Source Test Report for 2022 Performance Testing Thermal Treatment Unit (FG954TTU-S1) Corteva Agriscience LLC Midland, Michigan

Prepared For:

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For Submission To:

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P1028-test-20220314

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Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:	[signature]	**Date:**	05 / 16 / 2022
Name:	William Craig James, QSTI	**Title:**	Vice President, Technical

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature:	Henry M. Taylor	**Date:**	05 / 11 / 2022
Name:	Henry M. Taylor, QSTO	**Title:**	Senior Reporting QC Specialist

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1.0 Introduction

1.1 Summary of Test Program

Corteva Agriscience (Corteva) contracted Montrose Air Quality Services, LLC (Montrose) to perform a Title V ROP and MACT performance test program on the Thermal Treatment Unit (TTU) at the 954 building at the Corteva facility located in Midland, Michigan.

The test was conducted to determine compliance with MI-ROP-A4033 (SRN P1028) issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Additionally, the test is being used to demonstrate compliance with the existing source control requirements for the following 40 CFR Part 63 Subparts: MMM (Pesticide MACT) and FFFF (MON MACT).

The specific objectives were to:

- Spike the Inlet to the TTU 954 System using methyl chloride (CH_3Cl) to simulate worst-case conditions
- Measure methyl chloride in the TTU 954 Scrubber outlet
- Measure total organic compounds (TOC), hydrogen chloride (HCl), and chlorine (Cl_2) in the TTU 954 Scrubber inlet and outlet
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

Table 1-1
Summary of Test Program

Test Date	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
3/16/2022	FG954TTU-S1/ Scrubber Outlet-Stack	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	64
		O_2, CO_2	EPA 3A	3	64
		H_2O, CH_3Cl	EPA 320	3	64
		HCl, Cl_2	EPA 26A	3	64
		Gas Dilution System Verification	EPA 205	--	--
		Post-Test Meter Calibration Check	EPA ALT-009	--	--
	FG954TTU-S1/ Scrubber Inlet	HCl, Cl_2	EPA 26	3	64
	FG954TTU-S1/ Scrubber Inlet and Outlet	TOC	EPA 25A	3	64
		HCl	EPA 320	3	64

To simplify this report, a list of Units and Abbreviations is included in Appendix D.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose.

The test was conducted according to the test plan M024AS-005644-PP-409R2 dated January 11, 2022 that was submitted to and approved by the Michigan Department of EGLE.

1.2 Applicable Regulations and Emission Limits

The 954 TTU system can treat up to 8 vent streams which are subject to various 40 CFR Part 63 Subpart rules. The vents subject to MMM (Pesticide MACT) are routine. The vents subject to FFFF (MON MACT), G (HON MACT), U (Polymer and Resin I) and UUUU (Cellulosics) are infrequent.

On April 29, 2021, a process change occurred where 827 Bldg EU02 (PAIP MACT) tied its vents into the 954 TTU control system. This process change may have changed the worst-case emission profile for batch process vents used in the previous performance test; therefore, this performance test was conducted under a new worst-case emission profile using hypothetical worst-case conditions in accordance with 63.1365(b)(11)(ii).

The 954 TTU treats emission streams from numerous processes (see Section 2 for a summary), some of which are campaign operated. This makes it almost impossible to coordinate worst case venting from all contributing processes at the same time. To demonstrate that the required control can be met under a worst case, a spike test was conducted to represent hypothetical peak case conditions. Hypothetical peak case conditions are simulated test conditions that, at a minimum, contain the highest total average hour HAP load of emissions that could be predicted to be vented to the control device. The emission profile considers the capture and control system limitations and the highest hourly emissions that can be routed to the control device, based on maximum flow rate and concentrations possible because of limitations on conveyance and control equipment (e.g., fans, LEL alarms and safety bypasses). These testing conditions establish the peak emission profile as required by 63.1365(b)(11)(ii)(C) of PAIP MACT. The vents sent to 954 that are subject to the HON, MON, Cellulosics MACT, and Polymer & Resins 1 are infrequent and did not occur during this test.

The testing demonstrated compliance with the following MACT emission control standards.

PAIP MACT Process Vents and storage tanks:

- Reduce uncontrolled total organic HAP emissions from any process vent to an outlet concentration ≤ 20 ppmv or by ≥ 98% [§63.1362(b)(2)(ii)(A), 63.1362(b)(2)(iv)(A)]
- Reduce HCl and Cl_2 emissions, including HCl generated from combustion of halogenated process vent emissions, from the sum of all process vents within a process by ≥ 94% or to an outlet concentration ≤ 20 ppmv [§63.1362(b)(3)(ii)]

MON MACT Process vents:

- Reduce uncontrolled organic HAP emissions from one or more batch process vents within the process by venting through one or more closed-vent systems to any combination of control devices (excluding a flare) that reduce organic HAP to an outlet concentration ≤ 20 ppm TOC or total organic HAP , OR, Reduce collective uncontrolled organic HAP emissions from the sum of all batch process vents within the process by ≥ 98 percent by weight by venting emissions from a sufficient number of the vents through one or more closed-vent systems to any combination of control devices (except a flare) [§63.2460(a), Table 2 to Subpart FFFF],
- Use a halogen reduction device after the combustion control device to reduce overall emissions of hydrogen halide and halogen HAP within a process by > 99% by weight or to an outlet concentration ≤ 20 ppmv [§ 63.2460(a), Table 2 to Subpart FFFF]

Where control limits vary (eg, HCl/Cl_2 removal for PAIP MACT = 94% vs MON MACT = 99%), this test established compliance with the more restrictive requirement (ie, MON MACT 99%).

The average emission test results are summarized and compared to their respective permit limits in Table 1-2. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

Table 1-2
Summary of Average Compliance Results

March 16, 2022

Parameter/Units	Average Results	Emission Limits
Scrubber Inlet (TTU Outlet) Total Organic Compounds (TOC) as CH_3Cl		
TTU removal efficiency, %	98.4	≥ 98
Scrubber Outlet Total Organic Compounds (TOC) as CH_3Cl		
ppmvd	7.3	≤ 20.0
TTU/scrubber removal efficiency, %	98.4	≥ 98
Scrubber Outlet Hydrogen Chloride (HCl) – Method 26/26A		
ppmvd	0.14	≤ 20.0
lb/hr	0.0025	≤ 1.0
scrubber removal efficiency, %	99.9	≥ 99.0
Scrubber Outlet Hydrogen Chloride (HCl) – FTIR Method 320		
ppmvd	2.52	≤ 20.0
lb/hr	0.0295	≤ 1.0
scrubber removal efficiency, %	99.7	≥ 99.0
Scrubber Outlet Chlorine (Cl_2) – Method 26/26A		
ppmvd	0.20	≤ 20.0
lb/hr	0.0067	≤ 1.0
Scrubber Outlet Methyl Chloride (CH_3Cl) at MDL – FTIR Method 320		
ppmvd	< 0.99	≤ 20.0
lb/hr	< 0.024	≤ 1.0
scrubber removal efficiency, %	99.8	≥ 98 (MACT)/≥ 99.9 (Title V)
Scrubber Outlet Methyl Chloride (CH_3Cl) at MDL x 0.5 – FTIR Method 320		
ppmvd	< 0.49	≤ 20.0
lb/hr	< 0.012	≤ 1.0
scrubber removal efficiency, %	99.9	≥ 98 (MACT)/≥ 99.9 (Title V)

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	Corteva Agriscience Michigan Operations 701 Washington Street Midland, MI 48667	
Project Contact:	Patty Worden	Andy McCollum
Role:	Senior Environmental Specialist	Unit Engineer
Company:	Corteva Agriscience	Corteva Agriscience
Telephone:	989-898-5129	231-730-1054
Email:	patricia.worden@corteva.com	andrew.mccollum@corteva.com

Agency Information

Regulatory Agency: Michigan Department of EGLE, US EPA

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC	
Contact:	William Craig James	Phil Kauppi
Title:	Vice President, Technical	District Manager
Telephone:	708-987-4972	989-621-1860
Email:	wjames@montrose-env.com	pkauppi@montrose-env.com

Laboratory Information

Laboratory:	Montrose Air Quality Services, LLC	
City, State:	Wauconda, Illinois	Mount Pleasant, Michigan
Methods:	EPA 26 and 26A	EPA 320

Test personnel and observers are summarized in Table 1-3.

