

Eaton Rapids

Emission Test and LDAR Assessment of Small Glycol Dehydration Unit

ANR Pipeline Company Eaton Rapids Gas Storage System

3349 South Waverly Road
Eaton Rapids, Michigan

RECEIVED
APR 27 2015
AIR QUALITY DIV.



State Registration No. N3022

Prepared for
TransCanada
Houston, Texas

April 23, 2015

Bureau Veritas Project No. 11015-000004.00



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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 Permit (ROP) 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 specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name ANR Pipeline Company, Eaton Rapids Gas Storage Sys County Eaton Rapids

Source Address 3349 South Waverly Road City Eaton Rapids

AQD Source ID (SRN) N3022 ROP No. MI-ROP-N3022-Propo ROP Section No. C and D

Please check the appropriate box(es):

Annual Compliance Certification (Pursuant to Rule 213(4)(c))

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 ROP, 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 ROP.

2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, 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 ROP, unless otherwise indicated and described on the enclosed deviation report(s).

Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))

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

1. During the entire reporting period, ALL monitoring and associated recordkeeping requirements in the ROP 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 ROP 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 _____ To _____

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

Test Report evaluating compliance with 40 CFR 63, Subpart HHH for the existing small glycol dehydration unit. This form shall certify that the testing was conducted in accordance with the approved test plan and that the facility operating conditions were in compliance with permit requirements or at maximum routine operating conditions.

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

ANTHONY KORNAKA DIRECTOR, FIELD OPERATIONS 248-205-7465
Name of Responsible Official (print or type) Title Phone Number

Anthony Kornaka 4/22/2015
Signature of Responsible Official Date

* Photocopy this form as needed.



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APR 27 2015

AIR QUALITY DIV.

Executive Summary

TransCanada retained Bureau Veritas North America, Inc. to evaluate the closed-vent system and test air emissions at the ANR Pipeline Company (ANR) Eaton Rapids Gas Storage System in Eaton Rapids, Michigan. TransCanada stores natural gas in underground reservoirs and transports gas via pipelines to other companies and end-users after the gas is processed through glycol dehydration units. Testing was conducted on the Eaton Rapids glycol dehydration unit. The purpose of the testing was to:

- Evaluate the glycol dehydration unit's closed-vent system for leaks.
- Measure benzene, toluene, ethylbenzene, and xylenes (BTEX) emissions from the Eaton Rapids glycol dehydration unit's thermal oxidizer exhaust stack.
- Evaluate compliance with 40 CFR Part 63, National Emissions Standards for Hazardous Air Pollutants for Source Categories, Subpart HHH, "National Emissions Standards for Hazardous Air pollutants for Natural Gas Transmission and Storage Facilities," incorporated in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-N3022-Proposed.

The glycol dehydration system is defined as an "existing small glycol dehydration unit" in accordance with 40 CFR 63, Subpart HHH, and subject to:

- Leak Detection and Repair (LDAR) standards.
- Control device BTEX, total organic compound (TOC), or total hazardous air pollutants (HAPs) emission standards.

The testing was completed in accordance with United States Environmental Protection Agency (USEPA) Reference Methods 1 through 4, 18, and 21. On February 27, 2015, testing was conducted at Eaton Rapids and consisted of completion of the LDAR assessment and three 60-minute test runs to measure BTEX.

Leak Detection and Repair

Detailed results of the LDAR assessment are presented in Table 3-2. Documentation of the LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included in Appendix C of this report. The results of the LDAR assessment are summarized in the following table.



LDAR Assessment Results

Date (2015)	Glycol Dehydration Unit	Number of Components Evaluated	Number of Readings Below Leak Criterion of 500 ppmv	Number of Readings Exceeding Leak Criterion of 500 ppmv	Comment
Feb 27	Eaton Rapids	19	19	0	No leaks detected

ppmv; part per million by volume

Based on the results of the LDAR assessment, no volatile organic compound (VOC) readings were measured at a concentration exceeding the criterion of a leak (i.e., 500 part per million by volume [ppmv]).

Performance Testing

The emission testing was conducted to evaluate compliance with the emission limit of the thermal oxidizer, which controls air emissions from the glycol dehydration system. Emission testing was conducted on the Eaton Rapids glycol dehydration unit.

Detailed results of the Eaton Rapids testing are presented in Table 1 after the Tables Tab of this report. The results of the testing are summarized in the following table.

BTEX Emission Results Compared to Permit Emission Limits

Date (2015)	Glycol Dehydration Unit	Emission Unit	Parameter	Units	Average Result ¹	Emission Limit ²
Eaton Rapids						
Feb 27	Eaton Rapids	EUERGLYDEH	Benzene [†]	lb/hr	<0.00015	NA
			Toluene [†]		0.00036	NA
			Ethylbenzene [†]		<0.00030	NA
			Total Xylenes [†]		0.00073	NA
			Mass rate of BTEX	lb/hr	0.0015	NA
			Mg/yr		0.0025	13.80

[†] Corrected for spike recovery following USEPA Method 18.

¹ Based on typical maximum operating hours for the total withdrawal season.

² Emission limit was calculated based on the annual average daily throughput rates from 2009 through 2013 using Equation 1 of the regulation (40CFR63.1275(b)(1)(iii)).

lb/hr: pound per hour

Mg/yr: megagrams per year

NA: not applicable

BTEX: benzene, toluene, ethylbenzene, total xylenes



The BTEX measurements demonstrate that estimated annual air emissions from the thermal oxidizer controlling the glycol dehydration unit are within the allowable limit.



1.0 Introduction

1.1 Summary of Test Program

TransCanada retained Bureau Veritas North America, Inc. to evaluate the closed-vent system and test air emissions at the ANR Pipeline Company (ANR) Eaton Rapids Gas Storage System in Eaton Rapids, Michigan. TransCanada stores natural gas in underground reservoirs and transports gas via pipelines to other companies and end-users after the gas is processed through glycol dehydration units. Testing was conducted on the Eaton Rapids glycol dehydration unit. The purpose of the testing was to:

- Evaluate the glycol dehydration unit's closed-vent system for leaks.
- Measure benzene, toluene, ethylbenzene, and xylenes (BTEX) emissions from the Eaton Rapids glycol dehydration unit's thermal oxidizer exhaust stack.
- Evaluate compliance with 40 CFR Part 63, National Emissions Standards for Hazardous Air Pollutants for Source Categories, Subpart HHH, "National Emissions Standards for Hazardous Air pollutants for Natural Gas Transmission and Storage Facilities," incorporated in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP- N3022-Proposed.

The glycol dehydration system is defined as an "existing small glycol dehydration unit" in 40 CFR 63, Subpart HHH, and subject to:

- Leak Detection and Repair (LDAR) standards.
- Control device BTEX, total organic compound (TOC), or total hazardous air pollutants (HAPs) emission standards.

Leak Detection and Repair

The LDAR assessment was conducted following the LDAR plan that Bureau Veritas prepared which outlined procedures to detect volatile organic compound (VOC) leaks from equipment components of the closed-vent system and identify necessary repairs as required by 40 CFR 60, Subpart HHH and MDEQ MI-ROP-N3022-Proposed.

When compliance with the emission standard is achieved using a control device or combination of control devices, the closed-vent system shall have no detectable emissions. A potential leak interface is evaluated to operate with no detectable organic emissions if the organic concentration is less than 500 parts per million by volume (ppmv).



Bureau Veritas conducted the following LDAR activities:

- Identified, tagged, and listed the components to be monitored and those that are difficult to inspect.
- Established procedures if the leak criterion is exceeded.
- Monitored components through initial visual inspection and LDAR monitoring following United States Environmental Protection Agency (USEPA) Method 21 guidelines.
- Communicated findings to TransCanada for leak repair (if applicable) and reporting by TransCanada.
- Reported the initial inspection findings.

