Executive Summary

Weyerhaeuser retained Bureau Veritas North America, Inc. to perform air emission compliance testing at the EUPRESSLINE Biofilter and FGDRYERS emission sources at the Weyerhaeuser facility in Grayling, Michigan.

The purpose of the emission test program was to evaluate compliance with the national emission standards for plywood and composite wood products (PCWP) regulation (40 CFR Part 63, Subpart DDDD) and Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B7302-2016b, effective March 8, 2016, and to determine relative accuracy of the continuous emissions rate monitoring systems (CERMS) for the EUPRESSLINE Biofilter and FGDRYERS emission sources.

The testing followed United States Environmental Protection Agency (USEPA) reference methods at the following locations:

- EUPRESSLINE Biofilter for formaldehyde emissions and removal efficiency by Method 320. Relative accuracy of the volatile organic compound (VOC) CERMS at the EUPRESSLINE Biofilter exhaust stack was also measured by Method 25A and Performance Specifications (PS) PS-6 and PS-8.
- FGDRYERS regenerative thermal oxidizer (RTO) exhaust stack for relative accuracy of the carbon monoxide (CO) CERMS, by Method 10, PS-4, and PS-6, and relative accuracy of the VOC CERMS, by Method 25A, PS-6, and PS-8.

In this report, the term VOC and THC are used interchangeably because the applicable ROP and test methods reference VOC, whereas the federal requirements of 40 CFR 60, Subpart DDDD, "National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products," reference THC.

Detailed results are presented in Tables 1 through 4 after the Tables Tab of this report. The following tables summarize the emissions results from testing performed on December 11 and 12, 2018.

EUPRESSLINE Biofilter (SVBIOFILTER) Results

Parameter		Result			Average	Permit Limit
		Run 1	Run 2	Run 3		
Formaldehyde mass emission rate (lb/hr)	Inlet	4.0	3.7	4.2	**3.9**	-
	Outlet	<0.09	<0.09	<0.09	**<0.09**	**1.0**
Formaldehyde mass removal efficiency (%)		97.6	97.5	97.9	**97.6**	**≥90**
Media bed temperature, 15-minute average (°F)		80.80	79.40	78.36	**79.61**	-

lb/hr: pound per hour

Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Difference between CEMS and RM	Relative Accuracy (%)	Performance Specification
EUPRESSLINE (Biofilter)					
VOCs (lb/hr, as carbon)	7.5	8.1	-0.7	5.4%	≤10% AS
FGDRYERS (RTO)					
VOCs (lb/hr, as carbon)	2.1	1.8	0.3	2.8%	≤10% AS
CO (lb/hr)	35.1	36.7	-1.5	1.5%	≤10% AS

CEMS: continuous emission monitoring system
lb/hr: pound per hour
RM: Reference Method
AS: Applicable Standard

1.0 Introduction

1.1 Summary of Test Program

Weyerhaeuser retained Bureau Veritas North America, Inc. to perform compliance air emissions testing at the EUPRESSLINE Biofilter and FGDRYERS emission sources at the Weyerhaeuser facility in Grayling, Michigan.

The testing followed United States Environmental Protection Agency (USEPA) reference methods at the following locations:

- EUPRESSLINE Biofilter for formaldehyde emissions and removal efficiency by Method 320. Relative accuracy of the volatile organic compound (VOC) continuous emission rate monitoring system (CERMS) at the EUPRESSLINE Biofilter exhaust stack was also measured by Method 25A and Performance Specifications (PS) PS-6 and PS-8.

- FGDRYERS regenerative thermal oxidizer (RTO) exhaust stack for relative accuracy of the carbon monoxide (CO) CERMS, by Method 10, PS-4, and PS-6, and relative accuracy of the VOC CERMS, by Method 25A, PS-6, and PS-8.

In this report, the term VOC and THC are used interchangeably because the applicable Renewable Operating Permit (ROP) and test methods reference VOC, whereas the federal requirements of 40 CFR 60, Subpart DDDD, "National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products," reference THC.

Relative accuracy (RA) means the absolute mean difference between the gas concentration, flow, or emission rate measured by the monitor and the value measured using the reference method (RM), plus the 2.5%-error confidence coefficient of a series of tests, divided by the mean of the RM test runs:

$$RA = 100\frac{\left|\overline{(C_{RM} - C_{m})}\right| + t_{\alpha,n-1}\left(\frac{S_d}{\sqrt{n}}\right)}{\overline{C_{RM}}}$$

where:

RA = % relative accuracy
C_{RM} = parameter measured by reference method
C_m = parameter measured by CEMS or CERMS (i.e., the monitor)
$\overline{|C_{RM} - C_m|}$ = absolute value of mean of the differences between C_{RM} and C_m for the valid test runs
$\overline{C_{RM}}$ = mean of test run parameter measured by reference method (mean of RM test runs)
$t_{\alpha,n-1}$ = t value with $\alpha = 0.025$, which is a confidence level of 97.5%
S_d = standard deviation of the differences between C_{RM} and C_m
n = number of measurements (i.e., test runs)

The confidence coefficient (CC) is:

$$CC = t_{\alpha,n-1}\left(\frac{S_d}{\sqrt{n}}\right)$$

The 2.5%-error confidence coefficient is calculated using a t value corresponding to the 97.5% confidence level.

Table 1-1 summarizes the sources, parameters, and test dates.

Table 1-1
Emission ID, Description, Location, Pollutants Measured, and Test Dates

Emission Unit ID	Unit Description	Sampling Location	Pollutants Measured	Test Date (2018)
EUPRESSLINE Biofilter	This emission unit covers the storage of dried flakes from the dryers, through the blending, forming, and pressing to form the board. The Biofilter and total enclosure, control the emissions from the press portion of this emission unit. Cyclones and baghouses control the emissions from the blending and forming portions.	SVBIOFILTER Inlet SVBIOFILTER Outlet	Formaldehyde VOC RATA	December 11
FGDRYERS: EUDRYER1, EUDRYER2, EUDRYER3, EUDRYER4	Within the flexible group FGDRYERS, these are 4 wood flake dryers. The heat source is a wood-fueled, suspension burner rated at 40-MMBtu/hr with an auxiliary gas start-up burner and a natural gas ring burner rated at 40 MMBtu/hr. Controlled by a Wet Electrostatic Precipitator (WESP) followed by a Regenerative Thermal Oxidizer (RTO).	SVRTO Outlet	CO and VOC RATA	December 12

1.2 Purpose of Testing

The purpose of the emission test program was to evaluate compliance with the national emission standards for plywood and composite wood products (PCWP) regulation (40 CFR Part 63, Subpart DDDD) and Michigan Department of Environmental Quality (MDEQ) ROP MI-ROP-B7302-2016b, effective March 8, 2016, and to determine relative accuracy of the CERMS for the EUPRESSLINE Biofilter and FGDRYERS emission sources. The permit emission limits evaluated during this test program are presented in Table 1-2.