Table 1-3
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
William Craig James	Montrose	Vice President, Technical/QSTI/Field Team Leader/Trailer Operator
Phil Kauppi	Montrose	District Manager/QI/FTIR Operator
Shawn Jaworski	Montrose	Senior Technician/QI/Sample Train Operator/Sample Recovery
Scott Dater, David Koponen	Montrose	Field Technician/Sample Train Operator/ Sample Platform Duties/Field Support
Debbie Olsen	Montrose	Report Preparation
Patty Worden	Corteva	Environmental Focal Point/Client Liaison/Test Coordinator
Andy McCollum	Corteva	Process Focal Point/Plant Operations Coordinator
Lindsey Wells	Michigan Department of EGLE	Observer

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

The 954 TTU system is a shared device which controls vents from the following process units:

Facility	Title V Emission Unit	Applicable MACT	Description / Comments	Title V Requirement
Bldg 1 Ag Multiproduct	EU01 (P1028)	PAIP MACT	The Bldg 1 facility produces herbicide active ingredients and has two equipment assets that are campaign operated. It has Group 1 batch process vents. HAPs emitted: acetonitrile, Isopar C (2,2,4 trimethyl pentane), methyl isobutyl ketone and methanol.	EU01 (MI-ROP-A4033-2017b) SC IV.1: Use FG954THROX conditions PTI application 287-09 states the 954 THROX has demonstrated organic removal > 99.9%. FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
827 Bldg Sulfoxaflor	EU02 (P1028)	PAIP MACT	The 827 facility produces the Sulfoxaflor insecticide active. It has Group 1 process vents and a Group 1 storage tank. HAPs emitted: toluene, acetonitrile, benzene, chloroform, hydrogen fluoride.	EU02 SC IV.1: Use FG954THROX conditions PTI 95-20 (issued 2021). PTI application states the 954 THROX has demonstrated organic removal > 99.9%. FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
680 Bldg Ag Production	EU13 (P1028)	PAIP MACT	The 680 Bldg facility produces herbicide active ingredients and is campaign operated. It has Group 1 process vents. HAPs emitted: methylene chloride, methanol and quinoline. *This facility stopped production in April 2022 and is being shut down.*	EU13 SC IV.1: Use FG954THROX conditions MI-ROP-A4033-2017b FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4

Facility	Title V Emission Unit	Applicable MACT	Description / Comments	Title V Requirement
1028 Spinetoram	EU1028 P1028)	PAIP MACT	The 1028 facility produces the Spinetoram insecticide active. It does not emit any HAPs. *This is a new process that will start venting to the TTU in November or December 2021.*	EU1028, SC III.3: (PTI 84-21; issued 2021) Organic removal in 954 TTU ≥ 99.0% Hydrogen bromide removal in 954 scrubber ≥ 99% (not part of this test) Use FG954THROX conditions FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
298 Bldg Ethocel™	EUB5 (P1027)	HON MACT MON MACT	The 298 facility produces Ethocel™. It has Group 1 batch process vents subject to the MON and a Group 1 continuous vent and storage tank subject to the HON. The 954 TTU is used as a backup control device about 2 weeks a year. HAPs emitted: ethyl chloride, toluene	EUB5, ROP MI-ROP-P1027-2020a (PTI 83-13) Use FG954 Throx conditions in MI-ROP-A4033-2107b FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
1131 Bldg Methocel™	EUB2 (P1027)	Cellulosics	The 1131 facility produces Methocel™. It has Group 1 batch process vents subject to the Cellulosics MACT. The 954 TTU is used as a backup control device for 1-2 weeks a year. HAPs emitted: methyl chloride, propylene oxide, methanol	EUB2, ROP MI-ROP-P1027-2020a Use FG954THROX conditions below from MI-ROP-A4033-2017b: FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4

Facility	Title V Emission Unit	Applicable MACT	Description / Comments	Title V Requirement
954 Anhydrous HCl	EU06 (P1027)	NA–no MACT requirements for vent	This emission unit offloads, stores and distributes anhydrous HCl. The 954 TTU is used as a backup control device about 2 weeks a year. HAPs emitted: HCl	EU06 Low purity, MI-ROP-P1027-2020 SC IV.1.b: ≥ 99.6% HCL removal in 954 absorber/scrubber. Use operating conditions listed in FG954THROX of MI-ROP-A4033-2017b FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
954 Propylene Oxide storage	EU08 (P1027)	NA–no MACT requirements for vent	This emission unit offloads, stores and distributes propylene oxide and operates ventless. The 954 TTU will only treat emissions from this in preparation for infrequency maintenance activities, at which time the storage vessel is considered a Group 1 storage tank.	EU08MI-ROP-P1027-2020 EU08 SC IV.4: Use operating conditions listed in FG954THROX of MI-ROP-A4033-2017b FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4
Butadiene storage	EU91 (P1025)	P&RI	This emission unit offloads, stores and distributes butadiene and operates ventless. The 954 TTU will only treat emissions from this Group 1 storage tank during infrequent maintenance activities.	EU91, MI-ROP-P1025 EU91 SC IV.3: Use operating conditions listed in FG954THROX of MI-ROP-A4033-2017b FG954THROX (MI-ROP-A4033-2017b) SC III: (value listed or established during testing) III.1 TTU exit gas temperature ≥ 760 C III.2 Excess O_2 ≥ 3% III.3 Quench exit gas temperature ≤ 80 C III.4 Scrubber liquid flow ≥ 23.8 gpm III.5 Scrubber pH ≥ 8.4

The 954 TTU system is represented by FG954THROX in the Title V permit and it does not have a finished product associated with it. The 954 TTU system includes a firebox followed by a water quench and caustic scrubber system. The formation of HCl and chlorine result from combusting halogenated organics. See Table 2-1 for a description of this equipment. Routine annual maintenance was performed on the 954 TTU system in October 2021 (instrument calibrations, internal inspection of boiler, quench, and scrubber).

Table 2-1
Description of Control Equipment

Control Device	Description
954 ME-3501 TTU Burner	Manufacturer: Cleaver Brooks Minimum Firebox temperature: 760 C Minimum residence time: > 0.38 seconds Capacity: 20 MM BTU/hr >99.9% destruction efficiency of organics
954 T-3601 Quench	Packed column scrubber (60" diameter; 20' of packing) Scrubbing fluid: water solution Design liquid rate: > 19 gpm Design vapor rate: 4500 scfm > 99% HCl/Cl_2 removal
954 T-3602 Scrubber	Packed column scrubber (60" diameter; 20' of packing) Scrubbing fluid: water/sodium hydroxide/sodium thiosulfate solution Design liquid rate: > 23 gpm Design vapor rate: 6050 scfm > 99% HCl/Cl_2 removal

As mentioned earlier, the 954 TTU treats vent streams from numerous different facilities, some of which are campaign operated. This makes it almost impossible to coordinate all facilities to be venting at their worst-case conditions at the same time. Therefore, a spike test (hypothetical worst-case conditions) was completed to ensure that worst-case conditions for the control device are adequate for MACT compliance. In addition to spiking with methyl chloride, the emission profile included normal operation process vents from the below facilities.

An emission profile by capture and control device limitation was used to describe the vent stream characteristics. The emission profile consisted of the following three primary HAP/organic vent streams to the 954 TTU:

- **827 process vent and Group 1 storage tank**: The 827 building Sulfoxalfor manufacturing process generates organic emissions as part of a batch process. HAPs emitted are acetonitrile, toluene, benzene, chloroform and hydrogen fluoride. During testing, 827 was running normally.

