Rapid River 35

Emission Test and LDAR Assessment of Small Glycol Dehydration Units

ANR Pipeline Company
Rapid River Compressor Station

2170 Rabourn Road NE
Kalkaska, Michigan

State Registration No. B7197

TransCanada
In business to deliver

Prepared for
TransCanada
Houston, Texas

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Bureau Veritas Project No. 11015-000004.00

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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) Rapid River Compressor Station located at 2170 Rabourn Road Northeast in Kalkaska, 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 Rapid River 35 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 glycol dehydration units' thermal oxidizer exhaust stacks.
- 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- B7197-2012a.

The glycol dehydration systems are defined as "existing small glycol dehydration units" 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. The testing was conducted on February 19, 2015, and consisted of completion of the LDAR assessments and three 60-minute test runs to measure BTEX.

Leak Detection and Repair

Detailed results of the LDAR assessments are presented in Table 3-2. Documentation of each LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included as Appendix C of this report. The results of the LDAR assessments 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 19	Rapid River 35	31	31	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 control air emissions from the glycol dehydration system. Emission testing was conducted on the Rapid River glycol dehydration unit.

Detailed results of the testing are presented in Table 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]
Rapid River 35 (EURRGLYDEH)						
Feb 19	Rapid River 35	EURRGLYDEH	Benzene†	lb/hr	<0.00016	NA
			Toluene†		<0.00034	NA
			Ethylbenzene†		<0.00033	NA
			Total xylenes†		<0.0007	NA
			Mass rate of BTEX	lb/hr	<0.0015	NA
				Mg/yr†	<0.0024	54.70

† 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) Rapid River Compressor Station located at 2170 Rabourn Road Northeast in Kalkaska, 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 Rapid River 35 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 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- B3721-2014.

The glycol dehydration systems are defined as "existing small glycol dehydration units" 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 assessments were 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-PTI-B7197-2012a.

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 each LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included as 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.

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)):

$$EL_{BTEX} = 3.10x10^{-4} \times \text{Throughput} \times C_{i,BTEX} \times 365 \frac{\text{day}}{\text{yr}} \times \frac{1\ \text{Mg}}{1x10^{6}\ \text{gram}}$$

Where:

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

$3.10x10^{-4}$ = BTEX emission limit, grams BTEX/standard cubic meter-ppmv

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

$C_{i,BTEX}$ = 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 19, 2015, Bureau Veritas conducted the following:

- The LDAR assessment
- Three 60-minute test runs at the exhaust of each 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
Rapid River 35		
Rapid River 35 thermal oxidizer exhaust	BTEX	February 19, 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. Jeremy Howe, Environmental Quality Analyst, and Mr. William Rogers, Environmental Quality Analyst, with MDEQ.

Table 1-2
Key Personnel

TransCanada	
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	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 Pedro Amieva US Plant Reliability TransCanada 717 Texas Street Houston, Texas 77002 Phone: 832.320.5839 pedro_amieva@transcanada.com
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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 locations evaluated as part of this test program are natural gas transmission and compression stations that operate natural gas storage fields.

The pipeline transports natural gas to and from the storage reservoir fields. Natural gas is injected into underground fields 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 units, natural gas is pumped into towers, 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 towers 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 towers.

