DESTRUCTION EFFICIENCY TEST REPORT

for

FG-2022 RTO No. 2

at

Orafol
67 Kay Industrial Drive
Lake Orion, Michigan

Test Date: July 25, 2024

Report Date: August 14, 2024

Prepared by:

Environmental Partners, Inc.
305 Hoover Boulevard, Suite 200
Holland, Michigan 49423

EPI
Environmental Partners Inc.

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Environmental Partners, Inc.
305 Hoover Boulevard, Suite 200
Holland, Michigan 49423

Report Certification:

Air emissions testing was performed under my observation and in conjunction with the production operations on July 25, 2024 for the RTO associated with Line 2 at the Orafol facility in Lake Orion, Michigan. This report presents the testing results and operational data collected during the testing. The data presented herein are believed to be a true and accurate representation of actual field conditions observed during the compliance testing exercise.

Bruce H. Connell

Principal

Environmental Partners, Inc.

August 14, 2024

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION AND PURPOSE OF THE TEST PROGRAM	1
2.0	PROCESS CONTROLS SYSTEM DESCRIPTION	2
3.0	TEST METHODOLOGIES	3
	3.1 Volumetric Flow Rate Determination – USEPA Methods 1 - 4	3
	3.2 Total Gaseous Organic Concentration Determination – USEPA Method 25A	4
4.0	PRESENTATION OF PRODUCTION DATA	5
5.0	PRESENTTION AND DISCUSSION OF TEST RESULTS	6

Tables

1	Estimated Material Throughput Rate (EU-LINE2)	5
2	Smoke Tube Directional Flow Observations	5
3	Enclosure Pressure Drop	5
4	RTO Temperature Data	6
5	Durr (RTO) Destruction Efficiency Test Summary	6

APPENDICES

A Test Plan and Letter of Approval

B EULINE2 Process and Control Device Operating Parameters and Field Test Data
- Material Usage Data
- Material EDS
- Process Parameter Data
- Oxidizer Combustion Chamber Temperature Data

C The Stack Test Group Report

1.0 INTRODUCTION AND PURPOSE OF THE TEST PROGRAM

A compliance test program was conducted at the Orafol manufacturing facility located in Lake Orion, Michigan on July 25, 2024. The purpose of the test program was to determine the Volatile Organic Compound (VOC) destruction efficiency of the air pollution control system used to control the VOC emissions from the adhesive coating line (EULINE2). The coating line is located in a fully contained enclosure with air locks for entry and egress.

The test program was conducted in accordance with the test plan dated April 30, 2024 and confirmed by Michigan Department of Environment, Great Lakes, and Energy (EGLE) by letter on June 26, 2024. A copy of the test plan and the EGLE confirmation is included in Appendix A.

The coating process under evaluation is regulated by the Michigan issued New Source Review Permit to Install No. 46-13A. The testing was conducted to satisfy special condition numbers V.2 and V.3 of FG-2022 and to confirm compliance with special condition numbers IV.2 and IV.4.

The overall compliance test program was coordinated by Mr. Bruce Connell, of Environmental Partners, Inc. The destruction efficiency test programs were performed by The Stack Test Group. Plant operations were coordinated by Mr. Michael Kozik, Orafol and Mr. Joshua Flood, Orafol. The compliance test program was witnessed by Mr. Andrew Riley, EGLE-AQD, Ms. Jilian Cellini, EGLE-AQD, and Mr. Mark Dziadosz, EGLE-AQD.

2.0 PROCESS AND CONTROLS SYSTEMS DESCRIPTION

Orafol operates an adhesive application line (EULINE2) that is used to apply adhesive to manufacture PVC casted film as well as, inks, or urethane clear topcoat. The application methods vary between reverse roll coating, rotary screen coating, knife-over-roller coating or slot die coating.

On the day of testing, the coating line was applying an adhesive (HA3C2 Duro-Tak 2835) in the knife-over-roller coating operation. In the process, a web fed substrate is fed through a series of rollers leading up to the application station. At the application station, liquid adhesive was applied to the substrate just before the knife blade. As the coating is deposited on the substrate the knife blade spreads it across the substrate to the desired thickness, with the assistance of the support roller located beneath the coated substrate.