Table 1-2
Permit Limits

Parameter	Units	Permit Limit
EUPRESSLINE Biofilter (SVBIOFILTER)		
Outlet formaldehyde mass emission rate	lb/hr	1.0
Formaldehyde removal efficiency	%	≥90

lb/hr: pound per hour

The specific objectives of the relative accuracy test audit (RATA) testing were:

EUPRESSLINE Biofilter

- Measure the RA of the VOC CERMS against the reference methods at the EUPRESSLINE Biofilter. In accordance with 40 CFR 60, Appendix F, the RATA was calculated in units of the applicable emissions standard, VOC lb/hr as carbon. The allowable relative accuracy based on PS-6 is no greater than 20% of the mean value of the RM's test data in terms of the units of the emission standard, or 10% of the applicable standard when the measured emissions are less than 50% of the applicable standard (19.5 lb/hr as carbon).

FGDRYERS RTO

- Measure the RA of the CO and VOC CERMS against the reference methods at the FGDRYERS RTO. In accordance with 40 CFR 60, Appendix F, the RATA was calculated in units of the applicable emissions standard, lb VOC/hr as carbon and lb CO/hr. The allowable relative accuracy based on PS-6 is no greater than 20% of the mean value of the RM's test data in terms of the units of the emission standard, or 10% of the applicable standard when the measured emissions are less than 50% of the applicable standard (18.6 lb VOC/hr as carbon; 147.3 lb CO/hr).

1.3 Key Personnel

Mr. David Kawasaki, Staff Consultant with Bureau Veritas, led the emission testing program. Weyerhaeuser personnel provided process coordination and recorded operating parameters. The testing program was witnessed by Mr. Robert Dickman and Ms. Rebecca Radulski, with MDEQ. Contact information for these individuals is presented in Table 1-3.

Table 1-3
Key Personnel

Permittee	Emission Testing Company
Weyerhaeuser 4111 West Four Mile Road Grayling, Michigan 49738 Telephone 989.348.3475 Facsimile 989.348.8226	**Bureau Veritas North America, Inc.** 22345 Roethel Drive Novi, Michigan 48375 Telephone 248.344.1770 Facsimile 248.344.2656
Kathi Moss Environmental Manager Telephone 989.348.3475 kathi.moss@weyerhaeuser.com	David Kawasaki, QSTI Staff Consultant Telephone 248.344.3081 david.kawasaki@us.bureauveritas.com
Michigan Department of Environmental Quality	
MDEQ – Air Quality Division **Technical Programs Unit** Cadillac District Office 120 West Chapin Street Cadillac, Michigan 49601 Telephone 231.876.4412 Facsimile 231.775.4050	**MDEQ – Air Quality Division** **Technical Programs Unit** Gaylord Field Office 2100 West M-32 Gaylord, Michigan 49735 Telephone 989.705.3404 Facsimile 989.731.6181
Robert Dickman Environmental Quality Analyst Telephone 231.876.4412 dickmanr@michigan.gov	Rebecca Radulski Environmental Engineer Telephone 989.705.3404 radulskir@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

Weyerhaeuser manufactures oriented-strand board (OSB) at its facility in Grayling, Michigan. Wood logs are sorted by species and stored in the wood yard. Logs are transferred to heated vats to clean and thaw (in winter months) the wood. The wood logs are conveyed from the vats to a debarking machine that removes the outer layers of the logs. A ring-strander cuts the logs into thin wood chips (strands). The strands are conveyed to a storage bin where they are fed into four wood-fired dyers. The dryers remove moisture from the strands to a product-specific content. The strands exit the dryers and are sorted according to size using shaker screens.

The fine strands are collected and used as fuel in the dryers and RTOs. The larger strands are conveyed to a blending area where wax and resins are added for adhesion purposes. The strands are then layered, at different angles for strength, onto an 8-foot-wide conveyor belt. The layered strands are cut into 8-foot-by-24-foot sections and formed into mats. The mats are stacked and the press is used to heat and compact the strands to form OSB. Depending on the thickness of the product (i.e., 7/16 or 3/8 inch) up to 16 mats can be compacted in less than 4 minutes. The OSB is cut, labeled, and prepared for shipment.

The testing was performed under representative operating conditions. Operating parameters recorded during testing are included in Appendix E.

2.2 Control Equipment Description

As part of the manufacturing process, emissions are generated by wood debarking and stranding, conveyance, drying, binding and pressing, milling, and painting (sides of wood). Weyerhaeuser operates pollution control equipment to control the discharge of pollutants to the atmosphere. The biofilter, wet electrostatic precipitator (WESP), and RTOs control emissions from the drying and pressing operations.

The VOC CERMS installed on the EUPRESSLINE Biofilter and the VOC and CO CERMS on the FGDRYERS RTO exhaust stacks are used to evaluate continuous compliance with permit limits.

2.2.1 EUPRESSLINE Biofilter

The biofilter controls VOC and HAP emissions from the press portion of emission unit EUPRESSLINE. The press heats and compacts alternating layers of fine and coarse wood strands and binders into the OSB. Emissions from the press are captured within the total building enclosure and directed to a humidifier followed by a two-chamber biofilter. The biofilter contains Douglas fir mulch that provides a microbial environment for pollutant removal. Treated emissions from the two biofilter chambers discharge to a single stack (SVBIOFILTER).

2.2.2 FGDRYERS RTOs

North and south RTOs are used to control VOC and HAP emissions from four wood-fired strand dryers and a Coen® burner. Emissions from each dryer and the Coen® burner exhaust to a combined single duct leading to a Lundberg E-Tube WESP. The WESP is designed to remove particulate matter from the flue gas prior to incineration by two RTOs.