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

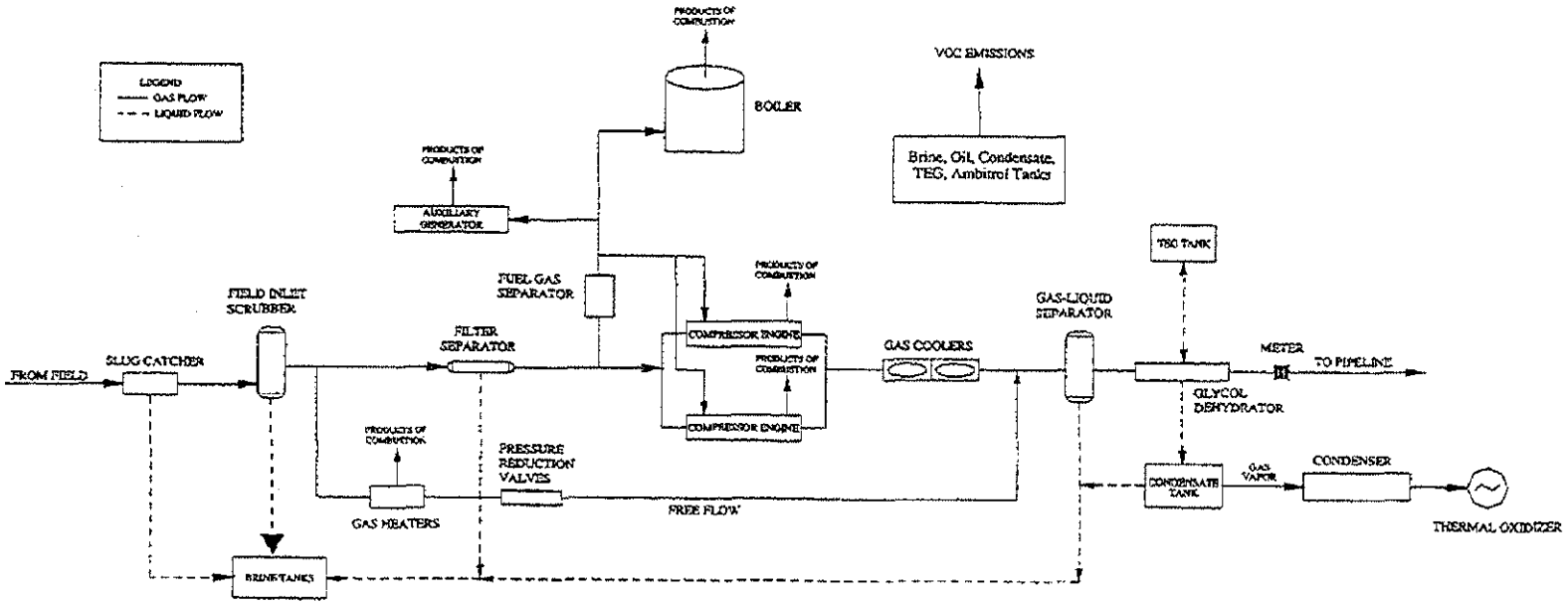
Figures 2-1 and 2-2 depict the general natural gas withdrawal and small glycol dehydration unit processes for Rapid River 35.

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
Rapid River (EURRGLYDEH)					
Natural gas throughput rate during testing	MMCFH	9.0	9.0	9.0	9.0
Thermal oxidizer combustion temperature	°F	1,512	1,559	1,547	1,539
Glycol recirculation Rate	GPM	6	6	6	6

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 Excelsior is 10.4 MMCFH.



Source: TransCanada.

