Formaldehyde Air Emissions Testing of Reciprocating Internal Combustion Engines EURC011 and EURC012

Reed City Compressor Station

7677 230th Avenue
Reed City, Michigan 49677
SRN: B3721

TransCanada
In business to deliver

Prepared for
TransCanada
Houston, Texas

Bureau Veritas Project No. 11015-000003.00

April 14, 2015

BUREAU VERITAS

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: ANR Pipeline Company, Reed City Compressor Station County: Osceola

Source Address: 7677 230th Avenue City: Reed City

AQD Source ID (SRN): B3721 RO Permit No.: MI-ROP-B3721-2014 RO Permit Section No.: 1

Please check the appropriate box(es):

☐ **Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From 4/14/2015 To _____

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Replacement of NSCR on units EURC012 & EURC013 per Op. Permit, Part D, Section V

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete.

Randy Schmidgall	Vice Pres. US Pipeline Op.	(832) 320-5511
Name of Responsible Official (print or type)	Title	Phone Number

Signature of Responsible Official: Randall W. Schmidgall Date: 04/17/2015

* Photocopy this form as needed.

EQP 5736 (Rev 9/01)

Executive Summary

TransCanada retained Bureau Veritas North America, Inc. to test air emissions at the ANR Pipeline Company Reed City Compressor Station at 7677 230th Avenue in Reed City, Michigan. ANR operates reciprocating internal combustion engines (RICE) to compress natural gas for transport via natural gas pipeline. The purpose of the emission test program was to evaluate compliance with National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ) and Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit MI-ROP-B3721-2014. Formaldehyde emissions were measured at the inlet and outlet of the catalysts of two engines.

The engines are listed under flexible groups FGRC001 and FGMACTZZZZ of the permit. The relevant emission standard is presented below:

Emission Standard

Pollutant	Limit	Equipment	USEPA Method	Applicable Requirement
Formaldehyde	Reduce formaldehyde emissions by 76% or more.	EURC011 EURC012	3A and 320	40 CFR Part 63, Subpart ZZZZ

The testing was completed in accordance with United States Environmental Protection Agency (USEPA) Reference Methods 3A and 320. The testing was conducted on February 26, 2015, and consisted of three 60-minute test runs at each source to measure formaldehyde concentrations.

Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. The results of the testing are summarized in the table on the following page.

Formaldehyde Emission Results
Compared to Permit Emission Limits

Date (2015)	Source ID	Parameter	Units	Average Result	Emission Limit
EURC011 Formaldehyde Removal Efficiency Testing					
Feb. 26	EURC011 Inlet	O_2	%	0.42	N/A
		Formaldehyde	ppmvd	3.9	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**1.1**	N/A
Feb. 26	EURC011 Outlet	O_2	%	0.37	N/A
		Formaldehyde	ppmvd	0.24	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**0.07**	N/A
Formaldehyde Removal Efficiency			**%**	**94**	**≥76**
EURC012 Formaldehyde Removal Efficiency Testing					
Feb. 26	EURC012 Inlet	O_2	%	0.41	N/A
		Formaldehyde	ppmvd	23.1	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**6.6**	N/A
Feb. 26	EURC012 Outlet	O_2	%	0	N/A
		Formaldehyde	ppmvd	0.40	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**0.11**	N/A
Formaldehyde Removal Efficiency			**%**	**98**	**≥76**

O_2 = oxygen
N/A not applicable
ppmvd = part per million by volume, dry basis

The measurements demonstrate that the EURC011 and EURC012 engines were operating within the allowable limit.

1.0 Introduction

TransCanada retained Bureau Veritas North America, Inc. to test air emissions at the ANR Pipeline Company Reed City Compressor Station at 7677 230th Avenue in Reed City, Michigan. ANR operates reciprocating internal combustion engines (RICEs) to compress natural gas for transport via natural gas pipeline. The purpose of the emission test program was to evaluate compliance with National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ) and Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit MI-ROP-B3721-2014. Formaldehyde emissions were measured at the inlet and outlet of the catalysts of two engines.

1.1 Summary of Test Program

The testing was completed in accordance with United States Environmental Protection Agency (USEPA) Reference Methods 3A and 320. Three 60-minute test runs were performed on February 26, 2015, to measure formaldehyde concentrations in part per million by volume, dry basis (ppmvd) corrected to 15% O_2. The inlet and outlet corrected formaldehyde concentrations were used to calculate the formaldehyde removal efficiency.