At the RTOs, valves alternate the flow direction through each of the RTO chambers. Each chamber contains heat exchange media that alternately heat the emissions entering one combustion chamber and absorbs heat from the emissions exiting the other combustion chamber. Supplemental heat is supplied in the combustion chambers with a gas burner. An induced draft fan transports the emissions through the RTOs, which discharges to the atmosphere via the RTO stack (SVRTOSTACK).

2.3 Flue Gas Sampling Locations

Refer to Figure 1 in the Appendix for a site map of the facility identifying the source locations, and Figures 2-1 and 2-2 for photographs of the sampling locations. Figures 2 through 4, located after the Figures Tab of this report, depict the source sampling ports and traverse point locations. Descriptions of each source sampling location are presented in Sections 2.3.1 through 2.3.3.

2.3.1 EUPRESSLINE Biofilter Inlet

Two sampling ports oriented at 90° to one another are located in a straight section of an 84-inch-internal-diameter duct. The sampling ports are located:

- Approximately 12.2 feet (1.7 duct diameters) from the nearest downstream disturbance.
- Approximately 49.1 feet (7.0 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via grating above the control room housing the biofilter CEMS and CERMS equipment.

A photograph of the EUPRESSLINE inlet and outlet sampling locations is presented in Figure 2-1. Figure 2 in the Appendix depicts the EUPRESSLINE Biofilter inlet sampling ports and traverse point locations.

Figure 2-1. EUPRESSLINE Biofilter Inlet and Outlet Sampling Locations

2.3.2 EUPRESSLINE Biofilter Outlet

Two sampling ports oriented at 90° to one another are located in a straight section of an 84-inch-internal-diameter duct. The sampling ports are located:

- Approximately 60 feet (8.6 duct diameters) from the nearest downstream disturbance.
- Approximately 70 feet (10 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via grating above the control room housing the biofilter CEMS and CERMS equipment.

A photograph of the EUPRESSLINE Biofilter inlet and outlet sampling locations is presented in Figure 2-1. Figure 3 in the Appendix depicts the EUPRESSLINE Biofilter outlet sampling port and traverse point locations.

2.3.3 FGDRYERS RTO Outlet

The FGDRYERS RTO exhausts to the atmosphere through a vertical 105-inch-internal-diameter exhaust stack equipped with four sampling ports. The sampling ports are located:

- Approximately 40 feet (4.6 duct diameters) from the nearest downstream disturbance.

- Approximately 30 feet (3.4 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible by elevator to the top floor of the Dryer Building and stairs to the SVRTOSTACK catwalk.

A photograph of the FGDRYERS RTO outlet sampling location is presented in Figure 2-2. Figure 4 in the Appendix depicts the FGDRYERS RTO outlet sampling ports and traverse point locations.

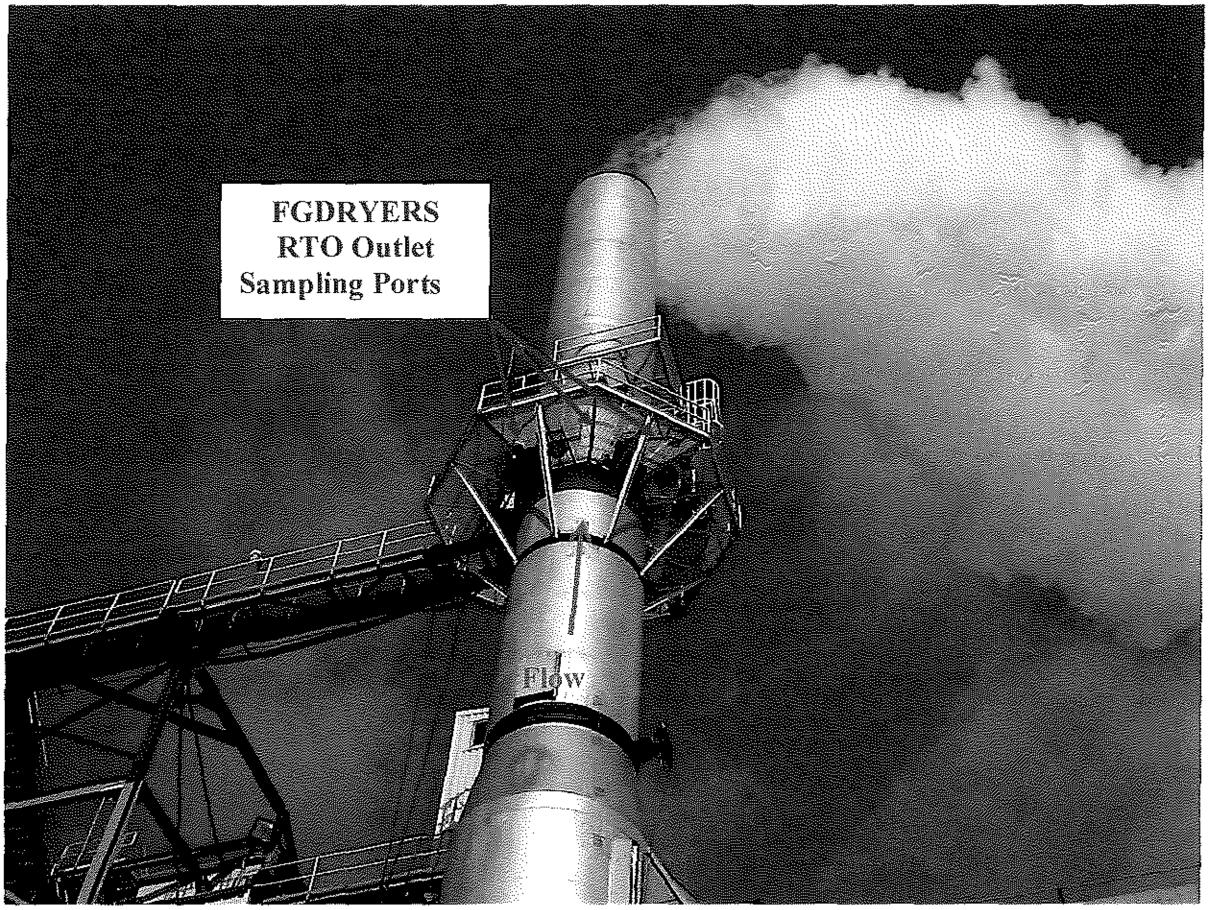

Figure 2-2. FGDRYERS RTO Outlet Sampling Location

2.4 Process Sampling Locations

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

2.5 Continuous Emission Rate Monitoring Systems

Description and identification of the instrumentation operated by Weyerhaeuser to monitor source emission rates are presented in Sections 2.5.1 and 2.5.2.