- **680 process vent**: The 680 facility can produce one of 3 products (all subject to the PAIP MACT). Cloransulam campaign chemicals were in vessels, but no active reactions or transfers occurred due to equipment issues. The process completed its last batch on April 22, 2022 and will be permanently shut down.
  - Flumetsulam HAPs: methanol
  - Diclosulam HAPs: methanol, methylene chloride, quinoline
  - Cloransulam HAPs: methanol, methylene chloride
- **Bldg 1 process vent**: The Bldg 1 manufacturing process has two equipment assets. The first equipment asset is campaign operated and produces on a batch basis. It can produce either the Starane or Clincher product. During the performance test, the asset was operating normally and producing Starane (will switch to Clincher in June 2022). The second equipment produces Arylex and was operating normally during the test.

The other facility vent streams that are controlled by the 954 TTU are sent on a very infrequent basis and were not venting during the test.

During each test run, continuous process monitoring system (CPMS) parameters were monitored and stack gas emissions were measured. The following sections briefly summarize these activities associated with the Performance test. The instruments that monitor the required CPMS parameters of TTU temperature, scrubber flow and scrubber pH were calibrated before the test as required by 63.8(c)(3).

2.2 Flue Gas Sampling Locations

Information regarding the sampling locations is presented in Table 2-2.

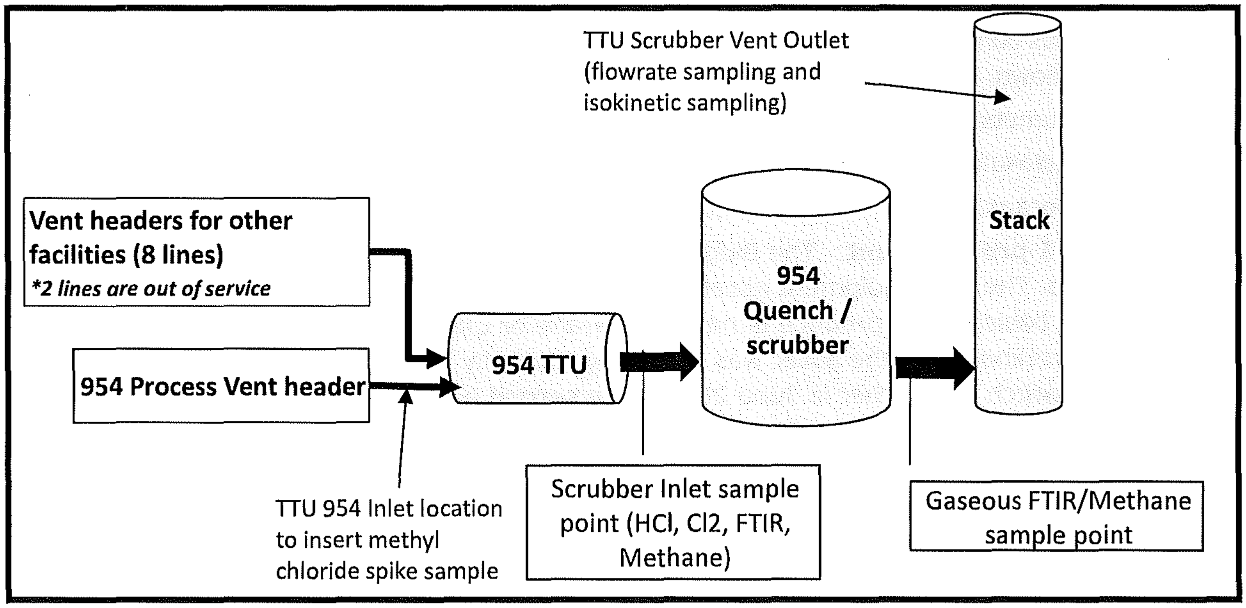
Table 2-2
Sampling Locations

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance Downstream EPA "B" (in./dia.)	Distance from Nearest Disturbance Upstream EPA "A" (in./dia.)	Number of Traverse Points
TTU Inlet (Spiking Location)	N/A	N/A	N/A	N/A
Scrubber Inlet	22	72.3 / 3.3	144 / 6.5	Gaseous: 1
Scrubber Outlet	22	360 / 16.4	192 / 8.7	Flow: 16 (8/port) Gaseous: 1

The volumetric flow rates measured at the Scrubber outlet were used to calculate the inlet loading rates. The sample locations were verified in the field to conform to EPA Method 1. Absence of cyclonic flow conditions was verified following EPA Method 1, Section 11.4.

The TTU process schematic and sampling locations are shown in Figure 2-1.

Figure 2-1
TTU Process Schematic and Sampling Locations



Due to the complexity of having all facilities that vent to the 954 TTU operating at their maximum HAP loading at the same time, Corteva used surrogate spiking to simulate worst-case conditions as the best approach to demonstrate compliance with the applicable standards. After review of the potentially present compounds, Corteva used methyl chloride (an EPA Class 1 POHC – Principal Organic Hazardous Constituent) as a surrogate spiking compound. Using methyl chloride as the spiking compound presents a number of benefits, including:

- Thermal stability ranking of Class 1, which puts it in line with the worst of the potentially present compounds,
- Methyl chloride behaves well in multiple sampling and analytical methods,
- Methyl chloride is readily available

A certified gas standard of known concentration of methyl chloride was used as the spiking material. The volume fed was monitored using the pre weight and post weight of the cylinder to determine the spiking rate, and support DRE calculations. The spiking material was shipped in sealed containers accompanied by certificates of analysis (COAs) and stored in a secure area.

TTU 954 Inlet (Spiking Location)

The spiking material was introduced into the Chemical Distribution vent inlet to the TTU at a rate of nominally 12 lb/hr which was measured and controlled with a mass flow controller. The spike rate was determined by evaluating the detection and collection limits of the suggested test method. This feed rate was also determined based on an acceptable feed rate of *gaseous* methyl chloride that can be achieved from purchased gas cylinders. The spike material cannot be fed as a liquid because there is no way to vaporize it before being fed into the vent line to the TTU. The TTU was also receiving vents from Bldg 1, 827 during the performance test so the extra methyl chloride spike load contributes to the worst-case load. Inlet loading was determined by the weight difference of the cylinder. A photograph of the inlet spiking location is provided in Appendix A.1.

Corteva opted to demonstrate DRE using only methyl chloride, and the mass loading rate was lower than the typical venting rate from the facilities. Depending on the processes that are running and the steps they are in, the facility vents can contribute > 30 lbs/hr of HAPs to the TTU load. It is more difficult to demonstrate compliance with the DRE requirement when feeding at a lower rate rather than higher rate because the low feed rate is in the denominator of the DRE calculation (DRE = 1 – mass out/mass in). This approach results in a more conservative DRE value and demonstrates the control device's ability to achieve the required DRE with a high degree of confidence.

The primary parameter that impacts the DRE of a TTU is the thermal stability (or difficulty to destroy) of the materials being fed to it. The DRE is not greatly impacted by the capacity of the unit or the HAP loading. The below table identifies the thermal stability (as represented by the Principle Organic Hazardous Constituent [POHC] classification) for the different HAPs being fed to it.

HAP	CAS #	POHC Class	Process Source
Methyl chloride	74-87-6	1	Spike Gas
Acetonitrile	75-05-8	1	827, Bldg 1
Toluene	108-88-3	2	827
Benzene	71-43-2	2	827
Methylene Chloride	75-09-2	2	680
Methanol	67-56-1	3	827, Bldg 1, 680
Chloroform	865-49-6	Not listed	827
Isopar C (2,2,4 Trimethyl pentane)	540-84-1	Not listed	Bldg 1
Methyl Isobutyl Ketone	105-10-1	Not listed	Bldg 1
Quinoline	91-22-5	Not listed	680
Hydrogen Chloride	7647-01-0	Not listed	827, 680
Hydrogen Fluoride	7664-39-3	Not listed	827
Butadiene	106-99-0	Not listed	EU91
Ethyl chloride	75-00-3	Not listed	Ethocel™
Propylene oxide	75-56-9	Not listed	Methocel™

There were no emissions sent to the TTU during the test from Ethocel™, Methocel™, or the storage/distribution of anhydrous HCl, propylene oxide or butadiene.