Documentation of the LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included in Appendix C of this report.

Performance Testing

The emission testing was conducted to evaluate compliance with the emission limit of the thermal oxidizer, which controls air emissions from the glycol dehydration system. Emission testing was conducted on the Eaton Rapids glycol dehydration unit.

The thermal oxidizer is subject to the following emission limit:

Unit-specific BTEX emission limit in megagrams (Mg) per year, calculated using Equation 1 of the regulation (40CFR63.1275(b)(1)(iii)):

$$EL_{\text{BTEX}} = 3.10 \times 10^{-4} \times \text{Throughput} \times C_{i,\text{BTEX}} \times 365 \frac{\text{day}}{\text{yr}} \times \frac{1 \text{ Mg}}{1 \times 10^6 \text{ gram}}$$

Where:

EL_{BTEX} = Unit-specific BTEX emission limit, megagrams per year

3.10×10^{-4} = BTEX emission limit, grams BTEX/standard cubic meter-ppmv

Throughput = Annual average daily natural gas throughput, standard cubic meters

$C_{i,\text{BTEX}}$ = Annual average BTEX concentration of the natural gas at the inlet to the glycol dehydration unit, ppmv

The throughput values were measured at the custody transfer meter and based on annual average daily throughput rates from 2009 through 2013.



The testing was completed in accordance with USEPA Reference Methods 1 through 4, 18, and 21 identified in §63.1282 of Subpart HHH of 40 CFR Part 63—Test Methods, Compliance Procedures, and Compliance Demonstrations. Measurement of BTEX concentrations following USEPA Method 18 incorporates the analytical procedures of Occupational Health and Safety Administration (OSHA) 7 and USEPA SW-846 Method 8260.

On February 27, 2015, Bureau Veritas conducted the following for the Eaton Rapids unit:

- The LDAR assessment.
- Three 60-minute test runs at the exhaust of the unit to measure BTEX concentrations.

The sampling conducted is summarized below in Table 1-1.

**Table 1-1
Sources Tested, Parameters, and Test Date**

Source	Test Parameter	Test Date
Eaton Rapids		
Eaton Rapids thermal oxidizer exhaust	BTEX	February 27, 2015
Closed vent system joints	VOC leaks	

BTEX: benzene, toluene, ethylbenzene, total xylenes
 VOC: volatile organic compound

1.2 Key Personnel

Key personnel involved in this test program are listed in Table 1-2. Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, led the emission testing program under the direction of Dr. Derek Wong, Director and Vice President with Bureau Veritas.

Mr. Jeff Punjak, Controls Specialist, Plant Reliability with TransCanada; Mr. Pedro Amieva, US Plant Reliability with TransCanada; Ms. Melinda Holdsworth, Environmental Air Emissions and GHG Advisor with TransCanada; and others coordinated with Bureau Veritas and arranged for process data to be recorded.

Portions of the testing were witnessed by Mr. Tom Gasloli, Environmental Quality Analyst, and Mr. Brad Myott, Environmental Quality Analyst, with MDEQ.



**Table 1-2
Key Personnel**

TransCanada	
<p>Jeff Punjak Controls Specialist, Plant Reliability TransCanada P.O. Box 336, Forest Road 241 Iron River, Wisconsin 54847 Phone: 248.205.7554 jeffrey_punjak@transcanada.com</p>	<p>Melinda Holdsworth Environmental Air Emissions & GHG Advisor TransCanada 700 Louisiana St., Suite 700 Houston, Texas 77002-2700 Phone: 832.320.5665 Melinda_Holdsworth@TransCanada.com</p> <p>Pedro Amieva US Plant Reliability TransCanada 717 Texas Street Houston, Texas 77002 Phone: 832.320.5839 pedro_amieva@transcanada.com</p>
Michigan Department of Environmental Quality	
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Bureau Veritas	
<p>Derek Wong, Ph.D., P.E. Director and Vice President Bureau Veritas North America, Inc. 22345 Roethel Drive Novi, Michigan 48375 Tel. 248.344.2669 Fax. 248.344.2656 derek.wong@us.bureauveritas.com</p>	<p>Thomas Schmelter Senior Project Manager Bureau Veritas North America, Inc. 22345 Roethel Drive Novi, Michigan 48375 Tel: 248.344.3003 Fax: 248.344.2656 thomas.schmelter@us.bureauveritas.com</p>



2.0 Source and Sampling Locations

2.1 Process Description

ANR, a wholly owned subsidiary of TransCanada, operates natural gas pipeline systems that connect supply basins and markets throughout the Midwest and south to the Gulf of México. ANR owns and operates several facilities in Michigan that are used in both natural gas transmission and storage. The location evaluated as part of this test program is a natural gas transmission and compression station that operates a natural gas storage field.

The pipeline transports natural gas to and from the storage reservoir field. Natural gas is injected into underground field in spring and summer and withdrawn in fall and winter for residential and commercial heating purposes. During injection, natural gas flows into the reservoir until the field pressure approaches pipeline pressure. When the pressures near equilibrium, one or more engines are used to compress the natural gas into the reservoir. Compression injection usually continues until the field reaches its maximum rated pressure.

During the storage period, natural gas absorbs hydrocarbons and water while in the underground geologic formation. Gas withdrawn from the storage field is conditioned through a glycol dehydration system to remove water. Dehydration is necessary in order to (1) meet contract sales specifications, (2) remove water vapor that may form hydrates, ice-like structures that can cause corrosion or plug equipment lines, and (3) to improve fuel heating values. Glycol dehydration is an absorption process in which a liquid glycol absorbent directly contacts the natural gas stream, which is circulated counter-current to the glycol flow, and absorbs water vapor in a contact tower or absorption column.

At the existing small glycol dehydration unit, natural gas is pumped into a tower, where the gas passes over a series of glycol trays. The glycol in these trays absorbs water and hydrocarbons in the natural gas. The conditioned natural gas can be fed into a separator to remove liquids that remain before being compressed and/or transported into the pipeline for distribution.

The rich, or "dirty," glycol that contains water and hydrocarbons accumulates in the bottom of the tower and is transported to a three-phase separator that separates heavy hydrocarbons from the glycol. The glycol is filtered before being transported into a re-boiler unit. The re-boiler evaporates water from the glycol. The resulting lean, or "clean," glycol is recirculated into the glycol tower.

Water from the re-boiler is condensed and transported to condensate and brine tanks, when necessary. The re-boiler vapors, which may contain volatile organic compounds (VOCs)—including HAPs such as BTEX—are directed to a condenser and/or thermal oxidizer for control prior to exhausting to atmosphere.



Figures 2-1 and 2-2 depict the general natural gas withdrawal and small glycol dehydration unit processes for Eaton Rapids.

The small glycol dehydration unit was tested when natural gas was being processed at the maximum routine operating conditions. The natural gas throughput rate was measured at the custody transfer meter. Process and control equipment data recorded during testing are included in Appendix F. Table 2-1 summarizes the process and control equipment data.

