

Capac

Emission Test and LDAR Assessment of Small Glycol Dehydration Unit

Mid-Michigan Gas Storage Company Capac Compressor Station

4876 Kettlehut Road
Capac, Michigan

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TransCanada
In business to deliver

State Registration No. B6481

Prepared for
TransCanada
Houston, Texas

October 15, 2015

Bureau Veritas Project No. 11015-000169.00



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Bureau Veritas North America, Inc.
22345 Roethel Drive
Novi, Michigan 48375
248.344.1770
www.us.bureauveritas.com/hse



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**RENEWABLE OPERATING PERMIT AIR QUALITY DIV.
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 - Capac Compressor Station County St. Clair

Source Address 4876 Kettlehut Road City Capac

AQD Source ID (SRN) B6481 ROP No. MI-ROP-B6481-2011 ROP Section No. C

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 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

Richard P. Connor	Director - US Pipeline Operations Great Lakes Region	(231)527-2122
Name of Responsible Official (print or type)	Title	Phone Number
		10-26-15
Signature of Responsible Official		Date

* Photocopy this form as needed.



Executive Summary

TransCanada retained Bureau Veritas North America, Inc. to evaluate the closed-vent system and test air emissions at the Mid-Michigan Gas Storage Company (MMGS) Capac Compressor Station in Capac, Michigan. TransCanada stores and/or removes 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 Capac 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 Capac 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- B6481-2011.

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 September 15, 2015, testing was conducted at Capac 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
Sept 15	Capac	42	42	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 Capac glycol dehydration unit.

Detailed results of the Capac 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
Capac						
Sept 15	Capac	EUCP003	Benzene [†]	lb/hr	<0.00016	NA
			Toluene [†]		<0.00033	NA
			Ethylbenzene [†]		<0.00034	NA
			Total Xylenes [†]		<0.00068	NA
			Mass rate of BTEX	lb/hr	<0.0015	NA
			Mg/yr	<0.0060	1.49	

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

¹ Based on 8,760 operating hours for the year.

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.



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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 Mid-Michigan Gas Storage Company (MMGS) Capac Compressor Station in Capac, Michigan. TransCanada stores and/or removes 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 Capac 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 Capac 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- B6481-2011.

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 ROP MI-ROP- B6481-2011.

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 Capac 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 September 15, 2015, Bureau Veritas conducted the following for the Capac 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
Capac		
Capac thermal oxidizer exhaust	BTEX	September 15, 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. Thomas Gasloli, Mr. Sebastian Kallumkal, and Ms. Kerry Kelly, Environmental Quality Analysts, 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	
<p>Thomas Gasloli Environmental Quality Analyst Air Quality Division – Lansing District Office Constitution Hall 525 West Allegan Street, 2th Floor South Lansing, Michigan 30241 Telephone: 517.284.6778 Email: gaslolit@michigan.gov</p> <p>Sebastian Kallumkal Environmental Quality Analyst Air Quality Division Southeast Michigan District Office 27700 Donald Court Warren, Michigan 48092 Telephone: 586.753.3738 Email: kallumkals@michigan.gov</p>	<p>Kerry Kelly Environmental Quality Analyst Air Quality Division Southeast Michigan District Office 27700 Donald Court Warren, Michigan 48092 Telephone: 586.753.3746 Email: kellyk6@michigan.gov</p>
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

MMGS, 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. MMGS 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 from the storage reservoir field. 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 Capac.

