COMPLIANCE TEST REPORT
Wakefield Compressor Station (CS7)
EU-UNIT701 (Unit 701)

Prepared for:

TransCanada
In business to deliver

TransCanada Great Lakes Gas Transmission Lp
Wakefield, MI
Permit MI-ROP-N2168-2016
State Registration No. N2168

Prepared by:

EQM

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PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TransCanada in Wakefield, MI was performed in accordance with the procedures set forth by the United States Environmental Protection Agency, and that the data and results submitted within this report are an exact representation of the testing.

Karl Mast
Test Supervisor

I, Karl Mast, do hereby attest that all work on this project was performed under my direct supervision, and that this report accurately and authentically presents the source emissions testing conducted at TransCanada Great Lakes Gas Transmission LP's Wakefield Compressor Station in Wakefield, MI.

Karl Mast
Test Supervisor

SUMMARY

The compliance emissions testing program was performed on Unit 701 to comply with the established NOx standards pursuant to testing requirements specified in Permit MI-ROP-N2168-2016, R 336.1201(3), 40 CFR 60, Subpart GG, 40 CFR 60.332, and 40 CFR 60.335. A summary of the test results is given below:

EU-UNIT701				
Parameter	**High Load**	**Mid-High Load**	**Mid-Low Load**	**Low Load**
NOx ppmvd @ 15% O_2	139.60	114.07	104.25	89.57
NOx lb/hr	98.56	66.64	54.17	37.83
Limit	</=184 ppmvd@15% O2 and </=123 lb/hr			

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1. INTRODUCTION

This report presents the results of the source emissions testing conducted by Environmental Quality Management, Inc. (EQM) for TransCanada's Great Lakes Gas Transmissions LP's (GLGT) Wakefield Compressor Station, near Wakefield, MI, which is located in Gogebic County. The primary purpose of this testing program was to conduct emissions testing to determine compliance with operating permit No. MI-ROP-N2168-2016, (R 336.1201(3)), 40 CFR 60, Subpart GG, 40 CFR 60.332, and 40 CFR 60.335 for the on Unit 701 at GLGT 's gas compressor facility.

To ensure that compliance with the emission limits is maintained, the Air Compliance Team of TransCanada's GLGT (GLGT) contracted Environmental Quality Management, Inc. (EQM) to perform source emissions testing on Unit 701. The primary purpose of this testing program was to conduct emissions testing to determine compliance with permit No. MI-ROP-N2168-2016 at GLGT's gas compressor facility.

EQM's responsibility was to conduct the compliance testing for the NO_x, CO, and O_2 emission rates and perform data reduction for conformance evaluation. GLGT's responsibility was to maintain process operating parameters and to assist in providing process operating data per compliance test requirements.

The following report provides information pertaining to TransCanada's process operations, and Compliance testing. The Compliance testing conducted on Unit 701 was performed on December 18, 2018 from 10:33 A.M. to 5:12 P.M.

The following requirements were specific for the testing program:

1. Equipment calibrations performed and calibration data provided.
2. Twelve (12) twemty (20) -minute, minimum, CO, O_2, and NOx test runs performed at the Unit 701 pursuant to EPA, Title 40, Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A and Subpart GG.
3. Process manufacturing operations maintained at 4 evenly spaced loads and production and fuel consumption rates recorded during the emissions testing periods.
4. All testing and analyses performed in accordance with current EPA test methodologies and analytical procedures for O_2, CO, and NO_x, emissions determinations.

5. Stratification was found to be less than 5% in the turbine exhaust.

The testing program was approved by and/or coordinated with Shawn Flannigan, TransCanada's GLGT, LP. The emission testing was managed by Karl Mast, Manager Air Emissions, EQM and performed by Zach Hill, Team Leader, EQM and Emily Woerpel, Test Technician, EQM. The emission testing was observed by Jeremy Howe, MDEQ.

2. TEST RESULTS SUMMARY

The compliance testing was performed on Unit 701 system in accordance with the requirements of the Code of Federal Regulations, Title 40, Part 60, Appendix A and Subpart GG. A summary of the test results is given below:

Table 1. NO_x Test Results Summary -Unit 701

EU-UNIT701				
Parameter	**High Load**	**Mid-High Load**	**Mid-Low Load**	**Low Load**
NOx ppmvd @ 15% O_2	139.60	114.07	104.25	89.57
NOx lb/hr	98.56	66.64	54.17	37.83
Limit	</=184 ppmvd@15% O2 and </=123 lb/hr			

Based on the information provided above, the Unit 701 met the acceptance criteria during the course of the testing. A complete list of performance parameters for each test run that was performed at the stack sampling locations can be found in Table 2-11.

