FINAL REPORT

FCA US LLC

WARREN, MICHIGAN

WARREN TRUCK ASSEMBLY PLANT – WEST PAINT SHOP TRANSFER EFFICIENCY AND CAPTURE EFFICIENCY TESTING

RWDI #2104810

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) and JLB Industries, LLC were retained by FCA US LLC (FCA) to complete compliance testing of the coating operations at their Warren Truck Assembly Plant (WTAP) West Paint Shop located at 21500 Mound Road, Warren, Michigan. The scope of the test program was to complete paint solids transfer efficiency (TE) and Booth and Oven Capture Efficiency (BCE/OCE) testing of the Primer/Tutone operations (EUPRIMERWEST) and Topcoat operations (EUTOPCOATWEST). This compliance testing program focusses solely on the West Paint Shop. The West Paint Shop has one coating line. The program considered the following coatings:

- Primer;
- Tutone Primer;
- Tutone Coloring Primer;
- Basecoat; and
- Clearcoat.

Results of the testing are considered representative of plant production. The results will support on-going VOC monthly emission calculations. WTAP West Paint Shop currently operates under Permit to Install (PTI) Permit # 13-19B dated June 23, 2021.

The testing program consisted of Transfer Efficiency (TE) testing and Capture Efficiency (CE) testing. Determination of TE and CE were conducted in accordance with all applicable procedures contained in USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations". The testing was completed during the week of September 13th, 2021 concluding on September 17th, 2021. The testing consisted of the following:

- Paint solids transfer efficiency (TE) – the percent of paint solids sprayed that deposit on the painted part. was measured when applying primer, tutone primer, tutone coloring primer, basecoat and clearcoat and are considered to be representative for all Primer and Topcoat Operations.
- Volatile Organic Compound (VOC) capture efficiency (CE) was completed on the booth, heated flash zone and bake oven zones for the "EUPRIMERWEST and EUTOPCOATWEST" lines. This includes the percent of VOC captured from the curing of the coating in the spray booths, heated flash, and bake ovens. The spray booth, heated flash and bake oven VOC CE is used to calculate the mass of VOC captured per gallon of applied coating solids (lb VOC/gacs) and is also referred to as oven solvent loading. Spraybooth, heated flash and oven VOC CE was measured at the "EUPRIMERWEST and EUTOPCOATWEST" systems when applying primer, tutone primer, tutone coloring primer, basecoat and clearcoat and are considered to be representative for all primer and topcoat operations.

RWDI/JLB Industries used highly accurate weighing systems to determine the vehicle and panel weights before and after coating application. Calibrated volumetric flow meters, located on each applicator, were used to measure paint usage.

Material samples were collected from the paint circulation tanks directly after vehicle spray out. Determination of percent solids by weight and density was performed by RTI Laboratories, located in Livonia, Michigan.

Transfer Efficiency (TE) Results Summary

Tested Coating	Solids Transfer Efficiency (%)
Gray Prime (Primer)	73.8%
Roof Prime (Tutone Primer)	84.7%
Tutone Monocoat (Tutone Coloring Primer)	60.3%
White Basecoat (Basecoat)	71.1%
Clearcoat	76.3%

Capture Efficiency (CE) Results Summary

		Loading (Lb/GACS)	Capture Efficiency
		EU-PRIMERWEST / EU-TOPCOAT WEST	
Gray Prime (Primer)	Booth/Flash	5.43	59.9%
	Oven	1.75	19.3%
	Total	**7.18**	**79.2%**
Roof Prime (Tutone Primer)	Booth/Flash	5.43	69.9%
	Oven	1.47	18.9%
	Total	**6.89**	**88.8%**
Tutone Monocoat (Tutone Coloring Primer)	Booth	6.49	51.1%
	Oven	2.86	22.6%
	Total	**9.35**	**73.7%**
White Basecoat (Basecoat)	Booth	1.19	17.8%
	Oven	3.91	58.5%
	Total	**5.10**	**76.3%**
Clearcoat (Clearcoat)	Booth	4.34	47.4%
	Oven	3.02	32.9%
	Total	**7.36**	**80.3%**

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1 INTRODUCTION

RWDI AIR Inc. (RWDI) and JLB Industries, LLC were retained by FCA US LLC (FCA) to complete compliance testing of the coating operations at their Warren Truck Assembly Plant (WTAP) West Paint Shop located at 21500 Mound Road, Warren, Michigan. The scope of the test program was to complete paint solids transfer efficiency (TE) and Booth and Oven Capture Efficiency (BCE/OCE) testing of the Primer/Tutone operations (EUPRIMERWEST) and Topcoat operations (EUTOPCOATWEST). This compliance testing program focusses solely on the West Paint Shop. The West Paint Shop has one coating line. The program considered the following coatings:

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- Volatile Organic Compound (VOC) capture efficiency (CE) was completed on the booth, heated flash zone and bake oven zones for the "EUPRIMERWEST and EUTOPCOATWEST" lines. This includes the percent of VOC captured from the curing of the coating in the spray booths, heated flash, and bake ovens. The spray booth, heated flash and bake oven VOC CE is used to calculate the mass of VOC captured per gallon of applied coating solids (lb VOC/gacs) and is also referred to as oven solvent loading. Spraybooth, heated flash and oven VOC CE was measured at the "EUPRIMERWEST and EUTOPCOATWEST" systems when applying primer, tutone primer, tutone coloring primer, basecoat and clearcoat and are considered to be representative for all primer and topcoat operations.

RWDI/JLB Industries used highly accurate weighing systems to determine the vehicle and panel weights before and after coating application. Calibrated volumetric flow meters, located on each applicator, were used to measure paint usage.

A Source Testing Plan, for the testing, was submitted to the Michigan Department of Environment, Great Lakes and Energy (EGLE) on July 14, 2021. Testing was successfully completed while all process equipment was operating under normal operating conditions during the week of September 13th, 2021. A copy of the Source Testing Plan is provided in **Appendix A.**

Testing of emissions was conducted by Mr. Jim Belanger, Mr. Jeff Monache and Mr. Kyle Lyons of JLB, and Mr. Steve Smith of RWDI. Mr. Bradley Wargnier and Mr. Thomas Caltrider were on-site to monitor the process operation and witness the testing on behalf of FCA US LLC. Testing was witness by Ms. Regina Angellotti and Mr Bob Byrnes from EGLE.

2 SOURCE AND SAMPLING LOCATIONS

2.1 Process Description

WTAP operates an automobile assembly plant that produces the Jeep Wagoneer models in the West Paint Shop and the Classic Ram 1500 series trucks in the East Paint Shop for FCA US LLC. This program focuses only on the West Paint Shop. Vehicle body panels are stamped and assembled on site from sheet metal components. The bodies are cleaned, treated, and prepared for painting in the phosphate system. Then the vehicle bodies are dip coated in electro deposition corrosion primer for protection (EUECOATWEST). The electro primer (E-coat) is heat-cured to the vehicle body in a high-temperature bake oven. After completing the E-coat operation, vehicle bodies are conveyed to the sealer area for application of various sealants to body seams and joints.