After leaving the application station, the substrate is fed through an indirect oil heated dryer with nine separate heating sections. The oil is pre-heated through a heat exchanger located in the exhaust of the regenerative thermal oxidizer (RTO). The RTO is manufactured by Durr, Inc. which has a rate air flow of 38,040 scfm when operating both EULINE2 and EULINE3 with a design destruction efficiency of 98%. On the day of testing only EU-LINE2 was operating and when only one line is in operation the RTO design flow rate is 19,020 scfm.

In accordance with Special Condition IV.2 of FG-2022, the RTO must maintain a minimum combustion chamber temperature above 1550 °F when operating the coating line.

Testing was conducted on July 25, 2024. Appendix B contains process related information along with periodic hand written recordings of the combustion chamber temperature, stack temperature, the RTO inlet temperature, and the process line speed, from the RTO control panel. In addition, differential pressure readings were recorded from 22 points along the dryer and across both the inside coating enclosure and the outer coating enclosure. These readings were in pascals and demonstrated a negative reading when the pressure outside the enclosure was greater than the pressure inside the enclosure, resulting in air being drawn into the enclosure.

The coating operation is located in a non-fugitive enclosure with all of the air from within the enclosure being directed to the RTO. The enclosure has two entrances, with each entrance having both and outer enclosure door and an inner enclosure door, providing an air lock between the general in-plant environment and the coating enclosure. The company has installed a differential pressure gauge, to monitor the pressure drop between the inside of the enclosure and the area immediately outside the enclosure. On the day of testing, differential pressure readings were recorded at intervals of every 10 minutes. This data is located in Appendix B along with the handwritten combustion chamber recordings.

3.0 TEST METHODOLOGIES

Three one-hour test runs were performed at the inlet and outlet of the oxidizer unit. For each test run, the concentrations and mass emission rates of VOCs at the inlet and outlet test locations were compared in order to determine the VOC destruction efficiency. All tests were conducted in accordance with USEPA Methods 1-4, and 25A, as described in the *Code of Federal Regulations, Title 40, Part 60, Appendix A*. Descriptions of these methods are as follows:

USEPA Method	Description
1	Sample and Velocity Traverses for Stationary Sources
2	Determination of Stack Gas Velocity and Volumetric Flow Rate
3	Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
4	Determination of Moisture Content in Stack Gases
25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

Additionally, differential pressure drop readings were recorded across the enclosure barrier to verify the inward flow of air into the enclosure which is indicative of the enclosure being negative relative to the room. The differential pressure gauges were located in clear view for EGLE-AQD staff to monitor throughout the test series. A copy of the recordings is included in Appendix B.

3.1 Volumetric Flow Rate Determination – USEPA Methods 1 - 4

The volumetric flow rate of the exhaust was determined following USEPA Methods 1 through 4. Velocity measurement points were selected in accordance with USEPA Method 1. Gas stream velocities were determined using a Type-S pitot tube and inclined manometer in accordance with USEPA Method 2.

Velocity measurements were made at the beginning and end of each one-hour test, at each test location (inlet and outlet). Concentrations of carbon dioxide were determined using the instrumental analyzer technique in accordance with USEPA Method 3A. Gas stream moisture contents were determined by passing the exhaust sample gas through a series of four chilled impingers containing pre-measured amounts of absorbing solution, followed by an impinger containing silica gel. Volumetric determinations were made of moisture gain, and equivalent water vapor volumes were determined in accordance with USEPA Method 4.

3.2 Total Gaseous Organic Concentration Determination – USEPA Method 25A

The procedures outlined in USEPA Method 25A were followed to determine the total gaseous organic concentration in the exhaust streams at the inlet and outlet of the oxidizer. For each test run, a gas sample was collected continuously for a minimum of 60 minutes from a single representative sampling point. The gas sample stream was passed through a heated filter and stainless steel probe, and drawn to a flame ionization analyzer via a Teflon sample line that was heated to at least 250°F.

The RTO the inlet and outlet concentrations were measured with separate JUM Model 3-300A Flame Ionization Analyzers. In each case the flame ionization analyzer was pre-calibrated in the applicable ranges. Appropriate mid-range and zero calibration gases were introduced, and the analyzer response was checked between each test run, as well as after the final test run. Calibration gases consisted of certified (Protocol 1) concentrations of propane in air. Sixty (60) one-minute averages for each run were totaled and averaged to determine an average organic concentration for each of the three test runs. Organic concentrations are expressed on a parts per million by volume as propane (ppmv C_3H_8) basis.