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**

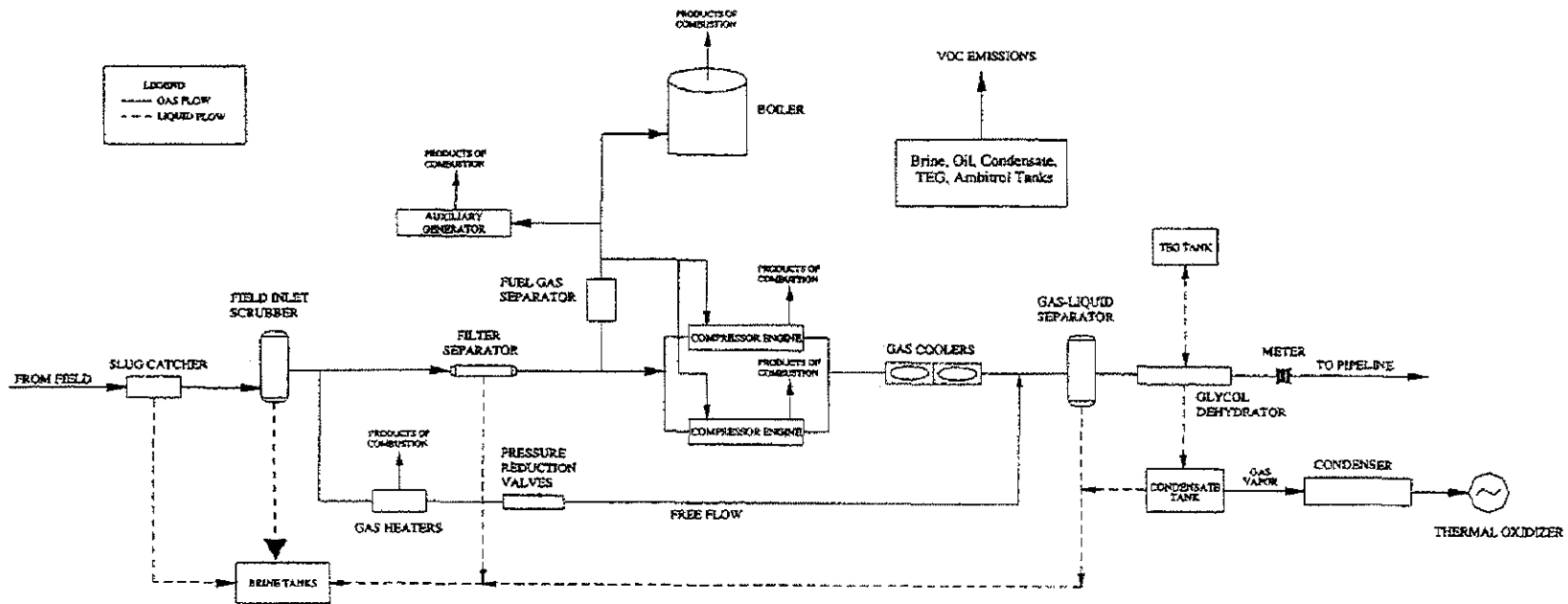
Parameter	Units	Run 1	Run 2	Run 3	Average
Capac (EUCP003)					
Natural gas throughput rate during testing	MMCFD	2.9	2.8	2.8	2.8
Thermal oxidizer combustion temperature	°F	1,473	1,472	1,474	1,473
Glycol recirculation Rate	GPM	2.4	2.1	2.0	2.2

MMCFD: million cubic feet per day

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 Capac is 6.4 MMCFD.



Source: TransCanada.

