FINAL REPORT

FCA US LLC

DETROIT, MICHIGAN

JEFFERSON NORTH ASSEMBLY PLANT (JNAP) TRANSFER EFFICIENCY AND OVEN SOLVENT LOADING TESTING

RWDI #2302204

April 16, 2023

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) and JLB Industries, LLC (JLB) were retained by FCA US LLC (FCA) to complete source testing of the Topcoat operations at their Jefferson North Assembly Plant (JNAP) located at 2101 Connor Ave., Detroit, Michigan. The test program included the completion of paint solids transfer efficiency (TE) and capture efficiency (CE) and Oven Solvent Loading (OSL) of one (1) of the Topcoat operations (EU-TOPCOAT1), on the following coatings:

- Metallic Basecoat
- Solid Basecoat
- Clearcoat

Results of the testing are considered representative of plant production. The results are used to support on-going VOC monthly emission calculations. JNAP currently operates under Renewable Operating Permit (ROP) MI-ROP-N2155-2017.

Transfer Efficiency values were derived using the Jeep Grand Cherokee model 4-door which accounts for majority of the production vehicles made at the facility. Personnel from the paint shop, FCA environmental staff and RWDI/JLB conducted the testing. These groups worked together at each stage of testing to ensure that the results were representative of production conditions.

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 JLB.

Transfer Efficiency (TE) Results Summary

Tested Coating	Solids Transfer Efficiency (%)
Basecoat (White Solid Basecoat)	74.4%
Basecoat (Black Metallic)	75.0%
Clearcoat	81.3%

Capture Efficiency (CE) Results Summary

		Loading (Lb/GACS)	Capture Efficiency
		EU-TOPCOAT1	EU-TOPCOAT1
Solid Basecoat (White)	Booth Control	4.51	41.2%
	Flash	0.74	6.8%
	Total Booth	***5.25***	***47.9%***
	Oven	0.73	6.7%
	Total Basecoat	***5.98***	***54.6%***
Metallic Basecoat (Black)	Booth Control	3.88	33.0%
	Flash	0.89	7.5%
	Total Booth	***4.77***	***40.5%***
	Oven	1.43	12.0%
	Total Basecoat	***6.21***	***52.5%***
Clearcoat	Booth	3.43	37.8%
	Oven	3.53	38.8%
	Totals	***6.96***	***76.6%***

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1 INTRODUCTION

RWDI USA LLC (RWDI) and JLB Industries, LLC (JLB) were retained by FCA US LLC (FCA) to complete source testing of the Topcoat operations at their Jefferson North Assembly Plant (JNAP) located at 2101 Connor Ave., Detroit, Michigan. The test program included the completion of paint solids transfer efficiency (TE) and capture efficiency (CE) and Oven Solvent Loading (OSL) of one (1) of the Topcoat operations (EU-TOPCOAT1), on the following coatings:

- Metallic Basecoat
- Solid Basecoat
- Clearcoat

Results of the testing are considered representative of plant production. The results are used to support on-going VOC monthly emission calculations. JNAP currently operates under Renewable Operating Permit (ROP) MI-ROP-N2155-2017.

A Source Testing Plan, for the testing, was submitted to the State of Michigan Department of Environment, Great Lakes and Energy (EGLE) on December 20, 2022. Testing was successfully completed while all process equipment was operating under representative operating conditions during the week of February 20th, 2023, with testing completed on February 21st to 23rd, 2023. 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. Hunter Griggs of RWDI. Mr. Steven Szura and Mr. Thomas Caltrider were on-site to monitor the process operation and witness the testing on behalf of FCA US LLC. Testing was witnessed by EGLE by Mr. Bob Byrnes and Mr. Andrew Riley.

2 SOURCE AND SAMPLING LOCATIONS

2.1 Process Description

JNAP is located at 2101 Conner Avenue in Detroit, Michigan. The facility completes assembly and paint operations for FCA US LLC. Vehicle body panels are assembled on site from sheet metal components. The bodies are cleaned, treated, and prepared for painting in the phosphate system. Drawing compounds, mill oils, and dirt are removed from the vehicle bodies utilizing both high pressure spray and immersion cleaning/rinsing techniques. Vehicle bodies then are dip coated in electro deposition corrosion primer paint for protection. 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. Vehicle bodies are then conveyed to an oven to cure the sealers.

