40CFR75 APPENDIX E NITROGEN OXIDES EMISSIONS ESTIMATION PROCEDURE

Performed At
Michigan Public Power Agency
Combustion Turbine Generation Facility
EU-TURBINE 1A
EU-TURBINE 1B
Kalkaska, Michigan

Test Dates
April 4 and 5, 2018

Report No.
TRC Environmental Corporation Report 298355

Report Submittal Date
May 9, 2018

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Report Certification

I certify that to the best of my knowledge:

- Testing data and all corresponding information have been checked for accuracy and completeness.
- Sampling and analysis have been conducted in accordance with the approved protocol and applicable reference methods (as applicable).
- All deviations, method modifications, or sampling and analytical anomalies are summarized in the appropriate report narrative(s).

Anthony Sakellariou
Senior Project Manager

May 9, 2018
Date

TRC was operating in conformance with the requirements of ASTM D7036-04 during this test program.

Bruce Randall
TRC Emission Testing Technical Director

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40CFR75 NITROGEN OXIDES EMISSIONS ESTIMATION PROCEDURE

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed a Title 40, Code of Federal Regulations, Part 75, Appendix E (40CFR75) nitrogen oxides (NO_X) emissions estimation procedure on April 4 and 5, 2018 at the Combustion Turbine Generation Facility of Michigan Public Power Agency (MPPA) in Kalkaska, Michigan. The tests were authorized by and performed for MPPA.

The purpose of this test program was to generate a curve relating the NO_X emissions rate to the heat input for four (4) load conditions while firing natural gas. This testing was performed in order to satisfy the requirements of the 40CFR75 Part 75, Appendix E. The test program was conducted according to the TRC Test Protocol dated February 28, 2018.

1.1 Project Contact and Qualified Individual (QI) Information

Participants		
Test Facility	Michigan Public Power Agency 1750 Prough Road SW Kalkaska, Michigan 49646 Permit No. MI-ROP-N7113-2016a Facility No. N7113	Mr. Matt Burk Power Generation Services Lead 517-323-8919 ext. 135 517-323-8373 (fax) mburk@mpower.org
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Mr. Gregory Rock Field Team Leader 262-960-3379 (phone) 312-533-2070 (fax) grock@trcsolutions.com

William Manny and Gregory Rock of TRC conducted the testing. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

Ms. Sharon LeBlanc and Mr. Jeremy Howe from the Michigan Department of Environmental Quality (MDEQ) observed the testing.

2.0 SUMMARY OF RESULTS

During this test program, three (3) Reference Method 7E NO_X and oxygen (O_2) test runs were conducted at each of four approximately equally spaced load conditions, ranging from the maximum operating load to the minimum operating load allowing for a 15-minute unit stabilization at each condition.

Unit operating data, recorded by plant personnel, are appended to the report. A standard fuel factor of 8710 dry standard cubic feet per million Btu (dscf/MMBtu) for natural gas was used to calculate the NO_X emissions on a pounds per million Btu (lb/MMBtu) basis. Heat input (calculated from operating data and fuel analysis) and lb/MMBtu were used to calculate the lb/hr emission rates. The results for the tests conducted are summarized in the following tables:

Table 1 – EU-TURBINE 1A

Fuel	Load MW	Heat Input MMBtu/hr	O_2 % dry	NO_X ppmvd	NO_X ppmvd at 15% O_2	NO_X lb/MMBtu	NO_X lb/hr
Natural gas	29.6	305.2	14.80	24.15	23.37	0.086	26.35
	23.6	248.0	15.61	20.64	23.02	0.085	21.08
	26.3	270.6	15.53	20.97	23.03	0.085	22.91
	20.6	222.3	15.93	20.65	24.53	0.090	20.08

Table 2 – EU-TURBINE 1B

Fuel	Load MW	Heat Input MMBtu/hr	O_2 % dry	NO_X ppmvd	NO_X ppmvd at 15% O_2	NO_X lb/MMBtu	NO_X lb/hr
Natural gas	30.4	312.8	14.73	23.07	22.07	0.081	25.34
	24.4	256.5	15.57	20.22	22.39	0.082	21.12
	27.7	284.0	15.40	20.39	21.86	0.081	22.91
	21.4	230.8	15.83	20.15	23.43	0.086	19.85

Complete test results from this program are presented in Section 6.0

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operations appeared normal during the entire test program. No changes or problems were encountered that required modification of any procedures presented in the test plan. No adverse test or environmental conditions were encountered during the conduct of this test program.

4.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. Sample was collected at 12 points during each test run.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.1.1 O_2 Determination by USEPA Method 3A

This method is applicable for the determination of O_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O_2 analyzer was equipped with a paramagnetic-based detector.