Table 2. Engine Operating & Ambient Conditions-Unit 701 High Load

Run	1	2	3	
Date	12/18/18	12/18/18	12/18/18	
Time	10:33	10:56	11:17	
Engine Operating Conditions	High	High	High	Averages
Unit Horsepower from Control Panel	17,831.1	18,263.7	17,918.6	18,004.5
% Load	57.5	58.9	57.8	58.1
Unit Speed (rpm) CT/GG/GP/Jet	5,004.0	5,010.0	5,015.0	5,009.7
% CT Speed	30.4	30.5	30.5	30.5
Gas Compressor Speed (rpm) PT/Booster	8,837.3	8,840.0	8,840.0	8,839.1
% CT Speed	120.2	120.3	120.3	120.3
Compressor Suction Pressure (PSIG)	610.4	603.7	600.7	604.9
Compressor Suction Temperature (°F)	38.8	39.3	39.6	39.2
Compressor Discharge Pressure (PSIG)	820.9	835.4	842.6	833.0
Compressor Discharge Temperature (°F)	82.4	86.8	89.2	86.2
Compressor Flow (MMSCF/D)	1248.5	1153.4	1116.0	1,172.6
% Torque	189.1	193.4	189.6	190.7
Heat Rate (BTU/HP-hr)	9,739.2	9,477.6	9,654.9	9,623.9
Ambient Conditions				
Ambient Temperature (°F)	28.00	28.00	34.00	30.00
Barometric Pressure (psi)	13.81	13.81	13.79	13.80
Ambient Relative Humidity (%)	60.00	60.00	56.00	58.67
Absolute Humidity (grains/LB)	29.31	29.31	34.97	31.20

Table 3. Emissions Concentrations/Calculated Emissions, & Flow Data-High Load

Run	1	2	3	
Date	12/18/18	12/18/18	12/18/18	
Time	10:33	10:56	11:17	
Emissions Concentrations & Calculated Mass Emissions	High	High	High	Averages
NO_x ppm (BIAS Corrected)	129.46	128.79	128.85	129.03
NO_X g/BHP-HR	2.53	2.44	2.48	2.48
NO_X LB/HR	99.54	98.16	97.97	98.56
NO_X (ppm @ 15% O_2)	140.67	139.17	138.98	139.60
NO_X (ppm @ 15% O_2, ISO)	218.26	215.94	215.08	216.42
NOx LB/MMBTU	0.52	0.51	0.51	0.51
CO ppm (raw measured dry)	14.62	12.19	12.19	13.00
CO ppm (BIAS Corrected)	14.62	12.19	12.19	13.00
CO g/BHP-HR	0.17	0.14	0.14	0.15
CO LB/HR	6.84	5.66	5.64	6.05
CO LB/MMBTU **	0.04	0.03	0.03	0.03
CO (ppm @ 15% O_2)	15.89	13.17	13.15	14.07
CO (ppm @ 15% O_2, ISO)	24.65	20.44	20.35	21.81
% O_2 (raw measured dry)	15.47	15.44	15.43	15.45
% O_2 (BIAS Corrected)	15.47	15.44	15.43	15.45
Calculated Emissions Concentrations				
% CO_2 (Wet) *	2.89	2.90	2.91	2.90
%CO_2 (Dry) *	3.09	3.10	3.11	3.10
% H_2O *	6.33	6.35	6.47	6.38
% O_2 (Wet) *	14.49	14.46	14.43	14.46
% N_2 + CO (Wet) *	76.29	76.28	76.19	76.25
Calculated Flows				
Fuel Flow - (SCFM)	3122.33	3112.17	3110.50	3115.00
Fuel Flow - (SCFH)	187,340	186,730	186,630	186,900
Fuel Flow (LB/HR)	5,984.0	5,966.8	5,954.0	5,968
Exhaust Flow (LB/HR)	419,280.9	415,763.4	413,040.3	416,028
Exhaust Flow (WSCFM)	109,777.5	108,894.0	108,661.7	109,111
Air Flow (WSCFM)	103,115	102,220	101,980	102,438
Exhaust Flow Method 19 (wscfm)	107,111	106,176	105,925	106,404
Exhaust Flow Method 19 (lbm/min)	4,776	4,734	4,725	4,745
Exhaust Flow Carbon Balance (lbm/min)	8,226.07	8,155.96	8,137.26	8,173
Air flow Beshouri (scfm)	107,029.07	106,116.87	105,873.61	106,340
BSAC, #/BHP-hr	26.36	25.51	25.94	26
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	187.34	186.73	186.63	186.90
Fuel Flow (SCFH) From Fuel Orifice	134,570	134,184	133,894	134,216
Fuel Gas Differential Pressure ("H_2O)	119.82	120.78	121.05	121
Fuel Gas Static Pressure (PSIG)	349.09	348.55	348.28	349
Fuel Gas Temperature (°F)	50.71	55.87	58.32	55
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 1	Run 2	Run 3	
* BASED ON CARBON BALANCE (STOICH. + O2) - A/F IS TOTAL MASS RATIO				

