



**EUTURBINE1,
EUTURBINET70, and
EUTURBINEC50
Emissions Test Report**

Prepared for:

DTE Gas Company

Detroit, Michigan

Belle River Mills Compressor Station
China Township, Michigan

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AIR QUALITY DIVISION

Project No. 17-5020.00

April 25, 2017

BT Environmental Consulting, Inc.
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EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by DTE Gas Company (DTE) to measure oxides of nitrogen (NO_x) and carbon monoxide (CO) emission rates from three compressor turbines (EUTURBINE1, EUTURBINET70, and EUTURBINEC50) located at the DTE Belle River Mills Compressor Station in China Township, Michigan. The emissions test program was conducted on April 11, 12, and 13, 2017. Testing of EUTURBINE1 consisted of triplicate 20-minute test runs at each of three natural gas producer (NGP) speeds, testing of EUTURBINEC50 consisted of triplicate 20-minute test runs at each of three NGP speeds, and testing of EUTURBINET70 consisted of triplicate 20-minute test runs at each of two NGP speeds. The results of the emission test program are summarized by Tables E-I, E-II, and E-3.

**Table E-I
Emission Test Program Results Summary
EUTURBINE1**

Emission Unit Identification	Pollutant	Test Result (102% NGP)	Test Result (98% NGP)	Test Result (93% NGP)	Limit
EUTURBINE1	NO _x (ppm@15% O ₂)	7.4	14.7	21.0	25
	NO _x (lb/hr)	3.3	5.8	7.2	N/A
	CO (lb/hr)	0.3	0.3	0.3	N/A

**Table E-II
Emission Test Program Results Summary
EUTURBINEC50**

Emission Unit Identification	Pollutant	Test Result (100% NGP)	Test Result (98% NGP)	Test Result (93% NGP)	Limit
EUTURBINEC50	NO _x (ppm@15% O ₂)	9.6	10.5	13.4	25
	NO _x (lb/hr)	1.91	2.03	2.20	3.67
	CO (lb/hr)	0.17	0.15	0.16	3.72



Table E-III
Emission Test Program Results Summary
EUTURBINET70

Emission Unit Identification	Pollutant	Test Result (100% NGP)	Test Result (98% NGP)	Limit
EUTURBINET70	NOx (ppm@15% O ₂)	11.0	5.5	25
	NOx (lb/hr)	3.29	1.22	5.34
	CO (lb/hr)	0.27	0.31	5.42



1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by DTE Gas Company (DTE) to measure oxides of nitrogen (NO_x) and carbon monoxide (CO) emission rates from three compressor turbines (EUTURBINE1, EUTURBINET70, and EUTURBINEC50) located at the DTE Belle River Mills Compressor Station in China Township, Michigan. The emissions test program was conducted on April 11, 12, and 13, 2017. Testing of EUTURBINE1 consisted of triplicate 20-minute test runs at each of three natural gas producer (NGP) speeds, testing of EUTURBINEC50 consisted of triplicate 20-minute test runs at each of three NGP speeds, and testing of EUTURBINET70 consisted of triplicate 20-minute test runs at each of two NGP speeds.

The Air Quality Division (AQD) of Michigan's Department of Environmental Quality has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). This document is provided as Appendix A. The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Field sampling for the emissions compliance test program was conducted on April 11, 12, and 13, 2017 at the DTE Belle River Mills Compressor Station located at 5440 Puttygut Road in China Township, Michigan.

1.b Purpose of Testing

The purpose of the testing was to verify compliance with turbine NO_x and CO emission limitations included in ROP No. MI-ROP-B6478-2016.

1.c Source Description

The Belle River Mills Compressor Station located at 5440 Puttygut Road, St. Clair, Michigan, employs the use of three natural gas-fired combustion turbines (EUTURBINE1, EUTURBINET70, and EUTURBINEC50) with low NO_x combustors for NO_x control. The turbines generate line pressure assisting the transmission of natural gas into and out of the gas storage field as well as to and from the pipeline transmission system in Southeast Michigan.