**Table 2-1
Summary of Process Operating Parameters**

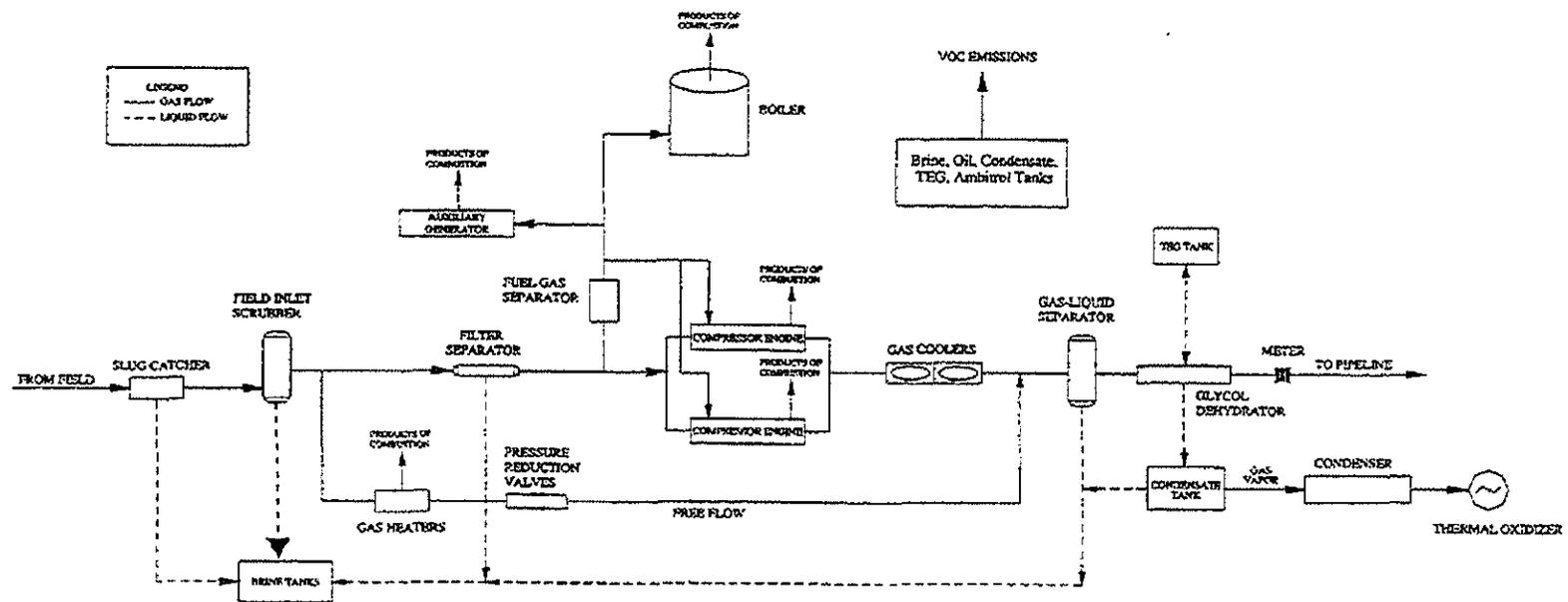
Parameter	Units	Run 1	Run 2	Run 3	Average
Eaton Rapids (EUERGLYDEH)					
Natural gas throughput rate during testing	MMCFH	5.1	5.1	5.0	5.1
Thermal oxidizer combustion temperature	°F	1,433	1,442	1,428	1,434
Glycol recirculation Rate	GPM	4	5	5	5

MMCFH: million cubic feet per hour

GPM: gallon per minute

Notes

1. The throughput values were measured at the custody transfer meter.
2. As provided by TransCanada, the maximum facility withdrawal rate for Eaton Rapids is 5.7 MMCFH.



Source: TransCanada.

Figure 2-1. General Gas Withdrawal Process Flow

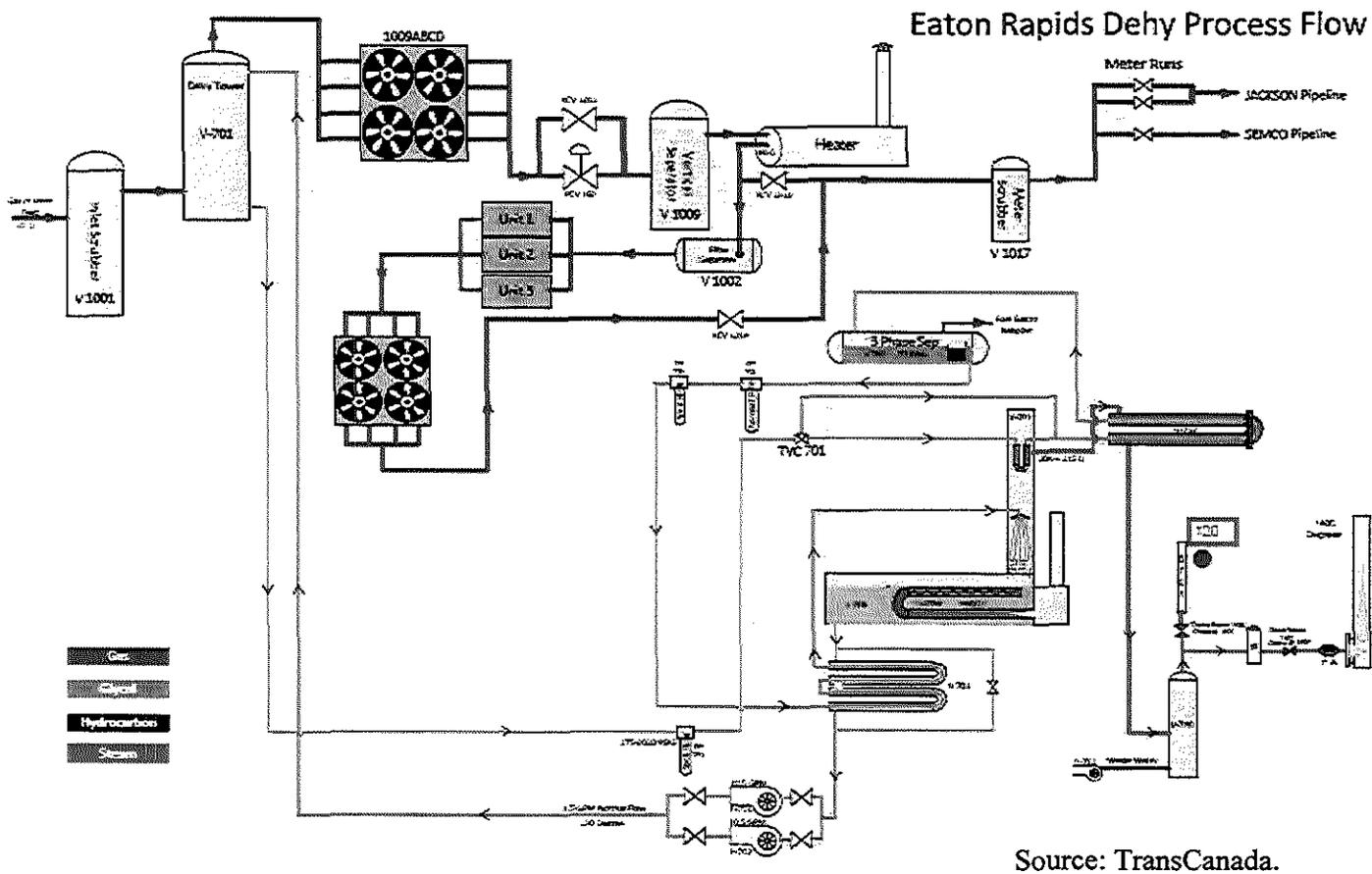


Figure 2-2. Eaton Rapids Dehydration Unit Process Flow



2.2 Control Equipment

From the gas conditioning process, the glycol dehydration re-boiler vent is the primary source of emissions. These emissions can be controlled by vapor recovery (condensation), combustion, and pollution prevention.

A condenser controls emissions from the small glycol dehydration unit. The condenser converts components in the vapor phase to the liquid phase by reducing the temperature of the process vent stream. The condenser not only reduces emissions, but also recovers condensable hydrocarbon vapors that can be used or sold for hydrocarbon liquid production or disposed.

Residual VOCs and HAPs in the exhaust gas of the condenser is combusted in the thermal oxidizer. Process gas enters the combustion chamber, where the burner heats the gas to 1,400°F to oxidize VOCs, producing primarily water vapor and carbon dioxide. The treated gas exiting the combustion chamber is discharged to the atmosphere through the exhaust stack. The incinerators are designed to obtain a minimum VOC destruction efficiency greater than 95%.