After the sealer oven, the vehicles are routed to the powder prime system and then topcoat operations. In the topcoat system, the bodies receive solvent borne basecoat and clearcoat coatings. After topcoat is applied, the vehicle is baked in the topcoat oven. After exiting the topcoat oven, the vehicles are routed to inspection.

An overview of the process to be sampled is provided below.

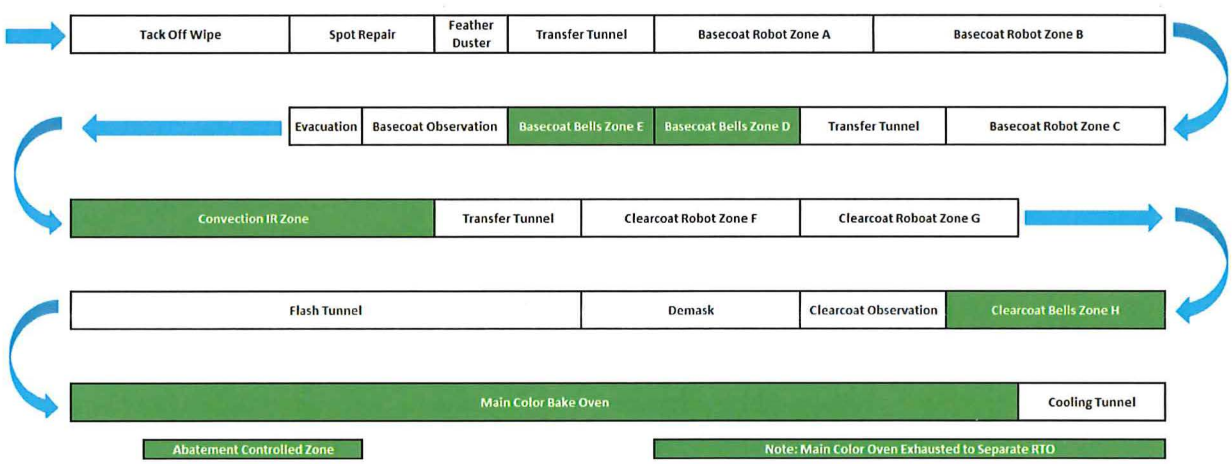

Figure 2.1-1: Process Overview

Table 2.1-1: Summary of "EU-TOPCOAT1" Applicator Parameters

Operation	Manufacturer	Applicator	Fluid Tip/ Bell Size	Air Cap	Gun Voltage (kV)	RPM	Gun-to-Target Distance (inch)
Basecoat Robot	ABB	EFC	1.5 mm	1 – ½"	80kVA	N/A	10 inches
Basecoat Fixed Bell	ITW	ITW MMA 303	0.9 mm	N/A	60-80 kV	38,000	10 - 12 inches
Basecoat Recip	ABB	ITW RMA 303	1.6 mm	N/A	N/A	N/A	14 inches
Clearcoat Robot	ABB	EFC	1.5mm	1-1/2"	80 kV	N/A	10 inches
Clearcoat Bell on Robot	ABB	ITW RMA 303	1.6 mm	N/A	80 kV	35,000	10 inches
Clearcoat Fixed Bell	ITW	ITW MMA 303	1.6 mm	N/A	60 - 80 kV	38,000	10 - 12 inches

Notes: mm – millimetres
kV – kilovolts
RPM – revolutions per minute
Line Speed – 16.9 fpm

2.2 Control Equipment

Topcoat Spray Booths are controlled using a downdraft ventilation system and water wash system below the booth grate to control paint overspray. Captured spraybooth and basecoat flash zone emissions are directed to a filter house, concentrator and a thermal oxidizer (one per booth) for VOC abatement and the VOC emissions from the ovens are controlled by a second set of thermal oxidizers (one per oven). All controls were functioning during the testing period, although not evaluated in the program.