1.d Test Program Contacts

The contacts for the source and test report are:

Mr. Mark Grigereit
Air Quality Engineer
DTE Energy
6100 West Warren, Room H136
Detroit, Michigan 48210
(313) 412-0305

Mr. Barry Boulianne
Source Testing Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8072

1.e Testing Personnel

Names and affiliations for relevant personnel who were present during the testing program are summarized by Table 1.

2. Summary of Results

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

2.a Operating Data

Numerous turbine operating parameters were monitored during the emissions test program. Operating data is included in the turbine control print screen shots included in Appendix E.

2.b Applicable Permit

The purpose of the testing was to verify compliance with turbine NO_x and CO emission limitations included in ROP No. MI-ROP-B6478-2016.

2.c Results

The overall results of the emissions test program are summarized by Tables 2, 3, and 4. Detailed results for each test run are summarized by Tables 5 through 12.

2.d Emission Regulation Comparison

Tables 2, 3, and 4 summarize the results of the emissions test program as well as the corresponding emission limitations.

3. Source Description

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

3.a Process Description

EUTURBINE1 is a 15,900 HP natural gas-fired turbine engine model Mars 100 driving a centrifugal natural gas compressor. EUTURBINET70 is a 10,915 HP natural gas-fired turbine engine model Taurus 70 driving a centrifugal natural gas compressor. EUTURBINEC50 is a 6,130 HP natural gas-fired turbine engine model Centaur 50 driving a centrifugal natural gas compressor.

3.b Process Flow Diagram

Due to the simplicity of the turbine processes, process flow diagrams are not provided.

3.c Raw and Finished Materials

The raw material used is natural gas.

3.d Process Capacity

EUTURBINE1 is a 15,900 HP natural gas-fired turbine engine model Mars 100 driving a centrifugal natural gas compressor. EUTURBINET70 is a 10,915 HP natural gas-fired turbine engine model Taurus 70 driving a centrifugal natural gas compressor. EUTURBINEC50 is a 6,130 HP natural gas-fired turbine engine model Centaur 50 driving a centrifugal natural gas compressor.

3.e Process Instrumentation

Relevant process instrumentation data is summarized in Appendix E.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used to verify emission rates from the turbine.

4.a Sampling Train and Field Procedures

The NO_x content of the gas stream was measured using a TECO Model 42i NO_x gas analyzer, the CO content of the gas stream was measured using a Teledyne Model T300M CO gas analyzer, and the O₂ content was measured using a Servomex Model 4100 CO₂/O₂ gas analyzer. A sample of the gas stream will be drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon® sample line, and through a Universal Analyzers 3080PV electronic sample conditioner to remove



the moisture from the sample before it enters the analyzer. Data will be recorded at 4-second intervals on a PC equipped with data acquisition software.

Sampling and analysis procedures will utilize the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 3A, “*Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources*”
- Method 7E, “*Determination of Nitrogen Oxide Emissions from Stationary Sources*”
- Method 10, “*Determination of Carbon Monoxide Emissions from Stationary Sources*”,
- Method 19, “*Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*”

Exhaust gas flowrates were calculated using turbine natural gas flowrate data and gross heating value data as well as gas composition (provided by DTE, see Appendix E) and the equations included in Method 19.

4.b Recovery and Analytical Procedures

No samples were recovered as part of the emissions test program.

4.c Sampling Ports

The exhaust stacks for EUTURBINE1 and EUTURBINET70 are rectangular and both are equipped with four test ports. The exhaust stack for EUTURBINEC50 is round and is equipped with two test ports.

4.d Traverse Points

For EUTURBINET70 and EUTURBINEC50, the absence of stratification was verified by traversing the stack at Method 1 locations with the probe moved at two-minute intervals during the first test run. During these test runs, each individual O₂ reading was within 0.3 percent of the overall mean and, consequently, the probe remained at a single point for all subsequent test runs. For EUTURBINE1, a stratification test was not conducted with the prior approval of MDEQ.