Table 4. Engine Operating & Ambient Conditions -Unit 701 Mid-High Load

Run	10	11	12	
Date	12/18/18	12/18/18	12/18/18	
Time	16:10	16:31	16:52	
Engine Operating Conditions	Mid High	Mid High	Mid High	Averages
Unit Horsepower from Control Panel	13,742.3	13,279.8	14,839.8	13,954.0
% Load	44.3	42.8	47.9	45.0
Unit Speed (rpm) CT/GG/GP/Jet	4,599.0	4,550.0	4,728.0	4,625.7
% CT Speed	28.0	27.7	28.7	28.1
Gas Compressor Speed (rpm) PT/Booster	8,638.6	8,592.9	8,697.6	8,643.0
% CT Speed	117.5	116.9	118.3	117.6
Compressor Suction Pressure (PSIG)	620	619	612.2	617.2
Compressor Suction Temperature (°F)	40	41	40.4	40.5
Compressor Discharge Pressure (PSIG)	836	837	842.6	838.4
Compressor Discharge Temperature (°F)	84	85	87.0	85.2
Compressor Flow (MMSCF/D)	976	924	987.3	962.5
% Torque	158.6	154.9	166.6	160.0
Heat Rate (BTU/HP-hr)	10,338.8	10,340.8	10,128.9	10,269.5
Ambient Conditions				
Ambient Temperature (°F)	39.0	39.0	38.00	38.67
Barometric Pressure (psi)	13.78	13.78	13.78	13.78
Ambient Relative Humidity (%)	62.0	62.0	62.00	62.00
Absolute Humidity (grains/LB)	47.33	47.33	45.50	46.72

Table 5. Emissions Concentrations/Calculated Emissions, & Flow Data – Unit 701Mid-High Load

Run	10	11	12	
Date	12/18/18	12/18/18	12/18/18	
Time	16:10	16:31	16:52	
Emissions Concentrations & Calculated Mass Emissions	Mid High	Mid High	Mid High	Averages
NO_X ppm (BIAS Corrected)	92.95	95.65	103.30	97.30
NO_X g/BHP-HR	2.13	2.15	2.22	2.16
NO_X LB/HR	64.40	63.03	72.48	66.64
NO_X (ppm @ 15% O_2)	111.24	112.64	118.34	114.07
NO_X (ppm @ 15% O_2, ISO)	175.36	177.57	185.64	179.52
NOx LB/MMBTU	0.41	0.41	0.44	0.42
CO ppm (raw measured dry)	20.14	20.21	18.21	19.52
CO g/BHP-HR	0.28	0.28	0.24	0.27
CO LB/HR	8.49	8.11	7.78	8.13
CO LB/MMBTU **	0.05	0.05	0.05	0.05
CO (ppm @ 15% O_2)	24.10	23.80	20.86	22.92
CO (ppm @ 15% O_2, ISO)	38.00	37.52	32.83	36.11
% O_2 (BIAS Corrected)	15.97	15.89	15.75	15.87
Calculated Emissions Concentrations				
% CO_2 (Wet) *	2.65	2.68	2.75	2.69
%CO_2 (Dry) *	2.82	2.86	2.94	2.87
% H_2O *	6.22	6.29	6.39	6.30
% O_2 (Wet) *	14.98	14.89	14.74	14.87
% N_2 + CO (Wet) *	76.16	76.13	76.12	76.14
Calculated Flows				
Fuel Flow - (SCFM)	2554.50	2469.00	2702.50	2575.33
Fuel Flow - (SCFH)	153,270	148,140	162,150	154,520
Fuel Flow (LB/HR)	4,897.4	4,731.3	5,181.1	4,937
Exhaust Flow (LB/HR)	372,704.8	354,876.8	378,934.2	368,839
Exhaust Flow (WSCFM)	97,775.1	93,169.1	99,534.2	96,826
Air Flow (WSCFM)	92,829	88,304	94,054	91,729
Exhaust Flow Method 19 (wscfm)	96,519	91,799	97,749	95,356
Exhaust Flow Method 19 (lbm/min)	4,310	4,099	4,364	4,257
Exhaust Flow Carbon Balance (lbm/min)	7,385.81	7,028.78	7,492.04	7,302
Air flow Beshouri (scfm)	96,096.53	91,451.23	97,478.70	95,009
BSAC, #/BHP-hr	30.79	30.31	28.89	30
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	153.27	148.14	162.15	154.52
Fuel Flow (SCFH) From Fuel Orifice	110,135	106,399	116,514	111,016
Fuel Gas Differential Pressure ("H_2O)	80.72	75.51	91.03	82
Fuel Gas Static Pressure (PSIG)	350.43	350.7	349.62	350
Fuel Gas Temperature (°F)	54.22	55.46	56.59	55
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 10	Run 11	Run 12	
* BASED ON CARBON BALANCE (STOICH. + O2) - A/F IS TOTAL MASS RATIO				

