbon Monoxide Emissions from Stationary Sources.*";

The emission testing of the incinerator Stack consisted of three (3) test runs each for NO_x and CO.

The duration of each test was as followed:

- Instrumental methods (NO_x, CO, O_2 and CO_2) tests were a minimum sixty (60) minutes in duration

The applicable limits demonstrated during the compliance test as well as the methods employed are listed in Table 3-1.

Table 3-1 Test Matrix and Objectives

Parameter	Test Method	Regulation	Emission Limit
O_2/CO_2	EPA Method 3A	40 CFR 60, Subpart DDDD	N/A
NO_X	EPA Method 7E	40 CFR 60, Subpart DDDD	76 ppmv @ 7% O_2
CO	EPA Method 10	40 CFR 60, Subpart DDDD	35 ppmv @ 7% O_2

3.2 Process Operating Rates

As required by the regulation and MDEQ guidance, all sampling was completed at normal operating conditions.

The normal operating rates were determined by reviewing the process data from the previous six months of operation. The average values do not include calibration data, startup data, shutdown data, malfunction data, and data obtained not burning waste.

Parameter	Normal Operating Rate	Operating Rate During Testing
Heat input (MMBtu/hr)	4-13	8.5
Tars Feed Rate (lb/hr)	180-420	407-411
Natural Gas Feed Rate (scfh)	1450-9000	1445-1453
O_2 in Vent Stack (%)	9-15	10.5-10.7

The results of the compliance test are listed below in Table 3-2.

Table 3-2 Testing Run Data (NO_x and CO)

	Run 1	Run 2	Run 3	Average
Run Date	12/5/2018	12/5/2018	12/5/2018	-
Run Times	9:15-10:15	10:30-11:30	11:47-12:47	-
Stack Gas O_2 (%)	12.43	12.48	12.53	12.48
Nitrogen Oxides				
ppmdv	34.5	36.6	39.9	37.0
ppmdv @7% O_2	56.6	60.5	66.2	61.1
Carbon Monoxides				
ppmdv[1]	<0.3	<0.3	<0.3	<0.3
ppmdv @7% O_2 [1]	<0.3	<0.3	<0.3	<0.3

[1] Actual results are below zero. <0.3 is based on the proxy of 1% of the analyzer span.

4. Sampling and Analytical Procedures

4.1 Sample Time

The duration of each test run for instrumental methods (NO_x and CO) was sixty (60) minutes. There are no minimum sample volume requirements for EPA methods 3A, 7E and 10.

4.2 Sample Test Runs

Three (3) sample test runs were performed for each method.

4.3 Sample Port Location

The stack is approximately 40-ft high with and inside diameter of 35 inches at the elevation of the sampling points. The sampling ports are approximately 64 inches downstream from the closest disturbance (stack breach) and 108 inches upstream from the next nearest disturbance (stack exit).

Figure 2 illustrates the sampling location.

4.4 Instrumental Methods

Emission gas was withdrawn from the Incinerator Stack and transported to the AECOM CEMS located at ground level. A stainless-steel sampling probe was inserted into the stack and used to collect sample gas. A heated Teflon sample line was used to transport the sample gas from the sampling probe to the CEMS. At the mobile laboratory, stack exhaust gas was dried using a condenser and routed to the individual analyzers for analysis on a dry basis (O_2, NO_x, CO). Data was collected using a dedicated data acquisition system. The system stores the data as fifteen-second averages.

Each analyzer was calibrated before testing using gas standards as specified by EPA Methods 7E, 3A and 10. Only EPA Protocol gases or certified pure zero nitrogen and air gases were used for calibration.

Method compliance is ensured by performing:

- Calibration error (challenging the calibrated instrument at three levels)
- System drift (challenging the overall system at two levels)
- System response testing
- Stratification check demonstrating lack of stratification, and allowing sample gas to be collected from a single point.
- Calibration drift (repeating system bias after testing)

A schematic of the instrumental sampling system is shown in Figure 3.