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 – EU-TOPCOAT1 – Spray Booth

Zone	February 21, 2023		February 22, 2023		February 23, 2023	
	Spray Booth Temperature (°F)	Spray Booth Relative Humidity (%)	Spray Booth Temperature (°F)	Spray Booth Relative Humidity (%)	Spray Booth Temperature (°F)	Spray Booth Relative Humidity (%)
ASH1	74	65	76	66	77	66
ASH2	75	16	75	21	76	24
ASH3	81	69	80	70	80	71
ASH4	80	56	81	54	79	57
ASH5	75	55	75	55	75	56
HF1	190	--	192	--	195	--
HF2	180	--	179	--	181	--
HF3	161	--	160	--	161	--

Note: ASH – Air supply House
HF – Heated Flash

Table 2.3-2: Summary of Operating Conditions – EU-TOPCOAT1 – Oven

Source	Zone	February 21,2023	February 22, 2023	February 23, 2023
Oven	Zone 1	235°F	236°F	235°F
	Sill Heater	288°F	290°F	292°F
	Zone 2	293°F	296°F	294°F
	Zone 2A	294°F	293°F	295°F
	Zone 3	280°F	281°F	279°F

2.4 Process Sampling Locations

Process samples of each coating applied during the testing were 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 by JLB 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 B**.

Table 2.4-1: Summary of Method 24 Coating Analysis

Sample	Parameter		
	Date	% Non-Volatile	Density (lb/gal)
White Solid (Basecoat)	2/28/2023	62.57 (TE/CE)	10.414 (TE/CE)
Black Metallic (Basecoat)	2/28/2023	50.35 (CE) / 50.25 (TE)	8.139 (CE) / 8.133 (TE)
Clearcoat	2/28/2023	55.6 (CE) / 55.8 (TE)	8.639 (CE) / 8.638 (TE)

3 SAMPLING AND ANALYTICAL PROCEDURES

3.1 Summary of Test Program

The topcoat process at JNAP is comprised of three (3) topcoat paint lines, "EU-TOPCOAT1", "EU-TOPCOAT2" and "EU-TOPCOAT3". Only EU-TOPCOAT1 line was tested for this program. The topcoat system consists of several spray sections followed by an associated curing oven. The spray booth operations are defined as follows:

- Basecoat Robots – Basecoat was applied to the exterior and interior surfaces; and
- Clearcoat Robots – Clearcoat was applied to the exterior and interior surfaces.

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

Currently, coatings are applied to the Jeep Grand Cherokee and Dodge Durango production models. Testing was completed on the Jeep Grand Cherokee model. 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 Topcoat Spray Booth where white solid basecoat, black metallic 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 vehicle bodies were used in calculating test results. Three vehicles were processed as normal production vehicles, and one vehicle was 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 analyzed by JLB Industries 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 electrocoat prime and processed through the Topcoat Spray Booth. The test sequence for the Transfer Efficiency test was:

White Solid Basecoat:

1. Test Unit ID TE1
2. Test Unit ID TE2
3. Test Unit ID TE3
4. Test Unit ID TE4 – (no-paint control)

Black Metallic Basecoat:

1. Test Unit ID TE1
2. Test Unit ID TE2
3. Test Unit ID TE3
4. Test Unit ID TE4 – (no-paint control)

Clearcoat:

1. Test Unit ID TE1
2. Test Unit ID TE2
3. Test Unit ID TE3
4. Test Unit ID TE4 – (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 Topcoat Spray Booth. 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.

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

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 was 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 and weighed to establish the initial unpainted panel weights (B0). 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 (B1 for Basecoat and C1 for Clearcoat). Basecoat panels were weighed again before and after the controlled flash (B2 and B3) and again after the oven process (B4). Clearcoat panels were weighed again before entering the controlled bake oven (C2). The panels were then placed on the test vehicle for travel through the curing oven. Upon exiting the oven, the Clearcoat panels were allowed to cool and then weighed a final time (C3).