1.2 Purpose of Testing

The purpose of the emission test program was to evaluate compliance with 40 CFR Part 63, Subpart ZZZZ by measuring the oxygen (O_2) and formaldehyde concentrations from the two engines upstream and downstream of the engine catalysts. The engines are listed under flexible groups FGRC001 and FGMACTZZZZ of MDEQ air permit MI-ROP-B3721-2014. The relevant emission standard is presented in Table 1-1.

Table 1-1
Emission Standard

Pollutant	Limit	Equipment	USEPA Method	Applicable Requirement
Formaldehyde	Reduce formaldehyde emissions by 76% or more.	EURC011 EURC012	3A and 320	40 CFR Part 63, Subpart ZZZZ

1.3 Contact Information

Contact information is listed in Table 1-2. Mr. Brian Young, Senior Project Manager with Bureau Veritas, led the emission testing program. TransCanada provided process coordination and arranged for facility operating parameters to be recorded. The testing was witnessed by Messrs. Jeremy Howe and Kurt Childs, Environmental Quality Analysts with MDEQ.

Table 1-2
Key Personnel

TransCanada	Bureau Veritas
Pedro Amieva US Plant Reliability **TransCanada** 717 Texas Street Houston, Texas 77002 Telephone: 832.320.5839 pedro_amieva@transcanada.com Steve Marsh **TransCanada** 7677 230th Avenue Reed City, Michigan 49677 Telephone: 231.832.7728 steve_marsh@transcanada.com	Brian Young Senior Project Manager **Bureau Veritas North America, Inc.** 22345 Roethel Drive Novi, Michigan 48375 Telephone: 248.344.3020 Facsimile: 248.344.2656 brian.young@us.bureauveritas.com
Michigan Department of Environmental Quality	
Jeremy Howe Environmental Quality Analyst Air Quality Division – Cadillac District Office 120 West Chapin Street Cadillac, Michigan 49601 Telephone: 231.876.4416 howej1@michigan.gov	Kurt Childs Environmental Quality Analyst Air Quality Division – Cadillac District Office 120 West Chapin Street Cadillac, Michigan 49601 Telephone: 231.876.4411 childsk@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

ANR operates a natural gas compressor station in Reed City, Michigan. The facility operates natural gas-fired, reciprocating internal combustion engines to compress natural gas for transport via natural gas pipeline. The engines fall under flexible groups FGRC001 and FGMACTZZZZ in the permit and are subject to 40 CFR Part 63, Subpart ZZZZ requirements. EURC011 and EURC012 are the units that were tested.

EURC011 and EURC012 are 660-horsepower White Superior engines model number 8G825. The engines were installed in 1963. Specifications of the engines are presented in Table 2-1.

Table 2-1
Non-Emergency Area Source RICE Tested

ID	Installation Date	Manufacturer	Model	Rating (hp)	Fuel
EURC011	1963	White Superior	8G825	660	Natural gas
EURC012	1963	White Superior	8G825	660	Natural gas

Operating parameters recorded during testing are included in Appendix E.

2.2 Control Equipment

The exhausts of the engines pass through nonselective catalytic reduction catalysts (NSCR) prior to discharge to the atmosphere. NSCR is the conversion of oxides of nitrogen (NO_x), carbon monoxide (CO), and hydrocarbons to water, carbon dioxide (CO_2), and nitrogen.

2.3 Flue Gas Sampling Locations

Figure 1 after the Figures Tab of this report, depicts the EURC011 and EURC012 sampling ports and traverse point locations. Descriptions of the sampling locations are presented in Sections 2.3.1 and 2.3.2

2.3.1 EURC011 Sampling Location

The inlet to the EURC011 catalyst was sampled from a single sampling port. The sampling port is located in a straight section of a 10-inch-internal-diameter duct. The port is located:

- 4 feet (4.8 duct diameters) from the nearest downstream disturbance
- 1 foot (1.2 duct diameters) from the nearest upstream disturbance

The ports were accessible via a ladder.

The EURC011 catalyst exhaust was sampled from a single sampling port. The sampling port is located in a straight section of a 10-inch-internal-diameter duct. The port is located:

- 3 feet (3.6 duct diameters) from the nearest downstream disturbance
- 4 feet (4.8 duct diameters) from the nearest upstream disturbance

The port was accessible via a manlift.