Figure 2-1. General Gas Withdrawal Process Flow

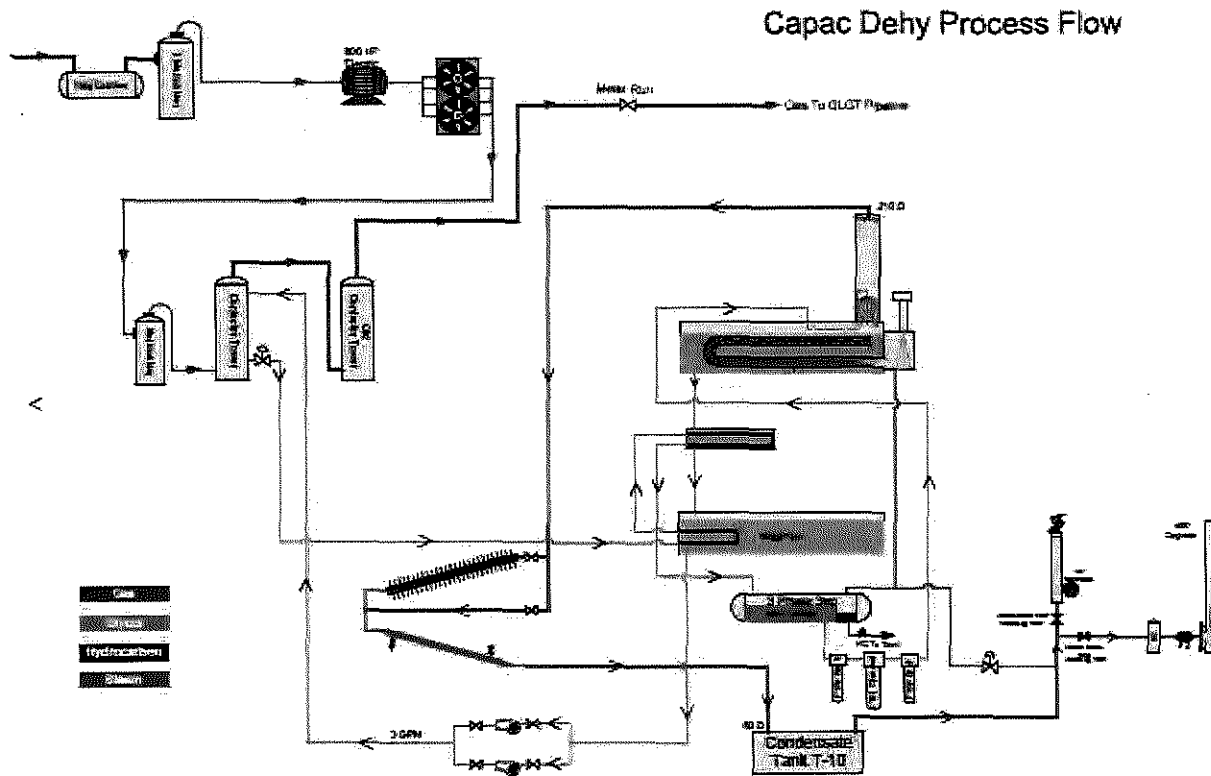


Figure 2-2. Capac Dehydration Unit Process Flow



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 are 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 incinerator is 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 Capac sampling location. Because two sampling ports were not present, 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 Capac Thermal Oxidizer Exhaust

The Capac thermal oxidizer exhaust stack is 20 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 (2.75 duct diameters) from the nearest downstream disturbance.
- 252 inches (12.6 duct diameters) from the nearest upstream disturbance.

The port was accessible via an articulating boom lift.

Figure 2-3 is a photograph of the Capac 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 Capac 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 Capac small glycol dehydration unit. The LDAR test locations are presented in Figure 2-4.