The vehicles are then routed to a prep tunnel; two (2) automatic primer booths (EUPRIMERWEST- one for solvent borne main primer and Tutone primer, and one for solvent borne Tutone colorant/coloring primer, (also referred to as Monocoat or Black Roof); a primer/Tutone observation zone; two (2) ambient flash-off areas; and a natural gas fired primer oven. Coating booth overspray is controlled by a waterwash particulate control system. A portion of the primer and Tutone coating booths exhaust is filtered and recirculated to the booth air make-up system. The primer and Tutone coating booth emissions are exhausted through a bank of particulate filters, then to the west concentrator and then to the west RTO (via concentrator desorption exhaust). Primer Oven emissions are exhausted directly to the west RTO. Emissions from the observation zones and ambient flash-off areas are controlled by particulate control system and exhausted to the ambient air.

After the primer booths, the vehicles are routed to an automatic topcoat spray application consisting of a waterborne basecoat coating booth, a basecoat observation zone, a basecoat ambient flash-off area, a basecoat heated flash-off area, a solvent borne clearcoat coating booth, a clearcoat observation zone, a clearcoat ambient flash-off area and a natural gas fired curing oven. A portion of the basecoat and clearcoat coating booth exhaust will be filtered and recirculated to the booth air make-up system. All spray booth emissions some ambient flash-off areas are exhausted through a bank of particulate filters, then to the west concentrator and then to the west RTO. Oven emissions are exhausted directly to the west RTO. Emissions from the observation zones and the balance of ambient flash-off areas are controlled by particulate control system and exhausted to the ambient air.

An overview of the process to be sampled and associated sampling sites is provided below. The sampling locations were changed from the initial Source Testing Plan to accommodate additional locations as discussed with EGLE on-site. Two (2) additional weighing locations were added in the tutone controlled area for the Primer and Tutone Primer in order to obtain any additional VOCs captured in the tutone controlled area. Any carryover (VOCs captured int the Tutone controlled area) was included into the booth capture values.

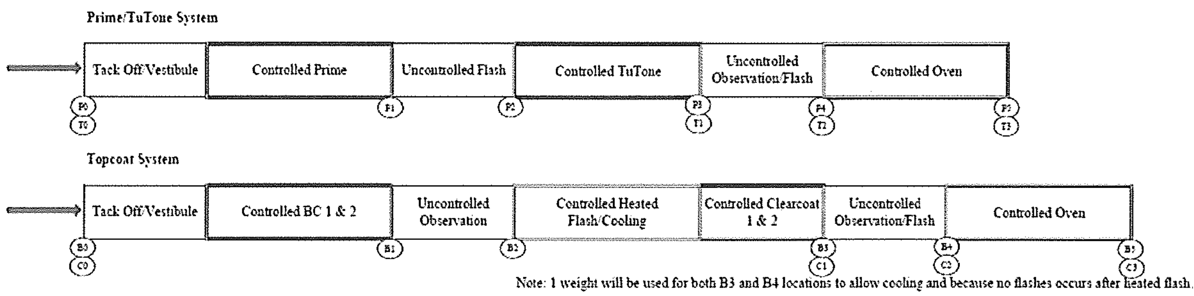

Figure 1: Process and Sampling Location Overview

Table 2.1-1: Summary of Applicator Parameters

Operation	Manufacturer	Applicator	Bell Size	Gun Voltage (kV)	RPM	Gun-to-Target Distance (inch)	Remarks
Primer	Fanuc	Versa Bell III	80mm	80kV	50k	10"	Solventborne
Tutone	Fanuc	Versa Bell III	65mm	30 to 80 kV	50 – 55k	8" interior 10"exterior	Solventborne
Basecoat	Fanuc	Versa Bell III	65mm	30 – 80kV	35 – 50k	8" interior 10"exterior	Waterborne
Clearcoat	Fanuc	Versa Bell III	65mm	30 – 80kV	50 – 55k	8" interior 10"exterior	Solventborne

Notes: mm – millimetres
kV – kilovolts
RPM – revolutions per minute
26 jobs per hour - Prime
25 jobs per hour - Topcoat

2.2 Control Equipment

Primer, Tutone and Topcoat Spray Booths are controlled using a downdraft ventilation system and water wash system below the booth grate to control paint overspray. Captured primer, tutone primer, tutone coloring primer, basecoat and clearcoat booth, heated flash zone and bake oven VOC emission and some ambient flash areas are directed to regenerative thermal oxidizer for VOC abatement. All controls were functioning during the testing period.

2.3 Operating Parameters

The following process control measures were recorded during the testing:

- Coating usage;
- Application information;
- Bake Oven Temperature;
- Spray booth relative humidity; and
- Spray booth temperature.

The following summarizes the Spray booth and Bake Oven process conditions.

Table 2.3-1: Summary of Operating Conditions - Primer

Source	Primer Spray Booth Temperature			Primer Spray Booth Relative Humidity			Surfacer Oven Temperature		
	Unit	09/14/21	09/15/21	Unit	09/14/21	09/15/21	Unit	09/14/21	09/15/21
Primer	Primer	74°F	76°F	Primer	63%	66%	Zone 1	376°F	375°F
	--						Zone 1 Sill	350°F	353°F
	--						Zone 2	391°F	391°F
	--						Zone 2 Sill	355°F	355°F
	--						Zone 3	310°F	310°F
	--						Zone 4	310°F	310°F
	--						Zone 5	310°F	310°F
	--						Zone 6	298°F	300°F
							Cooling	77°F	71°F

Table 2.3-2: Summary of Operating Conditions - Tutone

Source	Tutone Spray Booth Temperature		Tutone Spray Booth Relative Humidity		Surfacer Oven Temperature	
	Unit	09/16/21	Unit	09/16/21	Unit	09/16/21
Primer	Tutone	76°F	Tutone	61%	Zone 1	375°F
	--				Zone 1 Sill	347°F
	--				Zone 2	389°F
	--				Zone 2 Sill	355°F
	--				Zone 3	309°F
	--				Zone 4	310°F
	--				Zone 5	310°F
	--				Zone 6	299°F
					Cooling	63°F

Table 2.3-3: Summary of Operating Conditions - Basecoat

Source	Basecoat Spray Booth Temperature		Basecoat Spray Booth Relative Humidity		Basecoat Heated Flash Temperate/Relative Humidity		Topcoat Oven Temperature	
	Unit	09/17/21	Unit	09/17/21	Unit	09/17/21	Unit	09/17/21
Primer	Basecoat	75°F	Basecoat	61%	Basecoat	151°F / 6%	Zone 1	320°F
	--						Zone 1 Sill	255°F
	--						Zone 2	326°F
	--						Zone 2 Sill	254°F
	--						Zone 3	296°F
	--						Zone 4	291°F
	--						Zone 5	281°F
							Cooling	63°F