2.3.2 EURC012 Sampling Location

The inlet to the EURC012 catalyst was sampled from a single sampling port. The sampling port is located in a straight section of a 10-inch-internal-diameter duct. The port is located:

- 4 feet (4.8 duct diameters) from the nearest downstream disturbance
- 1 foot (1.2 duct diameters) from the nearest upstream disturbance

The port was accessible via a ladder.

The EURC012 catalyst exhaust was sampled from a single sampling port. The sampling port is located in a straight section of a 10-inch-internal-diameter duct. The port is located:

- 3 feet (3.6 duct diameters) from the nearest downstream disturbance.
- 4 feet (4.8 duct diameters) from the nearest upstream disturbance.

The port was accessible via a manlift.

2.4 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., diesel, natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers).

3.0 Summary and Discussion of Results

3.1 Objectives

The testing was performed to evaluate compliance with National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ) by measuring oxygen and formaldehyde concentrations at the inlet and the outlet of the two engine catalysts. The relevant emission standard is provided in Table 1-1.

3.2 Test Matrix

Table 3-1 presents the sampling and analytical test matrix.

Table 3-1
Test Matrix

Sampling Location	No. of Runs	Test Parameter	Sampling Method (USEPA)	Run Duration (min)	Analytical Method
Inlet and outlet of EURC011	3	O_2 Formaldehyde	3A 320	60	Paramagnetic Fourier transform infrared spectroscopy
Inlet and outlet of EURC012	3	O_2 Formaldehyde	3A 320	60	Paramagnetic Fourier transform infrared spectroscopy

3.3 Field Test Changes and Issues

Field test changes were not required to complete the emission testing.

3.4 Results

The results of the testing are compared to the applicable emission limit in Table 3-2. Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. Graphs of the measured oxygen and formaldehyde concentrations are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
Formaldehyde Emission Results Compared to Emission Limit

Date (2015)	Source ID	Parameter	Units	Average Result	Emission Limit
EURC011 Formaldehyde Removal Efficiency Testing					
Feb. 26	EURC011 Inlet	O_2	%	0.42	N/A
		Formaldehyde	ppmvd	3.9	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**1.1**	N/A
Feb. 26	EURC011 Outlet	O_2	%	0.37	N/A
		Formaldehyde	ppmvd	0.24	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**0.07**	N/A
Formaldehyde Removal Efficiency			%	**94**	**≥76**
EURC012 Formaldehyde Removal Efficiency Testing					
Feb. 26	EURC012 Inlet	O_2	%	0.41	N/A
		Formaldehyde	ppmvd	23.1	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**6.6**	N/A
Feb. 26	EURC012 Outlet	O_2	%	0	N/A
		Formaldehyde	ppmvd	0.40	N/A
		Formaldehyde	**ppmvd at 15% O_2**	**0.11**	N/A
Formaldehyde Removal Efficiency			%	**98**	**≥76**

O_2 = oxygen
N/A not applicable
ppmvd = part per million by volume, dry basis

The measurements demonstrate the EURC011 and EURC012 engines were operating within the allowable limit.

4.0 Sampling and Analytical Procedures

Bureau Veritas measured emissions in accordance with USEPA Methods 3A and 320, identified in Table 4 to Subpart ZZZZ of Part 63—Requirements for Performance Tests. The sampling and analytical methods used during this test program are listed in the following table.

Table 4-1
Sampling and Analytical Test Methods

USEPA Sampling Method	Parameter	Analysis
3A	Oxygen	Paramagnetic
320	Formaldehyde	Extractive Fourier transform infrared spectroscopy (FTIR)

4.1 Test Methods

4.1.1 Oxygen Concentrations (USEPA Method 3A)

USEPA Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)" was used to measure oxygen concentrations of the flue gas. Figure 2 in the Appendix depicts the USEPA 3A sampling train. Flue gas was continuously sampled from the stack and conveyed to a paramagnetic analyzer for oxygen concentration measurements. Flue gas oxygen concentration was measured to correct the formaldehyde concentration to 15% oxygen.

Flue gas was extracted from the stack through:

- A stainless-steel probe
- A heated Teflon sample line to prevent condensation
- A chilled Teflon® condenser (equipped with a peristaltic pump) to remove moisture from the flue gas
- A paramagnetic O_2 gas analyzer

Data were recorded at 1-second intervals by a computer equipped with data acquisition software. Recorded concentrations were reported as 1-minute averages over the duration of each test run and included in Appendix D of this report.