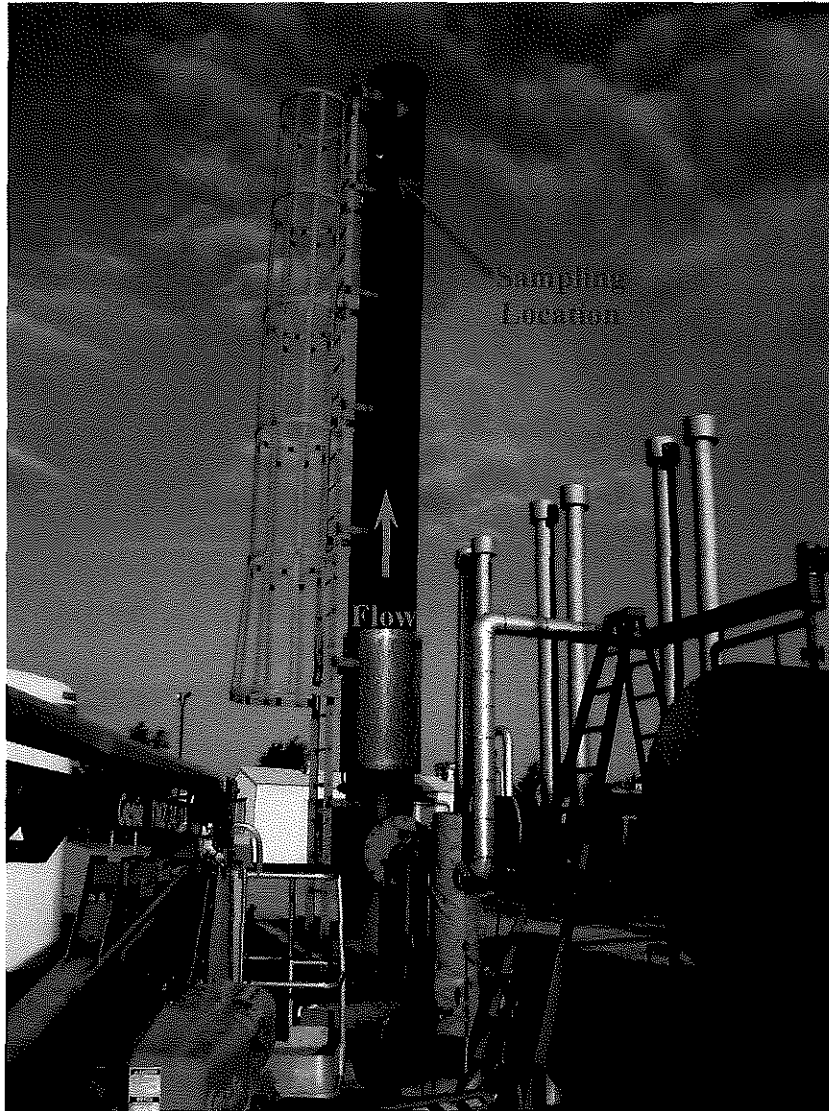


Figure 2-3. Capac Thermal Oxidizer Exhaust Stack

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Capac LDAR Tags

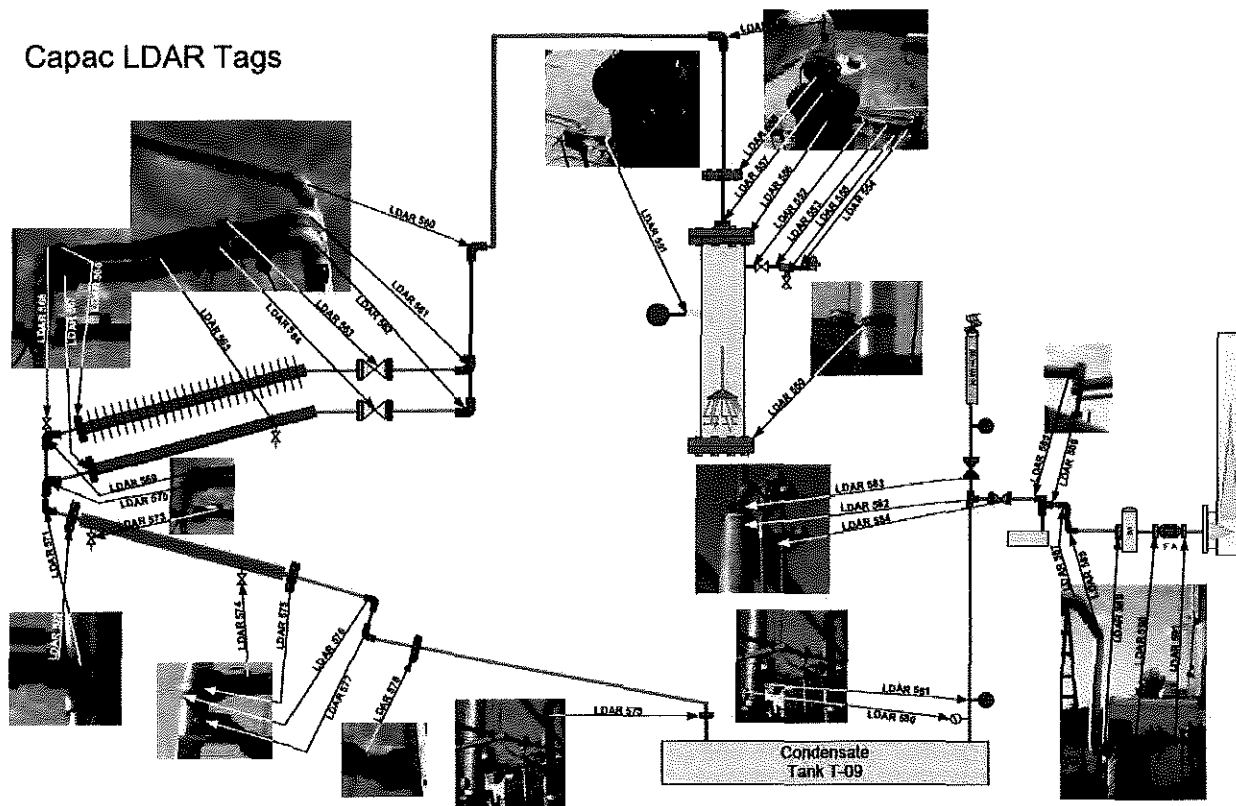


Figure 2-4. Capac LDAR Sampling Locations



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 Capac 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- B6481-2011.

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
Capac (EUCP003)	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
Capac LDAR Results - September 15, 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
550	Base of still column	Flange	14:53	-	1.4	No
551	Thermowell on still column	Thermowell	14:10	-	15	No
552	Piping at relief valve nipple #1	Nipple 1	14:10	-	1.8	No
553	Piping at relief valve nipple #2	Nipple 2	14:11	-	1.7	No
554	Piping at relief valve nipple #3	Nipple 3	14:12	-	1.6	No
555	Piping at relief valve nipple #4	Nipple 4	14:12	-	1.6	No
556	Top of still column big flange	Flange	14:12	-	5.4	No
557	Top of still column screw threaded pipe outlet	Pipe	14:12	-	1.5	No
558	Top of still column 6" flange	Flange	14:13	-	1.6	No
559	Top of still column elbow	Pipe	14:13	-	1.7	No
560	Lower elbow piping from still column outlet	Pipe	14:28	-	84	No
561	Elbow inlet to fin condenser	Pipe	14:28	-	15	No