Table 2.3-4: Summary of Operating Conditions - Clearcoat

Source	Clearcoat Spray Booth Temperature		Clearcoat Spray Booth Relative Humidity		Clearcoat Heated Flash Temperate/Relative Humidity		Topcoat Oven Temperature	
	Unit	**09/16/21**	**Unit**	**09/16/21**	**Unit**	**09/16/21**	**Unit**	**09/16/21**
Primer	**Clearcoat**	80°F	**Clearcoat**	**64%**	Clearcoat	151°F / 6%	**Zone 1**	320°F
	--						**Zone 1 Sill**	254°F
	--						**Zone 2**	328°F
	--						**Zone 2 Sill**	254°F
	--						**Zone 3**	295°F
	--						**Zone 4**	290°F
	--						**Zone 5**	281°F
							Cooling	63°F

2.4 Process Sampling Locations

A process sample of each coating applied during the testing was collected for analysis. The coatings were collected following procedures in USEPA's "Standard Procedure for Collection of Coating and Ink Samples for Analysis by Method 24 and 24A".

Coating samples were collected at the application point into four (4) ounce glass sampling jars with minimal headspace. The coating-as-applied samples were analyzed using USEPA Method 24 to measure percent VOC, percent water and density. The results are summarized below in **Table 2.4-1** and in **Appendix C**.

Table 2.4-1: Summary of Method 24 Coating Analysis

Sample	Parameter									
	Date	% Non-Volatile	% Volatile	Density		% Water	VOC		VOC-Water	
				g/ml	lb/gal		g/L	lb/gal	g/L	lb/gal
Gray Prime (Primer)	9/17/21	66.64	33.36	1.345	11.23	N/A	0.449	3.75	N/A	N/A
Roof Primer (Tutone Primer)	9/17/21	65.73	34.27	1.293	10.79	N/A	0.443	3.70	N/A	N/A
Black Monocoat (Tutone Colorant)	9/17/21	52.88	47.12	1.025	8.56	N/A	0.483	4.03	N/A	N/A
White (Basecoat)	9/17/21	47.70	52.30	1.258	10.50	36.7	0.196	1.64	0.367	3.06
Clearcoat Part A	9/17/21	57.38	24.62	1.055	8.80	N/A	0.450	3.75	N/A	N/A
Clearcoat Part B	9/17/21	58.03	41.97	1.012	8.45	N/A	0.425	3.55	N/A	N/A

In addition, seven (7) samples were collected by RWDI/JLB (6 samples + 1 blank) of waterborne coating (basecoat) to analyze for percent moisture. The samples were collected at the point of application on foil panels attached to the test vehicles. The coated foils were then transferred into a four (4) ounce glass sampling jar and anhydrous methanol was added to the sampling jar to allow the coating to disperse. The sample was then allowed to separate and analyzed for percent water using ASTM E203-08 "Standard Test Method for Water Using Volumetric Karl Fischer Titration". The ASTM E203 -08 coating analysis is summarized in **Table 2.4-2** and **Appendix C.**

Table 2.4-2: Summary of Volumetric Karl Fischer Titration Coating Analytical

Sample	Date	Parameter Percent Water
Blank	9/17/2021	0.020
Sample B1 White Solid	9/17/2021	0.160
Sample B2 White Solid	9/17/2021	0.160
Sample B3 White Solid	9/17/2021	0.170
Sample B4 White Solid	9/17/2021	0.170
Sample B5 White Solid	9/17/2021	0.140
Sample B6 White Solid	9/17/2021	0.070

3 SAMPLING AND ANALYTICAL PROCEDURES

3.1 Summary of Test Program

The EUPRIMERWEST and EUTOPCOATWEST process at WTAP West Paint Shop is comprised of one (1) paint line. The primer, tutone and topcoat system consists of several spray sections followed by an associated curing oven. The spray booth operations are defined as follows:

- Primer Robots: Liquid solvent based primer was applied to the exterior and interior surfaces;
- Tutone Primer Robots: Liquid tutone solvent based primer was applied to the exterior and interior surfaces;
- Tutone Colorant Robots: Tutone monocoat solvent based coating was applied to the exterior and interior surfaces;
- Basecoat Robots – Basecoat waterborne was applied to the exterior and interior surfaces; and
- Clearcoat Robots - Clearcoat solventborne was applied to the exterior and interior surfaces.

Skidded vehicles are conveyed through the booth and coated with coating materials (primer, tutone primer, tutone coloring primer, basecoat and clearcoat). The vehicles are processed through a bake oven where the coating is cured.

Currently, coatings are applied to the Jeep Wagoneer production models. Production units on which an electrocoat corrosion inhibiting primer had been applied were used in the test program for the transfer efficiency testing. For the CE testing, scrap vehicles were used for the testing program. The test program is summarized below.

3.2 Transfer Efficiency Test

Transfer Efficiency testing was conducted in the Spray Booths where Primer, Tutone Primer, Tutone Coloring Primer, basecoat, and clearcoat were applied. Applicator and environmental conditions were monitored to ensure that the testing accurately reflected production conditions. Measured parameters included: Vehicle weight gain, material usage, material analysis (percent solids by weight and density), applicator settings, film build and oven heat settings.

A total of four (4) vehicle bodies were used in calculating test results. Three (3) vehicles were processed as normal production vehicles, and one vehicle were dedicated as a no-paint, control vehicle in conjunction with the testing. All units were production vehicles with cured body shop sealer.

An off-line vehicle weigh station (VWS) was constructed to measure the weight of the test units before and after each painting process. Test vehicles were routed to a dedicated conveyor spur. A fixed stop was secured to assure repeatable positioning of the vehicles. Test vehicles were lifted free from their carriers by two lift-table mounted scale bases. Ultra-high molecular weight (UHMW) plastic blocks were strategically placed on the scale bases to lift the vehicle at the center of gravity locations. The UHMW blocks minimized friction loading on vehicles and scale bases.

Vehicle weights were measured several times and recorded. All test vehicles were weighed with production fixtures (door hooks and hood props) installed. The vehicle weigh station scales were calibrated using Class-F calibration weights conforming to the National Bureau of Standards handbook 105-1. A one or two-pound avoirdupois, Class F stainless steel weight was added periodically during pre- and post-process weighing to verify scale linearity.

Coating thickness was measured on a representative test vehicle to verify paint film-build was within the production specification. The data was taken with a handheld Elcometer gauge.

Coating material usage was monitored via volumetric flow measurement devices located on each applicator. A verification of each applicator was performed by FCA personnel to ensure accurate usage measurement. Material samples of applied coatings were collected from the respective systems directly after testing. Samples were sent to RTI Laboratories for analysis to determine density by ASTM D1475 and weight solids content by ASTM D2369 (referenced in EPA Method 24). The laboratory results were used in calculating the Transfer Efficiency and Capture Efficiency values.