Table 6. Engine Operating & Ambient Conditions -Unit 701 Mid-Low Load

Run	7	8	9	
Date	12/18/18	12/18/18	12/18/18	
Time	14:47	15:08	15:29	
Engine Operating Conditions	Mid Low	Mid Low	Mid Low	Averages
Unit Horsepower from Control Panel	11,326.0	12,024.0	12,264.6	11,871.5
% Load	36.5	38.8	39.6	38.3
Unit Speed (rpm) CT/GG/GP/Jet	4,258.0	4,383.0	4,448.0	4,363.0
% CT Speed	25.9	26.6	27.0	26.5
Gas Compressor Speed (rpm) PT/Booster	8,493.6	8,536.5	8,584.9	8,538.3
% CT Speed	115.6	116.1	116.8	116.2
Compressor Suction Pressure (PSIG)	637.5	631.6	629	632.8
Compressor Suction Temperature (°F)	40.7	40.6	41	40.6
Compressor Discharge Pressure (PSIG)	822.0	826.5	828	825.5
Compressor Discharge Temperature (°F)	77.4	79.5	80	79.0
Compressor Flow (MMSCF/D)	927.9	953.8	969	950.1
% Torque	141.1	145.6	146.3	144.3
Heat Rate (BTU/HP-hr)	10,681.7	10,686.8	10,847.5	10,738.7
Ambient Conditions				
Ambient Temperature (°F)	39.00	39.00	39.0	39.00
Barometric Pressure (psi)	13.77	13.77	13.77	13.77
Ambient Relative Humidity (%)	59.00	64.00	59.0	60.67
Absolute Humidity (grains/LB)	45.05	48.91	45.05	46.34

Table 7. Emissions Concentrations/Calculated Emissions, & Flow Data – Unit 701 Mid-Low Load