Figure 2-1. General Gas Throughput Process Flow

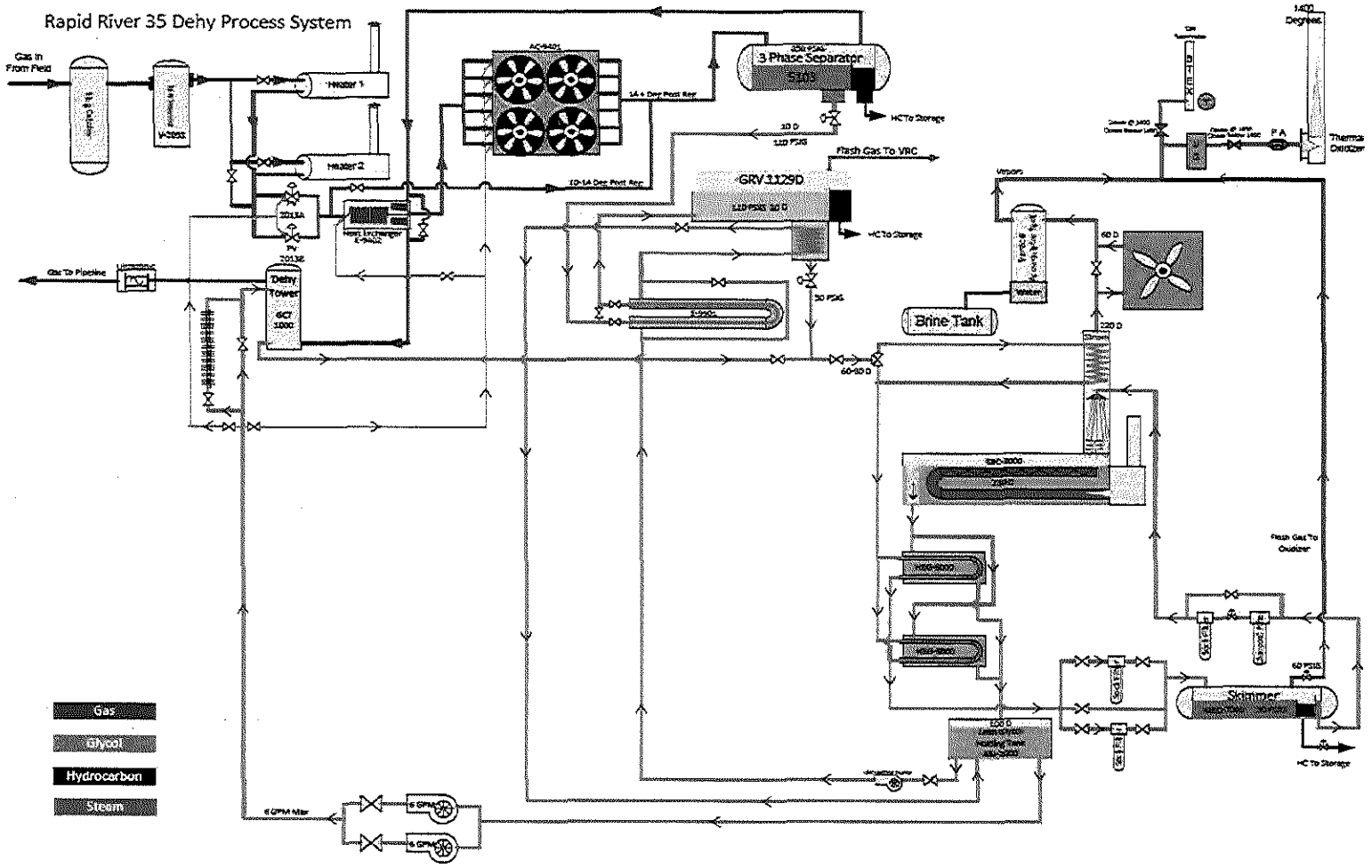


Figure 2-2. Rapid River 35 Dehydration Unit Process Flow

Source: TransCanada.

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 of.

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 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 Locations

The sampling port location met the upstream and downstream siting requirements of USEPA Method 1; however, only one sampling port is available at the Rapid River 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 sampling location is presented in Section 2.3.1.

2.3.1 Rapid River 35 Thermal Oxidizer Exhaust

The Rapid River 35 thermal oxidizer exhaust stack is 21 inches in diameter and has one 3-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.
- 237 inches (11.2 duct diameters) from the nearest upstream disturbance.

The port was accessible via an articulating boom lift.

Figure 2-3 is a photograph of the Rapid River 35 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 Rapid River 35 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 Rapid River 35 small glycol dehydration unit. The LDAR test locations are presented in Figure 2-4.