Production vehicles with body shop sealer were prepared with e-coat and processed through the Spray Booth systems. The test sequence for the Transfer Efficiency test was:

Gray Primer (Primer):

1. Test Unit ID TE1 – Carrier 1293
2. Test Unit ID TE2 – Carrier 1278
3. Test Unit ID TE3 – Carrier 1274
4. Test Unit ID TE4 – Carrier 1199 (no-paint control)

Roof Prime (Tutone Primer)

1. Test Unit ID TE1 – Carrier 1293
2. Test Unit ID TE2 – Carrier 1278
3. Test Unit ID TE3 – Carrier 1275
4. Test Unit ID TE4 – Carrier 1199 (no-paint control)

Tutone Monocoat (Tutone Colorant)

1. Test Unit ID TE1 – Carrier 1293
2. Test Unit ID TE2 – Carrier 1278
3. Test Unit ID TE3 – Carrier 1275
4. Test Unit ID TE4 – Carrier 1199 (no-paint control)

White Basecoat (Basecoat)

1. Test Unit ID TE1 – Carrier 1293
2. Test Unit ID TE2 – Carrier 1278
3. Test Unit ID TE3 – Carrier 1275
4. Test Unit ID TE4 – Carrier 1199 (no-paint control)

Clearcoat (Clearcoat)

1. Test Unit ID TE1 – Carrier 1293
2. Test Unit ID TE2 – Carrier 1278
3. Test Unit ID TE3 – Carrier 1275
4. Test Unit ID TE4 – Carrier 1199 (no-paint control)

Test Vehicles were routed through the bake oven and back to the vehicle weigh station. After cooling, the test vehicles were weighed and released to production.

3.3 Capture Efficiency Tests

A panel weigh station (PWS) was assembled at the Spray Booths. A precision balance with measurement capability to 0.001 gram was placed on an isolation platform inside an enclosure to minimize vibration and air movement.

The testing conformed to the methods described in ASTM 5087-02 for solvent borne coatings and ASTM 6266-00a (Reapproved 2005) for waterborne coatings.

Test panels were placed on a test vehicle and processed with normal production spray programming.

At least three electrocoated panels were used for each test. Each group of test panels was weighed in several locations (see panel test diagram) to determine the relative distribution of VOC that is released in the controlled booth zone and bake oven. The panels were attached to test vehicles by magnet, which allowed for removal of the wet panels with minimal disturbance to the coating during handling. Panel mounting locations were chosen to achieve a representative coating film based on the observation of normal vehicle production.

Before the panels were coated, they were marked (1, 2, 3, blank) and weighed to establish the initial unpainted panel weights (P0). The panels were then attached to a test vehicle and routed through the Spray Booth. After coating, the panels were carefully removed from the test vehicle and brought to the balance for weighing immediately upon exit from the controlled booth zone (P1). Panels were weighed again before entering the controlled bake oven (P2). The panels were then placed on the test vehicle for travel through the curing oven. Upon exiting the oven, the panels were allowed to cool and then weighed a final time (P3). The sampling locations were changed from the initial Source Testing Plan to accommodate additional locations as per discussion with EGLE on-site. Two (2) additional weighing locations were added in the tutone controlled area in order to determine if any additional VOCs were captured in the controlled zone. Any carryover (VOCs from tutone controlled) was included into the booth capture values.

4 TEST EQUIPMENT AND QA/QC PROCEDURES

Equipment used in this program passed the Quality Assurance /Quality Control (QA/QC) procedures. **Appendix D** contains the calibration records of the equipment and inspection sheets.

4.1 Pretest QA/QC Activities and Audits

Before testing, the equipment was inspected and calibrated according to the procedures outlined in the applicable procedures outlined in the USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobiles and Light Duty Truck Topcoat Operations", as referenced in 40 CFR 63, Subpart IIII. Refer to **Appendix D** for inspection and calibration sheets.

The results of select sampling and equipment QA/QC audits are presented in the following sections. Refer to **Appendix D** for inspection and calibration sheets. Test Equipment and QA/QC Procedures

4.1.1 Vehicle Weigh Station (VWS)

A dedicated vehicle weigh station (VWS) equipped with two 1,000 lb. capacity scale bases was used to obtain pre- and post-process vehicle weights. The VWS is accurate to better than 0.05 pounds.

The scales were calibrated as directed by the operating instruction manual. Scales were powered up and exercised by placing 250 pounds of Class F calibration weights on each scale platform. Then, the VWS was calibrated with 500 pounds of Class F calibration weights. VWS linearity was checked using a one-pound, Class F stainless steel calibration weight. The one-pound weight was also added to each test vehicle during pre- and post-process weighing to verify scale linearity.

4.1.2 Material Usage

Coating material usage was monitored via volumetric flow measurement devices located on each applicator. A verification of the applicators was performed by FCA personnel before testing to ensure accurate usage data. Paint usage was measured at each applicator in a graduated cylinder and compared to the expected volume.

A sample of each material was taken after each test and analyzed by Advanced Technologies of Materials, located in Waverly, Ohio. These values were used in calculating the paint solids sprayed and the transfer efficiency. ASTM Method D-2369 was used to determine paint solids. ASTM Method D-1475 was used to determine paint density.

4.1.3 Panel Weigh Station

A panel weigh station (PWS) with measurement capability to 0.001 gram was used to measure panel weights. The balance was warmed up and then calibrated with a 300 gram test weight. The balance was tested with 100, 50, 10 and 1 gram weights before commencing weighing operations. A blank panel weight was measured at the beginning of the testing program and again at the time of each subsequent panel weight measurement. The balance was placed on an isolation platform and inside an enclosure to minimize vibration and airflow at the measurement point.

5 RESULTS

The testing program consisted of Transfer Efficiency (TE) testing and Capture Efficiency (CE) testing. Determination of TE and CE were conducted in accordance with all applicable procedures contained in USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations".

The test results will be used to demonstrate compliance with Auto MACT requirements and for use in monthly emissions compliance calculations for the CAAP Permit and 40CFR 63 Subpart IIII – National Emissions Standards or Hazardous Pollutants: Surface Coating of Automobiles and Light Duty Trucks, emission limits.

5.1 Results

Results are summarized in Tables 5.2-1 and 5.2-2 for TE and CE. Detailed VOC CE and paint solids TE results are presented in Table Section. All sampling field notes are provided in **Appendix F**. Sample Calculations are provided in **Appendix G**. All laboratory results are included in **Appendix C**. Process Data is provided in **Appendix B**.