A calibration error check was performed on each analyzer by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to evaluate if the analyzer responds to within ±2% of the calibration span. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases are introduced at the probe tip to measure if the response was within ±5% of the analyzer calibration span.

At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The acceptable analyzer drift tolerance is ±3% of the calibration span. The results of the pre- and post-test system bias checks were used to correct the measured pollutant concentrations for analyzer drift.

Calibration data, along with the USEPA Protocol 1 certification sheets for the calibration gases, are included in Appendix A.

4.1.2 Formaldehyde Concentrations (USEPA Method 320)

Formaldehyde emissions were measured using USEPA Method 320, "Measurements of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy." Gaseous samples were withdrawn from the stack and transferred to the FTIR spectrometer. The USEPA Method 320 sampling train is depicted in Figure 3. FTIR data is provided in Appendix F.

The samples were directed through a heated probe, heated filter, and heated transfer line connected to the FTIR. The probes, filters, transfer lines, and FTIR were maintained at 191° C (376° F) during testing. Concentrations were measured based on their infrared absorbance compared to reference spectra. The FTIR analyzer scans the sample approximately once per second. A data point consists of the co-addition of 64 scans, with a data point generated every minute.

FTIR quality assurance procedures followed USEPA Method 320. A calibration transfer standard (CTS) was analyzed before and after testing. Acetaldehyde spiking was performed before and after the test. Section 3.29 of USEPA Method 320 allows the use of a surrogate analyte for spiking. Acetaldehyde was chosen as surrogate to formaldehyde for the following reasons:

- The highest obtainable formaldehyde cylinder is 30 parts per million (ppm): therefore, the spiked concentration would be 3 ppm (analyte spiking consists of sampling 1 part calibration gas in the presence of 9 parts effluent gas). The formaldehyde concentrations of the source tested had the potential to be much higher than 3 ppm.

- Acetaldehyde's physical and chemical properties are similar to those of formaldehyde. Formaldehyde is the C_1 aldehyde (CH_2O); acetaldehyde is the C_2 aldehyde (CH_3CHO).

The analyte spikes are set to a target dilution ratio of 1:10 or less. Acetaldehyde spike recoveries were within the Method 320 allowance of ±30%.

4.2 Procedures for Obtaining Process Data

Process data were recorded by TransCanada personnel. Refer to Section 2.1 and 2.2 for discussions of process and control device data and Appendix E for the operating parameters recorded during testing.

4.3 Sampling Identification and Custody

Gaseous pollutant concentrations were measured using analyzers processing the flue gas in real time; therefore, recovery and analytic procedures for laboratory samples were not necessary.

5.0 QA/QC Activities

Equipment used in this emissions test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment calibration and inspection sheets. Field data sheets are presented in Appendix C. Computer-generated Data Sheets are presented within Appendix D.

5.1 Pretest QA/QC Activities

Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling methods and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods."

5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits and the acceptable tolerance are presented in the following sections. Analyzer calibration and gas certification sheets are presented in Appendix A.

5.2.1 Instrument Analyzer QA/QC Audits

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Calibration gas selection, error, bias, and drift checks are included in Appendix A. The gas cylinders used during the test program are presented in Table 5-1.

Table 5-1
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Oxygen Carbon dioxide	Pangaea Gases	EB0049262	20.01% O_2 19.89% CO_2	March 6, 2022
	Airgas	CC68032	10.89% O_2 11.21 % CO_2	February 17, 2023
Nitrogen	Pangaea Gases	EB0049226	99.999%	February 26, 2017

5.3 QA/QC Blanks

Reagent and field train blanks were not applicable to this test program.

5.4 QA/QC Problems

QA/QC problems were not encountered during this test program.

Limitations

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This report prepared by: _____

Brian P. Young
Senior Project Manager
Health, Safety, and Environmental Services

This report reviewed by: _____

Derek R. Wong, Ph.D., P.E.
Director and Vice President
Health, Safety, and Environmental Services

Table

Table 1
EURC011 Formaldehyde Removal Efficiency Results
TransCanada - Reed City Compressor Station
Reed City, Michigan
Bureau Veritas Project No. 11015-000003.00
Sampling Date: February 26, 2015

