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I. INTRODUCTION

Network Environmental, Inc. was retained by National Energy of Lincoln, Michigan to perform a Relative Accuracy Test Audit (RATA) on the Continuous Emissions Monitoring System (CEMS) that services their wood fired boiler. The CEMS is for oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and oxygen (O_2).

The RATA was performed on August 22, 2023. Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc. conducted the RATA in accordance with 40 CFR Part 60 Appendix B Performance Specifications 2 for NO_x and SO_2, 3 for O_2 and 4 for CO. Assisting with the RATA were Mr. Kenny Mumma and Mr. Robert Travis of National Energy and the operating staff of the facility. Mr. Dave Bowman and Mr. Daniel J. Droste of the Michigan Department of Environment, Great Lakes and Energy (EGLE) – Air Quality Division were present to observe the sampling and source operation.

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II. PRESENTATION OF RESULTS

II.1 TABLE 1
NOₓ (LBS/MMBTU) RELATIVE ACCURACY TEST AUDIT RESULTS
WOOD FIRED BOILER
NATIONAL ENERGY
LINCOLN, MICHIGAN
AUGUST 22, 2023

| Run # | Time | REFERENCE METHOD | | | CEM | DIFF |
		NO_x [1]	O_2 [2]	Lbs/MMBTU	Lbs/MMBTU	
1	09:22-09:47	135.6	4.8	0.199	0.183	0.016
2[3]	10:07-10:32	134.3	4.9	0.198	0.181	0.017
3	10:52-11:17	135.5	4.9	0.200	0.183	0.017
4[3]	11:39-12:04	140.9	5.1	0.211	0.193	0.018
5	12:25-12:50	134.1	5.4	0.205	0.188	0.017
6	13:21-13:46	133.6	4.9	0.197	0.181	0.016
7	14:09-14:34	136.0	4.9	0.201	0.184	0.017
8[3]	14:51-15:16	135.6	5.2	0.204	0.186	0.018
9	15:40-16:05	143.3	4.7	0.209	0.193	0.016
10	16:19-16:44	142.5	4.7	0.208	0.193	0.015
11	17:03-17:28	138.6	4.7	0.202	0.189	0.013
12	17:44-18:09	126.9	4.3	0.181	0.169	0.012

Mean Reference Value = 0.20022

Absolute Value of the Mean of the Difference = 0.01544

Standard Deviation = 0.00181

Confidence Co-efficient = 0.00139

Relative Accuracy = 8.41% of the mean of the reference method

[1] = Concentration in terms of PPM by volume on a dry basis
[2] = Concentration in terms of % by volume on a dry basis
[3] = Not used in relative accuracy calculation

II.2 TABLE 2
NOₓ (PPM) RELATIVE ACCURACY TEST AUDIT RESULTS
WOOD FIRED BOILER
NATIONAL ENERGY
LINCOLN, MICHIGAN
AUGUST 22, 2023

Run #	Time	REFERENCE METHOD NO_x [1]	CEM NO_x [1]	DIFF
1	09:22-09:47	135.6	126.1	9.5
2	10:07-10:32	134.3	124.7	9.6
3	10:52-11:17	135.5	126.0	9.5
4[2]	11:39-12:04	140.9	130.7	10.2
5	12:25-12:50	134.1	125.0	9.1
6	13:21-13:46	133.6	124.2	9.4
7	14:09-14:34	136.0	126.6	9.4
8[2]	14:51-15:16	135.6	125.9	9.7
9[2]	15:40-16:05	143.3	133.4	9.9
10	16:19-16:44	142.5	133.1	9.4
11	17:03-17:28	138.6	130.3	8.3
12	17:44-18:09	126.9	119.3	7.6

Mean Reference Value = 135.23333

Absolute Value of the Mean of the Difference = 9.08889

Standard Deviation = 0.68272

Confidence Co-efficient = 0.52479

Relative Accuracy = 7.11% of the mean of the reference method

[1] = Concentration in terms of PPM by volume on a dry basis
[2] = Not used in relative accuracy calculation