5. Test Results and Discussion

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

5.a Results Tabulation

The results of the emissions test program are summarized by Table 2, 3, and 4. The emissions test plan proposed testing each turbine at three different NGP speeds (102%, 98%, and 93%). However, with the on-site approval of MDEQ, the turbines were tested at the loads that each could achieve at the time of testing (i.e., EUTURBINE1 at 102%, 98%,



and 93%; EUTURBINEC50 at 100%, 98%, and 93%; EUTURBINET70 at 100% and 98%).

5.b Discussion of Results

Emission limitations and the results of the emissions test program are summarized by Tables 2, 3, and 4.

5.c Sampling Procedure Variations

No sampling procedure variations were used during the emissions test program. The emissions test plan proposed testing each turbine at three different NGP speeds (102%, 98%, and 93%). However, with the on-site approval of MDEQ, the turbines were tested at the loads that each could achieve at the time of testing (i.e., EUTURBINE1 at 102%, 98%, and 93%; EUTURBINEC50 at 100%, 98%, and 93%; EUTURBINET70 at 100% and 98%).

5.d Process or Control Device Upsets

No process or control device upsets occurred during the emissions testing.

5.e Control Device Maintenance

The turbines are not equipped with add-on emissions control devices.

5.f Audit Sample Analyses

Audit samples are not applicable to this emissions test program.

5.g Calibration Sheets

Certificates of analysis for the calibration gases used during testing are provided as Appendix B.

5.h Sample Calculations

Sample calculations are provided as Appendix C.

5.i Field Data Sheets

Copies of field data sheets and relevant field notes are provided as Appendix D.

5.j Laboratory Data

There are no laboratory results for this test program.

Table 1
Testing Personnel

Name	Affiliation
Susan King	DTE
Matthew Young	BTEC
Shane Rabideau	BTEC
Tom Gasloli	MDEQ
Robert Elmouchi	MDEQ

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Table 2
Emission Test Program Results Summary
EUTURBINE1

Emission Unit Identification	Pollutant	Test Result (102% NGP)	Test Result (98% NGP)	Test Result (93% NGP)	Limit
EUTURBINE1	NOx (ppm@15% O ₂)	7.4	14.7	21.0	25
	NOx (lb/hr)	3.3	5.8	7.2	N/A
	CO (lb/hr)	0.3	0.3	0.3	N/A

Table 3
Emission Test Program Results Summary
EUTURBINEC50

Emission Unit Identification	Pollutant	Test Result (100% NGP)	Test Result (98% NGP)	Test Result (93% NGP)	Limit
EUTURBINEC50	NOx (ppm@15% O ₂)	9.6	10.5	13.4	25
	NOx (lb/hr)	1.91	2.03	2.20	3.67
	CO (lb/hr)	0.17	0.15	0.16	3.72

Table 4
Emission Test Program Results Summary
EUTURBINET70

Emission Unit Identification	Pollutant	Test Result (100% NGP)	Test Result (98% NGP)	Limit
EUTURBINET70	NOx (ppm@15% O ₂)	11.0	5.5	25
	NOx (lb/hr)	3.29	1.22	5.34
	CO (lb/hr)	0.27	0.31	5.42

Table 5
Mars 100 (102%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 13, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/13/2017	4/13/2017	4/13/2017	
Test Run Time	9:10 - 9:30	9:38 - 9:58	10:08 - 10:28	
Carbon Monoxide Concentration (ppmv)	1.4	1.3	1.4	1.4
Oxides of Nitrogen Concentration (ppmv)	6.9	6.7	6.6	6.7
Oxygen concentration (%)	15.7	15.7	15.7	15.7
Oxygen concentration (%) (corrected as per USEPA 7E)	15.7	15.7	15.7	15.7
Natural Gas Flowrate (lbs/hr)	5,092	5,050	5,027	5,056
Natural Gas Flowrate (kscf/hr)	113.6	112.6	112.1	112.8
Natural Gas Heating Value (Btu/scf)	1058	1058	1058	1058
NOx Concentration (ppmv, corrected as per USEPA 7E)	6.7	6.5	6.5	6.6
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	8.0E-07	7.7E-07	7.7E-07	7.8E-07
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.028	0.027	0.027	0.027
CO Concentration (ppmv, corrected as per USEPA 7E)	1.0	0.9	1.0	1.0
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.003	0.002	0.003	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.307	0.285	0.315	0.302
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	3.3	3.2	3.2	3.3
NOx Concentration (ppmv@15% O ₂)	7.6	7.3	7.4	7.4