Parameter		Units	Run 1	Run 2	Run 3	Average
Sample Time			13:15-14:15	14:25-15:25	15:35-16:35	
Duration		min	60	60	60	
Inlet	O_2 Concentration (C_{avg})	%	0.39	0.36	0.32	0.36
	Pre-test system calibration, zero gas (C_O)	%	0.0	-0.1	-0.1	-0.07
	Post-test system calibration, zero gas (C_O)	%	-0.1	-0.1	0.0	-0.07
	Certified low bracket gas concentration (C_{MA})	%	10.89	10.89	10.89	10.89
	Pre-test system calibration, low bracket gas (C_M)	%	10.9	10.8	10.8	10.8
	Post-test system calibration, low bracket gas (C_M)	%	10.8	10.8	10.8	10.8
	Corrected O_2 Concentration (C_{gas})[†]	%	**0.44**	**0.46**	**0.37**	**0.42**
	Formaldehyde Concentration	ppmv	3.0	3.3	3.4	3.2
	Moisture Content	%	17.8	17.9	18.0	17.9
	Formaldehyde Concentration	ppmvd	3.6	4.0	4.1	3.9
	Formaldehyde Concentration Corrected to 15% Oxygen	ppmvd	**1.0**	**1.2**	**1.2**	**1.1**
Outlet	O_2 Concentration (C_{avg})	%	0.67	0.71	0.71	0.70
	Pre-test system calibration, zero gas (C_O)	%	0.3	0.3	0.4	0.33
	Post-test system calibration, zero gas (C_O)	%	0.3	0.4	0.3	0.33
	Certified low bracket gas concentration (C_{MA})	%	10.89	10.89	10.89	10.89
	Pre-test system calibration, low bracket gas (C_M)	%	11.1	11.2	11.2	11.2
	Post-test system calibration, low bracket gas (C_M)	%	11.2	11.2	11.2	11.2
	Corrected O_2 Concentration (C_{gas})[†]	%	**0.38**	**0.36**	**0.36**	**0.37**
	Formaldehyde Concentration	ppmv	<0.2	<0.2	<0.2	<0.2
	Moisture Content	%	18.0	17.9	18.0	17.9
	Formaldehyde Concentration	ppmvd	0.24	0.24	0.24	0.24
	Formaldehyde Concentration Corrected to 15% Oxygen	ppmvd	**0.07**	**0.07**	**0.07**	**0.07**
Formaldehyde Removal Efficiency		%	**93**	**94**	**94**	**94**

[†] corrected for analyzer drift

C_O average of the initial and final system calibration bias check responses from the low-level (or zero) calibration gas, ppmv

C_{MA} actual concentration of the upscale calibration gas, ppmv

C_M Average of initial and final system calibration bias check responses for the upscale calibration gas, ppmv

C_{gas} Average effluent gas concentration adjusted for bias, ppmv

ppmvd part per million by volume, dry basis

O_2 oxygen

Table 2
EURC012 Formaldehyde Removal Efficiency Results
TransCanada - Reed City Compressor Station
Reed City, Michigan
Bureau Veritas Project No. 11015-000003.00
Sampling Date: February 26, 2015

Parameter		Units	Run 1	Run 2	Run 3	Average
Sample Time			8:10-9:10	9:25-10:25	10:35-11:35	
Duration		min	60	60	60	
Inlet	O_2 Concentration (C_{avg})	%	0.46	0.41	0.40	0.42
	Pre-test system calibration, zero gas (C_O)	%	0.04	0	0	0.01
	Post-test system calibration, zero gas (C_O)	%	0	0	0	0
	Certified low bracket gas concentration (C_{MA})	%	10.89	10.89	10.89	10.89
	Pre-test system calibration, low bracket gas (C_M)	%	10.9	10.9	10.9	10.9
	Post-test system calibration, low bracket gas (C_M)	%	10.9	10.9	10.9	10.9
	Corrected O_2 Concentration (C_{gas})†	%	**0.44**	**0.41**	**0.40**	**0.41**
	Formaldehyde Concentration	ppmv	18.9	19.2	18.9	19.0
	Moisture Content	%	17.8	17.8	17.7	17.8
	Formaldehyde Concentration	ppmvd	22.9	23.4	23.0	23.1
	Formaldehyde Concentration Corrected to 15% Oxygen	ppmvd	**6.6**	**6.7**	**6.6**	**6.6**
Outlet	O_2 Concentration (C_{avg})	%	0.086	0.14	0.24	0.16
	Pre-test system calibration, zero gas (C_O)	%	0.7	0.1	0.2	0.3
	Post-test system calibration, zero gas (C_O)	%	0.1	0.2	0.3	0.2
	Certified low bracket gas concentration (C_{MA})	%	10.89	10.89	10.89	10.89
	Pre-test system calibration, low bracket gas (C_M)	%	11.2	11	11	11.1
	Post-test system calibration, low bracket gas (C_M)	%	11	11	11.1	11.0
	Corrected O_2 Concentration (C_{gas})†	%	**0**	**0**	**0**	**0**
	Formaldehyde Concentration	ppmv	0.3	0.3	0.3	0.3
	Moisture Content	%	18.1	18.1	18.1	18.1
	Formaldehyde Concentration	ppmvd	0.41	0.38	0.41	0.40
	Formaldehyde Concentration Corrected to 15% Oxygen	ppmvd	**0.12**	**0.11**	**0.11**	**0.11**
Formaldehyde Removal Efficiency		%	**98**	**98**	**98**	**98**