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II.3 TABLE 3
CO (LBS/MMBTU) RELATIVE ACCURACY TEST AUDIT RESULTS
WOOD FIRED BOILER
NATIONAL ENERGY
LINCOLN, MICHIGAN
AUGUST 22, 2023

| Run # | Time | REFERENCE METHOD | | | CEM | DIFF |
		CO [1]	O_2 [2]	Lbs/MMBTU	Lbs/MMBTU	
1	09:22-09:47	145.5	4.8	0.130	0.138	-0.008
2	10:07-10:32	129.8	4.9	0.117	0.126	-0.009
3[3]	10:52-11:17	109.2	4.9	0.098	0.111	-0.013
4[3]	11:39-12:04	94.1	5.1	0.086	0.100	-0.014
5[3]	12:25-12:50	79.5	5.4	0.074	0.090	-0.016
6	13:21-13:46	135.5	4.9	0.122	0.134	-0.012
7	14:09-14:34	126.2	4.9	0.114	0.126	-0.012
8	14:51-15:16	169.7	5.2	0.156	0.167	-0.011
9	15:40-16:05	136.1	4.7	0.121	0.130	-0.009
10	16:19-16:44	112.5	4.7	0.100	0.113	-0.013
11	17:03-17:28	164.1	4.7	0.146	0.156	-0.010
12	17:44-18:09	238.5	4.3	0.207	0.211	-0.004

Mean Reference Value = 0.13478

Absolute Value of the Mean of the Difference = 0.00978

Standard Deviation = 0.00273

Confidence Co-efficient = 0.00210

Relative Accuracy = 8.81% of the mean of the reference method

(1) = Concentration in terms of PPM by volume on a dry basis
(2) = Concentration in terms of % by volume on a dry basis
(3) = Not used in relative accuracy calculation

II.4 TABLE 4
SO₂ (LBS/MMBTU) RELATIVE ACCURACY TEST AUDIT RESULTS
WOOD FIRED BOILER
NATIONAL ENERGY
LINCOLN, MICHIGAN
AUGUST 22, 2023

| Run # | Time | REFERENCE METHOD | | | CEM | DIFF |
		SO_2 [1]	O_2 [2]	Lbs/MMBTU	Lbs/MMBTU	
1[3]	09:22-09:47	54.0	4.8	0.110	0.101	0.009
2[3]	10:07-10:32	64.6	4.9	0.133	0.124	0.009
3	10:52-11:17	67.7	4.9	0.139	0.132	0.007
4	11:39-12:04	78.5	5.1	0.163	0.156	0.007
5	12:25-12:50	94.5	5.4	0.201	0.192	0.009
6	13:21-13:46	80.1	4.9	0.165	0.159	0.006
7	14:09-14:34	58.1	4.9	0.119	0.117	0.002
8	14:51-15:16	34.8	5.2	0.073	0.073	0.000
9	15:40-16:05	65.3	4.7	0.132	0.128	0.004
10	16:19-16:44	86.2	4.7	0.175	0.166	0.009
11	17:03-17:28	69.2	4.7	0.140	0.133	0.007
12[3]	17:44-18:09	63.3	4.3	0.125	0.117	0.008

Mean Reference Value = 0.14522

Absolute Value of the Mean of the Difference = 0.00567

Standard Deviation = 0.00308

Confidence Co-efficient = 0.00237

Relative Accuracy = 5.53% of the mean of the reference method

(1) = Concentration in terms of PPM by volume on a dry basis
(2) = Concentration in terms of % by volume on a dry basis
(3) = Not used in relative accuracy calculation

II.5 TABLE 5
O_2 (%) RELATIVE ACCURACY TEST RESULTS
WOOD FIRED BOILER
NATIONAL ENERGY
LINCOLN, MICHIGAN
AUGUST 22, 2023

Run #	Time	REFERENCE METHOD O_2 [1]	CEM O_2 [1]	DIFF
1	09:22-09:47	4.8	4.6	0.2
2[2]	10:07-10:32	4.9	4.6	0.3
3[2]	10:52-11:17	4.9	4.6	0.3
4	11:39-12:04	5.1	4.9	0.2
5	12:25-12:50	5.4	5.2	0.2
6	13:21-13:46	4.9	4.7	0.2
7[2]	14:09-14:34	4.9	4.6	0.3
8	14:51-15:16	5.2	4.9	0.3
9	15:40-16:05	4.7	4.6	0.1
10	16:19-16:44	4.7	4.6	0.1
11	17:03-17:28	4.7	4.6	0.1
12	17:44-18:09	4.3	4.2	0.1