VOC emission results for each test are presented on a concentration basis (parts per million by volume as propane, ppmv C_3H_8), and mass emission rate basis (pounds per hour as propane). The VOC destruction efficiency of the oxidizer was calculated by comparing the mass of VOC measured at the oxidizer inlet to the mass of VOC measured in the oxidizer exhaust for each test run, and computing the arithmetic average of the three efficiency values. The calculated destruction efficiency for the RTO is summarized in Table 5.

During each test run the process line was operating at line speed of 65.8 feet per minute. During test run #1 the coating line tripped off line momentarily and required a few minutes to recover to full line speed. Therefore, an additional eight (8) minutes of data was collected to supplement the run #1.

4.0 PRESENTATION OF PRODUCTION DATA

The EGLE-AQD stack test approval letter, dated June 26,2024, requested that the RTO be operated at its standard settings. In addition, the letter requested that process data be reported for the RTO combustion temperature, the RTO retention time, the coating line usage rate and VOC content, and smoke current flow demonstrations be conducted at each natural draft opening (NDO) of enclosure.

Unknown at the time of the permit application, the manufacturer of the coating line installed individual differential pressure readings (digital displays) across critical points in the process.

- Across the outer enclosure measuring differential pressure drop (Pa) from outside the total enclosure to inside the coating enclosure. This included the intermediate chamber where the operator monitored the coater.
- Across the inner enclosure measuring the differential pressure drop (Pa) between the intermediate enclosure and the inner coating enclosure.
- At 22 select locations along the 9 separate sections of the dryer, differential pressure drop (Pa) displays placed to demonstrate the differential pressure between the general in-plant environment and inside the dryer.

Table 1 presents a summary of the coating usage rate and emission estimates. Table 2 presents a summary of the combustion chamber temperatures, as recorded on the datalogger and from handwritten field notes. Table 3 presents the range of differential pressures across the process enclosure.

Table 1 – Estimated Material Throughput Rate (EU-LINE2)

Test #	**Usage (gal)**	**Uncontrolled VOC (lbs/hr)**	**Coating Width (inches)**	**Line Speed (fpm)**
1	67	298.6	48.75	65.8
2	62	313.1	48.75	65.8
3	65	328.3	48.75	65.8

Table 2 – Smoke Tube flow directions

Test #	**Lower Enclosure**			**Upper Enclosure**		
	Web Entrance	Access Door 1	Access Door 2	Web Exit	Access Door 1	Access Door 2
1	Negative	Negative	Negative	Negative	Negative	Negative
2	Negative	Negative	Negative	Negative	Negative	Negative
3	Negative	Negative	Negative	Negative	Negative	Negative

- Negative represents air movement into the enclosure
- Positive represents air movement out of the enclosure

Table 3 – Enclosure Pressure Drop

	Test Run 1		Test Run 2		Test Run 3	
	Differential Pressure (Pa)		Differential Pressure (Pa)		Differential Pressure (Pa)	
Dryer	Min	Max	Min	Max	Min	Max
1	--13	-21	-14	-19	-16	-19
2	-45	-66	-46	-63	-50	-64
3	-52	-78	-46	-63	-49	-76
4	-46	-67	-40	-70	-31	-90
5	-50	-72	-43	-76	-47	-77
6	-51	-70	-44	-67	-45	-54
7	-42	-66	-35	-54	-44	-61
8	-33	-49	-30	-39	-25	-43
9	-21	-53	-19	-38	-30	-43
10	-35	-45	-23	-41	-35	-48
11	-27	-51	-22	-36	-28	-49
12	-30	-52	-25	-33	-26	-54
13	-25	-34	-19	-37	--32	-43
14	-14	-40	-21	-33	-22	-40
15	-25	-41	-28	-42	-27	-44
16	-17	-48	-24	-35	-18	-50
17	-16	-38	-18	-33	-17	-27
18	-15	-40	-23	-30	-16	-34
19	-20	-37	-19	-34	-20	-25
20	-12	-28	-15	-27	-14	-27
21	-7	-31	-9	-31	-17	-27
22	-6	-17	-4	-10	-6	-14
Inside Lower Enclosure	-15	-16	-13	-17	-14	-17
Outside Lower Enclosure	-4	-7	-6	-8	-6	-9
Inside Upper Enclosure	-14	-18	-14	-17	-16	-18
Outside Upper Enclosure	-8	-10	-5	-10	-8	-11

Table 4 – RTO Temperature Data (average value)

Test #	Combustion Chamber (F)	RTO Outlet Temp (F)	RTO Inlet Temp (F)	RTO Burner Position
1	1,693.5	228.3	167.5	Off
2	1,652.6	238.3	171.7	Off
3	1,633.7	238.7	172.0	Off

The RTO was operating in a self-sustain mode such that the combustion zone burner was not providing additional heat.