Table 5.1-1: Transfer Efficiency Results Summary

Tested Coating	Solids Transfer Efficiency (%)
Gray Prime (Primer)	73.8%
Roof Prime (Tutone Primer)	84.7%
Tutone Monocoat (Tutone Colorant)	60.3%
White Basecoat (Basecoat)	71.1%
Clearcoat	76.3%

Table 5.1-2 Capture Efficiency (CE) Results Summary

		Loading (Lb/GACS)	Capture Efficiency
		EU-PRIMERWEST / EU-TOPCOAT WEST	
Gray Prime (Primer)	**Booth/Flash**	5.43	59.9%
	Oven	1.75	19.3%
	Total	**7.18**	**79.2%**
Roof Prime (Tutone Primer)	**Booth/Flash**	5.43	69.9%
	Oven	1.47	18.9%
	Total	**6.89**	**88.8%**
Tutone Monocoat (Tutone Colorant)	**Booth**	6.49	51.1%
	Oven	2.86	22.6%
	Total	**9.35**	**73.7%**
White Basecoat (Basecoat)	**Booth**	1.19	17.8%
	Oven	3.91	58.5%
	Total	**5.10**	**76.3%**
Clearcoat (Clearcoat)	**Booth**	4.34	47.4%
	Oven	3.02	32.9%
	Total	**7.36**	**80.3%**

5.2 Discussion of Results

There were no significant disruptions to the testing program.

6 PROCESS CONDITIONS

Operating conditions during the sampling were monitored by FCA personnel. All equipment was operated under normal maximum operating conditions. Process Data is provided in **Appendix B**.

Contact was maintained between the operator and the sampling team. A member of the RWDI/JLB sampling team was in contact with FCA staff during the entire sampling program.

7 CONCLUSIONS

Testing was successfully completed during the week of September 13th, 2021. All parameters were tested in accordance with referenced methodologies.

TABLES

Table 1: Gray Prime Transfer Efficiency (Primer)
WTAP, September 2021

Vehicle ID	Vehicle Weight Gain (lb.)	Avg. Vehicle Weight Gain (lb.)	Avg. Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Avg. Solids Sprayed (lb.)	Transfer Efficiency (%)
Variable:	VWG	AVWG	PS	CD	WSF	SS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(PS*CD*WSF)	(AVWG/SS)
TE 1	2.14	2.13	0.386	11.23	0.6664	2.89	**73.8%**
TE 2	2.09						
TE 3	2.16						

All Vehicle Weight Gains witin 10% of Average
Upper Limit 2.34
Lower Limit 1.92

Table 2: Roof Prime Transfer Efficiency (Tutone Primer)
WTAP, September 2021

Vehicle ID	Vehicle Weight Gain (lb.)	Avg. Vehicle Weight Gain (lb.)	Avg. Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Avg. Solids Sprayed (lb.)	Transfer Efficiency (%)
Variable:	VWG	AVWG	PS	CD	WSF	SS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(PS*CD*WSF)	(AVWG/SS)
TE 1	2.26	2.24	0.131	10.79	0.6573	0.93	**84.7%**
TE 2	2.27		0.228	11.23	0.6664	1.71	
TE 3	2.18						
						2.64	

Note: Total solids sprayed (2.64 lb) is the sum of the Roof Prime (0.93 lb) and Gray Prime (1.71 lb) sprayed.

All Vehicle Weight Gains witin 10% of Average
Upper Limit 2.46
Lower Limit 2.01

Table 3: Tutone Transfer Efficiency (Tutone Monocoat) WTAP, September 2021

Vehicle ID	Vehicle Weight Gain (lb.)	Avg. Vehicle Weight Gain (lb.)	Avg. Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Avg. Solids Sprayed (lb.)	Transfer Efficiency (%)
Variable:	VWG	AVWG	PS	CD	WSF	SS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(PS*CD*WSF)	(AVWG/SS)
TE 1	0.48	0.51	0.186	8.56	0.5288	0.84	**60.3%**
TE 2	0.52						
TE 3	0.52						

All Vehicle Weight Gains witin 10% of Average

Upper Limit	0.56
Lower Limit	0.46

Table 4: Clearcoat Transfer Efficiency
WTAP, September 2021

Vehicle ID	Vehicle Weight Gain (lb.)	Avg. Vehicle Weight Gain (lb.)	Avg. Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Avg. Solids Sprayed (lb.)	Transfer Efficiency (%)
Variable:	VWG	AVWG	PS	CD	WSF	SS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(PS*CD*WSF)	(AVWG/SS)
TE 1	2.08	2.09	0.275	8.80	0.5738	1.39	**76.3%**
TE 2	2.07		0.275	8.45	0.5803	1.35	
TE 3	2.12						
					Total Solids Sprayed:	**2.74**	

Note: Total solids sprayed (2.74 lb) is the sum of the part A (1.39 lb) and part B (1.35 lb) sprayed.

All Vehicle Weight Gains witin 10% of Average
Upper Limit 2.30
Lower Limit 1.88

Table 5: White Basecoat Transfer Efficiency
WTAP, September 2021

Vehicle ID	Vehicle Weight Gain (lb.)	Avg. Vehicle Weight Gain (lb.)	Avg. Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Avg. Solids Sprayed (lb.)	Transfer Efficiency (%)
Variable:	VWG	AVWG	PS	CD	WSF	SS	TE
Calculation:	(W2-W1)	(avg VWG-CTL)	(avg PS)	(Method 24)	(Method 24)	(PS*CD*WSF)	(AVWG/SS)
TE 1	2.10	2.16	0.606	10.50	0.4770	3.04	**71.1%**
TE 2	2.21						
TE 3	2.16						

All Vehicle Weight Gains witin 10% of Average
Upper Limit 2.37
Lower Limit 1.94

Table 6a: Prime Booth VOC Capture Efficiency (Primer)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC remaining after zone (g)	Weight of VOC remaining per Weight Solids Deposited (g)	Mass Fraction Solids	Mass Fraction VOC in Coating	VOC fraction remaining on Panel after Zone	Section Capture Efficiency (%)
Variable	P0	P1	P5	Wsdep	Wrem	P_m	W_s	W_{VOC}	P_{VOC}	CE
Formula				P3-P0	P1-P3	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
P1	188.019	190.063	189.697	1.678	0.366	0.218				
P2	187.448	189.707	189.318	1.870	0.389	0.208				
P3	185.894	188.180	187.776	1.882	0.404	0.215				
P4	186.241	188.401	188.020	1.779	0.381	0.214				
Average				1.802	0.385	0.214	0.6664	0.3336	0.427	**57.3%**

Booth Loading Calculation

	VOC Content (lb VOC/gal)	Volume Solids Fraction	Transfer Efficiency (%)	Weight of VOC generated per volume of solids deposited (lb/GACS)	Capture Efficiency	Weight of VOC captured per volume of applied solids deposited (lb/GACS)
Variable	VOC	V_S	TE	VOC_G	CE	VOC_A
Formula				VOC/ (V_S*TE)		$CE*VOC_G$
Lab	3.745	0.5604	73.8%	9.06	0.573	5.19

Table 6b: Prime VOC Loading/Capture Efficiency Carryover (Primer) (note carryover is the VOC loading from the controlled Tutone zone . Results are added to booth results) - WTAP, September 2021

