## 1.0 Executive Summary

JLB Industries, LLC completed a compliance environmental testing program during the weeks of September 20, November 1, and November 8, 2021, in the paint shop at the Ford Michigan Assembly Plant (MAP) facility located in Wayne, Michigan. The testing program included Transfer Efficiency (TE) and Capture Efficiency (CE) testing of the 3-Wet spraybooths and ovens. 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* and with 40 CFR Chapter 1, Appendix A to Subpart IIII of Part 63. The test results will be used to demonstrate compliance with Auto MACT requirements and in monthly emissions compliance calculations.

Transfer Efficiency values were derived for the Ford Branco five-door and three-door models, which currently makes up a significant part of the production volume at the facility. Personnel from the paint shop, Ford environmental staff and JLB Industries, LLC conducted the testing. These groups worked together at each stage of testing to ensure that the results were representative of production conditions. Regina Angellotti and Stephen Weis from the Michigan Department of Environment, Great Lakes, and Energy, Air Quality Division, were on-site to witness the testing.

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 Industries, LLC. located in Rochester Hills, Michigan.

**Table 1 – Transfer Efficiency Testing Results Summary**

| Tested Coating | Solids Transfer Efficiency (%) |
|---|---|
| Enamel 2, Five-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 73.9% |
| Enamel 2, Three-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 76.2% |
| Enamel 1, Five-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 71.6% |
| Enamel 1, Three-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 72.6% |
| Average Five-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 72.7% |
| Average Three-Door, 3-Wet System (Prime, Basecoat and Clearcoat) | 74.4% |

**Table 2 – Capture Efficiency Testing Results Summary**

| Tested Coating | Booth Capture Efficiency | Oven Capture Efficiency | Total Capture Efficiency |
|---|---|---|---|
| Enamel 2 Prime | 79.0% | 10.2% | 89.3% |
| Enamel 2 Basecoat | 72.3%* | 14.7% | 87.0% |
| Enamel 2 Clearcoat | 54.3% | 26.8% | 81.1% |
| Enamel 1 Prime | 76.5% | 10.3% | 86.8% |
| Enamel 1 Basecoat | 75.0%* | 13.6% | 88.6% |
| Enamel 1 Clearcoat | 60.7% | 22.5% | 83.2% |

* Basecoat booth CE includes carryover to Clearcoat zone.

## 2.0 Introduction

JLB Industries, LLC (JLBI) was contracted by Ford Michigan Assembly Plant (MAP) to perform Transfer Efficiency (TE) and Capture Efficiency (CE) testing program on the 3-Wet Systems in the paint shop at the Michigan Assembly Plant located in Wayne, Michigan. This testing was conducted on the Ford Branco five-door and three-door models during the weeks of September 20, November 1, and November 8, 2021.

## 3.0 Sampling and Analytical Procedures

Transfer Efficiency Test

Transfer Efficiency testing was conducted in the Enamel 1 and Enamel 2 (E1 & E2) 3-Wet Spraybooth where Light Gray Prime, Cactus Gray, Velocity Blue, and Carbonized Gray 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.

Three vehicles, five-door style, were processed as normal production vehicles for the test in each system while two vehicles, three-door style, were processed as normal production vehicles for the test in each system, one five-door and one three-door vehicle were dedicated as no-paint control vehicles and were run through each system. All units were production vehicles with sealer.

An on-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 several representative applicators was performed by MAP personnel to ensure accurate usage measurement. Material samples of applied

coatings were collected from the respective systems directly after testing. Samples were tested by JLB Industries, LLC in Rochester Hills, Michigan, for analysis to determine density by ASTM D1475-13 (Reapproved 2020) and weight solids content by ASTM D2369-20 (referenced in EPA Method 24). The laboratory results were used in calculating the Transfer Efficiency and Capture Efficiency values.

Production vehicles with paint shop sealer were prepared with e-coat and processed through the E1 and E2 3-Wet Spraybooths. The test sequence and color for each vehicle and booth was:

Enamel 2 Five-Door
1. Test Unit ID TE 1 (Cactus Gray)
2. Test Unit ID TE 2 (Cactus Gray)
3. Test Unit ID TE 6 (Cactus Gray)

Enamel 1 Five-Door
1. Test Unit ID TE 3 (Cactus Gray)
2. Test Unit ID TE 4 (Cactus Gray)
3. Test Unit ID TE 7 (Cactus Gray)

Enamel 2 Three-Door
1. Test Unit ID TE 12 (Velocity Blue)
2. Test Unit ID TE 13 (Velocity Blue)

Enamel 1 Three-Door
1. Test Unit ID TE 10 (Carbonized Gray)
2. Test Unit ID TE 11 (Carbonized Gray)

Enamel 1&2 Five-Door (Control Vehicle)
1. Test Unit ID TE 5 (No Paint)

Enamel 1&2 Three-Door (Control Vehicle)
1. Test Unit ID TE 8 (No Paint)

Test vehicles were baked and routed back to the VWS for post-weights.