2.5.1 EUPRESSLINE Biofilter Outlet

The VOC monitor is a California Analytical Instruments, Inc., Model 600 HFID, Serial Number B05011. The system extracts sample gas through a heated sample probe and heated filter connected to the monitor by a heated sample line. The VOC analyzer measures total hydrocarbons using a flame ionization detector (FID). The VOC monitor operates on a single range/span of 0 to100 parts per million (ppm).

The flowrate monitor is a Teledyne UltraFlow Model 150, Serial Number 1501355. The air flowrate is measured by ultrasonic methods. The flow monitoring system uses 20% oxygen and 0% carbon dioxide for the flowrate calculations.

2.5.2 FGDRYERS RTO Outlet

The VOC monitor is a California Analytical Instruments, Inc., Model 600 HFID, Serial Number B05010. The system extracts sample gas through a heated sample probe and heated filter connected to the monitor by a heated sample line. The VOC analyzer measures total hydrocarbons using a FID. The VOC monitor operates on a dual range span: 0 to 100 ppm and 0 to 1,000 ppm.

The CO monitor is a California Analytical Instruments, Inc., Model 601, Serial Number B06014-M. The system extracts sample gas through a heated sample probe and heated filter connected to the gas conditioning system by a heated sample line. Moisture is removed from the sample before the sample is analyzed. The CO analyzer measures carbon monoxide concentration by non-dispersive infrared analysis. The analyzer has a span of 0 to 500 ppm.

The flowrate monitor is a Teledyne UltraFlow Model 150, Serial Number 1501354. The air flowrate are measured by ultrasonic methods. The flowrate monitoring system uses 20% oxygen and 1% carbon dioxide for the flowrate calculations.

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The purpose of the emission test program was to evaluate compliance (1) with the MDEQ ROP MI-ROP-B7302-2016b, effective March 8, 2016, for the EUPRESSLINE Biofilter and FGDRYERS emission sources, and (2) with the national emission standards for PCWP regulation (40 CFR Part 63, Subpart DDDD) for the EUPRESSLINE Biofilter.

Tables 3-1 and 3-2 present the sampling and analytical test matrix.

Table 3-1
EUPRESSLINE Biofilter Test Matrix

Date 2018	Run	Start Time	Stop Time	Sampling Method	Parameter
Dec. 11	1 outlet	07:07	07:28	25A, PS-6, PS-8	VOC RATA
	2 outlet	07:29	07:50		
	3 outlet	07:51	08:12		
	4 outlet	08:27	08:48		
	5 outlet	08:49	09:10		
	6 outlet	09:11	09:32		
	7 outlet	09:42	10:03		
	8 outlet	11:06	11:27		
	9 outlet	11:28	11:49		
	10 outlet	12:11	12:32		
Dec. 11	1 inlet/outlet	07:07	08:07	320	Formaldehyde
	2 inlet/outlet	08:27 11:22	08:47 12:02		
	3 inlet/outlet	12:11	13:11		

Table 3-2
FGDRYERS RTO Outlet Test Matrix

Date 2018	Run	Start Time	Stop Time	Sampling Method	Parameter
Dec. 12	1 RTO outlet	06:55	07:16	10, PS-4, PS-6 25A, PS-6, PS-8	CO RATA VOC RATA
	2 RTO outlet	07:59	08:20		
	3 RTO outlet	09:06	09:27		
	4 RTO outlet	09:28	09:49		
	5 RTO outlet	09:50	10:11		
	6 RTO outlet	10:25	10:46		
	7 RTO outlet	10:47	11:08		
	8 RTO outlet	11:09	11:30		
	9 RTO outlet	11:44	12:05		
	10 RTO outlet	12:06	12:27		

3.2 Field Test Changes and Issues

Representatives of Weyerhaeuser and Bureau Veritas discussed field test changes and issues with the MDEQ. The following change was approved by MDEQ:

- Testing during Test Run 2, for formaldehyde at the EUPRESSLINE Biofilter, was paused at 08:47 due to a production issue. Testing was resumed at 11:22 and Test Run 2 was completed.

3.3 Results

The average concentrations and emission rates are compared to the applicable emission limits in Tables 3-3 and 3-4. Detailed results are presented in Tables 1 through 4 in the Tables Tab of this report. Graphs of the measured concentrations are presented in the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-3
EUPRESSLINE Biofilter (SVBIOFILTER) Results

Parameter		Result			Average	Permit Limit
		Run 1	Run 2	Run 3		
Formaldehyde mass emission rate (lb/hr)	Inlet	4.0	3.7	4.2	**3.9**	-
	Outlet	<0.09	<0.09	<0.09	**<0.09**	**1.0**
Formaldehyde mass removal efficiency (%)		97.6	97.5	97.9	97.6	**≥90**
Media bed temperature, 15-minute average (°F)		80.80	79.40	78.36	**79.61**	-

lb/hr: pound per hour

Table 3-4
Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Difference between CEMS and RM	Relative Accuracy (%)	Performance Specification
EUPRESSLINE (Biofilter)					
VOCs (lb/hr as carbon)	7.5	8.1	-0.7	5.4%	≤10% AS
FGDRYERS (RTO)					
VOCs (lb/hr as carbon)	2.1	1.8	0.3	2.8%	≤10% AS
CO (lb/hr)	35.1	36.7	-1.5	1.5%	≤10% AS

CEMS: continuous emission monitoring system
lb/hr: pound per hour
RM: Reference Method
AS: Applicable Standard

4.0 Sampling and Analytical Procedures

Bureau Veritas measured emissions in accordance with the procedures specified in USEPA's Standards of Performance for New Stationary Sources. Table 4-1 presents the emissions test parameters and sampling methods.