† corrected for analyzer drift

C_O average of the initial and final system calibration bias check responses from the low-level (or zero) calibration gas, ppmv

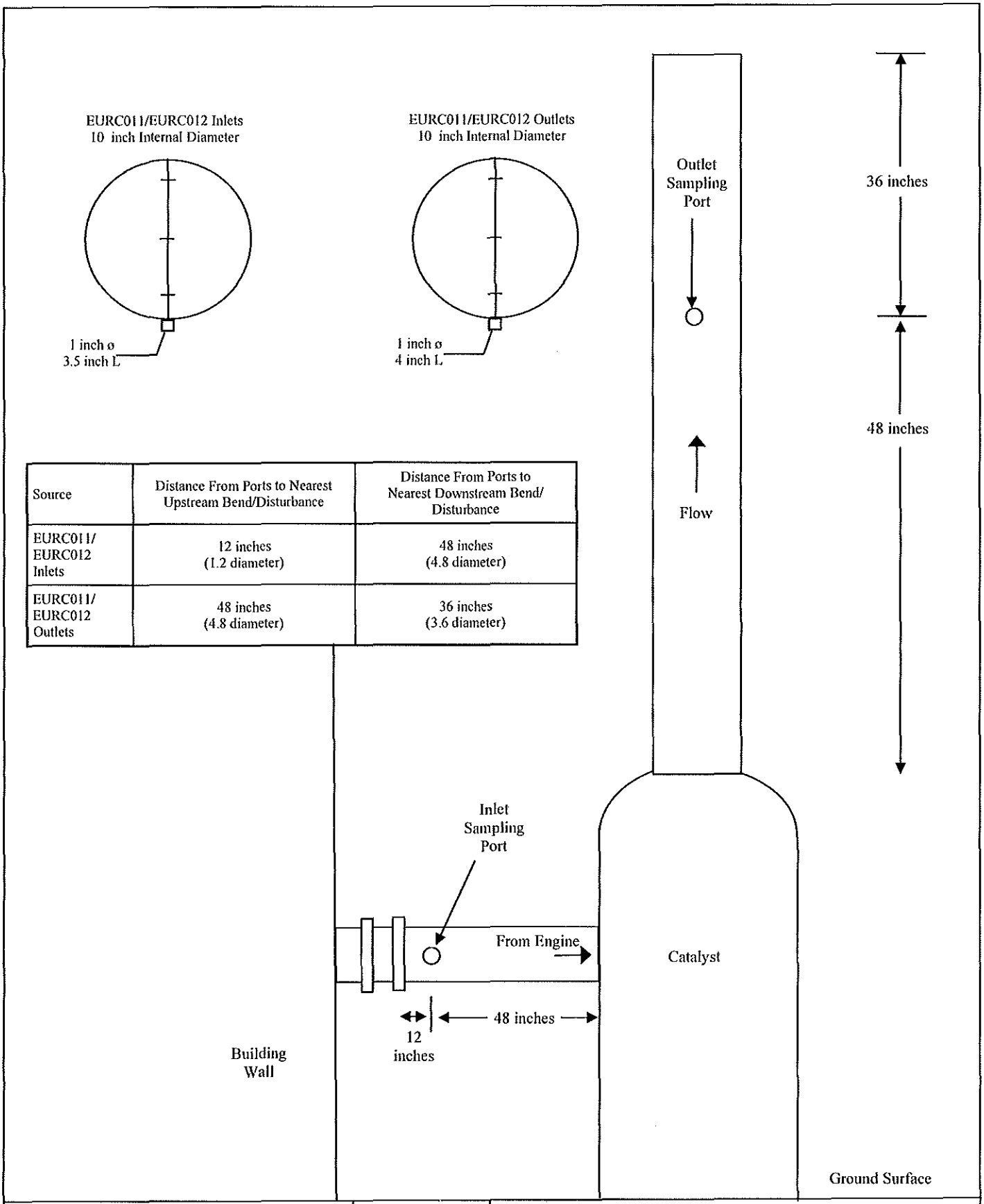
C_{MA} actual concentration of the upscale calibration gas, ppmv