102% Load

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations

lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_p F_d * 20.9 / (20.9 - \%O_{2d})$
 NOx @ 15% O₂ = NOx measured (ppm) X (5.9/(20.9-O₂% measured))

NOx Correction			
Co	0.17	0.22	0.20
Cma	25.50	25.50	25.50
Cm	25.67	25.62	25.57

CO Correction			
Co	0.40	0.34	0.39
Cma	50.01	50.01	50.01
Cm	49.71	49.50	49.35

O ₂ Correction			
Co	0.08	0.12	0.11
Cma	10.03	10.03	10.03
Cm	10.07	10.06	10.06

Table 6
Mars 100 (98%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 13, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/13/2017	4/13/2017	4/13/2017	
Test Run Time	10:38 - 10:58	11:06 - 11:26	11:35 - 11:55	
Carbon Monoxide Concentration (ppmv)	1.3	1.3	1.3	1.3
Oxides of Nitrogen Concentration (ppmv)	12.6	12.6	12.7	12.6
Oxygen concentration (%)	15.9	15.9	15.9	15.9
Oxygen concentration (%) (corrected as per USEPA 7E)	15.9	15.9	15.9	15.9
Natural Gas Flowrate (lb/hr)	4,515	4,531	4,504	4,517
Natural Gas Flowrate (kscf/hr)	100.7	101.1	100.5	100.7
Natural Gas Heating Value (Btu/scf)	1058	1058	1058	1058
NOx Concentration (ppmv, corrected as per USEPA 7E)	12.5	12.5	12.5	12.5
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.5E-06	1.5E-06	1.5E-06	1.5E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.054	0.054	0.054	0.054
CO Concentration (ppmv, corrected as per USEPA 7E)	1.0	1.0	1.0	1.0
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.003	0.003	0.003	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.274	0.281	0.290	0.282
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	5.8	5.8	5.8	5.8
NOx Concentration (ppmv@15% O ₂)	14.7	14.7	14.7	14.7

98% Load

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cmi = Average of initial and final calibration gases

Equations

lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_i F_i * 20.9 / (20.9 - \%O_{2,i})$
 NOx @ 15% O₂ = NOx measured (ppm) X (5.9/(20.9-O₂% measured))

NOx Correction			
Co	0.21	0.22	0.23
Cma	25.50	25.50	25.50
Cmi	25.51	25.55	25.58

CO Correction			
Co	0.39	0.29	0.27
Cma	50.01	50.01	50.01
Cmi	49.37	49.27	49.07

O ₂ Correction			
Co	0.11	0.11	0.11
Cma	10.03	10.03	10.03
Cmi	10.06	10.06	10.05

Table 7
Mars 100 (93%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 13, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/13/2017	4/13/2017	4/13/2017	
Test Run Time	12:03 - 12:23	12:33 - 12:53	13:02 - 13:22	
Carbon Monoxide Concentration (ppmv)	1.4	1.4	1.2	1.3
Oxides of Nitrogen Concentration (ppmv)	17.2	17.3	17.1	17.2
Oxygen concentration (%)	16.1	16.0	16.0	16.0
Oxygen concentration (%) (corrected as per USEPA 7E)	16.1	16.1	16.1	16.1
Natural Gas Flowrate (lbs/hr)	3,900	3,954	3,938	3,931
Natural Gas Flowrate (kscf/hr)	87.0	88.2	87.8	87.7
Natural Gas Heating Value (Btu/scf)	1059	1059	1059	1059
NOx Concentration (ppmv, corrected as per USEPA 7E)	17.1	17.2	17.1	17.1
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	2.0E-06	2.1E-06	2.0E-06	2.0E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.077	0.077	0.077	0.077
CO Concentration (ppmv, corrected as per USEPA 7E)	1.2	1.2	1.1	1.1
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.003	0.003	0.003	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.310	0.296	0.269	0.292
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	7.1	7.2	7.2	7.2
NOx Concentration (ppmv@15% O ₂)	20.9	21.0	20.9	21.0