Solvent Loading

Sample	Blank Panel Weights (g)	Wet Panel Weights - Enter Zone (g)	Wet Panel Weights - Exit Zone (g)	Panel Weights - After Bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P2	P3	P5	Wcos	Wa	CL
Formula					P3-P0	P1-P2	$(W_a/W_{cos})*D_{cos}$
P1	188.019	189.968	189.948	189.697	1.678	0.020	0.16
P2	187.448	189.615	189.573	189.318	1.870	0.042	0.30
P3	185.894	188.086	188.053	187.776	1.882	0.033	0.23
P4	186.241	188.311	188.277	188.020	1.779	0.034	0.26
Average							**0.24**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	11.23	0.6664	0.5604	1.24	0.3336	13.35

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc) (Wvoc)			(V_s) (TE)		(P) (V_{sdep}) (100)/(VOC)
0.3336	11.23	3.745	73.8%	0.5604	0.413	0.24	**2.6%**

Table 6c: Prime Oven VOC Capture Efficiency (Primer)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Bake (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P4	P5	Wcos	Wa	CL
Formula				P3-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
P1	188.019	189.922	189.697	1.678	0.225	1.79
P2	187.448	189.561	189.318	1.870	0.243	1.73
P3	185.894	188.023	187.776	1.882	0.247	1.75
P4	186.241	188.250	188.020	1.779	0.230	1.73
Average				1.802	0.236	**1.75**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	11.23	0.6664	0.5604	1.0	0.3336	13.35

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			(V_s)(TE)		(P)(V_{sdep})(100)/(VOC)
0.3336	11.23	3.745	73.8%	0.5604	0.413	1.75	**19.3%**

Table 7a: Roof Prime Booth VOC Capture Efficiency (Tutone Primer)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC remaining after zone (g)	Weight of VOC remaining per Weight Solids Deposited (g)	Mass Fraction Solids	Mass Fraction VOC in Coating	VOC fraction remaining on Panel after Zone	Section Capture Efficiency (%)
Variable	P0	P1	P5	Wsdep	Wrem	P_m	W_s	W_{VOC}	P_{VOC}	CE
Formula				P3-P0	P1-P3	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
RP1	187.272	189.822	189.426	2.154	0.396	0.184				
RP2	187.798	189.042	188.877	1.079	0.165	0.153				
RP3	187.668	188.924	188.764	1.096	0.160	0.146				
RP4	188.021	189.241	189.092	1.071	0.149	0.139				
Average				1.350	0.218	0.161	0.6573	0.3427	0.309	**69.1%**

Booth Loading Calculation

	VOC Content (lb VOC/gal)	Volume Solids Fraction	Transfer Efficiency (%)	Weight of VOC generated per volume of solids deposited (lb/GACS)	Capture Efficiency	Weight of VOC captured per volume of applied solids deposited (lb/GACS)
Variable	VOC	V_S	TE	VOC_G	CE	VOC_A
Formula				$VOC/(V_S*TE)$		$CE*VOC_G$
Lab	3.697	0.5616	84.7%	7.77	0.691	5.37

Table 7b: Roof Prime VOC Loading/Capture Efficiency Carryover (Tutone Primer) (note carryover is the VOC loading from the controlled Tutone zone . Results are added to booth results) - WTAP, September 2021

Solvent Loading

Sample	Blank Panel Weights (g)	Wet Panel Weights - Enter Zone (g)	Wet Panel Weights - Exit Zone (g)	Panel Weights - After Bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P2	P3	P5	Wcos	Wa	CL
Formula					P3-P0	P1-P2	$(W_a/W_{cos})*D_{cos}$
RP1	187.272	189.743	189.730	189.426	2.154	0.013	0.08
RP2	187.798	189.008	189.006	188.877	1.079	0.002	0.02
RP3	187.668	188.886	188.882	188.764	1.096	0.004	0.05
RP4	188.021	189.218	189.210	189.092	1.071	0.008	0.09
Average							**0.06**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	10.79	0.6573	0.5616	0.95	0.3427	12.63

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.3427	10.79	3.697	84.7%	0.5616	0.476	0.06	**0.8%**

Table 7c: Roof Prime Oven VOC Capture Efficiency (Tutone Primer)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Bake (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P4	P5	Wcos	Wa	CL
Formula				P3-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
RP1	187.272	189.708	189.426	2.154	0.282	1.65
RP2	187.798	188.996	188.877	1.079	0.119	1.39
RP3	187.668	188.880	188.764	1.096	0.116	1.34
RP4	188.021	189.202	189.092	1.071	0.110	1.30
Average				1.350	0.157	**1.47**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	10.79	0.6573	0.5616	1.0	0.3427	12.63

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc) (Wvoc)			(V_s) (TE)		(P) (V_{sdep}) (100)/(VOC)
0.3427	10.79	3.697	84.7%	0.5616	0.476	1.47	**18.9%**

Table 8a: Tutone Booth VOC Capture Efficiency (Tutone Monocoat)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC remaining after zone (g)	Weight of VOC remaining per Weight Solids Deposited (g)	Mass Fraction Solids	Mass Fraction VOC in Coating	VOC fraction remaining on Panel after Zone	Section Capture Efficiency (%)
Variable	P0	P1	P3	Wsdep	Wrem	P_m	W_s	W_{VOC}	P_{VOC}	CE
Formula				P3-P0	P1-P3	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
TT1	187.313	190.038	189.205	1.892	0.833	0.440				
TT2	185.802	188.036	187.358	1.556	0.678	0.436				
TT3	186.310	188.517	187.850	1.540	0.667	0.433				
TT4	187.836	190.185	189.477	1.641	0.708	0.431				
Average				1.657	0.721	0.435	0.5288	0.4712	0.489	**51.1%**

Booth Loading Calculation

	VOC Content (lb VOC/gal)	Volume Solids Fraction	Transfer Efficiency (%)	Weight of VOC generated per volume of solids deposited (lb/GACS)	Capture Efficiency	Weight of VOC captured per volume of applied solids deposited (lb/GACS)
Variable	VOC	V_S	TE	VOC_G	CE	VOC_A
Formula				$VOC/(V_S*TE)$		$CE*VOC_G$
Lab	4.032	0.5272	60.3%	12.68	0.511	6.49

Table 8b: Tutone Oven VOC Capture Efficiency (Tutone Monocoat)
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Bake (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P2	P3	Wcos	Wa	CL
Formula				P3-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
TT1	187.313	189.828	189.205	1.892	0.623	2.83
TT2	185.802	187.885	187.358	1.556	0.527	2.91
TT3	186.310	188.366	187.850	1.540	0.516	2.88
TT4	187.836	190.021	189.477	1.641	0.544	2.85
Average				1.657	0.552	**2.86**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	8.56	0.5288	0.5272	1.6	0.4712	8.58