Pollution prevention refers to system optimization of the small glycol dehydration units by adjustment of process variables to reduce air emissions. For example, small glycol dehydration units may circulate more glycol than necessary to meet contract specifications. High glycol circulation rates increase the amount of BTEX absorbed from the natural gas stream; therefore, more BTEX and VOCs are released from the small glycol dehydration unit re-boiler vent during regeneration of the glycol. Optimizing the glycol circulation rate and other process variables may reduce associated air emissions.

Process and control equipment data recorded during testing are included in Appendix F. Table 2-1 summarizes the process and control equipment data.

2.3 Flue Gas Sampling Location

The sampling port location meets the upstream and downstream siting requirements of USEPA Method 1; however, only one sample port is available at the Eaton Rapids sampling location. Because two sampling ports were not present Eaton Rapids sampling location, a single sampling port was used for volumetric flowrate measurements. This sampling approach was approved by MDEQ prior to testing.

A description of the flue gas sampling location is presented in Section 2.3.1.



2.3.1 Eaton Rapids Thermal Oxidizer Exhaust

The Eaton Rapids thermal oxidizer exhaust stack is 21 inches in diameter and has one 2-inch-diameter sampling port. Six traverse points were used to measure stack gas velocity. The port is located:

- 55 inches (2.6 duct diameters) from the nearest downstream disturbance.
- 252 inches (12 duct diameters) from the nearest upstream disturbance.

The port was accessible via an articulating boom lift.

Figure 2-3 is a photograph of the Eaton Rapids thermal oxidizer sampling location. Figure 1 in the Appendix depicts the sampling ports and traverse point locations.

2.4 LDAR Sampling Locations

The process equipment at the Eaton Rapids location that was evaluated for LDAR included valves, flanges, pressure relief devices, and other connections.

Bureau Veritas conducted the initial LDAR monitoring by inspecting closed-vent system joints, seams, or other connections that are permanently or semi-permanently sealed (e.g., a welded joint between two sections of hard piping or a bolted or gasketed ducting flange).

The inspection consisted of a (1) visual examination and (2) no-detectable-emission evaluation. The visual examination evaluated defects that could result in air emissions, such as visible cracks, holes, gaps in piping, loose connections, or broken or missing caps or other closure devices. The no-detectable-emissions evaluation was performed following USEPA Method 21 procedures discussed in Section 4.0.

Where metal wrap pipe insulation was present around a pipe joint, seam, or other connection and a visual inspection could not be performed without damage, the Method 21 monitoring was performed at the seams in the metal pipe wrap insulation near the inaccessible joint, seam, or other connection.

TransCanada identified the LDAR locations evaluated at the Eaton Rapids small glycol dehydration unit. The LDAR test locations are presented in Figure 2-4.

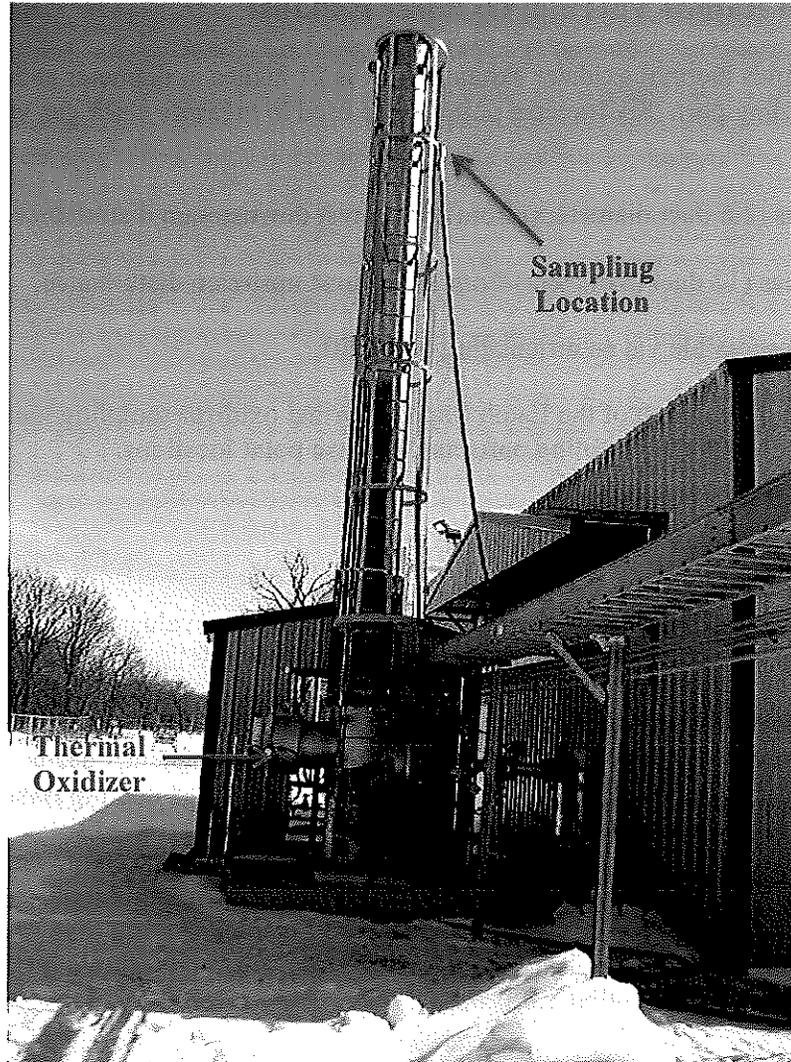


Figure 2-3. Eaton Rapids Thermal Oxidizer Exhaust Stack



3.0 Results

3.1 Objective

The objective of the testing was to evaluate the closed-vent system and test air emissions of the small glycol dehydration unit for:

- Leaks of VOCs.
- BTEX emissions from the Eaton Rapids glycol dehydration unit's thermal oxidizer exhaust stack.
- Compliance with 40 CFR Part 63, National Emissions Standards for Hazardous Air Pollutants for Source Categories, Subpart HHH, "National Emissions Standards for Hazardous Air pollutants for Natural Gas Transmission and Storage Facilities" incorporated in MDEQ ROP MI-ROP- N3022-Proposed.

Table 3-1 summarizes the sampling and analytical matrix.

**Table 3-1
Test Matrix**

Sampling Location	Sample/Type of Pollutant	Sampling Method	No. of Test Runs and Duration	Analytical Method	Analytical Laboratory
Eaton Rapids (EUERGLYDEH)	BTEX	1, 2, 3, 4, and 18	Three 60-minute runs	Field measurement Gas chromatography	Bureau Veritas and Fibertec Environmental Services
	VOC leaks	21	NA	Flame ionization detector	NA

3.2 Field Test Changes and Issues

Communication between TransCanada, Bureau Veritas, and MDEQ allowed the testing to be completed without field test changes.



3.3 Summary of Results

Detailed results of the LDAR assessment are presented in Table 3-2. Documentation of the LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included in Appendix C of this report.

The results of the BTEX testing are summarized in Table 3-3. Detailed results of the BTEX testing are presented in Table 1 after the Table Tab of this report. A graph of the BTEX emission rates is provided after the Graphs Tab in the Appendix. Sample calculations are presented in Appendix B.