The RTO inlet and outlet temperatures were recorded from the RTO control panel and represent the location on the inlet side of the RTO just after the heat exchanger and just after the heat exchanger on the discharge side of the RTO.

5.0 PRESENTATION AND DISCUSSION OF TEST RESULTS

The results of the compliance test program are summarized in Table 5. The test plan and EGLE-AQD acknowledgement letter, process operational data, control device data, summary calculations, field test data sheets, VOC concentration readings, equipment calibrations and calibration gas certification sheets are included in the following Appendices:

Summary

- The average calculated destruction efficiency for the RTO was above the required 98%.
- The Non-Fugitive Enclosure verification test demonstrated that the enclosure was operated under negative pressure with respect to the immediate area outside the enclosure.
- During the three test runs, the combustion chamber temperature was operating above the permit limit of 1550 °F.

Table 5
Durr (RTO) Destruction Efficiency Test Summary
(EU- LINE2 only operating)
Orafol
Lake Orion, Michigan
Test Date: July 25, 2024

Parameter	1	2	3	Avg.
Start Time	09:45	11:35	13:05	
Stop Time	10:52	12:35	14:05	
Test Data				
Inlet Volumetric Flow Rate (scfm)	19,186	19,042	19,179	19,136
Inlet VOC Concentration (ppmv C_3H_8)	2015.1	2208.6	2331.5	2185.1
Inlet VOC Mass Emission Rate (lbs/hr C_3H_8)	264.908	288.156	306.384	286.482
Outlet Volumetric Flow Rate (scfm)	24,961	26,091	26,356	25,803
Outlet VOC Concentration (ppmv C_3H_8)	4.1	3.2	3.8	3.7
Outlet VOC Mass Emission Rate (lbs/hr C_3H_8)	0.701	0.572	0.686	0.653
VOC Destruction Efficiency (%)	**99.74%**	**99.80%**	**99.78%**	**99.77%**

Appendix A

Test Plan and Letter of Approval

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY
LANSING

EGLE

PHILLIP D. ROOS
DIRECTOR

June 26, 2024

VIA E-MAIL

Joshua Flood
EHS Manager
Orafol
67 Kay Industrial Drive
Lake Orion, Michigan 48361

Dear Joshua Flood:

SUBJECT: Plan for VOC Destruction Efficiency Testing at the Orafol facility in Lake Orion July 2024; Michigan PTI No. 46-13A; SRN: N2702

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), Air Quality Division (AQD) has completed the quality assurance review of the test protocol for the determination of volatile organic compounds (VOC) destruction efficiency (DE) of the thermal oxidizer (TO) controlling emissions from EU-LINE2 operated at the Orafol facility located in Lake Orion, Michigan. The test plan was received on February 21, 2023. This testing is required by Permit to Install (PTI) No. 46-13A. All sampling will be performed according to the United States Environmental Protection Agency (USEPA) methods found at epa.gov/emc. Any modification to a method must be approved by the AQD technical programs unit (TPU) supervisor.

Process
Testing will be performed while EU-LINE2 operates at maximum routine Conditions. The RTO must operate at minimum of 1550°F and have a minimum retention time of 0.5 seconds. The AQD requests that the following facility process data is reported for each test run:

- RTO Combustion Temperature, °F;
- RTO retention time;
- Coating usages and VOC content; and
- Smoke current flow at each natural-ducted opening (NDO).

AQD district staff will coordinate the operation of the process and the collection of process data. If you have any questions about this, please contact Jillian Cellini at 586-234-2337 or CelliniJ1@Michigan.gov.

Testing
VOC DE sampling will be performed simultaneously at the inlet and outlet of the thermal oxidizer in accordance with the USEPA Reference Methods 1, 2, 3, 4, and 25A via three (3) 60-minute runs. A Fyrite analyzer may be used for stack gas molecular weight determination. Moisture may be determined using the wet bulb/dry bulb method if stack

Testing is scheduled for July 25, 2024. Please notify Jillian Cellini and me if there is a change in schedule.