93% Load

NOx Correction			
Co	0.25	0.27	0.30
Cma	25.50	25.50	25.50
Cm	25.57	25.47	25.36

CO Correction			
Co	0.22	0.25	0.21
Cma	50.01	50.01	50.01
Cm	49.10	49.23	49.25

O ₂ Correction			
Co	0.10	0.10	0.10
Cma	10.03	10.03	10.03
Cm	10.05	10.04	10.03

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations
 lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_{iF} * 20.9 / (20.9 - \%O_{2d})$
 NOx @ 15% O₂ = NOx measured (ppm) X (5.9/(20.9-O₂% measured))

Table 8
Centaur 500 (100%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 12, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/12/2017	4/12/2017	4/12/2017	
Test Run Time	12:12 - 12:38	12:47 - 13:07	13:15 - 13:35	
Carbon Monoxide Concentration (ppmv)	2.0	1.7	1.8	1.9
Oxides of Nitrogen Concentration (ppmv)	9.4	8.6	8.6	8.9
Oxygen concentration (%)	15.6	15.5	15.5	15.5
Oxygen concentration (%) (corrected as per USEPA 7E)	15.6	15.5	15.5	15.5
Natural Gas Flowrate (kscf/hr)	49.6	51.2	52.0	50.9
Natural Gas Heating Value (Btu/scf)	1057	1057	1057	1057
NOx Concentration (ppmv, corrected as per USEPA 7E)	9.3	8.5	8.5	8.8
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.1E-06	1.0E-06	1.0E-06	1.1E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.038	0.034	0.034	0.036
CO Concentration (ppmv, corrected as per USEPA 7E)	1.4	1.1	1.2	1.3
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.004	0.003	0.003	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.18	0.15	0.17	0.17
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	2.00	1.85	1.88	1.91
NOx Concentration (ppmv@15% O2)	10.4	9.3	9.3	9.6

100% Load

NOx Correction			
Co	0.18	0.23	0.25
Cma	25.50	25.50	25.50
Cm	25.31	25.33	25.29

CO Correction			
Co	0.64	0.64	0.55
Cma	50.01	50.01	50.01
Cm	50.26	50.11	49.91

O2 Correction			
Co	0.11	0.10	0.10
Cma	10.03	10.03	10.03
Cm	10.07	10.06	10.06

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations
 lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: E = C_dF_d * 20.9 / (20.9 - %O_{2,d})
 NOx @ 15% O2 = NOx measured (ppm) X (5.9/(20.9-O2% measured))

Table 9
Centaur 500 (98%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 12, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/12/2017	4/12/2017	4/12/2017	
Test Run Time	13:46 - 14:06	14:14 - 14:34	14:42 - 15:02	
Carbon Monoxide Concentration (ppmv)	1.8	1.9	1.8	1.8
Oxides of Nitrogen Concentration (ppmv)	9.6	9.5	9.4	9.5
Oxygen concentration (%)	15.6	15.6	15.6	15.6
Oxygen concentration (%) (corrected as per USEPA 7E)	15.6	15.6	15.6	15.6
Natural Gas Flowrate (kscf/hr)	49.4	49.5	49.2	49.4
Natural Gas Heating Value (Btu/scf)	1056	1056	1056	1056
NOx Concentration (ppmv, corrected as per USEPA 7E)	9.6	9.4	9.4	9.5
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.1E-06	1.1E-06	1.1E-06	1.1E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.039	0.039	0.039	0.039
CO Concentration (ppmv, corrected as per USEPA 7E)	1.2	1.2	1.1	1.2
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.005	0.003	0.003	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.16	0.16	0.14	0.15
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	2.05	2.02	2.00	2.03
NOx Concentration (ppmv@15% O ₂)	10.7	10.5	10.5	10.5