**Table 3-2
Eaton Rapids LDAR Results - February 27, 2015**

Tag	Description of Location	Device Type	Time Inspected	Yellow Tag [†] VOC Leak Inspection Readings (ppmv)	Red Tag [‡] VOC Leak Inspection Readings (ppmv)	Leak Detected
450	Base of still column stack	Flange	11:12	-	2.4	No
451	Mid way to the top of the still column stack	Flange	11:32	-	19	No
452	Top cap of still column stack	Flange	11:33	-	11	No
453	Exit line out of still column to condenser	Flange	11:33	-	4	No
454	Temperature monitoring gauge	Thermowell	11:16	-	2.2	No
455	Temp probe for reflux	Pipe fitting	11:16	-	2.4	No
456	Input to condenser	Flange	11:17	-	2.4	No
457	Condenser midway point Cap	Flange	11:18	-	2.9	No
458	Exit from condenser	Flange	11:19	2.7		No
459	Temp probe out of condenser	Pipe fitting	11:19	2.5		No
460	Entry point to V-706	Union	11:20	2.6		No
461	1" valve to V-706 lower inlet	Flange/Gasket	11:20	3.9		No
462	Exit out of V-706	Coupling	11:14	-	2.4	No
463	Betx vent valve inlet	Flange	11:14	-	3.0	No
464	Tee to Thermo oxidizer	Flange	11:15	-	2.5	No
465	Pipe flange to thermo oxidizer wall	Flange	11:16	3.5		No
466	Inlet to valve to Thermo oxidizer	Flange	11:18	3.7		No
467	Outlet from valve to Thermo oxidizer	Flange	11:20	1.7		No
468	Inlet Flange from arrester to Thermo oxidizer	Flange	11:20	4.8		No

ppmv: part per million by volume

VOC: volatile organic compound

BTEX: benzene, toluene, ethylbenzene, total xylenes

-: not applicable

[†]: Yellow Tag refers to a component that is accessible and monitored initially and annually.

[‡]: Red Tag refers to a component that is difficult to access and is monitored initially and every 5 years.

Notes

1. Background VOC reading = between 2 and 3 ppmv
2. No detections exceeding leak criterion of 500 ppmv

Based on the results of the LDAR assessment, results no VOC readings were measured at a concentration exceeding the criterion of a leak (i.e., 500 ppmv).



**Table 3-3
Summary of Air Emission Test Results**

Date (2015)	Glycol Dehydration Unit	Emission Unit	Parameter	Units	Average Result ¹	Emission Limit ²
Eaton Rapids						
Feb 27	Eaton Rapids	EUERGLYDEH	Benzene [†]	lb/hr	<0.00015	NA
			Toluene [†]		0.00036	NA
			Ethylbenzene [†]		<0.00030	NA
			Total Xylenes [†]		0.00073	NA
			Mass rate of BTEX	lb/hr	0.0015	NA
				Mg/yr	0.0025	13.80

[†] Corrected for spike recovery following USEPA Method 18.

¹ Based on typical maximum operating hours for the total withdrawal season.

² Emission limit was calculated based on the annual average daily throughput rates from 2009 through 2013 using Equation 1 of the regulation (40CFR63.1275(b)(1)(iii)).

lb/hr: pound per hour

Mg/yr: megagrams per year

NA: not applicable

BTEX: benzene, toluene, ethylbenzene, total xylenes

The BTEX measurements demonstrate that estimated annual air emissions from the thermal oxidizer controlling the glycol dehydration unit are within the allowable limit.



4.0 Sampling and Analytical Procedures

4.1 Test Methods

Bureau Veritas measured the flue gas volumetric flowrate and BTEX concentrations, and evaluated the closed vent system for leaks using USEPA Methods 1 through 4, 18, and/or 21 identified in §63.1282 of Subpart HHH of 40 CFR Part 63—Test Methods, Compliance Procedures, and Compliance Demonstrations. Measurement of BTEX following USEPA Method 18 incorporates the sampling and analytical procedures of OSHA 7, and USEPA SW-846 Method 8260. Bureau Veritas tested emissions using methods presented in Table 4-1.

**Table 4-1
Sampling Methods**

Parameter	Location	Reference	
	Exhaust Stack	Method	Title
Sampling ports and traverse points	•	EPA 1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	EPA 2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	•	EPA 3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture content	•	EPA 4	Determination of Moisture Content in Stack Gases
		EPA ALT-008	Alternative Moisture Measurement Method - Midget Impingers
BTEX	•	EPA 18	Measurement of Gaseous Organic Compound Emissions by Gas Chromatography
BTEX	•	OSHA 7	Organic Vapors
BTEX (in condensate)	•	EPA 8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)
VOC leaks	•	EPA 21	Determination of Volatile Organic Compound Leaks

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

Method 1, "Sample and Velocity Traverses for Stationary Sources," from 40 CFR 60, Appendix A, was used to evaluate the sampling location and the number of traverse points for the measurement of velocity profiles.

Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrate. An S-type Pitot tube and thermocouple assembly connected to a digital manometer and thermometer was



used. Because the dimensions of Bureau Veritas' Pitot tubes meet the requirements outlined in Method 2, Section 10.0, a baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned.

The digital manometer and thermometer are calibrated using calibration standards, which are traceable to National Institute of Standards (NIST). The Pitot tube inspection and calibration sheets are included in Appendix A.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the sampling location.

Cyclonic flow is defined as a flow condition with an average null angle greater than 20° . The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head readings—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack walls when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20° , the flue gas flow is considered to be cyclonic at that sampling location and an alternative location should be found.

The average of the measured traverse point flue gas velocity null angles was approximately 0° for the Eaton Rapids unit. Because the average null angle is less than 20° , the measurements indicate the absence of cyclonic flow.

4.1.2 O₂ and CO₂ Concentrations (USEPA Method 3)

Molecular weight was measured using USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." Flue gas was extracted from the stack through a probe positioned near the centroid of the duct and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO₂) and oxygen (O₂) were measured by chemical absorption with a Fyrite® gas analyzer to within $\pm 0.5\%$.

The average CO₂ and O₂ results of the grab samples were used to calculate the stack gas molecular weight.

4.1.3 Moisture Content (USEPA Methods 4 and ALT 008)

The moisture content at the exhaust was measured using USEPA Method 4, "Determination of Moisture Content in Stack Gases," incorporating the approved alternative procedures of Method ALT-008, "Alternative Moisture Measurement Method - Midget Impingers." Bureau Veritas' moisture content stack sampling system consists of:

- A stainless steel probe.
- A sampling line connecting the probe to the impingers.



- A set of three impingers (with the configuration shown in Table 4-2) situated in an ice bath.
- A sampling line connecting the impingers to a dry-gas meter.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Before initiating a test run, the sampling train was leak-checked by capping the sampling train and applying a vacuum of approximately 5 inches of mercury. The dry-gas meter was monitored for approximately 1 minute to measure that the sample train leak rate was less than 0.02 cubic feet per minute (cfm). The sampling probe was inserted into the sampling port near the centroid of the stack in preparation of sampling. Flue gas was extracted at a constant rate from the stack, with moisture removed from the sample stream by the chilled impingers.

Each test run duration was 60 minutes.

**Table 4-2
USEPA Method 4 and ALT-008 Impinger Configuration**

Impinger	Type	Contents	Amount
1	Midget	Water	10 milliliters
2	Midget	Water	10 milliliters
3	Midget	Silica desiccant	~15 grams

At the conclusion of the test run, a post-test leak check was conducted and the impinger train was disassembled. The weight of liquid and silica gel in each impinger was measured with a digital scale. The weight of water collected within the impingers and volume of flue gas sampled were used to calculate the percent moisture content. One moisture content sample was collected during each test run. Figure 4-1 depicts the USEPA Method 4 and ALT 008 sampling train.