Capture Efficiency Tests

Capture Efficiency testing was performed on both Enamel 1 and Enamel 2 systems. A panel weigh station (PWS) was assembled at a location near the 3-Wet Spraybooth. 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.

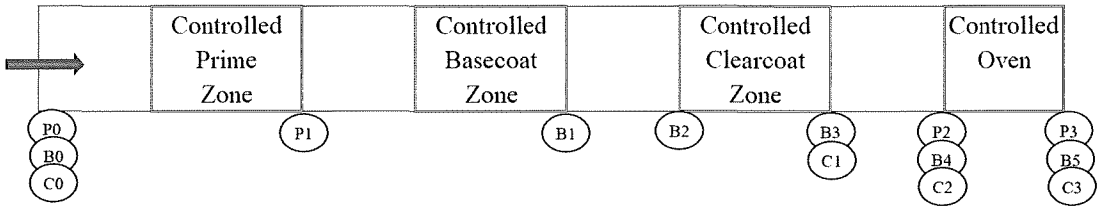
The testing conformed to the methods described in ASTM 5087-02 for solvent borne coatings. Capture Efficiency values for the controlled oven and spraybooth zones were calculated using the procedures outlined in the 40 CFR, Part 63.

All test panels were placed on vehicle bodies and processed with normal production spray programming.

Four electrocoated panels were used for each of the tests. 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 spray zones 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, 4, blank) and weighed to establish the initial unpainted panel weights (P0). The panels were then attached to a test vehicle and routed through the Spraybooth. After coating, upon exiting the controlled spraybooth zone, the panels were carefully removed from the test vehicle and brought to the balance for weighing (P1). The panels were weighed again immediately before entering the 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).

**Diagram 1 – Panel Testing Diagram**




## 4.0 Test Equipment and Calibration

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 200 pounds of Class F calibration weights on each scale platform. Then, the VWS was calibrated with 800 pounds of Class F calibration weights. VWS linearity was checked using a one or two-pound, Class F stainless steel calibration weight. The two-pound weight was also added to each test vehicle during pre- and post-process weighing to verify scale linearity.

Material Usage

Coating material usage was monitored via volumetric flow measurement devices located on each applicator. A verification of several representative applicators was performed by MAP 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. Verification data is included in section 7 of this report.

A sample of each material was taken after each test and analyzed by JLB Industries, LLC. These values were used in calculating the paint solids sprayed and the transfer efficiency for each type of calculation. ASTM Method D2369-20 was used to determine paint solids. ASTM Method D1475-13 (Reapproved 2021) was used to determine paint density.

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 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.

## 5.0 Discussion of Test Results

There were no significant disruptions to the testing process. Representative coatings were chosen for testing based on the production volume and the application process. The three-door control vehicle was used to adjust both E1and E2 three-door Transfer Efficiency.

## 6.0 Summary of Results

**Table 3 - Enamel 2, Five-Door, 3-Wet Transfer Efficiency Calculation Summary**
**Ford MAP, November 2021**

| Vehicle ID | Vehicle Weight Gain (lb.) | Prime Sprayed (gal) | Basecoat Sprayed (gal) | Clearcoat Sprayed (gal) |
|---|---|---|---|---|
| Variable: | VWG | PPS | BCPS | CCPS |
| Calculation: | (W2-W1) | | | |
| TE 1 | 4.39 | 0.215 | 0.559 | 0.529 |
| TE 2 | 4.52 | 0.213 | 0.559 | 0.529 |
| TE 6 | 4.70 | 0.215 | 0.558 | 0.529 |
| Average: | 4.54 | 0.215 | 0.559 | 0.529 |

| Material | Avg. Paint Sprayed (gal) | Coating Density (lb/gal) | Weight Solids Fraction | Avg. Solids Sprayed (lb.) | Transfer Efficiency (%) |
|---|---|---|---|---|---|
| Variable: | APS | CD | WSF | SS | TE |
| Calculation: | (Avg PS) | (Method 24) | (Method 24) | (APS*CD*WSF) | (AVWG/SS) |
| Prime | 0.215 | 9.64 | 0.5595 | 1.16 | |
| Basecoat | 0.559 | 8.93 | 0.5201 | 2.59 | |
| Clearcoat | 0.529 | 8.32 | 0.5428 | 2.39 | |
| | | | | **6.14** | **73.9%** |