TTU Outlet/Quench Inlet (FTIR Pickup Point 1)

Sample gas was extracted from this location as a single FTIR Pickup point in order to measure the CH_3Cl concentrations to determine both the Destruction Efficiency of the TTU and the inlet HCl Loading into the Quench/Scrubber. Method 25A was run in series with 320 at the exit of the FTIR sampling system. Method 26 was also performed to measure inlet Cl_2 loading into the Quench/scrubber. Because the TTU is a closed vent system, and there is not a suitable location to measure flow rates, the flow rates from the TTU Scrubber Vent Outlet were used to calculate emission rates. See discussion on this further below.

TTU Scrubber Vent Outlet (FTIR Pickup Point 2)

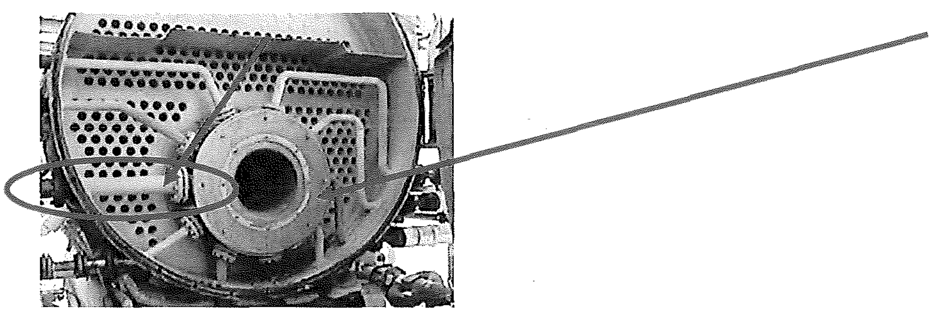
Sample gas was extracted from this location as a single FTIR Pickup point in order to measure HCl concentrations (by FTIR) to determine the Removal Efficiency of the Scrubber. This location consists of a single sampling port prior to the ID fan of the Scrubber Vent Outlet. Flow rates to determine emission rates were measured downstream of the fan before the exhaust vents to atmosphere.

TTU Scrubber Vent Outlet (Volumetric Flow, HCl/Cl_2 emissions)

Exhaust gas flow rates were determined by Method 2 on the vertical Scrubber Vent Outlet stack prior to venting to atmosphere. Additionally, Cl_2 concentrations were determined utilizing Method 26A. The sampling location is accessed with a Boom-Lift, as the two sampling ports are located approximately 40 feet from ground level. Per the PAI MACT, the vent velocity must be measured every 15 minutes. The velocity was measured continuously through the hour-long test as part of the isokinetic sampling train of 26A.

The vent gases from the sending facilities enter the 954 TTU combustion chamber through a ring of nozzles as shown below. Each facility has their own inlet nozzle. The vents are pulled by an induced draft fan located downstream of the scrubber. There is a flowmeter on each of the vent inlet lines to the TTU combustion chamber which records data continuously.

The natural gas fuel line is in the red circle. Combustion air enters inside/around the ring.



As part of the performance test, vent flow rate was measured at the stack vent exiting the scrubber because there is not a suitable port at the TTU outlet to measure velocity. There are no other vents / gases added to the system after the TTU inlet chamber, so the venting rate going into the scrubber equals the venting rate out the vent stack.

There is not a flow meter on the scrubber vent outlet but the facility does measure inlet pressure, RPMs, and horsepower associated with the blower on the scrubber outlet vent. These values can be used to correlate to flow using the blower curve. The blower operates at a constant speed while the TTU is burning vents. Below is a summary table of the associated instruments and parameters that were monitored during the test.

Nozzle	Instrument Description	Instrument Address
1	EU02 827 vent header flow rate	AI(404)A
2	Not in service	AI(405)A
3	These vents all share one TTU nozzle: EU13 680 Organic vent header flow rate EU13 680 Oxidizer vent header flow rate EU13 680 R-4100 vent header flow rate	 AI(407)A AI(425)A AI(482)A
4	EU01 Bldg 1 vent header flow rate	AI(406)A
5	EUB5 Ethocel / EUB2 Methocel vent header flow	AI(563)A
6	EU1028 vent header flow	AI(600)A
7	Not in service	AI(567)A
8	954 vent header flow rate	AI(562)A
9	Natural Gas flow	AI(402)A
10	Combustion air flow	AI(443)A
--	Blower inlet pressure	AI(535)A
--	Blower RPM	AI(528)A
--	Blower Horsepower	AI(540)A

2.3 Operating Conditions and Process Data

Process monitoring information pertinent to establishing that the unit is operating at normal conditions was recorded during the test by the TTU data acquisition system. One-minute average data was obtained from the process control system for each operating parameter for each test run. For each operating parameter, an average value was calculated for each test run.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. Data collected includes the following parameters:

- TTU Firebox Temperature, C
- TTU Scrubber Liquid Flow Rate (influent), gpm
- TTU Scrubber Liquid pH (effluent), N/A
- TTU Quench Liquid Flow, gpm
- TTU Quench Exit Gas Temperature, C
- Combustion Air Flow, scfm

- Excess O_2 in TTU Outlet Gas, %
- Flow rate for each vent stream feeding the TTU
- Blower inlet pressure
- Blower RPMs
- Blower Horsepower
- Production status of each facility venting to TTU / what product is being made

The MON MACT requires that a facility determine the scrubber gas inlet flow and average L/G over the performance test period. Per the rule, an acceptable determination method is using the design blower capacity, with appropriate adjustments for pressure drop. The blower has a variable speed motor. The plant measures RPMs and inlet pressure. Using these parameters along with the blower curve, the gas flow rate was established.

The TTU and scrubber process data is summarized in Table 2-3.

Table 2-3
Process Data Summary - TTU and Scrubber

Parameter	Instrument Tag	Run 1 11:05-12:18	Run 2 13:32-14:43	Run 3 15:20-16:31	Average
TTU temp. 1, °C	AI(456)A	760.1	760.7	760.1	760.3
TTU temp. 2, °C	AI(472)A	787.4	779.1	777.6	781.4
TTU temp., °C used for control (lowest temp)	**AC(240)A**	**759.9**	**760.1**	**760.0**	**760.0**
Scrubber flow, gpm	**AC(246)A**	**40.7**	**40.3**	**40.4**	**40.5**
Scrubber pH 1	AI(506)A	8.9	8.6	8.6	8.7
Scrubber pH 2	AI(524)A	8.8	8.4	8.4	8.5
Scrubber pH- used for control	**AC(244)A**	**8.8**	**8.4**	**8.4**	**8.5**
Quench exit gas temp. 1, °C	AI(513)A	47.3	47.1	47.2	47.2
Quench exit gas temp. 2, °C	AI(593)A	46.9	46.8	46.9	46.9
% Excess O_2 1	AI(533)A	5.9	6.0	5.9	6.0
% Excess O_2 2	AI(574)A	6.0	6.0	6.0	6.0
% Excess O_2 - value selected	AC(243)A	6.0	6.0	5.9	6.0

The process operational data for each test run is included in Appendix B.

3.0 Sampling and Analytical Procedures

3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

The sample port and traverse point locations are detailed in Appendix A.1.