Sincerely,

Andrew Riley
Air Quality Division

cc: Bruce Connel, Environmental Partners
Bill Byczynski, Stack Test Group
Jeremy Howe, EGLE
Joyce Zhu, EGLE
Mark Dziadosz, EGLE
Jillian Cellini, EGLE

EPI
Environmental Partners Inc.

305 Hoover Blvd, Suite 200
Holland, MI 49423
Ph: 616-928-9130
Fax: 616-928-9126

April 30, 2024

Mr. Jeremy Howe, Supervisor
EGLE-AQD
Technical Programs Unit
Constitution Hall, 2nd Floor South Tower
525 W. Allegan
Lansing, Michigan 48909-7760

Subject: Orafol
67 Kay Industrial, Lake Orion, MI
Notification of Performance Evaluation

Dear Mr. Howe:

Please find enclosed a Test Plan for the performance of capture verification and destruction efficiency testing on the regenerative thermal oxidizer (RTO No.2) at the Orafol facility in Lake Orion, Michigan. Testing, as required by PTI 46-13A, is currently scheduled to be conducted July 25, 2024.

Should you have any questions regarding the test plan, please call me at (616) 928-9127. For testing coordination or technical questions regarding the reverse roll coating process, please contact Joshua Flood at (248) 377-4999.

Sincerely,
Environmental Partners, Inc.

Bruce H. Connell
Principal

cc: Joshua Flood, Orafol
Ms. Joyce Zhu, EGLE-AQD Warren District Office
File

DESTRUCTION EFFICIENCY TEST PLAN

FOR

REGENERATIVE THERMAL OXIDIZER NO. 2

(RTO NO.2)

At

Orafol
67 Kay Industrial Drive
Lake Orion, Michigan 48361

April 30, 2024

Prepared by:

Environmental Partners, Inc.
305 Hoover Boulevard, Suite 200
Holland, Michigan 49423

EPI
Environmental Partners Inc.

1. Introduction

Orafol (SRN: N2702) in conjunction with Environmental Partners, Inc., has prepared the following air emissions compliance test plan to determine the Volatile Organic Compound (VOC) destruction efficiency of the regenerative thermal oxidizer (RTO No. 2) and the non-fugitive enclosure verification of the clean room enclosure around EU-Line2, located at the Lake Orion, Michigan manufacturing facility (67 Kay Industrial Drive).

Orafol (formerly known as KPMF USA Investment) is permitted under PTI#46-13A (FG-2022) for two (2) plastic coating which will be controlled by a shared regenerative thermos oxidizer (RTO No. 2). EU-Line2 will have the capability of applying either solvent based or water-based coatings to plastic. EU-Line3 will have the capability of producing plastic casted film line. A copy of the PTI is enclosed in Appendix A.

Coating Line EU-Line2 will be housed in a clean room which will meet the definition of a non-fugitive enclosure (NFE) and therefore capable of 100% capture. The exhaust from EU-Line2 be directed to a regenerative thermal oxidizer (RTO No.2).

Orafol has currently completed the installation of EU-Line2 and as required by special conditions FG-2022/v.2 and v.3 require a demonstration of air flow into the EU-Line2 enclosure using smoke tube and a destruction efficiency test of the RTO No. 2 within 180 days of completion of the installation.

EU-Line2 completed installation on March 25, 2024, requiring that the testing be completed by September 21, 2024. Orafol has tentatively set the destruction efficiency test and capture demonstration for Thursday, July 25, 2024, with a back-up date of Friday, July 26, 2024. This test plan identifies the test methodologies to be employed for both the destruction efficiency of the RTO and the capture efficiency verification for the NFE.

2. VOC Destruction Efficiency Testing Methodologies

2.1 Capture Verification Test

Permit-to-Install 46-13A, Flexible Group FG-2022, special condition V.2 requires verification of the capture efficiency of the non-fugitive enclosure for EU-Line2. In accordance with special condition V.2, this test plan proposes that verification will consist of visual observations of air current at each Non-ducted Opening (NDO) associated with each non-fugitive enclosure. These observations will occur during the RTO destruction efficiency testing.