**Table 4 - Enamel 1, Five-Door, 3-Wet Transfer Efficiency Calculation Summary**
**Ford MAP, November 2021**

| Vehicle ID | Vehicle Weight Gain (lb.) | Prime Sprayed (gal) | Basecoat Sprayed (gal) | Clearcoat Sprayed (gal) |
|---|---|---|---|---|
| Variable: | VWG | PPS | BCPS | CCPS |
| Calculation: | (W2-W1) | | | |
| TE 3 | 4.65 | 0.216 | 0.599 | 0.555 |
| TE 4 | 4.61 | 0.216 | 0.606 | 0.555 |
| TE 7 | 4.65 | 0.216 | 0.599 | 0.554 |
| Average: | 4.64 | 0.216 | 0.601 | 0.554 |

| Material | Avg. Paint Sprayed (gal) | Coating Density (lb/gal) | Weight Solids Fraction | Avg. Solids Sprayed (lb.) | Transfer Efficiency (%) |
|---|---|---|---|---|---|
| Variable: | APS | CD | WSF | SS | TE |
| Calculation: | (Avg PS) | (Method 24) | (Method 24) | (APS*CD*WSF) | (AVWG/SS) |
| Prime | 0.216 | 9.63 | 0.5580 | 1.16 | |
| Basecoat | 0.601 | 9.00 | 0.5216 | 2.82 | |
| Clearcoat | 0.554 | 8.32 | 0.5421 | 2.50 | |
| | | | | **6.48** | **71.6%** |

**Table 5 - Enamel 2, Three-Door, 3-Wet Transfer Efficiency Calculation Summary**
**Ford MAP, November 2021**

| Vehicle ID | Vehicle Weight Gain (lb.) | Prime Sprayed (gal) | Basecoat Sprayed (gal) | Clearcoat Sprayed (gal) |
|---|---|---|---|---|
| Variable: | VWG | PPS | BCPS | CCPS |
| Calculation: | (W2-W1) | | | |
| TE 12 | 3.45 | 0.189 | 0.459 | 0.462 |
| TE 13 | 3.50 | 0.189 | 0.458 | 0.462 |
| Average: | 3.48 | 0.189 | 0.459 | 0.462 |
| **AVWG:** | **3.63** | AVWG=(avg VWG-SWL) | | |

| Material | Avg. Paint Sprayed (gal) | Coating Density (lb/gal) | Weight Solids Fraction | Avg. Solids Sprayed (lb.) | Transfer Efficiency (%) |
|---|---|---|---|---|---|
| Variable: | APS | CD | WSF | SS | TE |
| Calculation: | (Avg PS) | (Method 24) | (Method 24) | (APS*CD*WSF) | (AVWG/SS) |
| Prime | 0.189 | 9.61 | 0.5526 | 1.00 | |
| Basecoat | 0.459 | 8.30 | 0.4339 | 1.65 | |
| Clearcoat | 0.462 | 8.32 | 0.5469 | 2.10 | |
| | | | | **4.76** | **76.2%** |

**Control Vehicle Sealer Weight Loss**

| Vehicle ID | Vehicle Weight Gain (lb.) |
|---|---|
| Variable: | SWL |
| Calculation: | (W2-W1) |
| TE 8 | -0.15 |

**Table 6 - Enamel 1, Three-Door, 3-Wet Transfer Efficiency Calculation Summary**
**Ford MAP, November 2021**

| Vehicle ID | Vehicle Weight Gain (lb.) | Prime Sprayed (gal) | Basecoat Sprayed (gal) | Clearcoat Sprayed (gal) |
|---|---|---|---|---|
| Variable: | VWG | PPS | BCPS | CCPS |
| Calculation: | (W2-W1) | | | |
| TE 10 | 3.55 | 0.190 | 0.454 | 0.485 |
| TE 11 | 3.49 | 0.189 | 0.454 | 0.485 |
| Average: | 3.52 | 0.189 | 0.454 | 0.485 |
| **AVWG:** | **3.67** | AVWG=(avg VWG-SWL) | | |

| Material | Avg. Paint Sprayed (gal) | Coating Density (lb/gal) | Weight Solids Fraction | Avg. Solids Sprayed (lb.) | Transfer Efficiency (%) |
|---|---|---|---|---|---|
| Variable: | APS | CD | WSF | SS | TE |
| Calculation: | (Avg PS) | (Method 24) | (Method 24) | (APS*CD*WSF) | (AVWG/SS) |
| Prime | 0.189 | 9.61 | 0.5526 | 1.01 | |
| Basecoat | 0.454 | 8.39 | 0.4819 | 1.84 | |
| Clearcoat | 0.485 | 8.32 | 0.5469 | 2.21 | |
| | | | | **5.05** | **72.6%** |