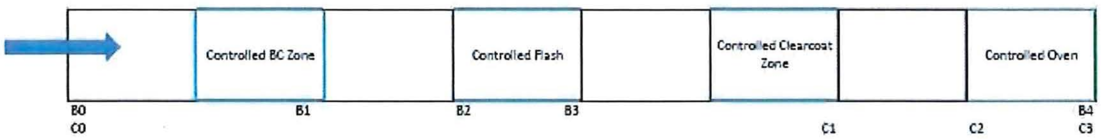

Figure 3.2-1: Panel Testing Diagram

4 TEST EQUIPMENT AND QA/QC PROCEDURES

Equipment used in this program passed the Quality Assurance /Quality Control (QA/QC) procedures. **Appendix C** 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 C** for inspection and calibration sheets.

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

4.2 Transfer Efficiency QA/QC Blanks

One (1) no-paint control vehicle was run through the process with each test batch to account for weight-loss attributable to sealers. The results of the control vehicles are presented in **Table 4.2-1**.

Table 4.2-1: Summary of Transfer Efficiency QA/QC Control Vehicles

Vehicle Identification	Vehicle Weight Gain (lb)	Vehicle Batch
TE-4	-0.18	White Solid Basecoat Batch
TE-4	0.00	Black Metallic Batch
TE-4	-0.18	Clearcoat Batch

4.3 Test Equipment and QA/QC Procedures

4.3.1 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.

4.3.2 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 JLB Industries. 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.

4.3.3 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 Oven 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".

5.1 Results

Results are summarized in Tables 5.1-1 and 5.1-2 for TE and CE. Detailed VOC CE and paint solids TE results are presented in Table Section of the Report. All sampling field notes are provided in **Appendix E.** Sample Calculations are provided in **Appendix F**. All laboratory results are included in **Appendix B.** Process Data is provided in **Appendix G.**

Table 5.1-1 – Transfer Efficiency Results Summary

Tested Coating	Solids Transfer Efficiency (%)
Basecoat (White Solid Basecoat)	74.4%
Basecoat (Black Metallic)	75.0%
Clearcoat	81.3%

Table 5.1-2 – Capture Efficiency Results Summary

		Loading (Lb/GACS)	Capture Efficiency
		EU-TOPCOAT1	EU-TOPCOAT1
Solid Basecoat (White)	Booth Control	4.51	41.2%
	Flash	0.74	6.8%
	Total Booth	***5.25***	***47.9%***
	Oven	0.73	6.7%
	Total Basecoat	***5.98***	***54.6%***
Metallic Basecoat (Black)	Booth Control	3.88	33.0%
	Flash	0.89	7.5%
	Total Booth	***4.77***	***40.5%***
	Oven	1.43	12.0%
	Total Basecoat	***6.21***	***52.5%***
Clearcoat	Booth	3.43	37.8%
	Oven	3.53	38.8%
	Totals	***6.96***	***76.6%***

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 G**.

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 February 20th, 2023. All parameters were tested in accordance with referenced methodologies.

TABLES

Table 1: White Solid Basecoat Transfer Efficiency Summary
DACJ Transfer Efficiency Test
February 2023

Vehicle ID	Vehicle Weight Gain (lb.)	Average Vehicle Weight Gain (lb.)	Average Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Average Solids Sprayed	Transfer Efficiency (%)
Variable:	VWG	AVWG	APS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	avg VWG - CTL	(PS)	(Method 24)	(Method 24)	(APS*CD*WSF)	(AVWG/BSS)
TE 1	2.71	2.99	0.616	10.41	0.6257	4.01	74.4%
TE 2	2.83						
TE 3	2.85						

Control Vehicle

Vehicle ID	Vehicle Weight Gain (lb.)
Variable:	CTL
Calculation:	(W2-W1)
TE 4	-0.19

Table 2: Black Metallic Basecoat Transfer Efficiency Summary
DACJ Transfer Efficiency Test
February 2023

Vehicle ID	Vehicle Weight Gain (lb.)	Average Vehicle Weight Gain (lb.)	Average Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Average Solids Sprayed	Transfer Efficiency (%)
Variable:	VWG	AVWG	APS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	avg VWG-CTL	(PS)	(Method 24)	(Method 24)	(APS*CD*WSF)	(AVWG/BSS)
TE 5	1.54	1.56	0.510	8.13	0.5025	2.09	75.0%
TE 6	1.57						
TE 7	1.58						