Run	7	8	9	
Date	12/18/18	12/18/18	12/18/18	
Time	14:47	15:08	15:29	
Emissions Concentrations & Calculated Mass Emissions	Mid Low	Mid Low	Mid Low	Averages
NO_x ppm (BIAS Corrected)	80.50	81.22	83.89	**81.87**
NO_X g/BHP-HR	2.05	2.04	2.12	**2.07**
NO_X LB/HR	51.23	54.08	57.21	**54.17**
NO_X (ppm @ 15% O_2)	103.93	103.28	105.53	**104.25**
NO_X (ppm @ 15% O_2, ISO)	164.40	163.57	165.40	**164.45**
NOx LB/MMBTU	0.38	0.38	0.39	**0.38**
CO ppm (raw measured dry)	24.77	25.44	24.22	**24.81**
CO ppm (BIAS Corrected)	24.77	25.44	24.22	**24.81**
CO g/BHP-HR	0.38	0.39	0.37	**0.38**
CO LB/HR	9.60	10.31	10.05	**9.99**
CO LB/MMBTU **	0.07	0.07	0.07	**0.07**
CO (ppm @ 15% O_2)	31.98	32.35	30.47	**31.60**
CO (ppm @ 15% O_2, ISO)	50.12	51.23	47.75	**49.70**
% O_2 (raw measured dry)	16.33	16.26	16.21	**16.27**
% O_2 (BIAS Corrected)	16.33	16.26	16.21	**16.27**
Calculated Emissions Concentrations				
% CO_2 (Wet) *	2.47	2.51	2.53	**2.50**
%CO_2 (Dry) *	2.63	2.67	2.69	**2.66**
% H_2O *	5.84	5.98	5.95	**5.92**
% O_2 (Wet) *	15.38	15.29	15.25	**15.30**
% N_2 + CO (Wet) *	76.31	76.23	76.27	**76.27**
Calculated Flows				
Fuel Flow - (SCFM)	2175.17	2310.33	2392.00	**2292.50**
Fuel Flow - (SCFH)	130,510	138,620	143,520	**137,550**
Fuel Flow (LB/HR)	4,180.4	4,425.0	4,585.3	**4,397**
Exhaust Flow (LB/HR)	340,442.3	356,763.9	365,434.5	**354,214**
Exhaust Flow (WSCFM)	89,045.7	93,309.4	95,692.5	**92,683**
Air Flow (WSCFM)	85,202	89,146	91,324	**88,557**
Exhaust Flow Method 19 (wscfm)	88,661	92,750	95,004	**92,138**
Exhaust Flow Method 19 (lbm/min)	3,958	4,142	4,241	**4,114**
Exhaust Flow Carbon Balance (lbm/min)	6,765.89	7,081.76	7,256.71	**7,035**
Air flow Beshouri (scfm)	88,030.82	92,140.57	94,416.88	**91,529**
BSAC, #/BHP-hr	34.28	33.79	33.94	**34**
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	130.51	138.62	143.52	**137.55**
Fuel Flow (SCFH) From Fuel Orifice	94,010	99,510	103,116	**98,879**
Fuel Gas Differential Pressure ("H_2O)	57.89	65.2	70.25	**64**
Fuel Gas Static Pressure (PSIG)	352.04	351.5	350.97	**352**
Fuel Gas Temperature (°F)	49.22	50.83	51.68	**51**
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 7	Run 8	Run 9	
* BASED ON CARBON BALANCE (STOICH. + O2) - A/F IS TOTAL MASS RATIO				

Table 8. Engine Operating & Ambient Conditions -Unit 701 Low Load

Run	4	5	6	
Date	12/18/18	12/18/18	12/18/18	
Time	13:20	13:41	14:02	
Engine Operating Conditions	Low	Low	Low	Averages
Unit Horsepower from Control Panel	8,220.1	8,925.9	9,150.6	8,765.5
% Load	26.5	28.8	29.5	28.3
Unit Speed (rpm) CT/GG/GP/Jet	3,856.0	3,983.0	3,977.0	3,938.7
% CT Speed	23.4	24.2	24.2	23.9
Gas Compressor Speed (rpm) PT/Booster	8,265.3	8,356.6	8,313.6	8,311.9
% CT Speed	112.5	113.7	113.1	113.1
Compressor Suction Pressure (PSIG)	658.4	654.1	650.6	654.4
Compressor Suction Temperature (°F)	41.3	41.1	41.0	41.2
Compressor Discharge Pressure (PSIG)	802.6	808.8	812.8	808.1
Compressor Discharge Temperature (°F)	70	71.3	73.3	71.5
Compressor Flow (MMSCF/D)	893.3	940.3	877.0	903.6
% Torque	113.1	118.9	122.1	118.0
Heat Rate (BTU/HP-hr)	12,071.0	11,928.6	11,466.5	11,822.0
Ambient Conditions				
Ambient Temperature (°F)	36.00	36.00	36.00	36.00
Barometric Pressure (psi)	13.77	13.77	13.77	13.77
Ambient Relative Humidity (%)	56.00	56.00	59.00	57.00
Absolute Humidity (grains/LB)	37.95	37.95	40.00	38.63

Table 9. Emissions Concentrations/Calculated Emissions, & Flow Data – Unit 701 Low Load