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

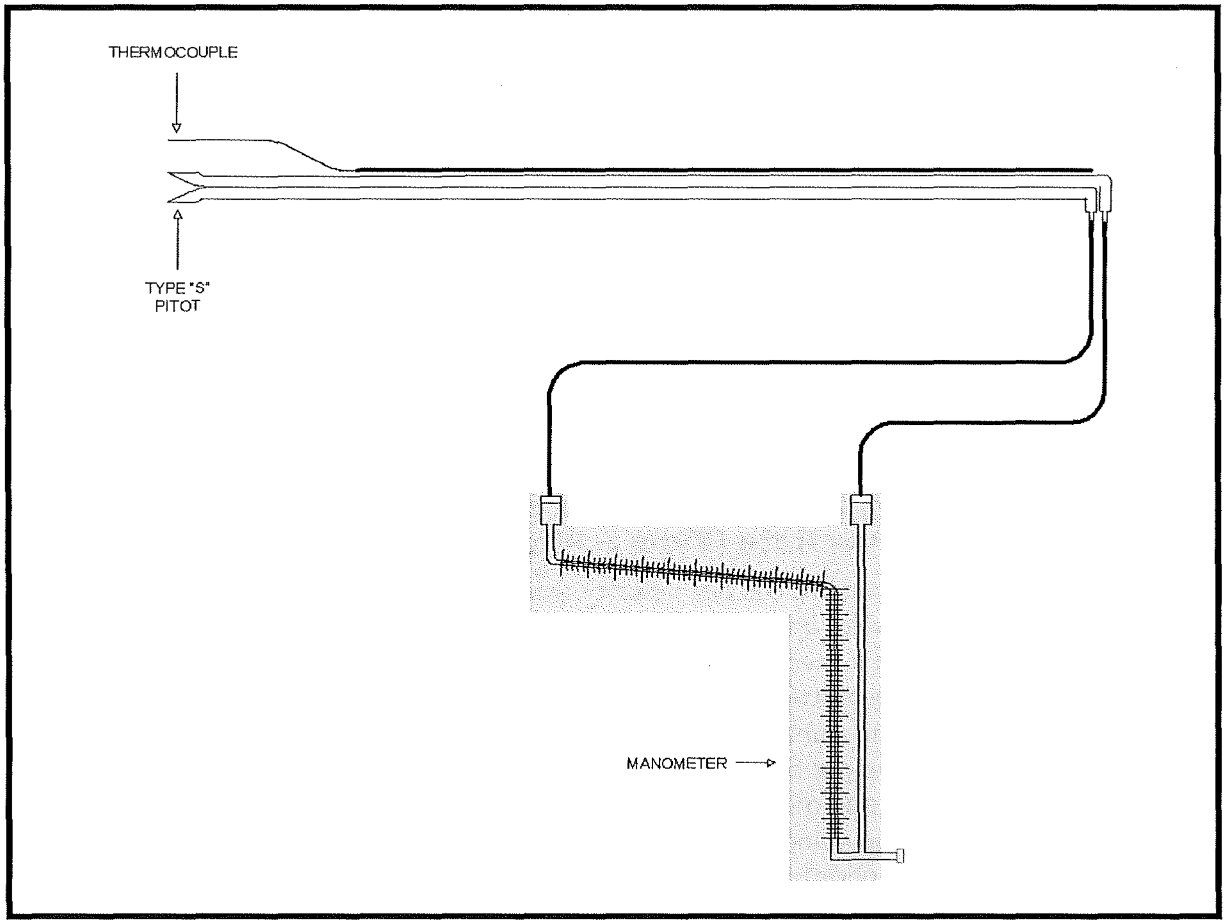
EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
- S-type pitot tube coefficient is 0.84
- Velocity measurements were only performed at the Scrubber outlet sampling location

The typical sampling system is detailed in Figure 3-1.

Figure 3-1
EPA Method 2 Sampling System



3.1.3 EPA Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 3A is an instrumental test method used to measure the concentration of O_2 and CO_2 in stack gas. The effluent gas is continuously or intermittently sampled and conveyed to analyzers that measure the concentration of O_2 and CO_2. The performance requirements of the method must be met to validate data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - A paramagnetic analyzer is used to measure O_2
  - A nondispersive infrared analyzer is used to measure CO_2

The typical sampling system is detailed below in Figure 3-2.

3.1.4 EPA Method 25A, Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

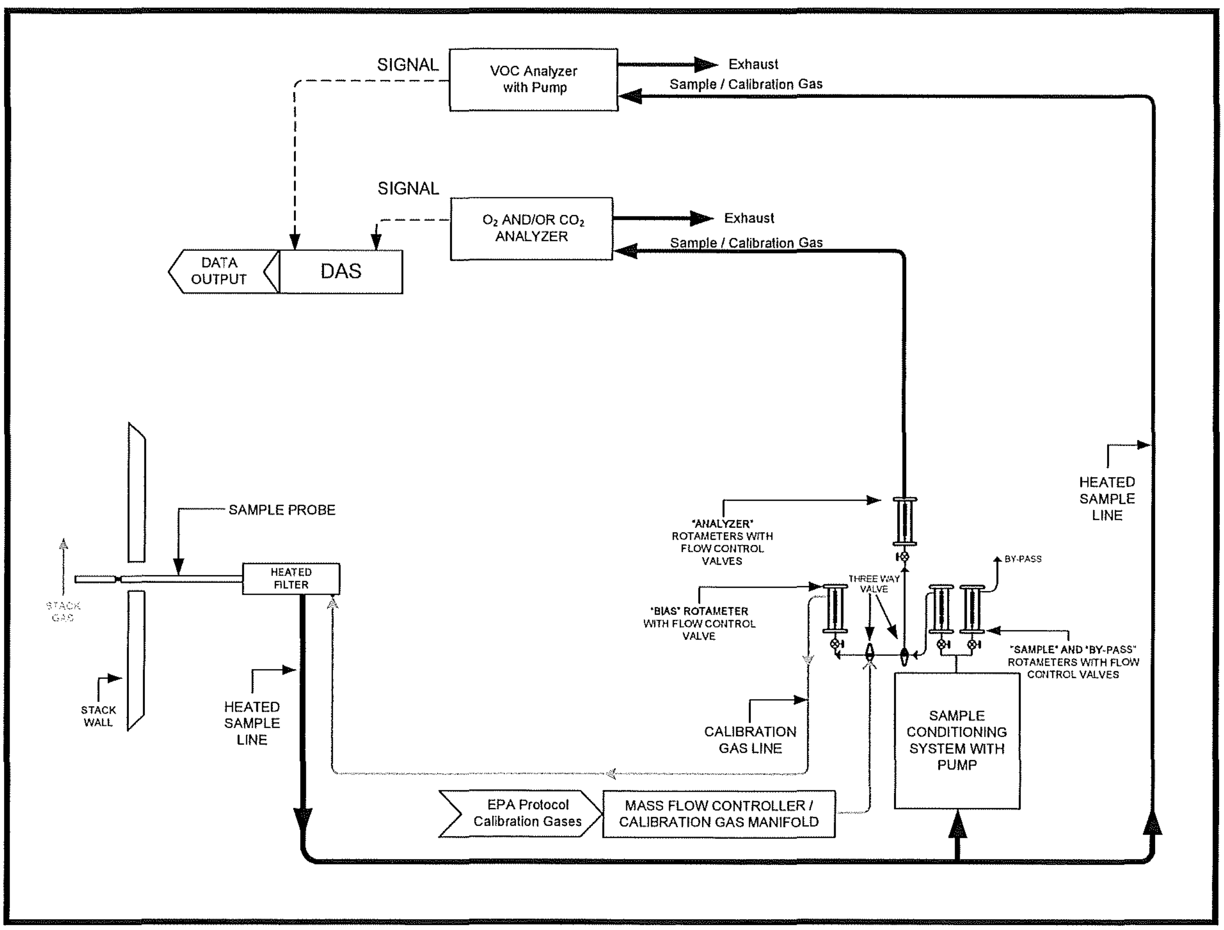
EPA Method 25A is an instrumental test method used to measure the concentration of TOC in stack gas. At both test locations, Method 25A was performed in series with the Method 320 sampling train. A gas sample is extracted from the exit of the FTIR through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA).