Control Vehicle

Vehicle ID	Vehicle Weight Gain (lb.)
Variable:	CTL
Calculation:	(W2-W1)
TE 4	0.00

Table 3: Clearcoat Transfer Efficiency Summary
DACJ Transfer Efficiency Test
February 2023

Vehicle ID	Vehicle Weight Gain (lb.)	Average Vehicle Weight Gain (lb.)	Average Paint Sprayed (gal)	Coating Density (lb/gal)	Weight Solids Fraction	Average Solids Sprayed	Transfer Efficiency (%)
Variable:	VWG	AVWG	APS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	avg VWG - CTL	(PS)	(Method 24)	(Method 24)	(APS*CD*WSF)	(AVWG/BSS)
TE 1	2.02	2.19	0.560	8.64	0.5579	2.70	81.3%
TE 2	2.16						
TE 3	1.87						

Control Vehicle

Vehicle ID	Vehicle Weight Gain (lb.)
Variable:	CTL
Calculation:	(W2-W1)
TE 4	-0.18

Table 4: Solid Basecoat Booth VOC Capture Efficiency
DACJ
February 2023

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit	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	P4	W_{sdcp}	W_{rem}	P_m	W_s	W_{VOC}	P_{VOC}	$CE_{Section}$
Formula				P4-P0	P1-P4	W_{rem}/W_{sdcp}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
B1	187.908	188.974	188.866	0.958	0.108	0.113				
B2	189.185	190.354	190.219	1.034	0.135	0.131				
B3	189.159	190.331	190.197	1.038	0.134	0.129				
Average						0.124	0.626	0.374	0.208	79.2%

*Ratio in ctl zone: 51.9%
Adjusted CE 41.2%

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				$VOC/(V_S*TE)$		$CE*VOC_G$
	3.898	0.478	0.744	10.95	0.412	4.51

$CE = CE_{Section} * (V_{section}/V_{total})$

*$V_{section}/V_{total}$ is ratio of coating sprayed in the control zone to total coating sprayed in the booth.
See Appendix G: Paint Metering Data Record

Table 5: White Solid Basecoat Flash VOC Capture Efficiency
DACJ
February 2023

Solvent Loading

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Flash (g)	Panel Weights - after Flash (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	P4	W_{cos}	W_a	CL
Formula					P4-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
B1	187.908	188.956	188.922	188.866	0.958	0.034	0.48
B2	189.185	190.340	190.275	190.219	1.034	0.065	0.86
B3	189.159	190.315	190.248	190.197	1.038	0.067	0.88
Average							**0.74**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	W_{voc}	D_{cos}
Formula					(Ws*Wc)/Vs
Solid BC	10.41	0.6257	0.4783	0.3743	13.62

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)	Section VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.3743	10.41	3.898	74.4%	0.4783	0.356	0.74	**6.8%**

Table 6: White Solid Basecoat Oven VOC Capture Efficiency
DACJ
February 2023

Solvent Loading

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	P3	P4	W_{cos}	W_a	CL
Formula				P4-P0	P3-P4	$(W_a/W_{cos})*D_{cos}$
B1	187.908	188.922	188.866	0.958	0.056	0.80
B2	189.185	190.275	190.219	1.034	0.056	0.74
B3	189.159	190.248	190.197	1.038	0.051	0.67
Average						**0.73**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	W_{voc}	D_{cos}
Formula					(Ws*Wc)/Vs
Solid BC	10.41	0.6257	0.4783	0.3743	13.62

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)	Section VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.3743	10.41	3.898	74.4%	0.4783	0.356	0.73	**6.7%**

Table 7: Metallic Basecoat Booth VOC Capture Efficiency
DACJ
February 2023

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit	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	P4	W_{sdep}	W_{rem}	P_m	W_s	W_{VOC}	P_{VOC}	$CE_{Section}$
Formula				P4-P0	P1-P4	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
B1	188.497	188.939	188.841	0.344	0.098	0.285				
B2	188.945	189.384	189.294	0.349	0.090	0.258				
B3	187.407	187.763	187.693	0.286	0.070	0.245				
Average						0.263	0.504	0.498	0.266	73.4%