562	Elbow inlet to top covered condenser	Pipe	14:34	-	22	No
563	Inlet valve to fin condenser	Valve	14:36	-	370	No
564	Inlet valve to covered top condenser	Valve	14:37	-	14	No
565	Top covered condenser plug	Plug	14:28	-	25	No
566	Outlet flange of fin condenser	Flange	14:15	-	1.6	No
567	Outlet flange of covered condenser	Flange	14:15	-	1.9	No
568	Valve at outlet of top covered condenser	Valve	14:16	-	1.6	No
569	Outlet elbow of fin condenser	Pipe	14:17	-	1.7	No
570	Outlet elbow of top covered condenser	Pipe	14:17	-	1.6	No
571	Inlet elbow to bottom covered condenser	Pipe	14:18	-	1.4	No
572	Inlet flange to bottom covered condenser	Flange	14:18	-	1.9	No
573	Inlet bottom covered condenser valve	Plug	14:19	-	1.4	No
574	Outlet bottom covered condenser valve	Plug	14:41	-	36	No
575	Bottom covered condenser outlet flange	Flange	14:43	-	37	No
576	Bottom covered condenser outlet elbow	Pipe	14:39	-	27	No
577	Inlet line to tank elbow	Pipe	14:40	-	9.4	No
578	Inlet line to tank flange #1	Flange	14:39	-	17	No
579	Inlet line to tank flange #2	Flange	14:54	1.7	-	No
580	Outlet line of tank temperature gauge	Pipe	14:48	1.6	-	No
581	Outlet line of tank temperature thermowell	Thermowell	14:48	1.6	-	No
582	Tank outlet tee	Flange	14:50	-	1.7	No
583	Valve to Btex vent	Valve	14:51	-	1.5	No
584	Valve to Thermoxidizer	Valve	14:51	-	1.5	No