C_M Average of initial and final system calibration bias check responses for the upscale calibration gas, ppmv

C_{gas} Average effluent gas concentration adjusted for bias, ppmv

ppmvd part per million by volume, dry basis

O_2 oxygen



Source	Distance From Ports to Nearest Upstream Bend/Disturbance	Distance From Ports to Nearest Downstream Bend/ Disturbance
EURC011/ EURC012 Inlets	12 inches (1.2 diameter)	48 inches (4.8 diameter)
EURC011/ EURC012 Outlets	48 inches (4.8 diameter)	36 inches (3.6 diameter)

Figure 1
EURC011 and EURC012 Sampling Ports and Traverse Point Locations

TransCanada
Reed City Compressor Station
Reed City, Michigan

Project No. 11015-000003.00

Last Revision:
February 26, 2015

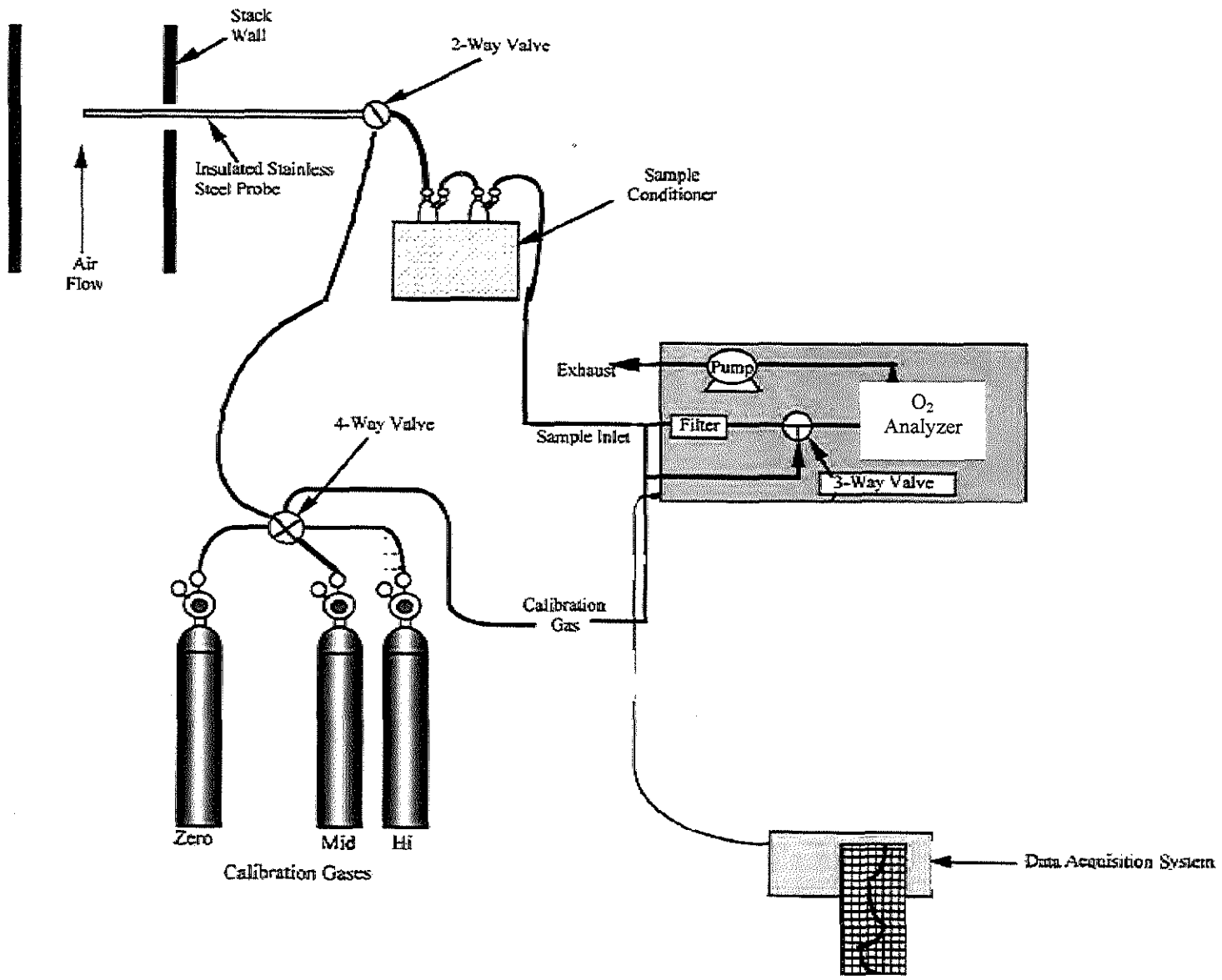


Figure 2
USEPA Method 3A Sampling Train

BUREAU VERITAS

TransCanada
Reed City Compressor Station
Reed City, Michigan

Project No. 11015-000003.00

Last Revision: February 26, 2015

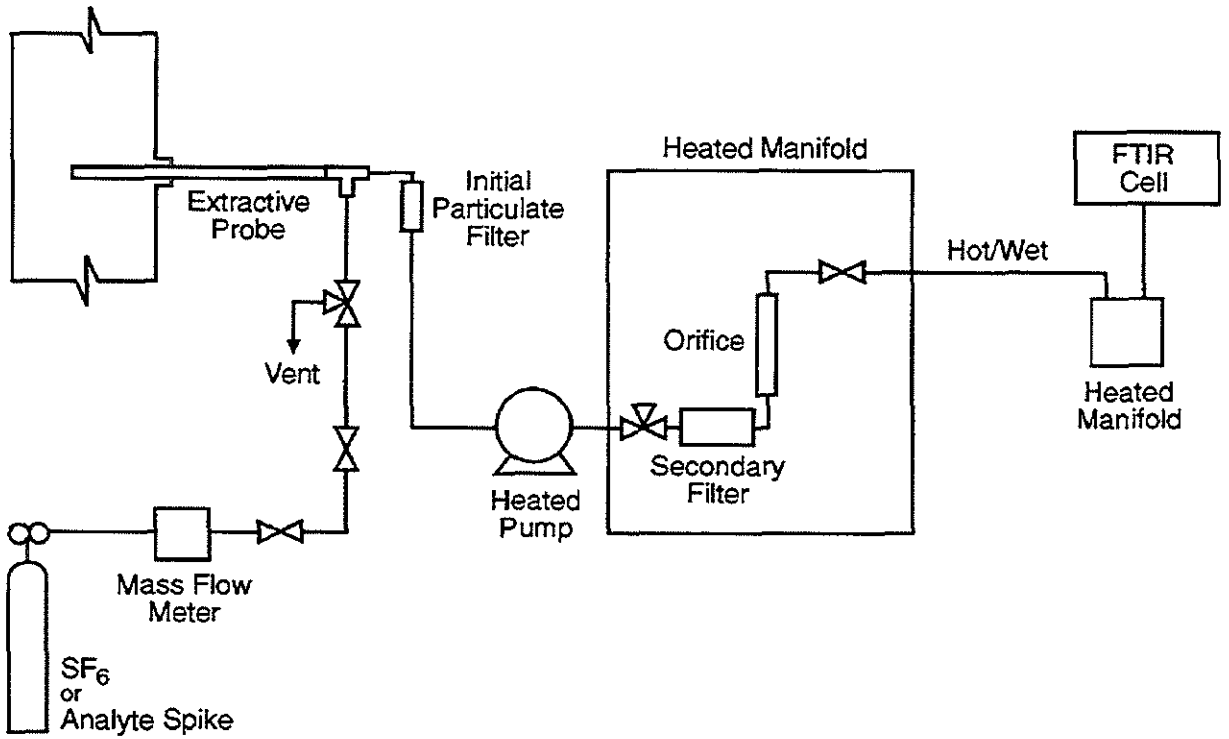


Figure 3
USEPA Method 320 Sampling Train

TransCanada
Reed City Compressor Station
Reed City, Michigan

Project No. 11015-000003.00

Last Revision: February 26, 2015