Run	4	5	6	
Date	12/18/18	12/18/18	12/18/18	
Time	13:20	13:41	14:02	
Emissions Concentrations & Calculated Mass Emissions	Low	Low	Low	Averages
NO_x ppm (BIAS Corrected)	58.29	63.02	65.34	62.22
NO_X g/BHP-HR	1.90	2.00	1.97	1.96
NO_X LB/HR	34.42	39.35	39.72	37.83
NO_X (ppm @ 15% O_2)	85.13	90.69	92.89	89.57
NO_X (ppm @ 15% O_2, ISO)	132.08	140.71	144.94	139.24
NOx LB/MMBTU	0.31	0.33	0.34	0.33
CO ppm (raw measured dry)	47.83	40.87	37.70	42.13
CO ppm (BIAS Corrected)	47.83	40.87	37.70	42.13
CO g/BHP-HR	0.95	0.79	0.69	0.81
CO LB/HR	17.19	15.53	13.95	15.56
CO LB/MMBTU **	0.16	0.13	0.12	0.14
CO (ppm @ 15% O_2)	69.85	58.81	53.60	60.75
CO (ppm @ 15% O_2, ISO)	108.38	91.25	83.63	94.42
% O_2 (raw measured dry)	16.86	16.80	16.75	16.80
% O_2 (BIAS Corrected)	16.86	16.80	16.75	16.80
Calculated Emissions Concentrations				
% CO_2 (Wet) *	2.22	2.25	2.27	2.25
%CO_2 (Dry) *	2.34	2.37	2.40	2.37
% H_2O *	5.19	5.25	5.34	5.26
% O_2 (Wet) *	15.98	15.92	15.86	15.92
% N_2 + CO (Wet) *	76.60	76.58	76.53	76.57
Calculated Flows				
Fuel Flow - (SCFM)	1784.00	1914.33	1886.50	1861.61
Fuel Flow - (SCFH)	107,040	114,860	113,190	111,697
Fuel Flow (LB/HR)	3,413.0	3,669.0	3,614.5	3,565
Exhaust Flow (LB/HR)	314,204.1	332,509.0	324,141.3	323,618
Exhaust Flow (WSCFM)	81,544.1	86,350.4	84,174.4	84,023
Air Flow (WSCFM)	78,931	83,474	81,281	81,229
Exhaust Flow Method 19 (wscfm)	82,256	86,974	84,677	84,636
Exhaust Flow Method 19 (lbm/min)	3,670	3,881	3,779	3,776
Exhaust Flow Carbon Balance (lbm/min)	6,250.20	6,612.01	6,440.06	6,434
Air flow Beshouri (scfm)	81,321.10	86,028.70	83,791.46	83,714
BSAC, #/BHP-hr	43.76	42.62	40.48	42
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	107.04	114.86	113.19	111.70
Fuel Flow (SCFH) From Fuel Orifice	76,753	82,509	81,283	80,182
Fuel Gas Differential Pressure ("H_2O)	38.45	44.25	42.96	42
Fuel Gas Static Pressure (PSIG)	352.31	352.31	352.85	352
Fuel Gas Temperature (°F)	47.85	46.2	46.97	47
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 4	Run 5	Run 6	
* BASED ON CARBON BALANCE (STOICH. + O2) - A/F IS TOTAL MASS RATIO				

3. FACILITY AND PROCESS DESCRIPTION

TransCanada's GLGT Wakefield Compressor Station (CS7) is located in Wakefield, MI and operates a natural gas fired compressor station. The plant is located at 400 Great Lakes Road, Wakefield, MI. The Unit 701 is a General Electric Model LM2500 GE Stationary Gas Turbine.

Table 10. Unit 701 Production Data (Horse Power)

Unit 701 Production Data (HP)				
Run No.	**High Load**	**Mid-High Load**	**Mid-Low Load**	**Low Load**
1	17,831	13,742	11,326	8,220
2	18,264	13,280	12,024	8,926
3	17,919	14,840	12,265	9,151
Average	18,005	13,954	11,872	8,766

Table 11. Unit 701 General Information

General Information

Date:	18-Dec-18
Company:	GLGT
Station:	Wakefield
Unit:	701
Engine Type:	General Electric

CT Rated RPM:	16450	RPM
PT Rated RPM:	7350	RPM
Rated BHP:	31000	BHP

Permit Limits

	ppm@15%	g/Bhp-Hr	lb/hr	TPY
NOx:	</=184		</=123	
CO:				
VOC:				
H2CO:				