Table 4-1
Emission Testing Parameters

Parameter	Source			USEPA Reference	
	Inlet Of Biofilter	Outlet of Biofilter	FGDRYERS RTO Outlet	Method	Title
Sampling ports and traverse points	●	●	●	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	●	●	●	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	●	●	●	3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture content			●	4	Determination of Moisture Content in Stack Gases
Carbon monoxide			●	10	Determination of Carbon Monoxide Emissions from Stationary Sources
Volatile organic compounds		●	●	25A	Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer
Gas dilution		●	●	205	Verification of Gas Dilution Systems for Field Instrument Calibrations
Formaldehyde and moisture content	●	●		320	Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy

4.1 Emission Test Methods

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

Method 1, "Sample and Velocity Traverses for Stationary Sources," from the Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, was used to evaluate the sampling location and the number of traverse points for sampling and the measurement of velocity profiles. Figures 2 through 4 in the Appendix depict the source locations and the source specific sampling locations and traverse points.

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. S-type Pitot tubes and thermocouple assemblies, calibrated in accordance with Method 2, Section 10.0, were used during testing. Because the dimensions of the Pitot tubes met the requirements outlined in Method 2, Section 10.1, and were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. The digital manometer and thermometer are calibrated using calibration standards that are traceable to National Institute of Standards and Technology (NIST). Refer to Appendix A for the Pitot tube inspection sheets.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow is present at the sampling locations.

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 used.

The average of the measured traverse point flue gas velocity null angles were less than 20° at the sampling locations. The measurements indicate the absence of cyclonic flow.

Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

4.1.2 Molecular Weight (USEPA Method 3)

Molecular weight was evaluated using 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 (CO_2) and oxygen (O_2) were then measured by chemical absorption with a Fyrite® gas analyzer to within ±0.5%. The average CO_2 and O_2 result of the grab samples were used to calculate molecular weight.

4.1.3 Moisture Content (USEPA Method 4)

Before testing, moisture content was estimated using previous test data, psychrometric charts, and/or saturation vapor pressure tables. This estimate was used in conjunction with preliminary velocity head and temperature data to (1) calculate flue gas velocity and ideal nozzle diameter, and (2) establish isokinetic sampling rates. USEPA Method 4 was used for moisture content measurements at the FGDRYERS RTO outlet stack.

Bureau Veritas' modular USEPA Method 4 stack sampling system consisted of:

- A stainless steel probe.
- Tygon® umbilical vacuum line connecting the probe to the impingers.
- A set of four Greenburg-Smith (GS) impingers with the configuration shown in Table 4-2 situated in a chilled ice bath.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-2
USEPA Method 4 Impinger Configuration

Impinger	Type	Contents	Amount
1	Modified	Water	~100 milliliters
2	Greenburg Smith	Water	~100 milliliters
3	Modified	Empty	0 milliliters
4	Modified	Silica desiccant	~300 grams

Prior to initiating a test run, the sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of water to the sampling train. The dry-gas meter was then monitored to measure that the sample train leak rate was less than 0.02 cubic feet per minute (cfm). The sampling probe was then inserted into the sampling port near the centroid of the stack in preparation of sampling. Flue gas was then extracted at a constant rate from the stack, with moisture removed from the sample stream by the chilled impingers.

At the conclusion of the test run, a post-test leak check was conducted and the impinger train was carefully disassembled. The weight of liquid or silica gel in each impinger was measured with a scale capable of measuring within 0.5 grams. The weight of water collected within the impingers and volume of flue gas sampled were used to calculate the percent moisture content.

Figure 4-1 depicts the USEPA Method 4 sampling train.

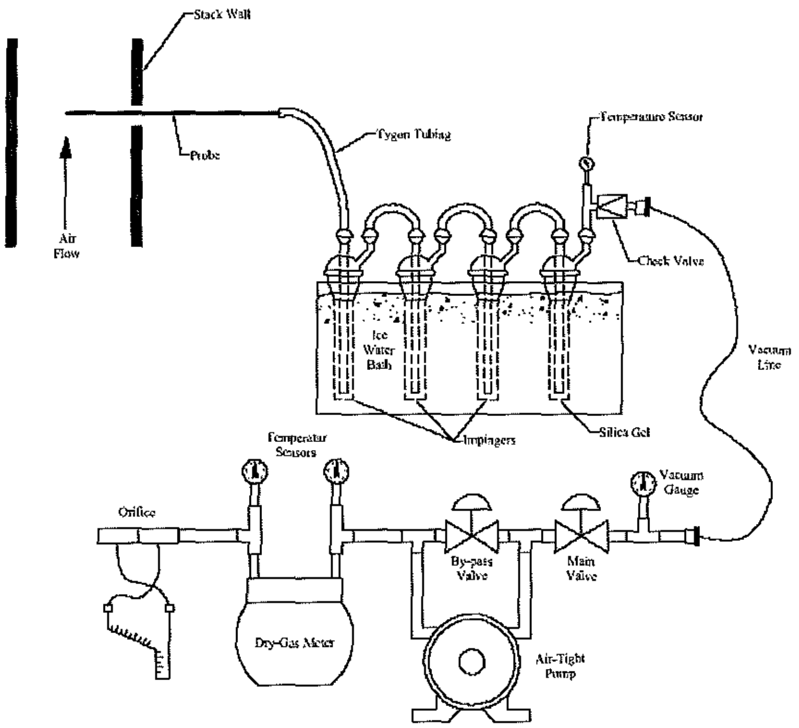

Figure 4-1. USEPA Method 4 Sampling Train

4.1.4 Carbon Monoxide (USEPA Method 10)

USEPA Method 10 "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrument Analyzer Procedure)" was used to measure CO concentrations. Flue gas was continuously sampled from the stack and conveyed to an infrared analyzer for CO concentration measurements. Flue gas was extracted from the stack through:

- A stainless steel probe.
- Heated Teflon sampling line to prevent condensation.

- A chilled Teflon impinger train (equipped with a peristaltic pump) to remove moisture from the sampled gas stream prior to entering the analyzer.
- CO gas analyzer.

Data were recorded at 1-second intervals on a computer equipped with data acquisition software.

For the RATA tests, the flue gas was withdrawn from three sampling points located at 16.7%, 50%, and 83.3% of the diameter of the stack. The sampling probe was moved to a new sampling point at 7-minute intervals during the 21-minute RATA tests.

The pollutant concentrations were measured using a CO gas analyzer calibrated with zero-, mid-, and high-level EPA-Traceability-Protocol-certified calibration gases. The mid-level gas was 40 to 60% of the high-level (also referred to as span) gas.