2.2 RTO Destruction Efficiency Test

Special Condition V.3 of FG-2022 requires the verification of the VOC destruction efficiency of RTO No.2. Testing will be conducted utilizing USEPA Methods 1, 2, 3, 4, 18 (as necessary), and 25A as described in the *Code of Federal Regulations, Title 40, Part 60, Appendix A*. Descriptions of these methods are as follows:

Destruction Efficiency Test Methods

USEPA Method	Description
1	Sample and Velocity Traverses for Stationary Sources
2	Determination of Stack Gas Velocity and Volumetric Flow Rate
3	Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
4	Determination of Moisture Content in Stack Gases
18	Measurement of Gaseous Organic Compound Emissions by Gas Chromatography
25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

For destruction efficiency test of the RTO, testing will include three separate one-hour test runs performed utilizing USEPA Methods 1 - 4 and 25A. The oxidizer outlet VOC concentration is expected to be below 50 ppmv as carbon based on the high efficiency of the control device, therefore U.S. EPA Method 25A is proposed for the test method. For each test run, the concentration and mass emission rate of VOC in the oxidizer exhaust will be compared to the

corresponding concentration and mass input rate of VOC to the oxidizer in order to determine the average VOC destruction efficiency.

Specific test locations, volumetric flow rates, and concentrations of oxygen, carbon dioxide and moisture in the exhaust streams will be determined in accordance with Methods 1 through 4. Two (2) velocity measurements will be made at each test location for each one-hour test run (i.e., one just before and one just after each test). If the ending of one test run is reasonably temporally coincidental to the start of a subsequent test run, the ending velocity measurement for the previous run will be utilized as the beginning velocity measurement for the subsequent test run.

Velocity measurements will be made in accordance with USEPA Methods 1 and 2. Molecular weight and moisture determinations will be made in accordance with USEPA Methods 3 and 4.

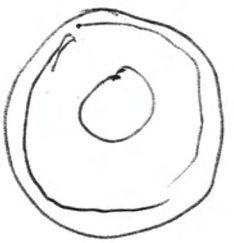
Gaseous samples will be extracted continuously and simultaneously at the inlet and outlet of the oxidizers to determine total gaseous organic concentrations during each test run using JUM Model VE-7 flame ionization analyzers, in accordance with Method 25A. The sample stream will be collected through a heated filter and stainless steel probe, and drawn to the analyzer via a heated Teflon sample line.

The sampling line will be heated to at least the minimum temperature required by the test method (Method 25A), or the temperature of the oxidizer exhaust, whichever is greater. The flame ionization analyzers will be pre-calibrated in the applicable ranges. Appropriate mid-range span and zero calibration gases will be introduced and the analyzer response will be checked between each test run, as well as after the final test run. Calibration gases will consist of certified (Protocol 1) concentrations of propane in air.

Sixty (60) one-minute averages for each run will be totaled and averaged to determine an average VOC concentration for each test run. VOC emission results for each test will be presented on a concentration basis (parts per million by volume as propane, ppmv C_3H_8), and mass emission rate basis (pounds per hour as propane). The VOC destruction efficiency of the regenerative thermal oxidizer will be calculated by comparing the mass of VOC measured at the RTO inlet to the mass of VOC measured in the RTO exhaust for each test run, and computing the arithmetic average of the three efficiency values.

If appropriate, the concentration of methane and ethane in the gas streams will be determined by collecting integrated gas samples at the inlet and outlet of the oxidizer, and analyzing for methane and ethane using USEPA Method 18.

Such concentrations of non-VOC compounds will be deducted from the total gaseous organic concentrations measured at both the inlet and outlet locations.



3. Operating Conditions and Process Data Monitoring

Testing will be conducted while the coating line is being operated under representative conditions. Material usages will be monitored during each test and the utilization rates will be used to demonstrate the representativeness of the process operating conditions during the compliance test program. This information will be included in the final test report.

The following process and control device parameters will be recorded during each test run:

1. RTO combustion chamber temperatures;

2. Production line speed for the coating line; and

3. Coating usages and VOC content

4. Documentation of smoke current flow at each Non-Ducted Opening (NDO)

At the conclusion of the test series, a comprehensive test report will be prepared detailing the methodologies, findings and conclusions of this test program. The report will include all test data, descriptions of test methods, calculation summaries, copies of applicable calibration data, process data and control device parameters.

4. Source Contact and Test Personnel

The contact for the source is:

Mr. Joshua Flood
Facilities & EHS Manager
Orafol
67 Kay Industrial Drive
Lake Orion, Michigan 48361
248-377-4999 ext. 3483
248-277-0573 Fax
Joshua_Flood@kayautomotive.net

The test program will be coordinated by:

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The test program will be conducted by:

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