The following instruments were used:

- EPA Method 3A (O_2/CO_2) - Teledyne model 300M; paramagnetic
- EPA Method 7E (NO_X) - TECO Model 42; chemiluminescent NO detector.
- EPA Method 10 (CO) - Teledyne Model 300M; gas filter correlation (GFC) infrared.

Figure 2 Sample Location

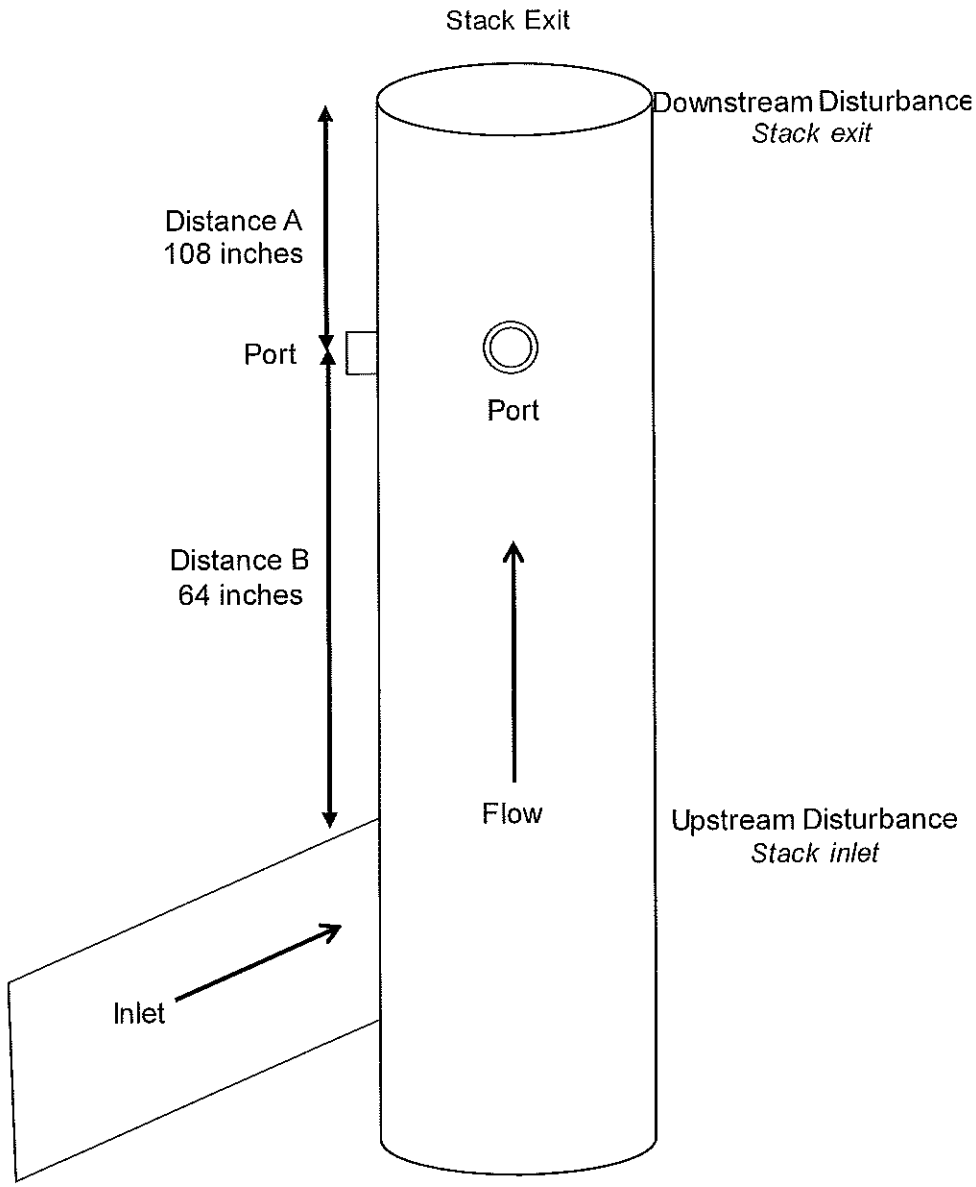
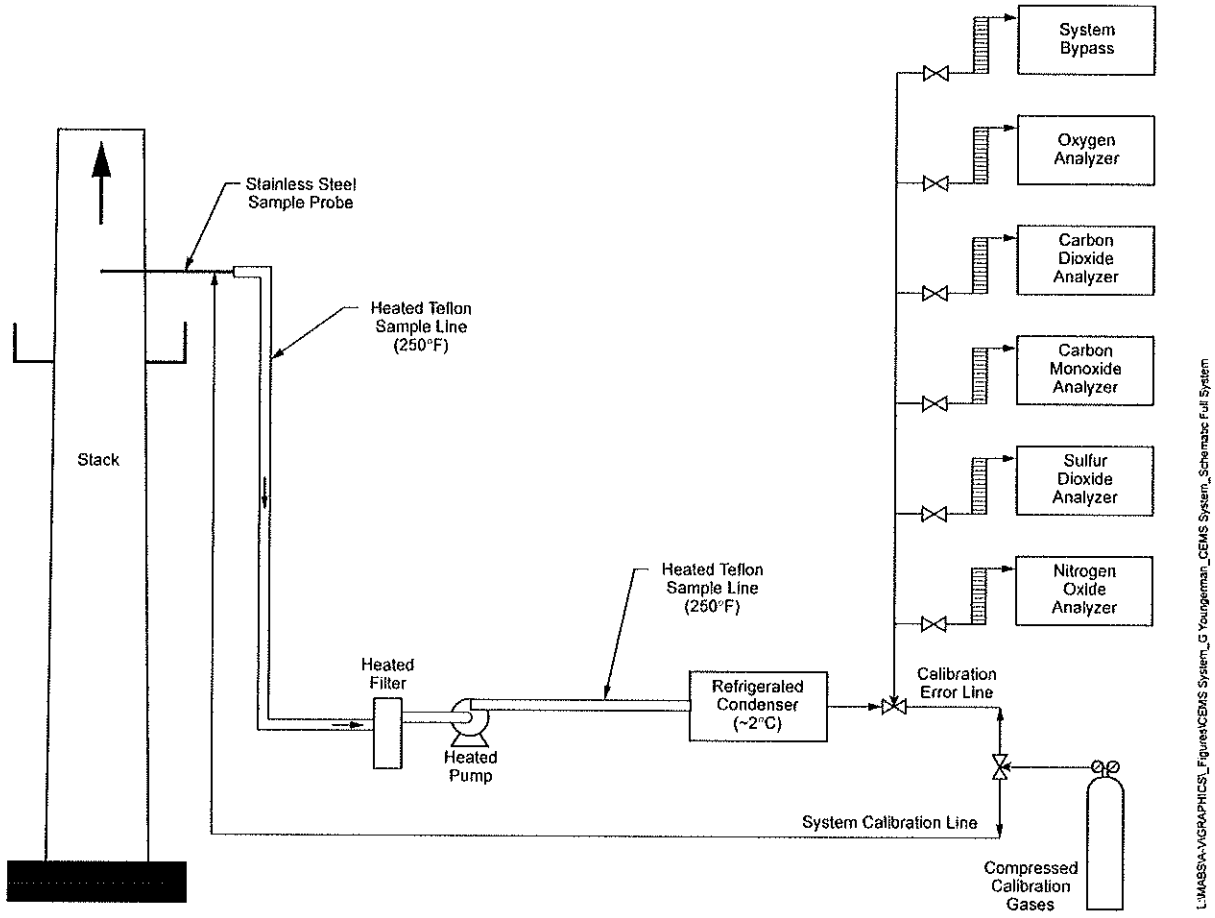