**Control Vehicle Sealer Weight Loss**

| Vehicle ID | Vehicle Weight Gain (lb.) |
|---|---|
| Variable: | SWL |
| Calculation: | (W2-W1) |
| TE 8 | -0.15 |

**Table 7 -- Enamel 2 Prime Booth VOC Capture Efficiency**
**Ford MAP, November 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 | $W_{sdep}$ | $W_{rem}$ | $P_m$ | $W_s$ | $W_{VOC}$ | $P_{VOC}$ | CE |
| Formula | | | | P3-P0 | P1-P3 | $W_{rem}/W_{sdep}$ | | | $(P_m)(W_s)/(W_{VOC})$ | $1-P_{VOC}$ |
| P1 | 187.948 | 189.208 | 189.000 | 1.052 | 0.208 | 0.198 | | | | |
| P2 | 187.196 | 188.320 | 188.131 | 0.935 | 0.189 | 0.202 | | | | |
| P3 | 188.426 | 189.548 | 189.390 | 0.964 | 0.158 | 0.164 | | | | |
| P4 | 187.187 | 189.074 | 188.886 | 1.699 | 0.188 | 0.111 | | | | |
| Average | | | | | | 0.169 | 0.5545 | 0.4455 | 0.210 | **79.0%** |

**Table 8 -- Enamel 2 Basecoat Booth VOC Capture Efficiency**
**Ford MAP, November 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 | | | | P5-P0 | P1-P5 | $W_{rem}/W_{sdep}$ | | | $(P_m)(W_s)/(W_{VOC})$ | $1-P_{VOC}$ |
| B1 | 188.119 | 189.228 | 188.952 | 0.833 | 0.276 | 0.331 | | | | |
| B2 | 187.479 | 188.436 | 188.205 | 0.726 | 0.231 | 0.318 | | | | |
| B3 | 188.094 | 189.216 | 188.917 | 0.823 | 0.299 | 0.363 | | | | |
| B4 | 187.534 | 188.605 | 188.317 | 0.783 | 0.288 | 0.368 | | | | |
| Average | | | | | | 0.345 | 0.5057 | 0.4943 | 0.353 | **64.7%** |

**Table 9 -- Enamel 2 Basecoat Booth VOC Capture Efficiency (carryover to Clearcoat)**
**Ford MAP, November 2021**

| 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 | | | | | P5-P0 | P2-P3 | (Wa/Wcos)*Dcos |
| B1 | 188.119 | 189.190 | 189.111 | 188.952 | 0.833 | 0.079 | 0.88 |
| B2 | 187.479 | 188.392 | 188.324 | 188.205 | 0.726 | 0.068 | 0.87 |
| B3 | 188.094 | 189.177 | 189.085 | 188.917 | 0.823 | 0.092 | 1.04 |
| B4 | 187.534 | 188.567 | 188.487 | 188.317 | 0.783 | 0.080 | 0.95 |
| Average | | | | | 0.791 | 0.080 | **0.94** |

**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 | | | | | | $(W_s*W_c)/V_s$ |
| Basecoat | 8.22 | 0.5057 | 0.4460 | 0.75 | 0.4943 | 9.32 |

**Capture Efficiency**

| Mass Fraction VOC in Coating | Coating Density (lb/gal) | Mass VOC per Volume Coating (lb/gal) | Transfer Efficiency (%) | Volume Fraction Solids | | Panel Test Result (lb VOC/ gal Solids) | Oven VOC Capture Efficiency (%) |
|---|---|---|---|---|---|---|---|
| $W_{voc}$ | $D_c$ | VOC | TE | $V_s$ | $V_{sdep}$ | P | CE |
| | | $(D_c)(W_{voc})$ | | | $(V_s)(TE)$ | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4943 | 8.22 | 4.062 | 73.9% | 0.4460 | 0.330 | 0.94 | **7.6%** |