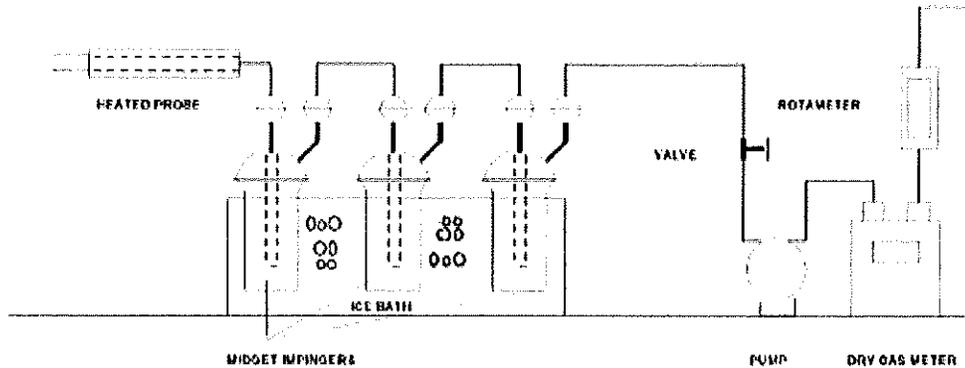


Figure 4-1. USEPA Method 4 and ALT 008 Sample Train

4.1.4 Organic Compounds (USEPA Method 18)

BTEX concentrations were measured following procedures in USEPA Method 18, "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography." The sampling and analytical procedures incorporated:

- USEPA Method 8260, "Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)."
- OSHA Method 7, "Organic Vapors."

Impingers and sorbent tubes were used to measure BTEX concentrations following USEPA Method 18 and OSHA 7 procedures. The sampling train consisted of:

- A set of two impingers (with the configuration shown in Table 4-3) situated in an ice bath.
- Unspiked (normal) or spiked sorbent tubes for the targeted analytes.
- Critical orifices to set the sampling flowrate.
- Teflon® tubing connecting the critical orifices to a rotameter.
- Sampling pump.



**Table 4-3
USEPA Method 18 Impinger Configuration**

Impinger	Type	Contents	Amount
1	Midget	Water	10 milliliters
2	Midget	Empty	0 milliliters

Flue gas passes through (1) impingers to remove water and residual glycol and (2) sorbent tubes positioned upstream of critical orifices (Gemini® twin-port sampler) that control flowrate, for the collection of BTEX. The critical orifices are connected to a rotameter and sampling pump. The sampling flowrate was monitored with the rotameter.

A similar sampling train using spiked sorbent tubes was collocated and placed parallel to the unspiked sorbent tubes for quality assurance/quality control (QA/QC) purposes.

Figure 4-2 depicts the USEPA Method 18 sampling train.

Based on expected concentrations and analytical detection limits, the USEPA Method 18 sampling train was set up to collect approximately 12 liters of flue gas at 0.2 liters per minute for each 60-minute test run. The mass of pollutant on a spiked sorbent tube was targeted to be 40 to 60% of the mass expected to be collected.

Before testing, the flowrate through each sorbent tube was measured using a rotameter and verified with a BIOS International DryCal® calibrator. The critical orifices were adjusted so that the sampling flowrate was within $\pm 20\%$ of the target sampling rate. The pre-test flowrate was recorded on a test run data sheet. After the sampling rate was measured, the sampling train was positioned to sample the flue gas. Flue gas was sampled through the impingers and into the sorbent tubes for 60 minutes per test run.

At the conclusion of each test run, the post-test sampling train flowrate was measured using the DryCal calibrator. The average of the pre- and post-test flowrates was used to calculate the flue gas sample volume for the test duration. The contents of the impingers were recovered and the sorbent tube was capped and stored in a chilled cooler. The samples were analyzed by Bureau Veritas' laboratory in Novi, Michigan and Fibertec Environmental Services laboratory in Holt, Michigan.

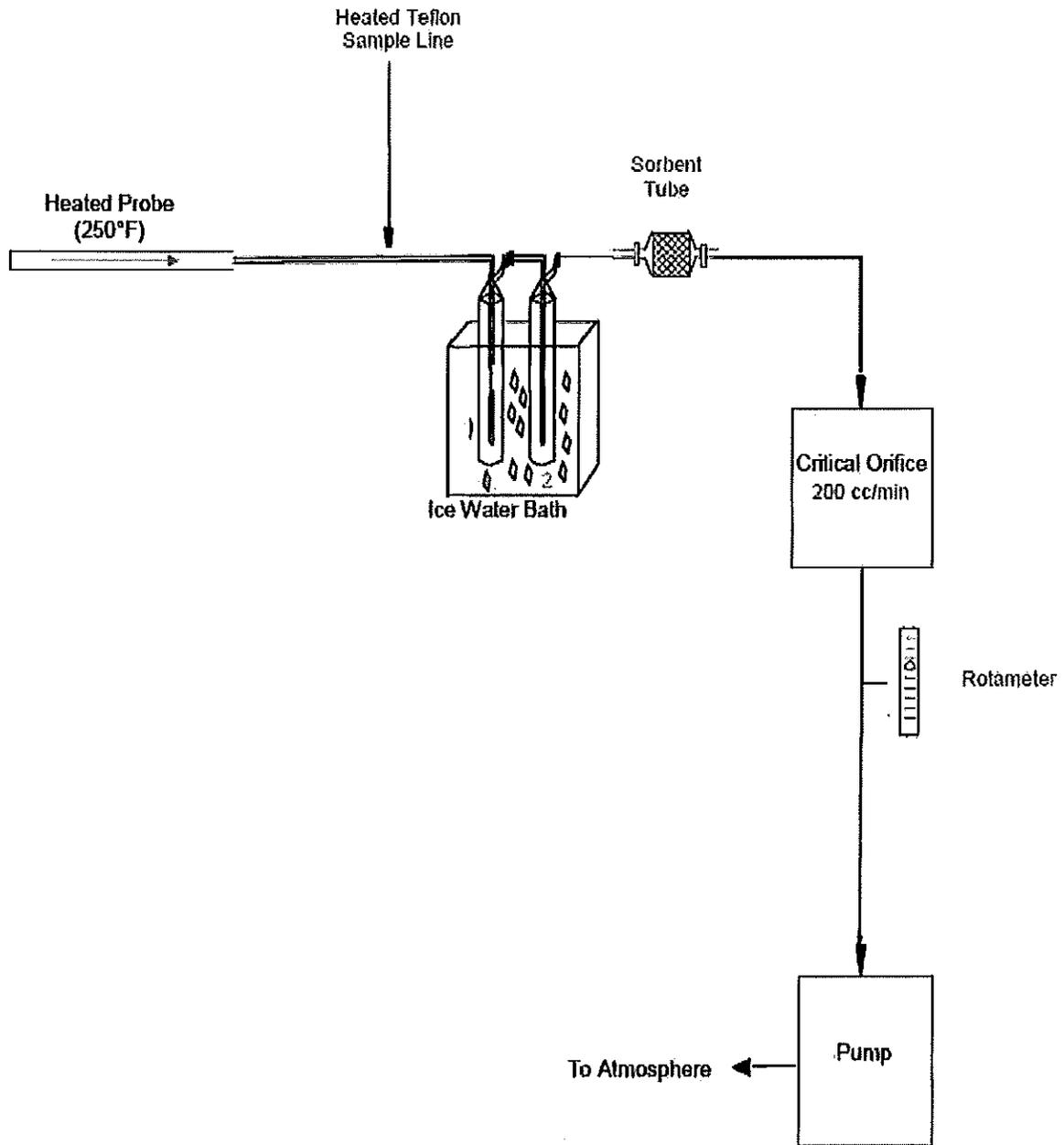


Figure 4-2. USEPA Method 18 Sampling Train



4.1.5 Volatile Organic Compound Leaks (USEPA Method 21)

USEPA Method 21, "Determination of Volatile Organic Compound Leaks" was used to evaluate the closed vent system for leaks. The process equipment evaluated includes valves, flanges, pressure relief devices, and other connections. A potential leak interface is determined to operate with no detectable organic emissions if the organic concentration is less than 500 ppmv. Bureau Veritas used a Thermo Scientific TVA 1000 portable FID that met the specification of Method 21 Section 6.0 to evaluate VOC leaks from the process sources.

Prior to testing, the analyzer was calibrated by introducing the following calibration gas standards alternatively in triplicate:

- Zero gas: air containing less than 10 ppmv VOC.
- Calibration gas: a mixture of methane in air at a methane concentration of 493.5 parts per million by volume. The calibration precision criterion is $\leq 10\%$ of the calibration gas value.