4.1.2 NO_x Determination by USEPA Method 7E

This method is applicable for the determination of NO_x concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The NO_x analyzer used a photomultiplier tube to measure the light emitted from the chemiluminescent decomposition of NO_2.

4.2 Determination of F-Factors by 40CFR75 Appendix F

This procedure is applicable for the determination of the pollutant emission rate using oxygen (O_2) or carbon dioxide (CO_2) concentrations and the appropriate F factor (the ratio of combustion gas volumes to heat inputs) and the pollutant concentration. The appropriate F-Factor was selected from Table 1 of 40CFR75 Appendix F.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Accreditation from the Louisiana Environmental Laboratory Accreditation Program (LELAP);
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *"AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found."* TRC conforms with this section by using approved test protocols for all tests.

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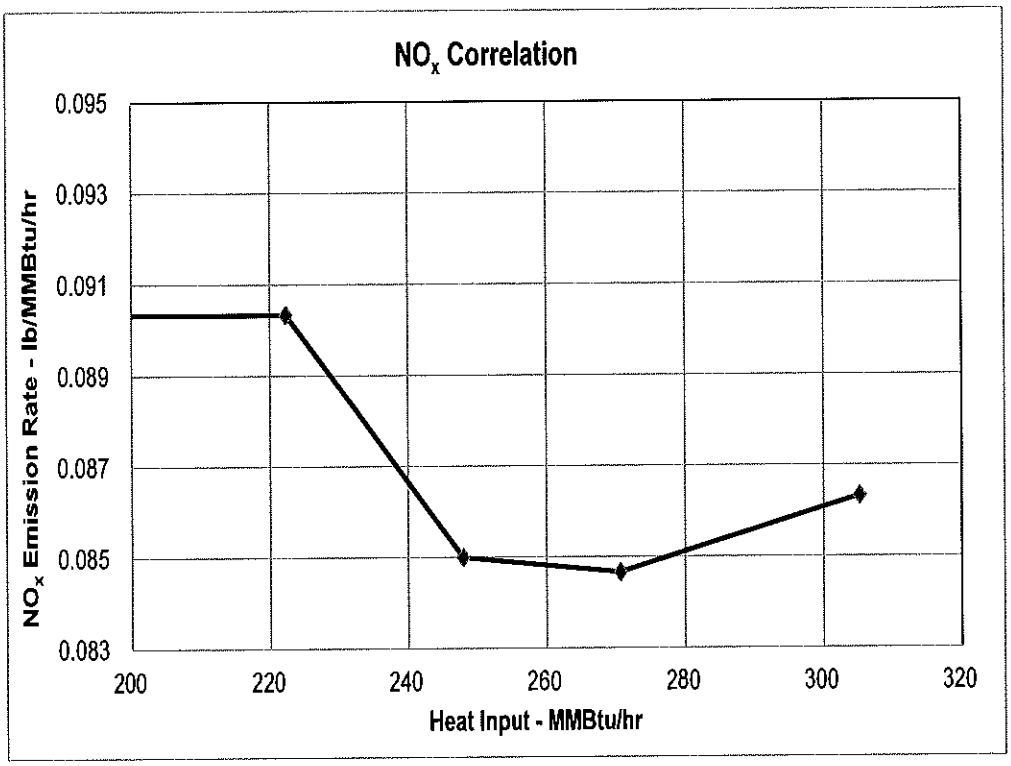
NITROGEN OXIDES EMISSIONS ESTIMATION SUMMARY

Project No.: 298355
Company: MPPA
Date: April 4 and 5, 2018
Plant: Combustion Turbine Generation Facility
Unit: EU-TURBINE 1A
Fuel: Natural Gas