*Ratio in ctl zone: 44.9%
Adjusted CE 33.0%

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				$VOC/(V_S*TE)$		$CE*VOC_G$
	4.041	0.458	0.750	11.78	0.330	3.88

$CE = CE_{Section} * (V_{section}/V_{total})$

*$V_{section}/V_{total}$ is ratio of coating sprayed in the control zone to total coating sprayed in the booth.
See Appendix G: Paint Metering Data Record

Table 8: Black Metallic Basecoat Flash VOC Capture Efficiency
DACJ
February 2023

Solvent Loading

Sample	Blank Panel Weights (g)	Wet Panel Weights - Before Flash (g)	Panel Weights - after Flash (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	P4	W_{cos}	W_a	CL
Formula					P4-P0	P2-P3	$(W_a/W_{cos})*D_{cos}$
B1	188.497	188.934	188.914	188.841	0.344	0.020	0.52
B2	188.945	189.387	189.345	189.294	0.349	0.042	1.08
B3	187.407	187.762	187.728	187.693	0.286	0.034	1.06
Average							**0.89**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	W_{voc}	D_{cos}
Formula					(Ws*Wc)/Vs
Metallic BC	8.14	0.5035	0.4578	0.4965	8.95

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)	Section VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.4965	8.14	4.041	75.0%	0.4578	0.343	0.89	**7.5%**

Table 9: Black Metallic Basecoat Oven VOC Capture Efficiency
DACJ
February 2023

Solvent Loading

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	P3	P4	W_{cos}	W_a	CL
Formula				P4-P0	P3-P4	$(W_a/W_{cos})*D_{cos}$
B1	188.497	188.914	188.841	0.344	0.073	1.90
B2	188.945	189.345	189.294	0.349	0.051	1.31
B3	187.407	187.728	187.693	0.286	0.035	1.10
Average						**1.43**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	W_{voc}	D_{cos}
Formula					(Ws*Wc)/Vs
Metallic BC	8.14	0.5035	0.4578	0.4965	8.95

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)	Section VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.5035	8.14	4.098	75.0%	0.4578	0.343	1.43	**12.0%**

Table 10: Clearcoat Booth VOC Capture Efficiency
DACJ
February 2023

Sample	Blank Panel Weights (g)	Wet Panel Weights - Control Zone Exit	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}	$CE_{Section}$
Formula				P3-P0	P1-P3	W_{rem}/W_{sdep}			$(P_m)(W_s)/(W_{VOC})$	$1-P_{VOC}$
C1	188.046	190.342	189.661	1.615	0.681	0.422				
C2	190.207	192.405	191.767	1.560	0.638	0.409				
C3	191.282	193.406	192.790	1.508	0.616	0.408				
Average						0.413	0.556	0.442	0.519	48.1%

*Ratio in ctl zone: 78.5%
Adjusted CE 37.8%

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				$VOC/(V_S*TE)$		$CE*VOC_G$
	3.838	0.520	0.813	9.09	0.378	3.43

$CE = CE_{Section} * (V_{section}/V_{total})$

*$V_{section}/V_{total}$ is ratio of coating sprayed in the control zone to total coating sprayed in the booth.
See Appendix G: Paint Metering Data Record

Table 11: Clearcoat Oven VOC Capture Efficiency
DACJ
February 2023

Solvent Loading

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	188.046	190.292	189.661	1.615	0.631	3.61
C2	190.207	192.352	191.767	1.560	0.585	3.46
C3	191.282	193.363	192.790	1.508	0.573	3.51
Average						**3.53**

Material Properties

Sample	Coating Density (lb/gal)	Mass Fraction Solids	Volume Fraction Solids	VOC mass fraction	Solids Density (lb/gal)
Variable	W_c	W_s	V_s	W_{voc}	D_{cos}
Formula					(Ws*Wc)/Vs
Clearcoat	8.64	0.5557	0.5196	0.4443	9.24

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)	Section VOC Capture Efficiency (%)
W_{voc}	D_c	VOC	TE	V_s	V_{sdep}	P	CE
		(Dc)(Wvoc)			$(V_s)(TE)$		$(P)(V_{sdep})(100)/(VOC)$
0.4443	8.64	3.838	81.3%	0.5196	0.422	3.53	**38.8%**