During calibration, the response time of the analyzer was measured by introducing the zero gas and then the calibration gas. After the calibration gas was introduced, the time required to attain 90% of the final stable reading is the response time. The response time criterion is ≤ 30 seconds.

Because the small glycol dehydration unit is located within a covered structure, a background VOC concentration was measured. The local ambient VOC concentration was measured by moving the instrument probe randomly within 3 to 6 feet from the closed vent system component to be monitored.

Although published response factors for the TVA 1000 are available, the measured VOC concentration was not converted to an "actual" concentration because the incoming process stream is natural gas and the majority of the VOCs in the closed vent system are likely to be methane. Thus, process system leaks were measured as methane, the calibration gas. Response factors for the analyzer calibrated using a methane standard are not applicable.

Inspection of the closed-vent system consisted of positioning the sampling probe at the surface of the component interface where a leak could occur. The probe was moved along the interface periphery while observing the instrument readout. If an increased concentration was observed, the sampling probe was slowly moved until the maximum concentration was obtained. The component was sampled for a minimum of twice the response time and if the maximum concentration, less the local ambient background VOC concentration, exceeded the leak definition, the data would have been recorded and reported to TransCanada for repair. No VOC readings were measured at a concentration exceeding the criterion of a leak.



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 F for the operating parameters recorded during testing.

4.3 Sampling Identification and Custody

Mr. Thomas Schmelter with Bureau Veritas was responsible for the handling and procurement of the data collected in the field. Mr. Schmelter ensured the data sheets were accounted for and completed.

Recovery and analytical procedures were applicable to the sampling methods used in this test program. Sampling and recovery procedures were described previously Section 4.0.

Applicable Chain of Custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."

For each sample collected (i.e., impinger, sorbent tube) sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- Containers were stored in a cooler.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."
- Samples were delivered to the laboratory.

Chains of custody and laboratory analytical results are included in Appendix E.



5.0 QA/QC Activities

Equipment used in this test program passed QA/QC procedures. Refer to Appendix A for equipment calibrations 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 method 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 Sampling Train QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-1 summarizes the QA/QC audits conducted for the Method 4 sampling train.



**Table 5-1
Method 4 Sampling Train QA/QC Audits**

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
Eaton Rapids (EUERGLYDEH)					
Sampling train leak check Post-test	0.000 ft ³ for 1 min at 7 in Hg	0.000 ft ³ for 1 min at 7 in Hg	0.000 ft ³ for 1 min at 7 in Hg	<0.020 ft ³ for 1 minute at ≥ sample vacuum recorded during test	Valid
Sampling vacuum (in Hg)	0	0	0		

5.2.2 Instrument Analyzer QA/QC Audits

The Method 21 sampling described in Section 4.1 was audited for measurement accuracy and data reliability. The analyzer passed the applicable calibration criteria. The following table summarizes gas cylinders used during this test program. Refer to Appendix A for additional calibration data.

**Table 5-2
Calibration Gas Cylinder Information**

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Total hydrocarbons (THC)	The American Gas Group	EB0019307	<0.1 ppm	NA
Methane (CH ₄)	Airgas	CC337690	493.5 ppm	September 27, 2020

5.2.3 Dry-Gas Meter QA/QC Audits

Table 5-3 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Refer to Appendix A for complete DGM calibrations.



**Table 5-3
Dry-gas Meter Calibration QA/QC Audit**

Dry-Gas Meter	Pre-test DGM Calibration Factor (Y) (dimensionless)	Post-Test DGM Calibration Factor (Y) (dimensionless)	Difference Between Pre- and Post-test DGM Calibrations	Acceptable Tolerance	Comment
2	0.993 (11/14/14)	0.991 (3/13/15)	0.002	±0.05	Valid

5.2.4 Thermocouple QA/QC Audits

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature (i.e., ice water bath, boiling water) prior to and after testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are presented in Appendix A.

5.2.5 QA/QC Blanks

Sample media blanks were analyzed for the parameters of interest. The results of the blanks are presented in the Table 5-4.

Refer to Appendix E for the laboratory results.



**Table 5-4
QA/QC Blanks**

Sample Identification	Result (µg)	Comment
BTEX Blank 1	<2 Benzene <4 Ethylbenzene <4 Toluene <8 Total Xylenes	Compounds of interest not detected
BTEX Blank 2	<2 Benzene <4 Ethylbenzene <4 Toluene <8 Total Xylenes	Compounds of interest not detected
BTEX Spike Blank 1	33 Benzene 31 Ethylbenzene 32 Toluene 61 Total Xylenes	The average mass of BTEX spike Blanks 1 and 2 were used in Method 18 spike recovery calculations
BTEX Spike Blank 2	34 Benzene 32 Ethylbenzene 33 Toluene 63 Total Xylenes	
	(µg/L)	
Water Blank 1	<1 Benzene <1 Ethylbenzene <1 Toluene <3 Total Xylenes	Compound of interest not detected
Water Blank 2	<1 Benzene <1 Ethylbenzene <1 Toluene <3 Total Xylenes	Compound of interest not detected

5.3 QA/QC Checks for Data Reduction and Validation

Mr. Thomas Schmelter validated the computer spreadsheets onsite. The computer spreadsheets were used to evaluate the accuracy of field calculations. The field data sheets were reviewed to evaluate whether data has been recorded and inputted appropriately. The computer data sheets were checked against the raw field data sheets for accuracy during review of the draft report. Sample calculations were performed to verify computer spreadsheet computations.

5.4 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy for the test runs.



6.0 Limitations

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Table 1

BTEX Results
TransCanada - Eaton Rapids
Eaton Rapids, Michigan
Bureau Veritas Project No. 11015-000004.00
Sampling Date: February 27, 2015