Date	Condition	Run #	Start Time	Stop Time	HHV Btu/scf	Fuel Factor dscf/MMBtu	Oper. Load MW	Gas Flow x100 scfh	Heat Input MMBtu/hr	O_2 % dry	NO_X ppmvd	NO_X at 15% O_2	NO_X lb/MMBtu	NO_X lbs/hr
04/04/18	High	1-1	5:14	5:52	1047	8710	29.6	2925.6	306.3	14.74	24.01	23.00	0.085	26.04
04/04/18	High	1-2	6:31	7:11	1047	8710	29.6	2910.0	304.7	14.83	24.23	23.55	0.087	26.51
04/04/18	High	1-3	7:30	8:18	1047	8710	29.6	2909.6	304.6	14.84	24.20	23.56	0.087	26.50
Average							**29.6**	**2915.1**	**305.2**	**14.80**	**24.15**	**23.37**	**0.086**	**26.35**
04/04/18	MidLow	2-1	9:08	9:46	1047	8710	23.6	2370.5	248.2	15.63	20.56	23.02	0.085	21.10
04/04/18	MidLow	2-2	10:07	10:46	1047	8710	23.6	2367.0	247.8	15.60	20.69	23.03	0.085	21.06
04/04/18	MidLow	2-3	11:07	11:45	1047	8710	23.6	2369.2	248.1	15.60	20.68	23.02	0.085	21.09
Average							**23.6**	**2368.9**	**248.0**	**15.61**	**20.64**	**23.02**	**0.085**	**21.08**
04/05/18	MidHigh	3-1	5:04	5:42	1047	8710	26.4	2593.6	271.5	15.49	20.71	22.59	0.083	22.53
04/05/18	MidHigh	3-2	5:59	6:37	1047	8710	26.4	2586.7	270.8	15.57	20.87	23.10	0.085	23.02
04/05/18	MidHigh	3-3	6:55	7:33	1047	8710	26.2	2572.6	269.4	15.52	21.34	23.40	0.086	23.17
Average							**26.3**	**2584.3**	**270.6**	**15.53**	**20.97**	**23.03**	**0.085**	**22.91**
04/05/18	Low	4-1	8:10	8:48	1047	8710	20.6	2120.3	222.0	15.99	20.60	24.75	0.091	20.20
04/05/18	Low	4-2	9:04	9:42	1047	8710	20.6	2125.6	222.6	15.92	20.66	24.48	0.090	20.03
04/05/18	Low	4-3	10:05	10:42	1047	8710	20.6	2124.5	222.4	15.89	20.69	24.37	0.090	20.02
Average							**20.6**	**2123.5**	**222.3**	**15.93**	**20.65**	**24.53**	**0.090**	**20.08**

EU-TURBINE 1A CORRELATION CHART



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NITROGEN OXIDES EMISSIONS ESTIMATION SUMMARY

Project No.: 298355
Company: MPPA
Date: April 4 and 5, 2018
Plant: Combustion Turbine Generation Facility
Unit: EU-TURBINE 1B
Fuel: Natural Gas

Date	Condition	Run #	Start Time	Stop Time	HHV Btu/scf	Fuel Factor dscf/MMBtu	Oper. Load MW	Gas Flow x100 scfh	Heat Input MMBtu/hr	O_2 % dry	NO_X ppmvd	NO_X at 15% O_2	NO_X lb/MMBtu	NO_X lbs/hr
04/04/18	High	1-1	5:14	5:52	1047	8710	30.4	2991.3	313.2	14.66	23.03	21.78	0.080	25.06
04/04/18	High	1-2	6:31	7:11	1047	8710	30.4	2986.3	312.7	14.74	23.09	22.12	0.081	25.33
04/04/18	High	1-3	7:30	8:18	1047	8710	30.4	2985.3	312.6	14.79	23.10	22.31	0.082	25.63
Average							**30.4**	**2987.6**	**312.8**	**14.73**	**23.07**	**22.07**	**0.081**	**25.34**
04/04/18	MidLow	2-1	9:08	9:46	1047	8710	24.4	2448.5	256.4	15.56	19.95	22.04	0.081	20.77
04/04/18	MidLow	2-2	10:07	10:46	1047	8710	24.4	2450.8	256.6	15.58	20.36	22.58	0.083	21.30
04/04/18	MidLow	2-3	11:07	11:45	1047	8710	24.4	2450.0	256.5	15.57	20.36	22.54	0.083	21.29
Average							**24.4**	**2449.8**	**256.5**	**15.57**	**20.22**	**22.39**	**0.082**	**21.12**
04/05/18	MidHigh	3-1	5:04	5:42	1047	8710	27.6	2701.8	282.9	15.39	20.21	21.64	0.080	22.63
04/05/18	MidHigh	3-2	5:59	6:37	1047	8710	27.6	2703.3	283.0	15.43	20.33	21.93	0.081	22.92
04/05/18	MidHigh	3-3	6:55	7:33	1047	8710	27.8	2731.3	286.0	15.37	20.63	22.01	0.081	23.17
Average							**27.7**	**2712.1**	**284.0**	**15.40**	**20.39**	**21.86**	**0.081**	**22.91**
04/05/18	Low	4-1	8:10	8:48	1047	8710	21.4	2198.5	230.2	15.89	20.12	23.69	0.087	20.03
04/05/18	Low	4-2	9:04	9:42	1047	8710	21.4	2204.6	230.8	15.81	19.96	23.14	0.085	19.62
04/05/18	Low	4-3	10:05	10:42	1047	8710	21.4	2210.5	231.4	15.78	20.37	23.47	0.086	19.90
Average							**21.4**	**2204.5**	**230.8**	**15.83**	**20.15**	**23.43**	**0.086**	**19.85**

EU-TURBINE 1B CORRELATION CHART