98% Load

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NO_x = 46.01)
 24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations
 lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_d F_d * 20.9 / (20.9 - \%O_{2d})$
 NO_x @ 15% O₂ = NO_x measured (ppm) X (5.9/(20.9-O₂% measured))

NOx Correction			
Co	0.26	0.26	0.25
Cma	25.50	25.50	25.50
Cm	25.21	25.11	25.01

CO Correction			
Co	0.59	0.66	0.71
Cma	50.01	50.01	50.01
Cm	49.98	50.17	50.06

O ₂ Correction			
Co	0.09	0.09	0.08
Cma	10.03	10.03	10.03
Cm	10.06	10.05	10.05

Table 10
Centaur 500 (93%) Detailed Emission Test Results Summary
DTE Gas Company
BTEC Project No. 17-5020.00
Sampling Date: April 12, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/12/2017	4/12/2017	4/12/2017	
Test Run Time	15:20 - 15:40	15:48 - 16:08	16:16 - 16:36	
Carbon Monoxide Concentration (ppmv)	2.0	2.0	2.0	2.0
Oxides of Nitrogen Concentration (ppmv)	11.3	11.2	11.3	11.3
Oxygen concentration (%)	15.9	15.9	15.9	15.9
Oxygen concentration (%) (corrected as per USEPA 7E)	15.9	15.9	15.9	15.9
Natural Gas Flowrate (kscf/hr)	42.1	42.7	42.1	42.3
Natural Gas Heating Value (Btu/scf)	1056	1056	1056	1056
NOx Concentration (ppmv, corrected as per USEPA 7E)	11.3	11.3	11.4	11.3
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.4E-06	1.3E-06	1.4E-06	1.4E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.049	0.049	0.050	0.049
CO Concentration (ppmv, corrected as per USEPA 7E)	1.4	1.3	1.3	1.3
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.004	0.003	0.003	0.004
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.16	0.16	0.15	0.16
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	2.19	2.21	2.21	2.20
NOx Concentration (ppmv@15% O ₂)	13.4	13.3	13.5	13.4

part 19-1

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations

lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_d F_d * 20.9 / (20.9 - \%O_2)$
 NOx @ 15% O₂ = NOx measured (ppm) X (5.9/(20.9-O₂% measured))

NOx Correction			
Co	0.26	0.26	0.25
Cma	25.50	25.50	25.50
Cm	25.21	25.11	25.01

CO Correction			
Co	0.59	0.66	0.71
Cma	50.01	50.01	50.01
Cm	49.98	50.17	50.06

O ₂ Correction			
Co	0.09	0.09	0.08
Cma	10.03	10.03	10.03
Cm	10.06	10.05	10.05

Table 11
Taurus 700 (100%) Detailed Emission Test Results Summary
 DTE Gas Company
 BTEC Project No. 17-5020.00
 Sampling Date: April 11, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/11/2017	4/11/2017	4/11/2017	
Test Run Time	13:23 - 14:01	14:12 - 14:32	14:42 - 15:02	
Carbon Monoxide Concentration (ppmv)	1.6	1.3	1.5	1.5
Oxides of Nitrogen Concentration (ppmv)	11.0	11.1	11.1	11.0
Oxygen concentration (%)	15.0	15.0	15.0	15.0
Oxygen concentration (%) (corrected as per USEPA 7E)	15.1	15.1	15.1	15.1
Natural Gas Flowrate (kscf/hr)	76.9	77.3	77.0	77.1
Natural Gas Heating Value (Btu/scf)	1058	1058	1058	1058
NOx Concentration (ppmv, corrected as per USEPA 7E)	10.8	10.8	10.9	10.8
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.3E-06	1.3E-06	1.3E-06	1.3E-06
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.040	0.040	0.041	0.040
CO Concentration (ppmv, corrected as per USEPA 7E)	1.5	1.3	1.6	1.5
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.003	0.003	0.004	0.003
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.28	0.25	0.29	0.27
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	3.26	3.29	3.31	3.29
NOx Concentration (ppmv@15% O2)	10.9	10.9	11.0	11.0