**Table 3-2
Capac LDAR Results - September 15, 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
585	Tee inlet to drop leg on top of tank	Pipe	14:46	-	1.6	No
586	Tee outlet to drop leg on top of tank	Pipe	14:46	-	1.7	No
587	Elbow #1 from drop leg to thermoxidizer	Pipe	14:06	-	1.6	No
588	Elbow #2 from drop leg to thermoxidizer	Pipe	14:05	-	1.5	No
589	Inlet to thermoxidizer separator	Flange	14:04	16	-	No
590	Inlet to flame arrester	Flange	14:03	2.6	-	No
591	Outlet from flame arrester	Flange	14:03	6.5	-	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 = 4.5 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
Capac						
Sept 15	Capac	EUCP003	Benzene [†]	lb/hr	<0.00016	NA
			Toluene [†]		<0.00033	NA
			Ethylbenzene [†]		<0.00034	NA
			Total Xylenes [†]		<0.00068	NA
			Mass rate of BTEX	lb/hr	<0.0015	NA
			Mg/yr	<0.0060	1.49	

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

¹ Based on 8,760 operating hours for the year.

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 Capac 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.

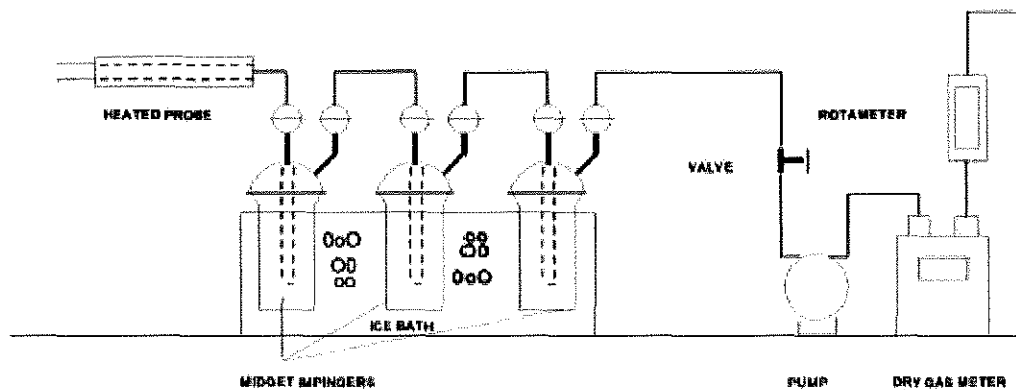


Figure 4-1. USEPA Method 4 and ALT 008 Sample Train

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.