Mean Reference Value = 4.86667

Absolute Value of the Mean of the Difference = 0.16667

Standard Deviation = 0.07071

Confidence Co-efficient = 0.05435

Relative Accuracy = 4.54% of the mean of the reference method

(1) = Concentration in terms of % by volume on a dry basis
(2) = Not used in relative accuracy calculation

III. DISCUSSION OF RESULTS

III.1 NO$_x$ RATA (LBS/MMBTU) - The results of the NO$_x$ RATA in terms of Lbs/MMBTU can be found in Table 1 (Section II.1). The relative accuracy calculations were performed in terms of Lbs/MMBTU in accordance with U.S. EPA Reference Method 19. The Lbs/MMBTU results were calculated using the formula found in Section 2.1 of Method 19 for O$_2$ on a dry basis. The F factor used was 9,475. Twelve (12), twenty-five (25) minute samples were collected from the boiler exhaust. Only nine (9) of the runs were used in the relative accuracy calculation.

The relative accuracy for the NO$_x$ CEMS in terms of Lbs/MMBTU was 8.41% of the mean of the reference method samples.

According to Performance Specification 2 in 40 CFR Part 60 Appendix B, "The relative accuracy (RA) of the CEMS shall be no greater than 20 percent of the mean value of the reference method test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater."

III.2 NO$_x$ RATA (PPM) - The results of the NO$_x$ RATA in terms of PPM (v/v) on a dry basis can be found in Table 2 (Section II.2). The relative accuracy calculations were performed in terms of PPM Dry. Twelve (12), twenty-five (25) minute samples were collected from the boiler exhaust. Only nine (9) of the runs were used in the relative accuracy calculation. All reference method data was corrected using Equation 7E-5 (U.S. EPA Method 7E) prior to performing the RATA calculations.

The relative accuracy for the NO$_x$ CEMS in terms of PPM was 7.11% of the mean of the reference method samples.

According to Performance Specification 2 in 40 CFR Part 60 Appendix B, "The relative accuracy (RA) of the CEMS shall be no greater than 20 percent of the mean value of the reference method test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater."

III.3 CO RATA (LBS/MMBTU) - The results of the CO RATA can be found in Table 3 (Section II.3). The relative accuracy calculations were performed in terms of Lbs/MMBTU in accordance with U.S. EPA Reference Method 19. The Lbs/MMBTU results were calculated using the formula

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found in Section 2.1 of Method 19 for O_2 on a dry basis. The F factor used was 9,475. Twelve (12), twenty-five (25) minute samples were collected from the boiler exhaust. Only nine (9) of the runs were used in the relative accuracy calculation.

The relative accuracy for the CO CEMS was 8.81% of the mean of the reference method samples.

According to Performance Specification 4 in 40 CFR Part 60 Appendix B, "The relative accuracy (RA) of the CEMS shall be no greater than 10 percent of the mean value of the reference method test data in terms of the units of the emission standard or 5 percent of the applicable standard, whichever is greater."

III.4 SO_2 RATA (LBS/MMBTU) - The results of the SO_2 RATA can be found in Table 4 (Section II.4). The relative accuracy calculations were performed in terms of Lbs/MMBTU in accordance with U.S. EPA Reference Method 19. The Lbs/MMBTU results were calculated using the formula found in Section 2.1 of Method 19 for O_2 on a dry basis. The F factor used was 9,475. Twelve (12), twenty-five (25) minute samples were collected from the boiler exhaust. Only nine (9) of the runs were used in the relative accuracy calculation.

The relative accuracy for the SO_2 CEMS was 5.53% of the mean of the reference method samples.