100% Lead

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NOx = 46.01)
 24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
 35.31 = ft³ per m³
 453600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations
 lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/453,600
 eq 19-1: $E = C_d F_d * 20.9 / (20.9 - \%O_2)$
 NOx @ 15% O2 = NOx measured (ppm) X (5.9/(20.9-O2% measured))

NOx Correction			
Co	0.29	0.37	0.28
Cma	25.50	25.50	25.50
Cm	25.70	25.64	25.53

CO Correction			
Co	0.16	0.02	-0.03
Cma	50.01	50.01	50.01
Cm	48.39	48.46	48.75

O2 Correction			
Co	0.12	0.13	0.13
Cma	10.03	10.03	10.03
Cm	10.00	10.00	10.01

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Table 12
Taurus 700 (98%) Detailed Emission Test Results Summary
 DTE Gas Company
 BTEC Project No. 17-5020.00
 Sampling Date: April 12, 2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/12/2017	4/12/2017	4/12/2017	
Test Run Time	9:28 - 9:48	9:56 - 10:16	10:25 - 10:45	
Carbon Monoxide Concentration (ppmv)	2.3	1.9	2.7	2.3
Oxides of Nitrogen Concentration (ppmv)	4.9	4.9	5.4	5.1
Oxygen concentration (%)	15.7	15.8	15.3	15.6
Oxygen concentration (%) (corrected as per USEPA 7E)	15.7	15.8	15.3	15.6
Natural Gas Flowrate (kscf/hr)	58.1	56.9	56.9	57.3
Natural Gas Heating Value (Btu/scf)	1057	1057	1057	1057
NOx Concentration (ppmv, corrected as per USEPA 7E)	4.7	4.8	5.2	4.9
NOx Concentration (lb/dscf, corrected as per USEPA 7E)	5.6E-07	5.7E-07	6.2E-07	5.9E-07
NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.020	0.020	0.020	0.020
CO Concentration (ppmv, corrected as per USEPA 7E)	2.0	1.6	2.5	2.0
CO Concentration (lb/dscf, corrected as per USEPA 7E)	0.000	0.000	0.000	0.000
CO Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.005	0.004	0.006	0.005
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.31	0.26	0.35	0.31
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	1.21	1.22	1.22	1.22
NOx Concentration (ppmv@15% O ₂)	5.3	5.5	5.5	5.5

100% Load

NOx Correction			
Co	0.19	0.22	0.18
Cma	25.50	25.50	25.50
Cm	25.64	25.44	25.39

CO Correction			
Co	0.37	0.27	0.22
Cma	50.01	50.01	50.01
Cm	48.96	49.53	49.59

O ₂ Correction			
Co	0.09	0.10	0.10
Cma	10.03	10.03	10.03
Cm	10.07	10.07	10.07

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet
 ppmv = parts per million on a volume-to-volume basis
 lb/hr = pounds per hour
 MW = molecular weight (NO_x = 46.01)
 24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
 35.31 = ft³ per m³
 433600 = mg per lb
 10⁶ = Btu per MMBtu

Co = Average of initial and final zero gases
 Cma = Actual concentration of the calibration gas
 Cm = Average of initial and final calibration gases

Equations
 lb/dscf = ppmv * MW/24.14 * 1/35.31 * 1/433,600
 eq 19-1: $E = C_p F_d * 20.9 / (20.9 - \%O_2)$
 NOx @ 15% O₂ = NOx measured (ppm) X (5.9/(20.9-O₂% measured))

BTEC Inc.