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			(V_s)(TE)		(P)(V_{sdep})(100)/(VOC)
0.4712	8.56	4.032	60.3%	0.5272	0.318	2.86	**22.6%**

Table 9a: Clearcoat Booth VOC Capture Efficiency
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC remaining after zone (g)	Weight of VOC remaining per Weight Solids Deposited (g)	Mass Fraction Solids	Mass Fraction VOC in Coating	VOC fraction remaining on Panel after Zone	Section Capture Efficiency (%)
Variable	P0	P1	P3	Wsdep	Wrem	P_m	W_s	W_{VOC}	P_{VOC}	CE
Formula				P3-P0	P1-P3	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
C1	187.865	191.028	190.138	2.273	0.890	0.392				
C2	188.337	191.368	190.522	2.185	0.846	0.387				
C3	186.761	189.532	188.779	2.018	0.753	0.373				
C4	187.195	190.370	189.479	2.284	0.891	0.390				
Average				2.190	0.845	0.386	0.5771	0.4230	0.526	**47.4%**

Booth Loading Calculation

	VOC Content (lb VOC/gal)	Volume Solids Fraction	Transfer Efficiency (%)	Weight of VOC generated per volume of solids deposited (lb/GACS)	Capture Efficiency	Weight of VOC captured per volume of applied solids deposited (lb/GACS)
Variable	VOC	V_S	TE	VOC_G	CE	VOC_A
Formula				$VOC/(V_S*TE)$		$CE*VOC_G$
Lab	3.649	0.5218	76.3%	9.17	0.474	4.34

Table 9b: Clearcoat Oven VOC Capture Efficiency
WTAP, September 2021

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Bake (g)	Panel Weights - after bake (g)	Weight of Coating Solids Deposited (g)	Weight of VOC available for abatement (g)	Weight of VOC available per volume of coating solids (lb/GACS)
Variable	P0	P2	P3	Wcos	Wa	CL
Formula				P3-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
C1	187.865	190.884	190.138	2.273	0.746	3.13
C2	188.337	191.227	190.522	2.185	0.705	3.08
C3	186.761	189.387	188.779	2.018	0.608	2.87
C4	187.195	190.193	189.479	2.284	0.714	2.98
Average				2.190	0.693	**3.02**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	Average Film Build Thickness (mil)	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	mil	W_{voc}	D_{cos}
Formula						(Ws*Wc)/Vs
Lab	8.63	0.5771	0.5218	2.6	0.4230	9.54

Capture Efficiency

Mass Fraction VOC in Coating	Coating Density (lb/gal)	Mass VOC per Volume Coating (lb/gal)	Transfer Efficiency (%)	Volume Fraction Solids	Volume Solids Deposited per Volume Coating Sprayed	Panel Test Result (lb VOC/ gal Solids)	Oven VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			(V_s)(TE)		(P)(V_{sdep})(100)/(VOC)
0.4230	8.63	3.648	76.3%	0.5218	0.398	3.02	**32.9%**

Table 10 White Solid Basecoat Booth Capture Efficiency
WTAP, September 2021

	Unit	Variable	Formula	Panel 1	Panel 2	Panel 3	Panel 4	
Blank Panel Weight	g	B0		188.059	188.681	188.200	187.669	
Panel at Booth Ctl Exit	g	B1		189.932	190.662	190.374	189.867	
Panel at Flash Exit/Oven Entrance	g	B3		189.512	190.213	189.805	189.292	
Baked Panel Weight	g	B5		189.350	190.054	189.652	189.110	
At Entrance to Flash								
% Nonvolatile	%	%NV	(P5-P0)/(P2-P0)	68.9%	69.3%	66.8%	65.6%	
% Volatile	%	%V	100-%NV	31.1%	30.7%	33.2%	34.4%	
% Water	%	$\%H_2O$	Average KF	6.90%	6.90%	6.90%	6.90%	
% VOC	%	%VOC	$\%V-\%H_2O$	24.2%	23.8%	26.3%	27.5%	Average W_{VOC1}
Weight of VOC Available for Control	g	W_{VOC}	(P2-P0)*%VOC	0.453	0.471	0.572	0.605	0.525
At Flash Exit/Oven Entrance	*Note: Flash exit and oven entrance weight are the same to allow for panel to cool before weight.*							
% Nonvolatile	%	%NV	(P3-P0)/(P2-P0)	88.9%	89.6%	90.5%	88.8%	
% Volatile	%	%V	100-%NV	11.1%	10.4%	9.5%	11.2%	
% Water	%	$\%H_2O$	Average KF	4.90%	4.90%	4.90%	4.90%	
% VOC	%	%VOC	$\%V-\%H_2O$	6.3%	5.5%	4.6%	6.3%	Average W_{VOC2}
Weight of VOC Available for Control	g	W_{VOC}	(P3-P0)*%VOC	0.091	0.084	0.074	0.103	0.088
At Oven Exit								
% Nonvolatile	%	%NV	(P3-P0)/(P3-P0)	100.0%	100.0%	100.0%	100.0%	
% Volatile	%	%V	100-%NV	0.0%	0.0%	0.0%	0.0%	
% Water	%	$\%H_2O$	Average KF	0.0%	0.0%	0.0%	0.0%	
% VOC	%	%VOC	$\%V-\%H_2O$	0.0%	0.0%	0.0%	0.0%	Average W_{VOC3}
Weight of VOC Available for Control	g	W_{VOC}	(P5-P0)*%VOC	0.000	0.000	0.000	0.000	0.000
Solids Coating Density								
Coating Density	lb/gal	W_C	Material Property					10.50
Mass Fraction Solids		W_S	Material Property					0.4770
Volume Fraction Solids		V_S	Material Property					0.3450
Solids Density	lb/gal	D_{COS}	$(W_S*W_C)/V_S$					14.52
Coating Solids Deposited								Average W_{COS}
Weight of Coating Solids Deposited	g	W_{COS}	(P3-P0)	1.291	1.373	1.452	1.441	1.389
Loading in Flash								
Weight VOC Available in Flash	g	$W_{VOC\ Flash}$	$W_{VOC1}-W_{VOC2}$					0.437
Weight of VOC available per GACS	lb/gal	C_{Lflash}	$(W_{VOC\ Flash}/W_{COS})*D_{COS}$					4.57
Loading in Oven								
Weight VOC Available in Oven	g	$W_{VOC\ Oven}$	$W_{VOC2}-W_{VOC3}$					0.088
Weight of VOC available per GACS	lb/gal	C_{Loven}	$(W_{VOC\ Oven}/W_{COS})*D_{COS}$					0.92
Weight VOC Available Total	lb/gal	C_L	$C_{Lflash}+C_{Loven}$					**5.49**
Capture Efficiency Calculation								
Mass Fraction VOC		W_{VOC}	Material Property					0.1560
Mass VOC per Volume Coating	lb/gal	VOC	W_C*W_{VOC}					1.638
Transfer Efficiency	%	TE						71.1%
Volume Solids Deposited per Volume Coating Sprayed		V_{sdep}	(V_S*TE)					0.245
VOC Not Captured in Booth	%	VOC_{NOT}	$C_L*V_{sdep}*100/VOC$					82.2%
Booth VOC Capture Efficiency	%	CE	$1-VOC_{NOT}$					**17.8%**