According to Performance Specification 2 in 40 CFR Part 60 Appendix B, "The relative accuracy (RA) of the CEMS shall be no greater than 20 percent of the mean value of the reference method test data in terms of the units of the emission standard or 10 percent of the applicable standard, whichever is greater."

III.5 O_2 RATA (%) - The results of the O_2 RATA on the BrandGaus monitor can be found in Table 5 (Section II.5). The relative accuracy calculations were performed in terms of percent (%) on a dry basis. Twelve (12), twenty-five (25) minute samples were collected from the boiler exhaust. Only nine (9) of the runs were used in the relative accuracy calculation. All reference method data was corrected using Equation 7E-5 (U.S. EPA Method 7E) prior to performing the RATA calculations.

The relative accuracy for the BrandGaus O_2 CEMS was 4.54% of the mean of the reference method samples.

According to Performance Specification 3 in 40 CFR Part 60 Appendix B, "The relative accuracy (RA) of the CEMS shall be no greater than 20 percent of the mean value of the reference method test data or 1 percent oxygen."

IV. SOURCE DESCRIPTION

The CEMS services a wood fired boiler with a capacity of 600 tons per day of fuel. The exhaust is controlled by an electrostatic precipitator. The boiler was operated at approximately 100% of load during the testing period. The waste wood was supplemented by tire derived fuel (TDF) during the RATA.

V. CEMS DESCRIPTION

The NO_x monitor is a Teledyne Model T200H NO_x analyzer, Serial # 297. The monitor records data on a dry basis. The span range is 0-500 PPM. The NO_x monitor was recently repaired, so the monitor was certified by PPM (v/v) Dry in addition to Lbs/MMBTU.

The CO monitor is a California Analytical Instruments Model ZPA analyzer, Serial # N8L1377. The monitor records data on a dry basis. The span range is 0-1000 PPM.

The SO_2 monitor is a Fuji Model # ZRF SO_2 analyzer, Serial # A7M4619T. The monitor operates using the non-dispersive infrared principle on a dry basis. The span range is 0-250 PPM.

The O_2 monitor is a BrandGaus Model 4705 O_2 analyzer, Serial # 10970. The monitor records data on a dry basis. The span range is 0-21 %.

VI. SAMPLING AND ANALYTICAL PROTOCOL

The RATA was performed in accordance with 40 CFR Part 60 Appendix B Performance Specifications 2 for NO_x and SO_2, 3 for O_2 and 4 for CO. The sampling was conducted on the 71 inch I.D. exhaust stack at a location that exceeds 8 duct diameters downstream and 2 duct diameters upstream from the nearest

disturbances (U.S. EPA Reference Method 1 requirement).

The RATA was performed in accordance with the protocol approved by the EGLE-Air Quality Division. Three (3)-point (16.7%, 50% & 83.3% of diameter) stratification tests, as described in U.S. EPA Method 7E have been performed and passed on numerous occasions. One (1) point (50% of diameter) sampling was used to collect the exhaust gas from the stack.

The sampling methods used for the reference method determinations were as follows:

VI.1 Oxides of Nitrogen

The NO_x sampling was conducted in accordance with U.S. EPA Reference Method 7E. A Thermo Environmental Model 42H gas analyzer was used to monitor the boiler exhaust. Sample gas was extracted through a heated probe. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the NO_x concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 191.0 PPM was used to establish the initial instrument calibration. Calibration gases of 55.6 PPM and 101.0 PPM were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 101.0 PPM gas to determine the system bias. After each sample, a system zero and system injection of 101.0 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler.

VI.2 Carbon Monoxide

The CO sampling was conducted in accordance with U.S. EPA Reference Method 10. A Thermo Environmental Model 48C gas analyzer was used to monitor the boiler exhaust. Sample gas was extracted through a heated probe. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas

conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the CO concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 998.0 PPM was used to establish the initial instrument calibration. Calibration gases of 251.0 PPM and 486.0 PPM were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 251.0 PPM gas to determine the system bias. After each sample, a system zero and system injection of 251.0 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler.