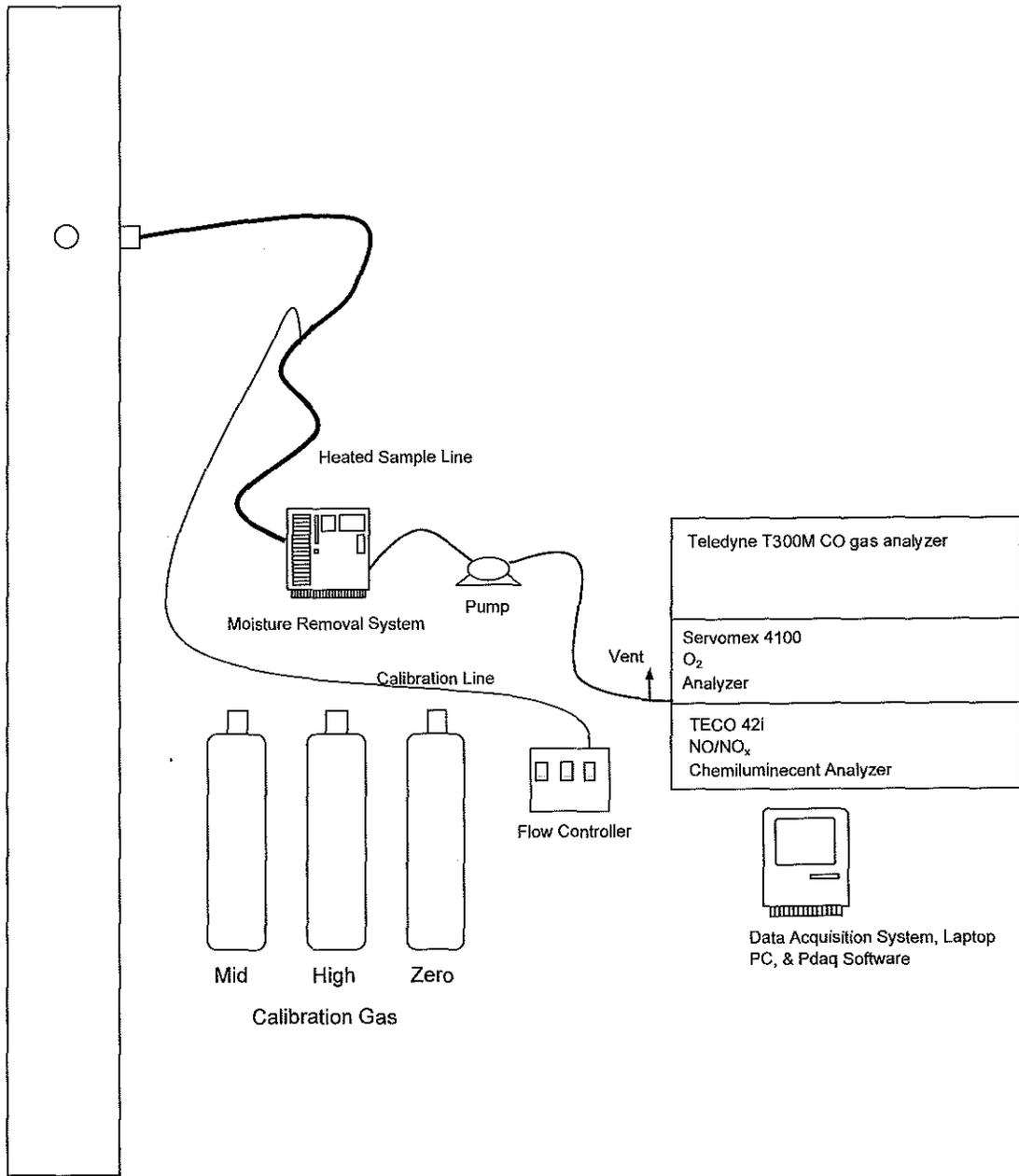


Figure 1

Site:
USEPA Methods 3A, 7E, and 10
DTE Belle River Mills
China Township, Michigan

Test Dates:
April 11, 12, and 13, 2017

BT Environmental Consulting Inc.
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