Figure 2-3. Rapid River 35 Thermal Oxidizer Exhaust Stack

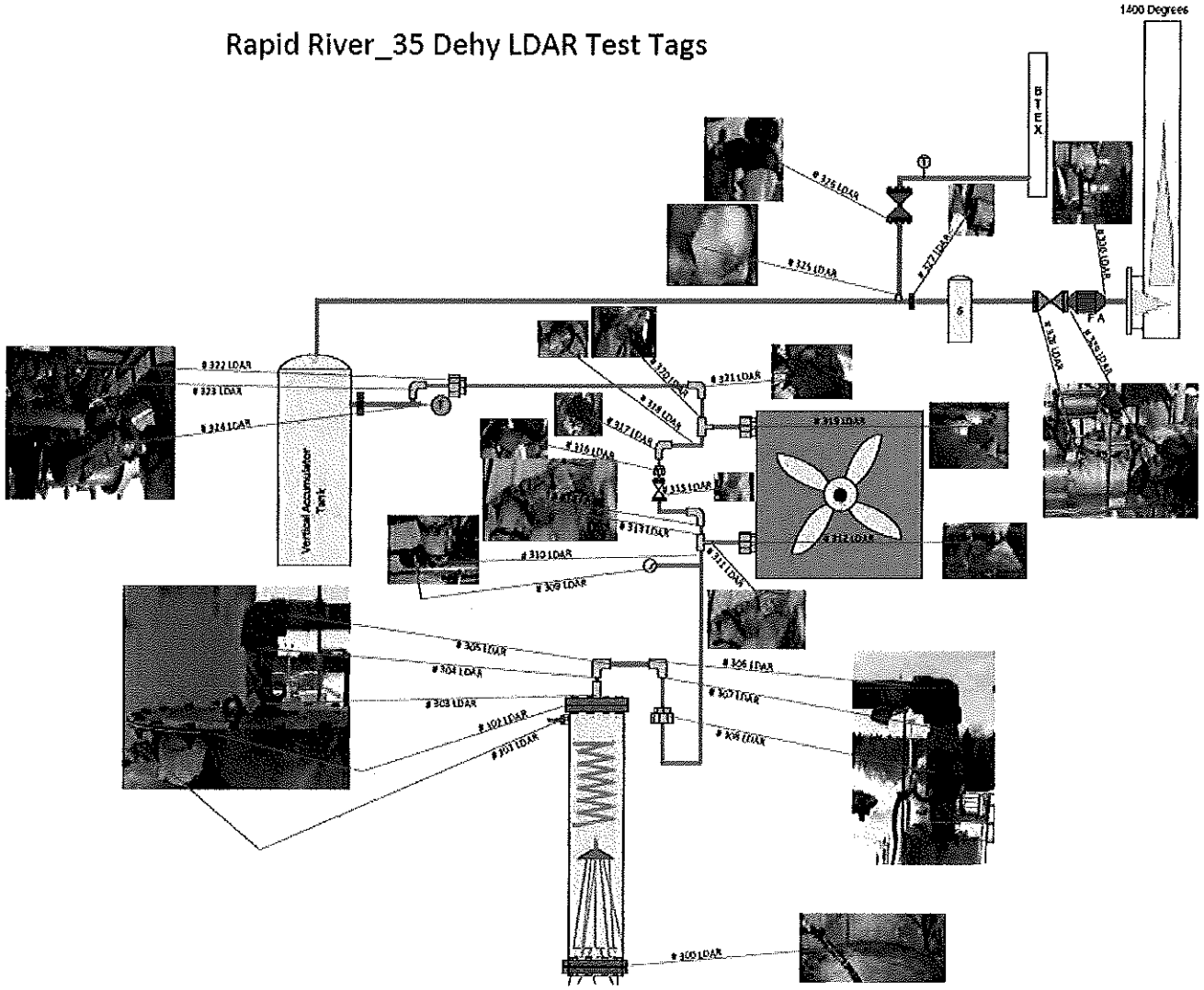


Figure 2-4. Rapid River 35 LDAR Sampling Locations

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 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- B7197-2012a