A calibration error check was performed by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to verify the analyzer response was within ±2% of the calibration span of the analyzer. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from the pre- and post-test system-bias checks. The system-bias check evaluated the analyzer drift against the ±3% quality assurance/quality control (QA/QC) requirement. The analyzer drift data was used to correct the measured flue gas concentrations. Recorded concentrations were averaged over the duration of each 21-minute test run.

Figure 4-2 depicts the USEPA Method 10 sampling train.

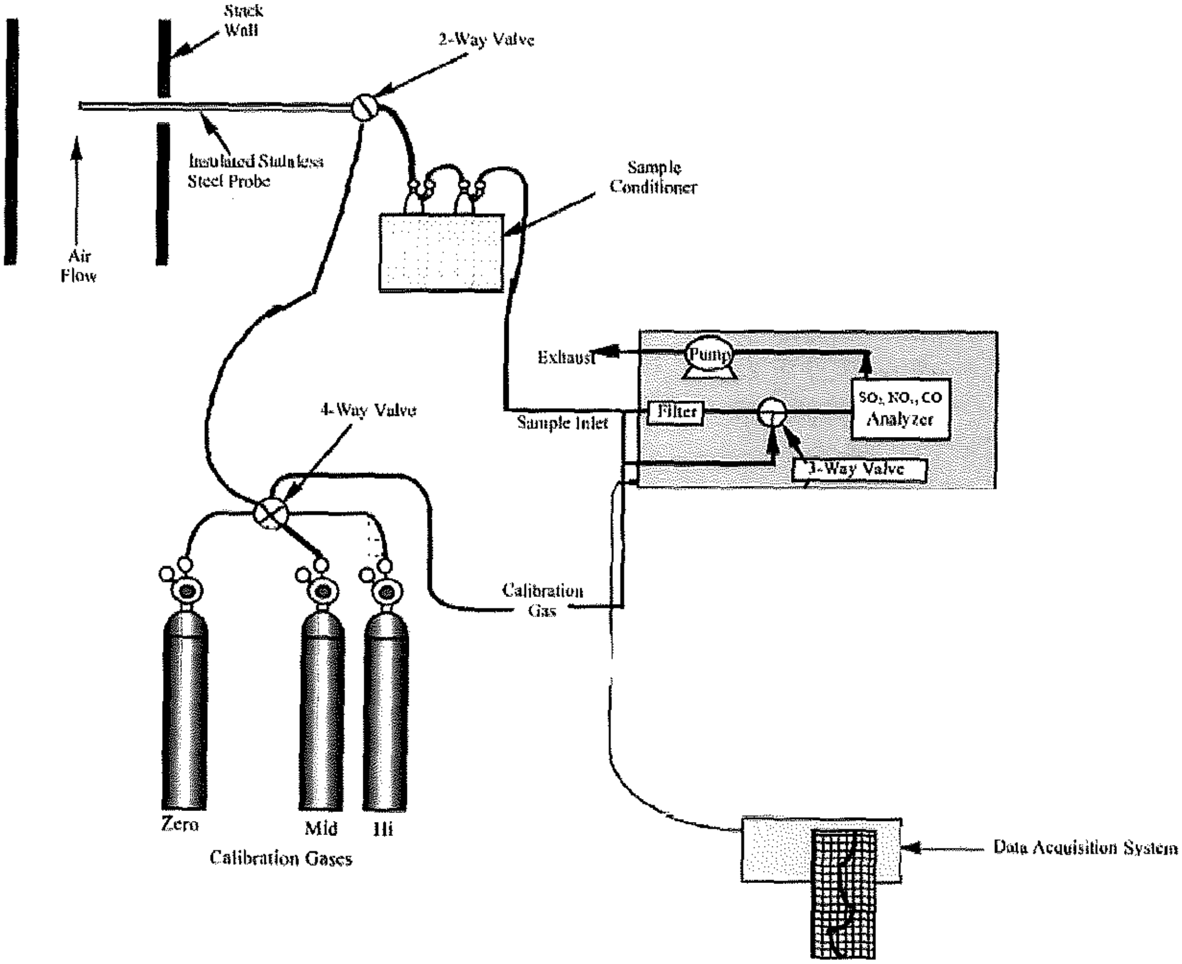

Figure 4-2. USEPA Method 10 Sampling Train

4.1.5 Volatile Organic Compounds (USEPA Method 25A)

VOC concentrations were measured following USEPA Method 25A, “Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer.” Samples were collected through a probe and heated sample line into the analyzer.

A FID measures the average hydrocarbon concentration in part per million by volume (ppmv) of VOC as the calibration gas methane. The FIDs are fueled by 100% hydrogen, which generates a flame with a negligible number of ions. Flue gas is introduced into the FID and enters the flame chamber.

The combustion of flue gas generates electrically charged ions. The analyzer applies a polarizing voltage between two electrodes around the flame, producing an electrostatic field. Negatively charged ions, anions, migrate to a collector electrode, while positively charged ions, cations, migrate to a high-voltage electrode. The current between the electrodes is directly proportional to the hydrocarbon concentration in the sample. The flame chamber is depicted in Figure 4-3.

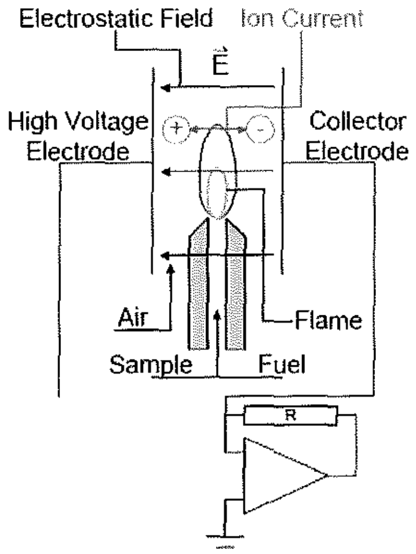

Figure 4-3. FID Flame Chamber

For the RATA tests, the flue gas was withdrawn from three sampling points located at 16.7%, 50%, and 83.3% of the diameter of the stack. The sampling probe was moved to a new sampling point at 7-minute intervals during the 21-minute RATA tests.