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Results are reported in terms of methane and equivalent methyl chloride
  - A response factor of 0.855 was determined for methyl chloride

The typical sampling system is detailed in Figure 3-2.

Figure 3-2
EPA Methods 3A and 25A Sampling Train



3.1.5 EPA Method 26, Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Non-Isokinetic Method

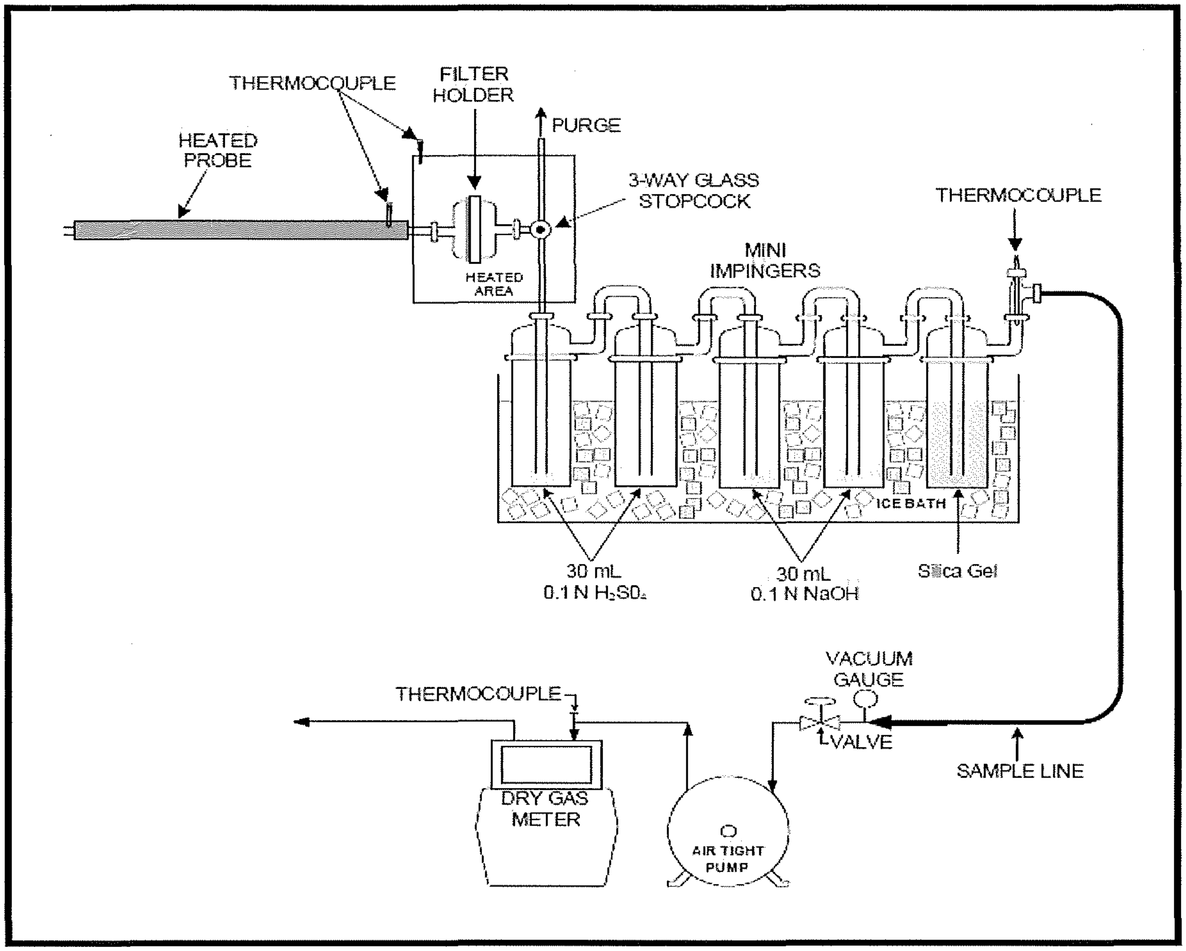
At the scrubber inlet location, an integrated sample is extracted from the source and passed through a pre-purged heated probe and filter into dilute sulfuric acid and dilute sodium hydroxide solutions which collect the gaseous hydrogen halides and halogens, respectively. The filter collects particulate matter including halide salts but is not routinely recovered and analyzed. The hydrogen halides are solubilized in the acidic solution and form chloride (Cl-), bromide (Br-), and fluoride (F-) ions. The halogens have a very low solubility in the acidic solution and pass through to the alkaline solution where they are hydrolyzed to form a proton (H+), the halide ion, and the hypohalous acid (HClO or HBrO). Sodium thiosulfate is added in excess to the alkaline solution to assure reaction with hypohalous acid to form a second halide ion such that 2 halide ions are formed for each molecule of halogen gas. The halide ions in the separate solutions are measured by ion chromatography (IC).

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Sample is extracted at 7-10 liters/min from the stack for FTIR analysis. Sample gas, via a 3/8" heated stainless steel tee junction at the exit of the FTIR sampling probe, will be extracted to the Method 26 sample train at nominally 2.0 liters per minute.
  - Method 26 sampling train includes both acidic and alkaline solutions, and analyzed for both HCl and Cl_2
- Target and/or Minimum Required Sample Duration: 64 minutes
- Target and/or Minimum Required Sample Volume: ~120 Liters
- Analytical Laboratory: Montrose, Wauconda, Illinois

The typical sampling system is detailed in Figure 3-3.