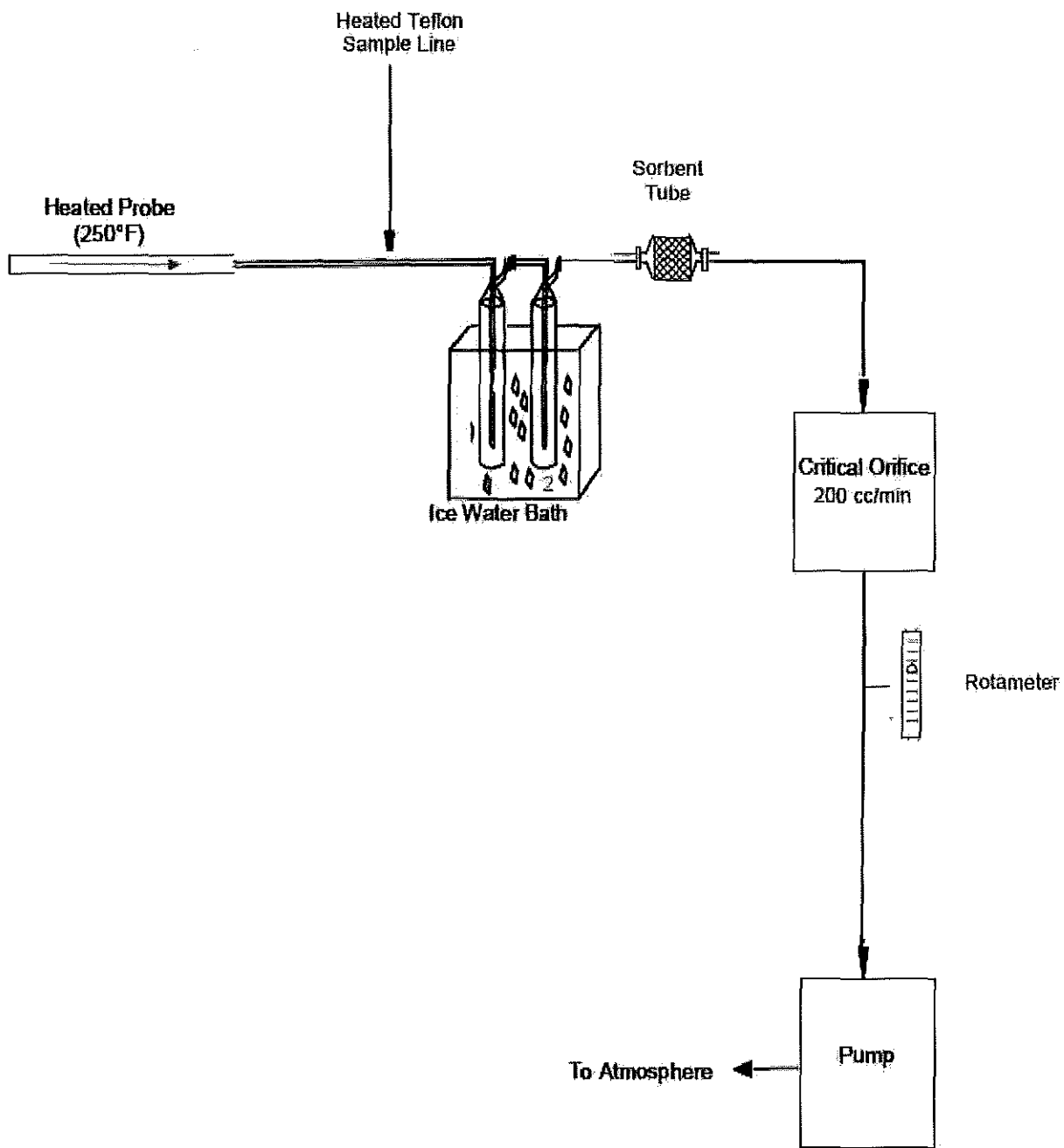


Figure 4-2. USEPA Method 18 Sampling Train



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
Capac (EUCP003)					
Sampling train leak check Post-test	0 ft ³ for 1 min at 4 in Hg	0 ft ³ for 1 min at 25 in Hg	0 ft ³ for 1 min at 25 in Hg	<0.020 ft ³ for 1 minute at ≥ sample vacuum recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		

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	0.991 August 3, 2015	0.974 October 12, 2015	0.017	±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	42 Benzene 41 Ethylbenzene 42 Toluene 79 Total Xylenes	The average mass of BTEX spike Blanks 1 and 2 were used in Method 18 spike recovery calculations
BTEX Spike Blank 2	41 Benzene 40 Ethylbenzene 41 Toluene 76 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

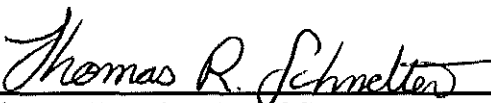
Equipment audits and QA/QC procedures demonstrate sample collection accuracy for the test runs.



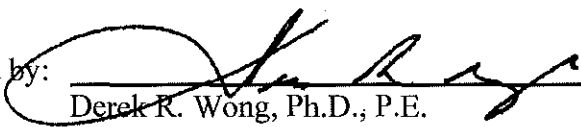
6.0 Limitations

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This report prepared by:


Thomas R. Schmelter, QSTI
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