Using the voltage analog signal, measured by the FID, the concentration of volatile organic compounds was recorded by a data acquisition system (DAS). The average concentration of VOC is reported as the calibration gas (i.e., methane) in equivalent units.

Figure 4-4 depicts the USEPA Method 25A sampling train.

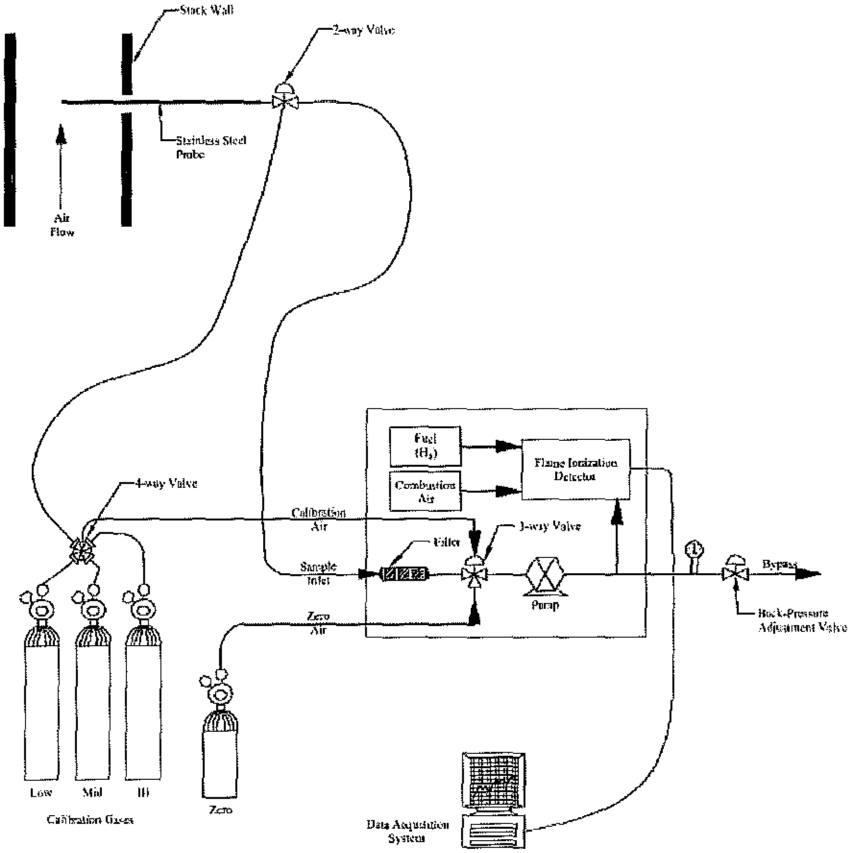

Figure 4-4. USEPA Method 25A Sampling Train

4.1.6 Gas Dilution (USEPA Method 205)

A gas dilution system was used to introduce known values of calibration gases into the CO and VOC analyzers. The gas dilution system consisted of calibrated orifices. The system diluted a high-level calibration gas to within ±2% of predicted values.

Before the start of a testing, the gas divider dilutions were measured to be within 2% of predicted values. Two sets of dilutions of a high level calibration gas were performed. Subsequently, a certified mid-level calibration gas was introduced into the analyzer; the calibration gas concentration was within 10% of the dilution. Refer to Appendix A for the certified calibration gas certificates and gas dilution field calibration notes.

4.1.7 Formaldehyde and Moisture Content(USEPA Method 320)

Formaldehyde emissions and moisture content at the inlet and outlet of the EUPRESSLINE Biofilter were measured in accordance with USEPA Method 320, "Vapor Phase Organic & Inorganic Emissions by Extractive FTIR."

Gaseous samples were drawn from the ducts and transferred to MKS Instruments MultiGas 2030 (or equivalent) FTIR spectrometers. The samples passed through a heated probe, heated filter, and heated transfer line in route to the FTIRs. The probes, filters, transfer lines, and FTIRs were maintained at 191°C (375°F). The formaldehyde determination was made from a hot, wet sample. Samples continuously flowed through the FTIR and sampling system during testing. The FTIR scanned the sample approximately once per second. A data point consists of the co-addition of the scans, with a data point generated every 30 seconds.

A calibration transfer standard (CTS) was analyzed before and after testing. Ethylene was used as the CTS. Acetaldehyde spiking was performed before the start of testing. Section 3.29 of USEPA Method 320 allows the use of a surrogate analyte for the purposes of analyte spiking. Acetaldehyde was chosen as the surrogate to formaldehyde because acetaldehyde shares many physical and chemical properties with formaldehyde. Formaldehyde is the C_1 aldehyde (CH_2O); acetaldehyde is the C_2 aldehyde (CH_3CHO).

Figure 4-5 depicts the FTIR sampling train.

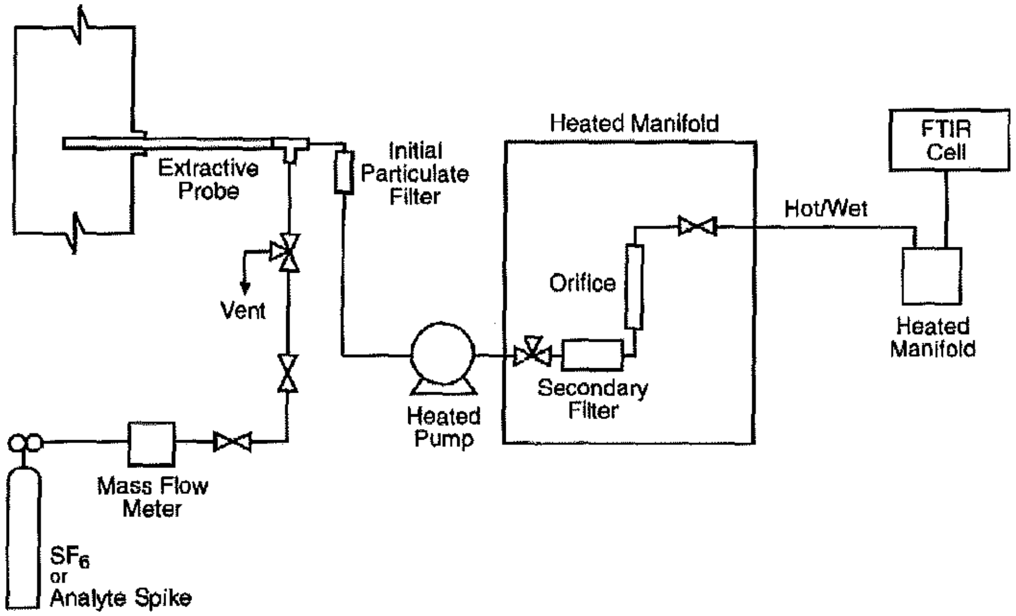

Figure 4-5. USEPA Method 320 Sampling Train

4.1.7 Formaldehyde and Moisture Content(USEPA Method 320)

Formaldehyde emissions and moisture content at the inlet and outlet of the EUPRESSLINE Biofilter were measured in accordance with USEPA Method 320, "Vapor Phase Organic & Inorganic Emissions by Extractive FTIR."