Figure 3-3
EPA Method 26 Sampling Train



3.1.6 EPA Method 26A, Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Isokinetic Method

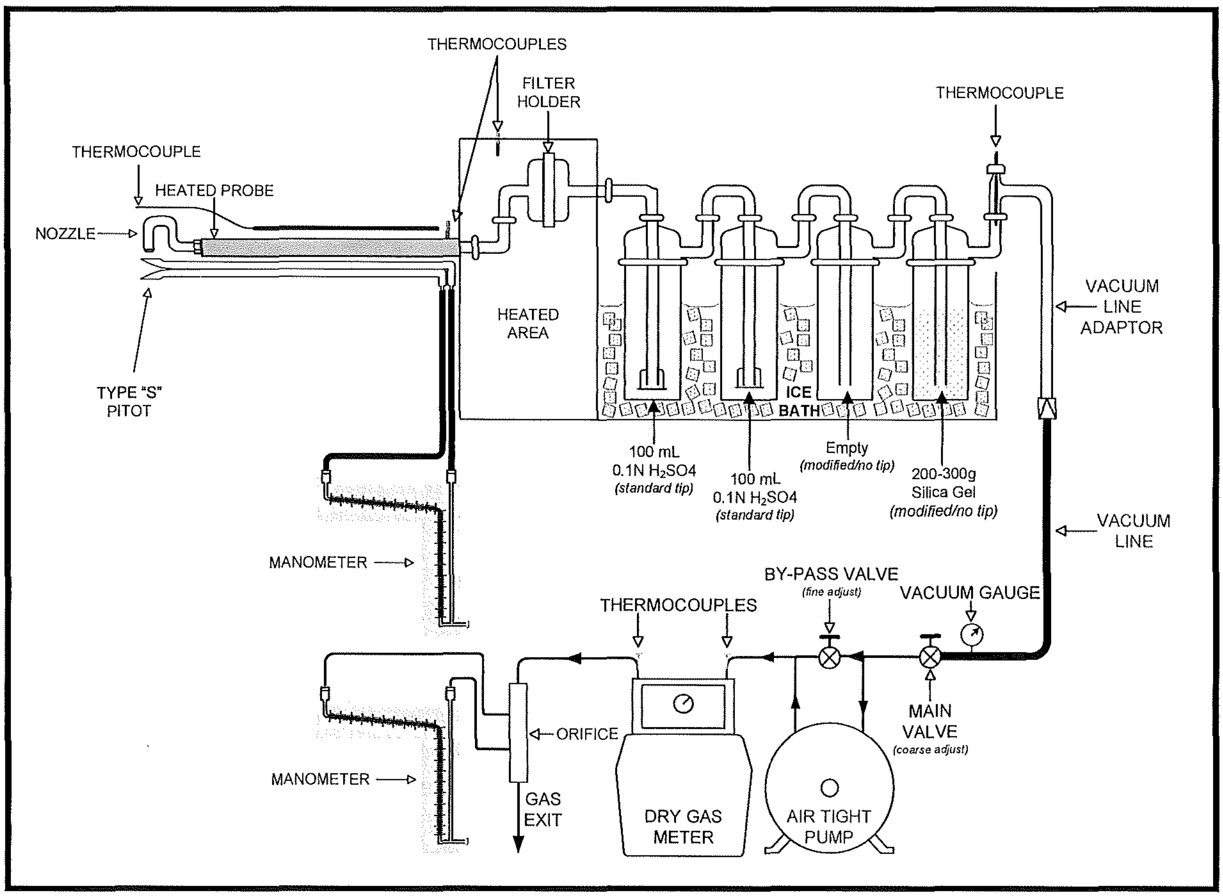
EPA Method 26A was utilized at the scrubber stack location, and is a manual, isokinetic method used to measure HCl/Cl_2 emissions from stationary sources. Gaseous and particulate pollutants are withdrawn isokinetically from the source and collected in an optional cyclone, on a filter, and in absorbing solutions. The cyclone collects any liquid droplets and is not necessary if the source emissions do not contain them; however, it is preferable to include the cyclone in the sampling train to protect the filter from any liquid present. The filter collects particulate matter including halide salts but is not routinely recovered or analyzed. Acidic and alkaline absorbing solutions collect the gaseous hydrogen halides and halogens, respectively. Following sampling of emissions containing liquid droplets, any halides/halogens dissolved in the liquid in the cyclone and on the filter are vaporized to gas and collected in the impingers by pulling conditioned ambient air through the sampling train. The hydrogen halides are solubilized in the acidic solution and form chloride (Cl^-), bromide (Br^-), and fluoride (F^-) ions. The halogens have a very low solubility in the acidic solution and pass through to the alkaline solution where they are hydrolyzed to form a proton (H^+), the halide ion, and the hypohalous acid (HClO or HBrO). Sodium thiosulfate is added to the alkaline solution to assure reaction with the hypohalous acid to form a second halide ion such that two halide ions are formed for each molecule of halogen gas. The halide ions in the separate solutions are measured by IC.

Pertinent information regarding the performance of the method is presented below:

- Target and/or Minimum Required Sample Duration: 64 minutes
- Target and/or Minimum Required Sample Volume: 32 dscf
- Analytical Laboratory: Montrose, Wauconda, Illinois

The typical sampling system is detailed in Figure 3-4.

Figure 3-4
EPA Method 26A Sampling Train



3.1.7 EPA Method 320, Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive FTIR Spectroscopy

EPA Method 320 is an instrumental test method used to measure specific analyte concentrations for which EPA reference spectra have been developed or prepared. Extractive emission measurements are performed using FTIR spectroscopy. The FTIR analyzer is composed of a spectrometer and detector, a high optical throughput sampling cell, analysis software, and a quantitative spectral library. The analyzer collects high resolution spectra in the mid infrared spectral region (400 to 4,000 cm-1), which are analyzed using the quantitative spectral library. This provides an accurate, highly sensitive measurement of gases and vapors.

An EPA Method 301 spiking study for HCl and methyl chloride was performed to validate the use of FTIR techniques to accurately measure the target analyte concentrations. The results of the validation study are used to determine if the FTIR procedures are valid for the stationary source type. EPA Method 320 allows the validation of FTIR-based measurements by a pair wise comparison between the results of a single FTIR system.

Sequential measurements are made of "native" (or unspiked) concentrations and dynamically spiked concentrations to provide a calculable change in analyte concentrations i.e. "method of additions analysis". Twelve independent measurements are made for native and spiked samples.

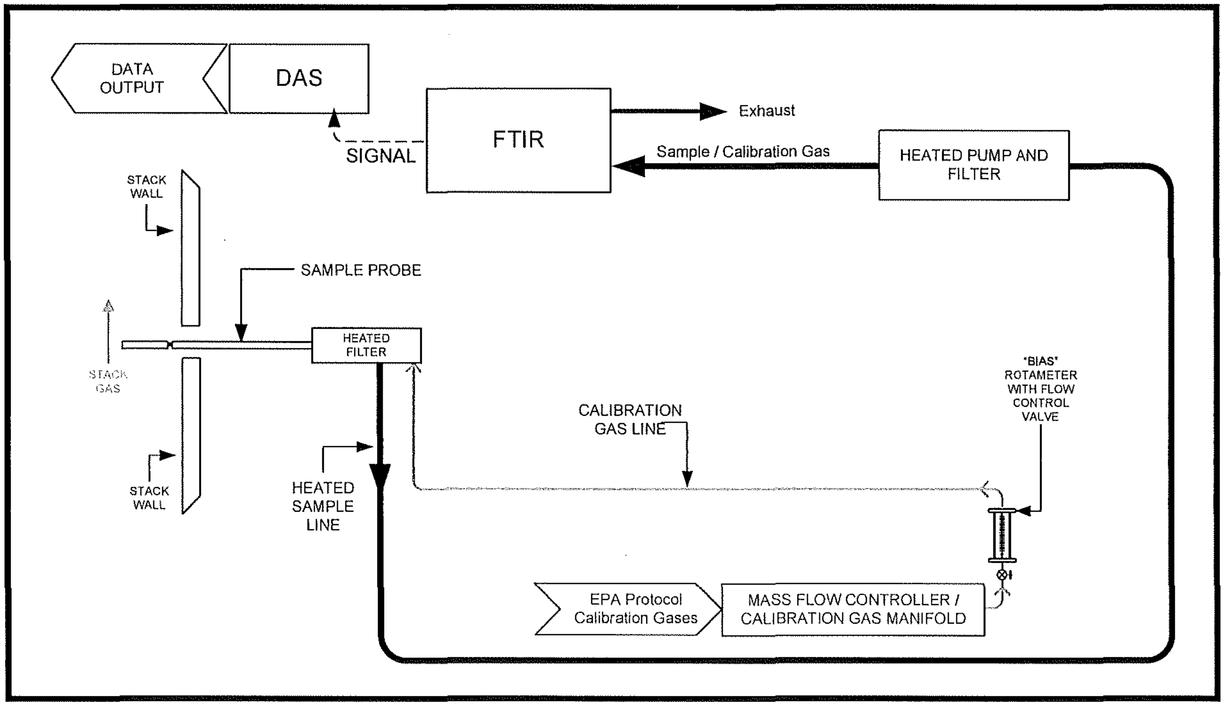
The means of the spiked results and calculated spiked levels provide a bias estimate for the FTIR measurements. A t-test is applied to the 12 differences in the values of these paired measurements to determine whether the bias is significant. If the results of the validation study indicate an accuracy of < ± 2% for each compound; a bias correction factor is not needed.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - The specific analyte concentrations include H_2O, HCl, and CH_3Cl
- Target and/or Minimum Required Sample Duration: 64 minutes
- Analytical Laboratory: Montrose, Mount Pleasant, Michigan

The typical sampling system is detailed in Figure 3-5.

Figure 3-5
EPA Method 320 Sampling Train



3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 Test Discussion and Results

4.1 Field Test Deviations and Exceptions

No field deviations or exceptions from the test plan or test methods occurred during this test program.