Parameter	Run 1		Run 2		Run 3		Average
	1 Normal	1 Spike	2 Normal	2 Spike	3 Normal	3 Spike	
Sampling Start Time	9:45		11:00		12:30		
Sample Duration (min)	60		60		60		60
Estimated Operating Hours							
Estimated Annual Operating Hours ¹ (hr/yr)	3,624						
Sampling Conditions							
Stack Flowrate (dscfm)	202		224		215		214
Ambient Temperature (°F)	55		70		75		66
Saturated Partial Pressure of Water Vapor (in Hg)	0.4		0.7		0.9		0.67
Atmospheric Pressure (in Hg)	29.4		29.5		29.5		29.5
Sampling Rate							
Pre-Sampling Flowrate (cc/min)	199.0	200.6	200.9	200.5	205.3	199.7	201.0
Post-Sampling Flowrate (cc/min)	204.7	182.3	194.8	197.8	194.2	193.0	195.1
Sampling Flowrate Pre-test to Post-test Change (%)	2.9	9.1	1.0	1.3	5.4	3.4	3.9
Average Sampling Flowrate (cc/min)	201.9	191.5	199.9	199.2	199.8	196.4	198.1
Average Sampling Flowrate (dry standard l/min)	0.200	0.190	0.192	0.191	0.189	0.186	0.191
Sample Volume (L, dry standard)	12.0	11.4	11.5	11.5	11.3	11.1	11.5
Impinger							
Mass of condensate collected (g)	13.4	13.2	1.2	0.5	0.7	0.5	4.9
Volume of condensate collected (ml)	13.4	13.2	1.2	0.5	0.7	0.5	4.9
Concentration of Benzene in condensate (µg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Concentration of Toluene in condensate (µg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Concentration of Ethylbenzene in condensate (µg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Concentration of Total Xylenes in condensate (µg/l)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Mass of Benzene in condensate (µg)	<0.0134	<0.0132	<0.0012	<0.0005	<0.0007	<0.0005	<0.0049
Mass of Toluene in condensate (µg)	<0.0134	<0.0132	<0.0012	<0.0005	<0.0007	<0.0005	<0.0049
Mass of Ethylbenzene in condensate (µg)	<0.0134	<0.0132	<0.0012	<0.0005	<0.0007	<0.0005	<0.0049
Mass of Total Xylenes in condensate (µg)	<0.0403	<0.0397	<0.0036	<0.0015	<0.0021	<0.0015	<0.0148
Sorbent Tube							
Benzene Mass (µg)	<2	33	<2	35	<2	33	18
Benzene Spike Mass (µg)	-	34	-	34	-	34	34
Benzene Concentration (mg/dscm)	<0.2	-	<0.2	-	<0.2	-	0.2
Benzene Spike Recovery (R)	-	0.93	-	0.99	-	0.93	0.95
Toluene Mass (µg)	8.0	41	<4	37	<4	34	21
Toluene Spike Mass (µg)	-	33	-	33	-	33	33
Toluene Concentration (mg/dscm)	0.7	-	<0.3	-	<0.4	-	0.5
Toluene Spike Recovery (R)	-	1.03	-	1.02	-	0.93	0.99
Ethylbenzene Mass (µg)	<4	34	<4	34	<4	32	19
Ethylbenzene Spike Mass (µg)	-	32	-	32	-	32	32
Ethylbenzene Concentration (mg/dscm)	<0.3	-	<0.3	-	<0.4	-	0.3
Ethylbenzene Spike Recovery (R)	-	0.96	-	0.95	-	0.89	0.93
Total Xylenes Mass (µg)	16	77	<8	71	<8	66	41
Total Xylenes Spike Mass (µg)	-	62	-	62	-	62	62
Total Xylenes Concentration (mg/dscm)	1.3	-	<0.7	-	<0.7	-	0.91
Total Xylenes Spike Recovery (R)	-	1.00	-	1.02	-	0.94	0.98
Total							
Benzene Mass in Impinger and Sorbent Tube (µg) ¹	<2.2		<2.0		<2.2		<2.1
Benzene Concentration (mg/dscm) ¹	<0.18		<0.18		<0.19		<0.18
Benzene Mass Emission Rate (lb/hr) ¹	<0.00014		<0.00015		<0.00015		<0.00015
Toluene Mass in Impinger and Sorbent Tube (µg) ¹	7.8		<3.9		<4.3		5.4
Toluene Concentration (mg/dscm) ¹	0.65		<0.34		<0.38		0.46
Toluene Mass Emission Rate (lb/hr) ¹	0.00049		<0.00029		<0.00031		0.00036
Ethylbenzene Mass in Impinger and Sorbent Tube (µg) ¹	<4.2		<4.2		<4.5		<4.3
Ethylbenzene Concentration (mg/dscm) ¹	<0.35		<0.37		<0.40		<0.37
Ethylbenzene Mass Emission Rate (lb/hr) ¹	<0.00026		<0.00031		<0.00032		<0.00030
Total Xylenes Mass in Impinger and Sorbent Tube (µg) ¹	16		<7.9		<8.5		10.8
Total Xylenes Concentration (mg/dscm) ¹	1.3		<0.68		<0.75		0.93
Total Xylenes Mass Emission Rate (lb/hr) ¹	0.0010		<0.00057		<0.00061		0.00073
Mass Rate of BTEX (lb/hr)	0.0019		<0.0013		<0.0014		0.0015
Mass Rate of BTEX (Mg/yr)	0.0031		<0.0022		<0.0023		0.0025

¹ Based on typical maximum operating hours for the total withdrawal season.

¹ Corrected for spike recovery following USEPA Method 18.

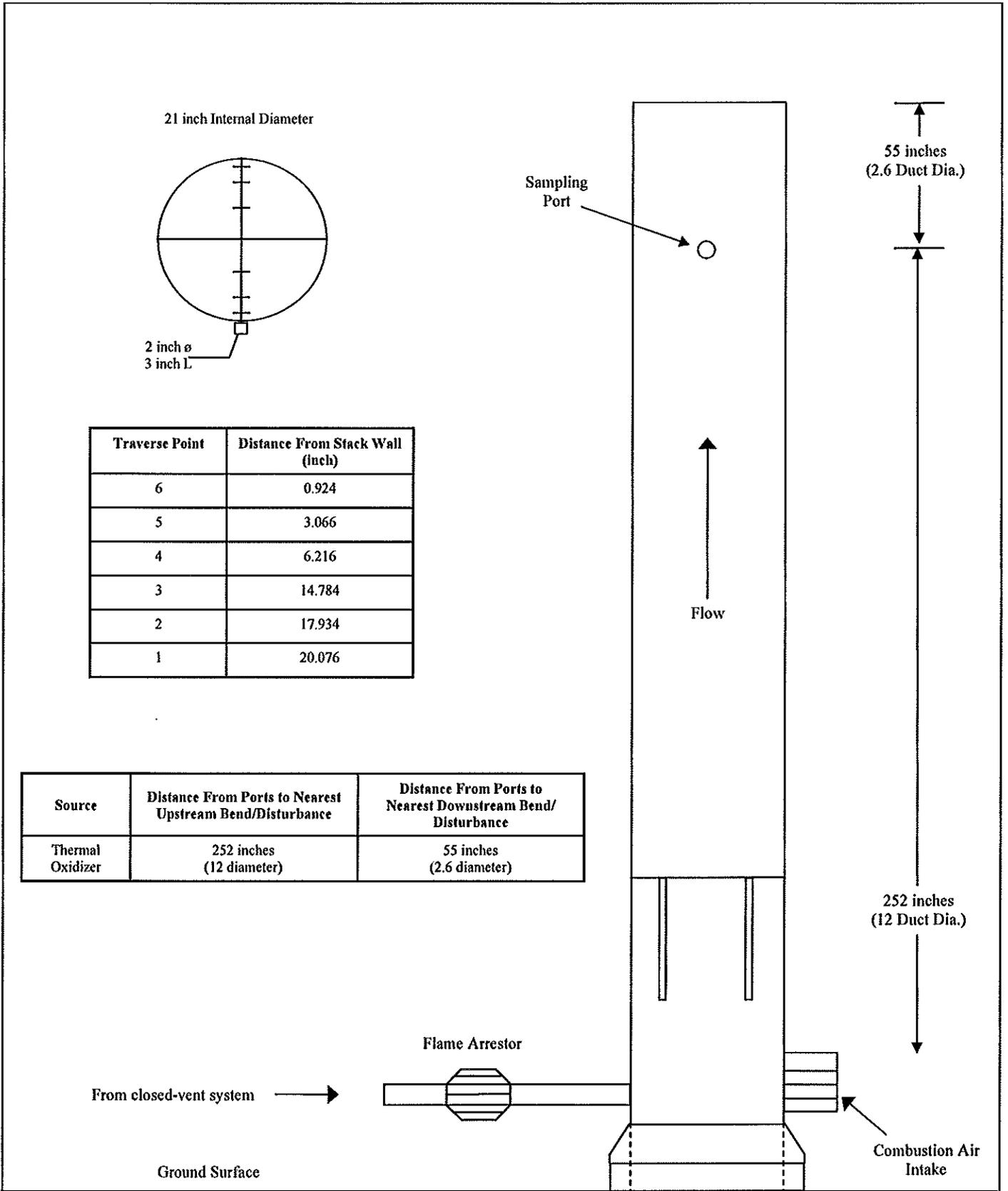


Figure 1
Eaton Rapids Thermal Oxidizer
Sampling Ports and Traverse
Point Locations





Glycol Dehydration Unit TO Exhaust BTEX Emission Rates
TransCanada - Eaton Rapids
Eaton Rapids, Michigan
Bureau Veritas Project No. 11015-000004.00
Sampling Date: February 27, 2015