Limits are actuallly listed as average values

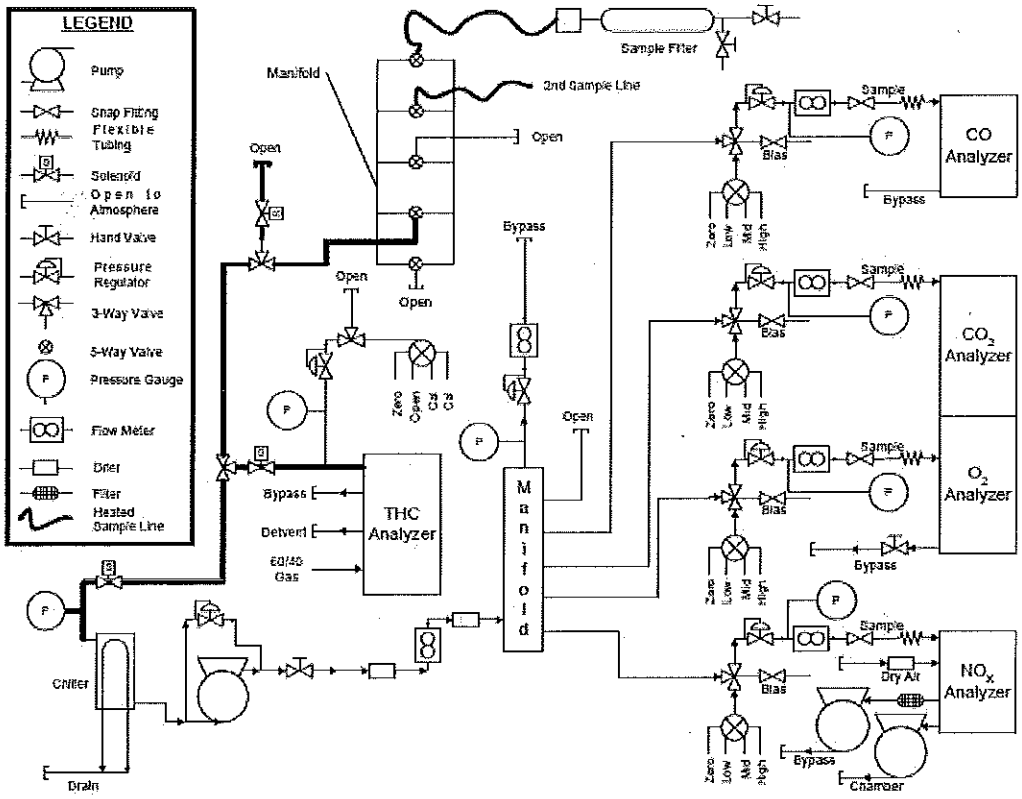
Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.716
Carbon Dioxide	0.681
Methane	95.056
Ethane	3.425
Propane	0.102
I-Butane	0.008
N-Butane	0.009
I-Pentane	0.002
N-Pentane	0.001
Hexane +	0.000
Total	100.000

Fuel Meter Type

Enter Type from List Below	2
Orifice Meter (upstream pressure tap):	1
Orifice Meter (downstream pressure tap):	2
Electronic Flow Meter (EFM):	3
Venturi (Nozzle) Meter:	4
Roots Meter w/ Accumulator:	5
Pipe I.D.:	3.068
Orifice I.D.:	1.5

Figure 1. Unit 701 Flow Schematic



4. TEST PROCEDURES

EQM and EQM's affiliates and subcontractors use current U.S. EPA accepted testing methodologies in their Air Quality Programs as listed in the U.S. Code of Federal Regulations, Title 40, Part 60, Appendix A. For this testing program, the following specific methodologies were utilized:

- U.S. EPA Method 3A – Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 7E – Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 10– Determination of Carbon Monoxide Emissions From Stationary Sources (Instrumental Analyzer Procedure)

USEPA Methods 3A, 7E, and 10 were performed at the Exhaust Stack sampling location by continuously extracting a gas sample from the stack through a single point stainless steel sample probe. The extracted sample was pulled through a series of filters to remove any particulate matter. Directly after the probe, the sample was conditioned by a series of refrigeration dryers to remove moisture from the gas stream. After the refrigeration dryers, the sample was transported through a Teflon® line to the analyzers. The flow of the stack gas sample was regulated at a constant rate to minimize drift.

At the start of the day, each monitor was checked for calibration error by introducing zero, mid-range and high-range EPA Protocol 1 gases to the measurement system at a point upstream of the analyzers. In this report, the calibration error test is referred to as instrument calibration. The gas was injected into the sampling valve located at the outlet of the sampling probe. The bias test was conducted before and after each consecutive test run by introducing zero and upscale calibration gases for each monitor. The upscale calibration gases used for each monitor were the high calibration gases.