4.2 Presentation of Results

The average results are compared to the permit limits in Table 1-2. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-4. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

Table 4-1
Total Organic Compounds Emissions Results - Unit 954 Control System (TTU and Scrubber)

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	3/16/2022	3/16/2022	3/16/2022	--
Time	11:05-12:18	13:32-14:43	15:20-16:31	--
TTU Inlet Methyl Chloride (CH_3Cl) Injection Rate				
lb/test	12.45	17.38	8.88	12.90
lb/hr	11.67	16.29	8.33	12.10
Flue Gas Parameters				
temperature, °F	111.6	117.3	113.4	114.1
velocity, average ft/sec	22.8	23.6	23.5	23.3
volumetric flow rate, acfm	3,605	3,734	3,719	3,686
volumetric flow rate, scfm	3,274	3,358	3,367	3,333
volumetric flow rate, dscfh	179,139	183,545	183,831	182,172
moisture, % volume	8.80	8.90	9.00	8.90
CO_2, % volume dry	6.95	6.91	6.92	6.92
O_2, % volume dry	7.46	7.51	7.49	7.48
CH_3Cl response factor	0.855	0.855	0.855	0.855
Scrubber Inlet (TTU Outlet) TOC as Methane				
ppmvd	6.4	7.3	6.2	6.6
ppmvd @ 3% O_2	8.5	9.7	8.2	8.8
lb/hr	0.048	0.055	0.047	0.050
Scrubber Outlet TOC as Methane				
ppmvd	4.8	6.8	7.2	6.3
ppmvd @ 3% O_2	6.4	9.1	9.6	8.4
lb/hr	0.036	0.052	0.055	0.048
Scrubber Inlet (TTU Outlet) TOC as Methyl Chloride				
ppmvd	7.5	8.5	7.2	7.7
ppmvd @ 3% O_2	18.0	20.3	17.2	18.5
lb/hr	0.176	0.205	0.174	0.185
TTU removal efficiency, %	98.5	98.7	97.9	98.4
Scrubber Outlet TOC as Methyl Chloride				
ppmvd	5.7	8.0	8.4	7.3
ppmvd @ 3% O_2	13.6	19.0	20.1	17.6
lb/hr	0.133	0.192	0.203	0.176
TTU/scrubber removal efficiency, %	98.9	98.8	97.6	98.4

Table 4-2
Hydrogen Chloride Emissions Results -
Unit 954 Scrubber Inlet and Outlet

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	3/16/2022	3/16/2022	3/16/2022	--
Time	11:05-12:18	13:32-14:43	15:20-16:31	--
Flue Gas Parameters				
temperature, °F	111.6	117.3	113.4	114.1
velocity, average ft/sec	22.8	23.6	23.5	23.3
volumetric flow rate, acfm	3,605	3,734	3,719	3,686
volumetric flow rate, scfm	3,274	3,358	3,367	3,333
volumetric flow rate, dscfh	179,139	183,545	183,831	182,172
moisture, % volume	8.80	8.90	9.00	8.90
CO_2, % volume dry	6.95	6.91	6.92	6.92
O_2, % volume dry	7.46	7.51	7.49	7.48
Scrubber Inlet Method 26 Hydrogen Chloride (HCl)				
ppmvd	175.9	227.1	83.8	162.3
lb/hr	2.983	3.944	1.458	2.795
Scrubber Outlet Method 26A Hydrogen Chloride (HCl)				
ppmvd	0.10	0.24	0.08	0.14
ppmvd @ 3% O_2	0.14	0.32	0.11	0.19
lb/hr	0.0018	0.0042	0.0014	0.0025
scrubber removal efficiency, %	99.9	99.9	99.9	99.9
Scrubber Inlet Method 320/FTIR Hydrogen Chloride (HCl)				
ppmvd	996.4	1,204.9	614.8	938.7
lb/hr	16.893	9.185	4.694	10.257
Scrubber Outlet Method 320/FTIR Hydrogen Chloride (HCl)				
ppmvd	3.29	2.31	1.98	2.52
ppmvd @ 3% O_2	4.38	2.81	2.40	3.20
lb/hr	0.0558	0.0176	0.0151	0.0295
scrubber removal efficiency, %	99.7	99.8	99.7	99.7

Table 4-3
Chlorine Emissions Results -
Unit 954 Scrubber Inlet and Outlet

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	3/16/2022	3/16/2022	3/16/2022	--
Time	11:05-12:18	13:32-14:43	15:20-16:31	--
Flue Gas Parameters				
temperature, °F	111.6	117.3	113.4	114.1
velocity, average ft/sec	22.8	23.6	23.5	23.3
volumetric flow rate, acfm	3,605	3,734	3,719	3,686
volumetric flow rate, scfm	3,274	3,358	3,367	3,333
volumetric flow rate, dscfh	179,139	183,545	183,831	182,172
moisture, % volume	8.80	8.90	9.00	8.90
CO_2, % volume dry	6.95	6.91	6.92	6.92
O_2, % volume dry	7.46	7.51	7.49	7.48
Scrubber Inlet Method 26 Chlorine (Cl_2)				
ppmvd	32.0	1.5	1.5	11.7
lb/hr	1.055	0.051	0.050	3.385
Scrubber Outlet Method 26A Chlorine (Cl_2)				
ppmvd	0.202	0.198	0.200	0.200
ppmvd @ 3% O_2	0.269	0.264	0.267	0.267
lb/hr	0.0067	0.0067	0.0068	0.0067
scrubber removal efficiency, %	99.4	86.9	86.4	90.9

Table 4-4
Methyl Chloride Emissions Results -
Unit 954 Scrubber Outlet

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	3/16/2022	3/16/2022	3/16/2022	--
Time	11:05-12:18	13:32-14:43	15:20-16:31	--
TTU Inlet Methyl Chloride (CH_3Cl) Injection Rate				
lb/test	12.45	17.38	8.88	12.90
lb/hr	11.67	16.29	8.33	12.10
Flue Gas Parameters				
temperature, °F	111.6	117.3	113.4	114.1
velocity, average ft/sec	22.8	23.6	23.5	23.3
volumetric flow rate, acfm	3,605	3,734	3,719	3,686
volumetric flow rate, scfm	3,274	3,358	3,367	3,333
volumetric flow rate, dscfh	179,139	183,545	183,831	182,172
moisture, % volume	8.80	8.90	9.00	8.90
CO_2, % volume dry	6.95	6.91	6.92	6.92
O_2, % volume dry	7.46	7.51	7.49	7.48
Scrubber Outlet Methyl Chloride (at MDL)				
ppmvd	< 0.99	< 0.99	< 0.99	< 0.99
ppmvd @ 3% O_2	< 1.32	< 1.32	< 1.32	< 1.32
lb/hr	< 0.023	< 0.024	< 0.024	< 0.024
CH_3Cl removal efficiency, %	99.8	99.9	99.7	99.8
Scrubber Outlet Methyl Chloride (at MDL x 0.5)				
ppmvd	< 0.49	< 0.49	< 0.49	< 0.49
ppmvd @ 3% O_2	< 0.66	< 0.66	< 0.66	< 0.66
lb/hr	< 0.012	< 0.012	< 0.012	< 0.012
CH_3Cl removal efficiency, %	99.9	99.9	99.9	99.9

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

The meter boxes and sampling trains used during sampling performed within the requirements of their respective methods. All post-test leak checks, minimum metered volumes, minimum sample durations, and percent isokinetics met the applicable QA/QC criteria.

EPA Method 3A calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

EPA Method 25A FIA calibration audits were within the measurement system performance specifications for the calibration drift checks and calibration error checks.

An EPA Method 205 field evaluation of the calibration gas dilution system was conducted. The dilution accuracy and precision QA specifications were met.

EPA Methods 26 and 26A analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

EPA Method 320 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

5.2 QA/QC Discussion

All QA/QC criteria were met during this test program.

5.3 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

Appendix A
Field Data and Calculations

Appendix A.1
Sampling Locations