Gaseous samples were drawn from the ducts and transferred to MKS Instruments MultiGas 2030 (or equivalent) FTIR spectrometers. The samples passed through a heated probe, heated filter, and heated transfer line in route to the FTIRs. The probes, filters, transfer lines, and FTIRs were maintained at 191°C (375°F). The formaldehyde determination was made from a hot, wet sample. Samples continuously flowed through the FTIR and sampling system during testing. The FTIR scanned the sample approximately once per second. A data point consists of the co-addition of the scans, with a data point generated every 30 seconds.

A calibration transfer standard (CTS) was analyzed before and after testing. Ethylene was used as the CTS. Acetaldehyde spiking was performed before the start of testing. Section 3.29 of USEPA Method 320 allows the use of a surrogate analyte for the purposes of analyte spiking. Acetaldehyde was chosen as the surrogate to formaldehyde because acetaldehyde shares many physical and chemical properties with formaldehyde. Formaldehyde is the C_1 aldehyde (CH_2O); acetaldehyde is the C_2 aldehyde (CH_3CHO).

Figure 4-5 depicts the FTIR sampling train.

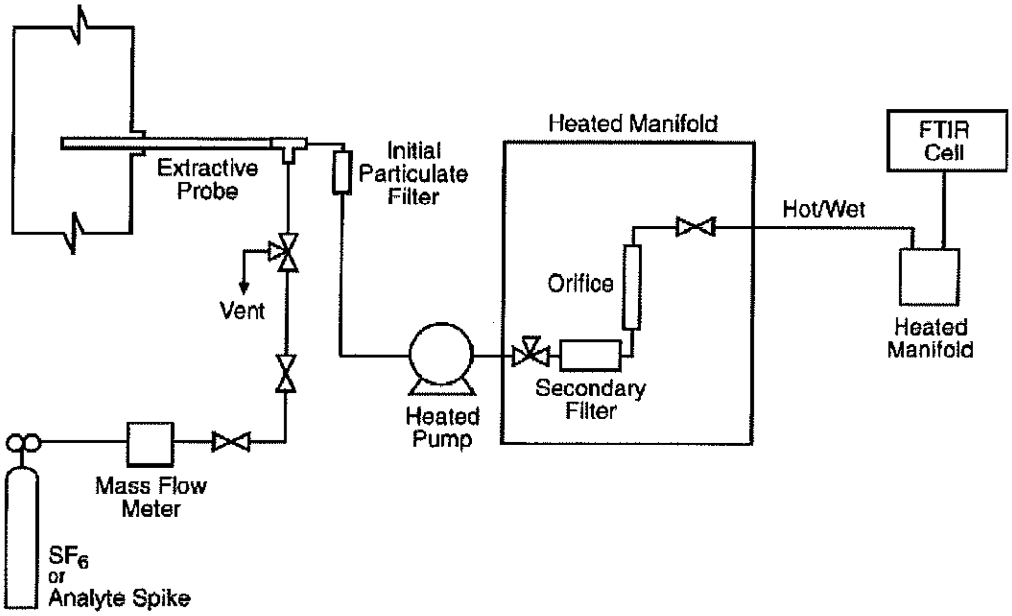

Figure 4-5. USEPA Method 320 Sampling Train

4.2 Procedures for Obtaining Process Data

Process data were recorded by Weyerhaeuser personnel. Refer to Section 2.0 for discussions of process and control device data and Appendix E for the operating parameters recorded during testing.

4.3 Sampling Identification and Custody

Recovery and analytical procedures were not applicable to the sampling methods used in this test program.

5.0 QA/QC Activities

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

5.1 Pretest QA/QC Activities

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

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. Calibration measurements for pitot tubes are presented in Appendix A.

5.2.1 Instrument Analyzer QA/QC Audits

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Calibration gas selection, error, bias, and drift checks are included in Appendix A.

5.2.2 Sampling Train QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The following tables summarize the QA/QC audits conducted on each sampling train.

Table 5-1
FGDRYERS RTO Outlet Sampling Train QA/QC Audits

Parameter	Run 1	Run 2	Run 3	Run 4	Method Requirement	Comment
Method 4						
Sampling train leak check Post-test	0.004 ft^3/min at 8 in Hg	0 ft^3/min at 5 in Hg	0 ft^3/min at 5 in Hg	0 ft^3/min at 5 in Hg	<0.020 ft^3/min at vacuum greater than recorded during test run	Valid
Test run sampling vacuum (in Hg)	0	0	1	0		

5.2.3 Dry-Gas Meter QA/QC Audits

Table 5-2 summarizes the dry-gas meter calibration checks compared to the acceptable USEPA tolerance. Refer to Appendix A for complete DGM calibrations.

Table 5-2
Dry-gas Meter Calibration QA/QC Audit

Dry-Gas Meter	Pre-test DGM Calibration Factor (Y) (dimensionless)	Post-Test DGM Calibration Check Value (Y_{qa}) (dimensionless)	Difference Between Pre- and Post-test DGM Calibrations	Acceptable Tolerance	Comment
X	0.995 (11/30/2018)	0.992 (12/17/2018)	0.003	±0.05	Valid

5.2.4 Thermocouple QA/QC Audits

Temperature measurements using thermocouples and digital pyrometers were compared to reference temperatures to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperatures within ±1.5% (i.e., the USEPA acceptance criterion) of reference temperatures. Thermocouple and pyrometer calibration results are presented in the Appendix A.

6.0 Limitations

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This report prepared by:
David Kawasaki, QSTI
Staff Consultant
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