Measurement System Performance Specifications were as follows:

- Analyzer Calibration Error - Less than +/- 2% of the span of the zero, mid-range and high-range calibration gases.
- Sampling System Bias - Less than +/-5% of the span for the zero, mid-range and high-range calibration gases.
- Zero Drift - Less than +/-3% of the span over the period of each test run.
- Calibration Drift - Less than +/-3% of the span over the period of each set of runs.

Calculations that were used in this testing event for the Unit 701 are as follows:

NO_x concentrations will be reported in the units of ppm dry volume corrected to 15% Oxygen.

Calibration Correction

$$C_{GAS} = (C_R - C_O)\frac{C_{MA}}{C_M - C_O}$$

Where:

C_{GAS}:	Corrected flue gas concentration (ppmvd)
C_R:	Flue gas concentration (ppmvd)
C_O:	Average of initial and final zero checks (ppmvd)
C_M:	Average of initial and final span checks (ppmvd)
C_{MA}:	Actual concentration of span gas (ppmvd)

EPA F-Factor

$$F_d = \frac{\left[(3.64 \cdot H_{Wt\%} \cdot 100) + (1.53 \cdot C_{Wt\%} \cdot 100)\right]}{\frac{GCV}{\rho_{FuelGas}}} \cdot 10^6 + \frac{\left[(0.14 \cdot N_{2Wt\%} \cdot 100) - (0.46 \cdot O_{2Wt\%} \cdot 100)\right]}{\frac{GCV}{\rho_{FuelGas}}} \cdot 10^6$$

Where:

F_d:	Fuel specific F-factor, dscf/MMBtu
$H_{Wt\%}$:	Hydrogen weight percent
$C_{Wt\%}$:	Carbon weight percent
$N_{2Wt\%}$:	Nitrogen weight percent
$O_{2Wt\%}$:	Oxygen weight percent
GCV:	Heating value of the fuel, BTU/dscf
$\rho_{Fuel\ Gas}$:	Density of the fuel gas, lb/scf

No_x Corrected to 15% O_2

$$NO_x = NO_{x\,obs} \times \frac{5.9}{20.9 - \%O_2}$$

Where:

E_m: Pollutant concentration corrected to 15% O_2, ppm
NO_x: Pollutant concentration, ppm
$\%O_2$: Oxygen concentration in percent, measured on a dry basis

Quality Assurance: Field quality assurance, the quality assurance/ quality control procedures as outlined in the test methods will be followed. Calibration gases shall be USEPA Protocol 1 certified. Analyzer calibrations will be performed at the beginning of each test day along with the required system pre- and post-test calibration. The final test report will include the complete data recorder output used to calculate emission rates.

Mass Emissions Calculations, lb/hr

$$NOx_{\frac{lb}{hr}} = C_d \times F_d \times \frac{20.9}{20.9 - \%O_2} \times Q_h \times \frac{GCV}{10^6}$$

Where:

Cd: Pollutant concentration, lb/scf
Fd: Fuel specific F-factor, dscf/MMBtu
Qh: Fuel flow, scf/hr
%O2: Oxygen concentration in percent, measured on a dry basis
GCV: Upper dry heating value of fuel, Btu/dscf

5. QUALITY ASSURANCE PROCEDURES

Each reference method presented in the U.S. Code of Federal Regulations details the instrument calibration requirements, sample recovery and analysis, data reduction and verification, types of equipment required, and the appropriate sampling and analytical procedures to ensure maximum performance and accuracy. EQM and EQM's affiliates and subcontractors adhere to the guidelines for quality control set forth by the United States Environmental Protection Agency. These procedures are outlined in the following documents:

- Code of Federal Regulations, Title 40, Part 51
- Code of Federal Regulations, Title 40, Part 60
- Quality Assurance Handbook, Volume 1, EPA 600/9-76-005
- Quality Assurance Handbook, Volume 2, EPA 600/4-77-027a
- Quality Assurance Handbook, Volume 3, EPA 600/4-77-027b

6. CONCLUSIONS

An Emissions Test was conducted on the internal combustion reciprocating Unit 701 at TransCanada's GLGT LP's Wakefield Compressor Station located in Wakefield, Michigan. The testing was conducted on December 18, 2018.

During the course of the testing, the Unit 701 conformed to the requirements of Code of Federal Regulations, Title 40, Part 60, Appendix A and Subpart GG.

The usefulness and/or significance of the emissions values presented in this document as they relate to the compliance status of the Unit 701 emissions shall be determined by others.

For additional information pertaining to the testing program see Appendix E of this report