Loading in Booth

VOC Content (lb VOC/gal)	1.638
Volume Solids Fraction	0.345
Transfer Efficiency	71.1%
Weight of VOC generated per volume of solids deposited (VOC_G),(lb/GACS), VOC/(VS*TE)	6.68
Capture Efficiency	17.8%
Weight of VOC captured per volume of applied solids deposited (lb/GACS), $CE*VOC_G$	**1.19**

Table 11: White Solid Basecoat Karl Fisher

WTAP, September 2021 Foil Data Flash Entrance

Sample	Foil Weights (g)	Jar & Lid Weights (g)	Jar, Lid & Coated Foil Weights (g)	Jar, Lid, Coated Foil, & Methanol Weights (g)	KF % Water in Sample (% wt)	Weight of Paint Sample on Foil (g)	Weight of Methanol Used (g)	Water in Paint Sample (wt/wt)
Variable	F	J	K	L	KF	P	M	H2O Fract
Formula						K-(F+J)	L-K	(KF*(M+P)-KFb*M)/P
B1	3.440	123.252	128.296	205.307	0.160%	1.604	77.011	6.88%
B2	3.293	123.551	128.569	203.482	0.160%	1.725	74.913	6.24%
B3	3.085	123.841	128.552	208.765	0.170%	1.626	80.213	7.57%
Average								**6.90%**

KFb 0.020% = % H2O in field blank

Foil Data Oven Entrance

Sample	Foil Weights (g)	Jar & Lid Weights (g)	Jar, Lid & Coated Foil Weights (g)	Jar, Lid, Coated Foil, & Methanol Weights (g)	KF % Water in Sample (% wt)	Weight of Paint Sample on Foil (g)	Weight of Methanol Used (g)	Water in Paint Sample (wt/wt)
Variable	F	J	K	L	KF	P	M	H2O Fract
Formula						K-(F+J)	L-K	(KF*(M+P)-KFb*M)/P
B4	2.814	123.328	127.652	190.905	0.170%	1.510	63.253	6.45%
B5	2.862	124.250	128.757	201.523	0.140%	1.645	72.766	5.45%
B6	2.638	123.648	127.834	212.017	0.070%	1.548	84.183	2.79%
Average								**4.90%**

KFb 0.020% = % H2O in field blank

Table 12: White Solid Basecoat Oven Capture EfficiencyWTAP, September 2021

	Unit	Variable	Formula	Panel 1	Panel 2	Panel 3	Panel 4	
Blank Panel Weight	g	B0		188.059	188.681	188.200	187.669	
Panel at Flash Entrance	g	B2		189.795	190.511	190.195	189.684	
Panel at Flash Exit/Oven Entrance	g	B3		189.512	190.213	189.805	189.292	
Baked Panel Weight	g	B5		189.350	190.054	189.652	189.110	
At Entrance to Flash								
% Nonvolatile	%	%NV	(P5-P0)/(P2-P0)	74.4%	75.0%	72.8%	71.5%	
% Volatile	%	%V	100-%NV	25.6%	25.0%	27.2%	28.5%	
% Water	%	$\%H_2O$	Average KF	6.90%	6.90%	6.90%	6.90%	
% VOC	%	%VOC	$\%V-\%H_2O$	18.7%	18.1%	20.3%	21.6%	Average W_{VOC1}
Weight of VOC Available for Control	g	W_{VOC}	(P2-P0)*%VOC	0.325	0.331	0.405	0.435	0.374
At Flash Exit/Oven Entrance	*Note: Flash exit and oven entrance weight are the same to allow for panel to cool before weight.*							
% Nonvolatile	%	%NV	(P3-P0)/(P2-P0)	88.9%	89.6%	90.5%	88.8%	
% Volatile	%	%V	100-%NV	11.1%	10.4%	9.5%	11.2%	
% Water	%	$\%H_2O$	Average KF	4.90%	4.90%	4.90%	4.90%	
% VOC	%	%VOC	$\%V-\%H_2O$	6.3%	5.5%	4.6%	6.3%	Average W_{VOC2}
Weight of VOC Available for Control	g	W_{VOC}	(P3-P0)*%VOC	0.091	0.084	0.074	0.103	0.088
At Oven Exit								
% Nonvolatile	%	%NV	(P3-P0)/(P3-P0)	100.0%	100.0%	100.0%	100.0%	
% Volatile	%	%V	100-%NV	0.0%	0.0%	0.0%	0.0%	
% Water	%	$\%H_2O$	Average KF	0.0%	0.0%	0.0%	0.0%	
% VOC	%	%VOC	$\%V-\%H_2O$	0.0%	0.0%	0.0%	0.0%	Average W_{VOC3}
Weight of VOC Available for Control	g	W_{VOC}	(P5-P0)*%VOC	0.000	0.000	0.000	0.000	0.000
Solids Coating Density								
Coating Density	lb/gal	W_C	Material Property					10.50
Mass Fraction Solids		W_S	Material Property					0.4770
Volume Fraction Solids		V_S	Material Property					0.3450
Solids Density	lb/gal	D_{COS}	$(W_S*W_C)/V_S$					14.52
Coating Solids Deposited								Average W_{COS}
Weight of Coating Solids Deposited	g	W_{COS}	(P3-P0)	1.291	1.373	1.452	1.441	1.389
Loading in Flash								
Weight VOC Available in Flash	g	$W_{VOC\ Flash}$	$W_{VOC1}-W_{VOC2}$					0.286
Weight of VOC available per GACS	lb/gal	C_{Lflash}	$(W_{VOC\ Flash}/W_{COS})*D_{COS}$					2.99
Loading in Oven								
Weight VOC Available in Oven	g	$W_{VOC\ Oven}$	$W_{VOC2}-W_{VOC3}$					0.088
Weight of VOC available per GACS	lb/gal	C_{Loven}	$(W_{VOC\ Oven}/W_{COS})*D_{COS}$					0.92
Weight VOC Available Total	lb/gal	C_L	$C_{Lflash}+C_{Loven}$					**3.91**
Capture Efficiency Calculation								
Mass Fraction VOC		W_{VOC}	Material Property					0.1560
Mass VOC per Volume Coating	lb/gal	VOC	W_C*W_{VOC}					1.638
Transfer Efficiency	%	TE						71.1%
Volume Solids Deposited per Volume Coating Sprayed		V_{sdep}	(V_S*TE)					0.245
VOC Capture Efficiency	%	CE	$C_L*V_{sdep}*100/VOC$					**58.5%**