VI.3 Sulfur Dioxide

The SO_2 sampling was conducted in accordance with U.S. EPA Reference Method 6C. A Bovar Model 721M gas analyzer was used to monitor the boiler exhaust. Sample gas was extracted through a heated probe. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the SO_2 concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 269.0 PPM was used to establish the initial instrument calibration. Calibration gases of 95.2 PPM and 148.0 PPM were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 95.2 PPM gas to determine the system bias. After each sample, a system zero and system injection of 95.2 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler.
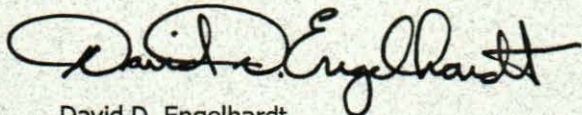
VI.4 Oxygen

The O_2 sampling was conducted in accordance with U.S. EPA Reference Method 3A. A Servomex Model 1400M portable stack gas analyzer was used to monitor the boiler exhaust. Sample gas was extracted through a heated probe. A heated teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the O_2 concentrations (%).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 21.0% was used to establish the initial instrument calibration. Calibration gases of 6.03% and 11.8% were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 6.03% gas to determine the system bias. After each sample, a system zero and system injection of 6.03% were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler.

This report was prepared by:

David D. Engelhardt
Vice President
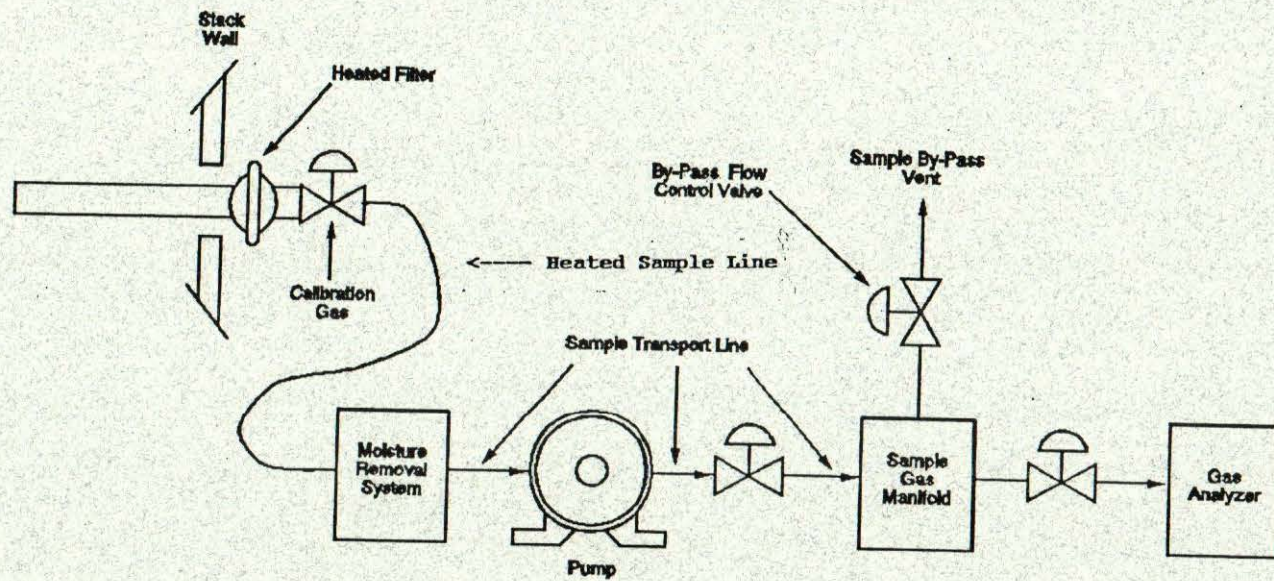
This report was reviewed by:

R. Scott Cargill
Project Manager

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Stack Wall

Heated Filter

Calibration Gas

<--- Heated Sample Line

By-Pass Flow Control Valve

Sample By-Pass Vent

Sample Transport Line

Moisture Removal System

Pump

Sample Gas Manifold

Gas Analyzer

Figure 1

NO_x, CO, SO_2 & O_2
Sampling Train