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
Rapid River 35 (EURRGLYDEH)	BTEX	1, 2, 3, 4, and 18	Three 60-minute runs	Field measurement Gas chromatography	Bureau Veritasand Maxxam Analytics†
	VOC leaks	21	NA	Flame ionization detector	NA

† Maxxam Analytics is a Bureau Veritas company

3.2 Field Test Changes and Issues

Significant field test changes were not required to complete the emissions testing. Communication between TransCanada, Bureau Veritas, and MDEQ allowed the testing to be completed as proposed.

3.3 Summary of Results

Detailed results of the LDAR assessments are presented in Table 3-2. Documentation of each LDAR assessment was recorded on LDAR Recordkeeping and Field Inspection Forms, which are included as 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 are provided after the Graphs Tab in the Appendix. Sample calculations are presented in Appendix B.

Table 3-2
Rapid River LDAR Results - February 19, 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
300	Base of still column	Flange	11:55	-	80	No
301	Tubing to reflux valve	Flange	14:14	-	2.3	No
302	Top of still column	Flange	14:15	-	2.2	No
303	Piping at top of still column	Flange	14:15	-	2.5	No
304	Coupling at top of still column	Coupling	14:15	-	1.3	No
305	Piping at top of still column	Elbow pipe	14:16	-	1.4	No
306	Piping at top of still column	Elbow pipe	14:16	-	1.4	No
307	Piping at top of still column	Elbow pipe	14:17	-	1.4	No
308	Union	Union	14:17	-	1.4	No
309	Temperature probe	Thermowell	11:56	-	6.3	No
310	Tee for bypass condenser to condenser	Piping tee	11:58	-	7.0	No
311	Tee for bypass condenser line to bypass line	Piping tee	11:57	-	6.3	No
312	Inlet to condenser	Coupling	11:58	-	6.9	No
313	Bypass 90 elbow nipple	Elbow pipe	11:59	-	6.7	No
314	Bypass 90 elbow nipple	Elbow pipe	12:00	-	6.9	No
315	Bypass Valve	Flange	12:00	-	7.0	No
316	Union below bypass valve	Union	12:01	-	6.3	No
317	Bypass 90 elbow nipple	Elbow pipe	12:01	-	6.9	No
318	Bypass 90 elbow nipple	Elbow pipe	12:02	-	6.0	No
319	Outlet from condenser coupling to tee	Piping	12:03	-	5.7	No
320	Outlet of condenser bypass tee	Tee	12:03	-	6.6	No
321	Piping elbow outlet to tank	Piping	12:05	-	6.4	No
322	Hammer union	Union	12:05	-	9.0	No
323	90 elbow	Elbow pipe	12:06	-	9.0	No

Table 3-2
Rapid River LDAR Results - February 19, 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
324	Tee thermowell	Thermowell	12:06	12.6	-	No
325	Tee to BTEX isolation valve	Piping	12:07		3.5	No
326	Flange to BTEX valve	Flange	12:08		6.2	No
327	Tee flange to thermal oxidizer	Flange	12:08		3.7	No
328	Inlet to thermal oxidizer valve	Flange	12:10	2.0	-	No
329	Outlet of thermal oxidizer valve	Flange	12:11	2.5	-	No
330	Outlet of flame arrester	Flange	12:12	1.4	-	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 = 4.0 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]
Rapid River 35 (EURRGLYDEH)						
Feb 19	Rapid River 35	EURRGLYDEH	Benzene†	lb/hr	<0.00016	NA
			Toluene†		<0.00034	NA
			Ethylbenzene†		<0.00033	NA
			Total Xylenes†		<0.0007	NA
			Mass rate of BTEX	lb/hr	<0.0015	NA
				Mg/yr†	<0.0024	54.70

† 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.