Figure 3 Schematic of AECOM CEM System



5. Calculation Examples

Analyzer Calibration Error Calculations

The calibration error test consisted of challenging each reference monitor at three measurement points against known calibration gas values. Calibration error for the reference is calculated using the following equation:

$$CE_{RM} = \frac{|Analyzer\ Response - Calibration\ Gas\ Value|}{Span\ of\ Analzyer} \times 100$$

Reference O_2 Calibration Error Example (Direct Calibration)

$$CE_{RM} = \frac{|(0.0\,\%) - (-0.09\%)|}{(19.94\,\%)} \times 100 = \underline{0.4\%}$$

$$CE_{RM} = \frac{|(19.87\,\%) - (19.94\,\%)|}{(19.94\,\%)} \times 100 = \underline{0.3\,\%}$$

$$CE_{RM} = \frac{|(9.86\,\%) - (9.98\,\%)|}{(19.94\,\%)} \times 100 = \underline{0.6\,\%}$$

System Calibration Bias Calculations

The system bias calibration test consisted of challenging the reference sample system at two measurement points against the local calibration values. Calibration bias calculations for the reference sample system are calculated using the following equation:

$$CB_{RM} = \frac{System\ Calibration\ Response - Analzyer\ Calibration\ Response}{Span\ of\ Analzyer} \times 100$$

Reference O_2 Initial System Bias Example (Pre- Test Run 1)

$$CB_{RM} = \frac{|(-0.02\,\%) - (-0.09\,\%)|}{(19.94\,\%)} \times 100 = \underline{0.3\,\%}$$

$$CB_{RM} = \frac{|(9.83\,\%) - (9.86\,\%)|}{(19.94\,\%)} \times 100 = \underline{-0.2\,\%}$$

Calibration Drift Calculations

The calibration drift tests were conducted at the beginning and end of each run. Analyzer maintenance, repair or adjustment could not be completed until the system calibration response was recorded. Calibration drift for the reference is calculated using the following equation:

$$CD_{RM} = \frac{|Final\ System\ Cal\ Response - Initial\ System\ Cal\ Response|}{Span\ of\ Analzyer} \times 100$$

Reference O_2 Calibration Drift Run #1 Example

$$CD_{RM} = \frac{|(0.01\,\%) - (0.02\,\%)|}{(19.94\,\%)} \times 100 = \underline{0.2\,\%}$$

$$CD_{RM} = \frac{|(9.81\,\%) - (9.83\,\%)|}{(19.94\,\%)} \times 100 = \underline{-0.1\,\%}$$

System Calibration Drift Correction

The gas concentrations are corrected for the system calibration bias. The concentrations are calculated using the following equations:

$$C_{Gas} = (\overline{C} - C_O)\left(\frac{C_{MA}}{C_M - C_O}\right)$$

Where: C_{Gas} = Effluent Concentration, dry ppm or %
$\overline{C}$ = Average Analyzer Concentration, ppm or %
C_O = Average Initial and Final System Calibration Responses for Zero Gas, ppm or %
C_M = Average Initial and Final System Calibration Responses for Upscale Calibration Gas, ppm or %
C_{MA} = Actual Concentration of Upscale Calibration Gas, ppm or %

O_2 System Calibration Drift Correction for Run #1 Example

$$C_{Gas} = (12.23\,\% - -0.006\,\%)\left(\frac{9.98\,\%}{9.82\,\% - -0.006\,\%}\right) = \underline{12.43\,\%}$$

6. Field test Data

Emission Summary Table
1130 Spec Mono CISIWI Re-Test
1130 Spec Mono
Throx

Run Identification	Run 1	Run 2	Run 3	Average
Run Date	12/5/18	12/5/18	12/5/18	
Run Time	09:15-10:15	10:30-11:30	11:47-12:47	
Exhaust Gas Conditions				
Oxygen (dry volume %)	12.43	12.48	12.53	12.48
Carbon Dioxide (dry volume %)	6.26	6.21	6.17	6.21
Carbon Monoxide				
ppmdv[1]	<0.3	<0.3	<0.3	<0.3
ppmdv @7% O_2 [1]	<0.3	<0.3	<0.3	<0.3
Nitrogen Oxides				
ppmdv	34.5	36.6	39.9	37.0
ppmdv @7% O_2	56.6	60.5	66.2	61.1

[1] Actual results are below zero. <0.3 is based on the proxy of 1% of the analyzer span.