**Table 10 -- Enamel 2 Clearcoat Booth VOC Capture Efficiency**
**Ford MAP, November 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 | 187.181 | 190.069 | 189.229 | 2.048 | 0.840 | 0.410 | | | | |
| C2 | 187.386 | 189.840 | 189.144 | 1.758 | 0.696 | 0.396 | | | | |
| C3 | 187.818 | 190.285 | 189.585 | 1.767 | 0.700 | 0.396 | | | | |
| C4 | 188.539 | 191.148 | 190.413 | 1.874 | 0.735 | 0.392 | | | | |
| Average | | | | | | 0.399 | 0.5341 | 0.4659 | 0.457 | **54.3%** |

**Table 11 -- Enamel 2 Prime Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P2 | P3 | $W_{cos}$ | $W_a$ | CL |
| Formula | | | | P3-P0 | P2-P3 | $(W_a/W_{cos})*D_{cos}$ |
| P1 | 187.948 | 189.142 | 189.000 | 1.052 | 0.142 | 1.45 |
| P2 | 187.196 | 188.248 | 188.131 | 0.935 | 0.117 | 1.35 |
| P3 | 188.426 | 189.509 | 189.390 | 0.964 | 0.119 | 1.33 |
| P4 | 187.187 | 189.026 | 188.886 | 1.699 | 0.140 | 0.89 |
| Average | | | | 1.162 | 0.130 | **1.20** |

**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 |
| Prime | 9.60 | 0.5545 | 0.4950 | 0.71 | 0.4455 | 10.76 |

**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 | $V_s$ | | P | CE |
| | | (Dc) (Wvoc) | | | $(V_s)$ (TE) | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4455 | 9.60 | 4.279 | 73.9% | 0.4950 | 0.366 | 1.20 | **10.2%** |

**Table 12 -- Enamel 2 Basecoat Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P4 | P5 | Wcos | Wa | CL |
| Formula | | | | P5-P0 | P4-P5 | $(W_a/W_{cos})*D_{cos}$ |
| B1 | 188.119 | 189.104 | 188.952 | 0.833 | 0.152 | 1.70 |
| B2 | 187.479 | 188.331 | 188.205 | 0.726 | 0.126 | 1.62 |
| B3 | 188.094 | 189.089 | 188.917 | 0.823 | 0.172 | 1.95 |
| B4 | 187.534 | 188.484 | 188.317 | 0.783 | 0.167 | 1.99 |
| Average | | | | 0.791 | 0.154 | **1.82** |

**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 | | | | | | $(W_s*W_c)/V_s$ |
| Basecoat | 8.22 | 0.5057 | 0.4460 | 0.75 | 0.4943 | 9.32 |

**Capture Efficiency**

| Mass Fraction VOC in Coating | Coating Density (lb/gal) | Mass VOC per Volume Coating (lb/gal) | Transfer Efficiency (%) | Volume Fraction Solids | | Panel Test Result (lb VOC/ gal Solids) | Oven VOC Capture Efficiency (%) |
|---|---|---|---|---|---|---|---|
| $W_{voc}$ | $D_c$ | VOC | TE | $V_s$ | $V_{sdep}$ | P | CE |
| | | $(D_c)(W_{voc})$ | | | $(V_s)(TE)$ | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4943 | 8.22 | 4.062 | 73.9% | 0.4460 | 0.330 | 1.82 | **14.7%** |

**Table 13 -- Enamel 2 Clearcoat Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P2 | P3 | Wcos | Wa | CL |
| Formula | | | | P3-P0 | P2-P3 | $(W_a/W_{cos})*D_{cos}$ |
| C1 | 187.181 | 189.907 | 189.229 | 2.048 | 0.678 | 3.00 |
| C2 | 187.386 | 189.679 | 189.144 | 1.758 | 0.535 | 2.76 |
| C3 | 187.818 | 190.143 | 189.585 | 1.767 | 0.558 | 2.86 |
| C4 | 188.539 | 190.995 | 190.413 | 1.874 | 0.582 | 2.81 |
| Average | | | | 1.862 | 0.588 | **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 |
| Clearcoat | 8.31 | 0.5341 | 0.4900 | 2.05 | 0.4659 | 9.05 |

**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 | $V_s$ | | P | CE |
| | | (Dc) (Wvoc) | | | $(V_s)$ (TE) | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4659 | 8.31 | 3.870 | 73.9% | 0.4900 | 0.362 | 2.86 | **26.8%** |

**Table 14 -- Enamel 1 Prime Booth VOC Capture Efficiency**
**Ford MAP, November 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 | $W_{sdep}$ | $W_{rem}$ | $P_m$ | $W_s$ | $W_{VOC}$ | $P_{VOC}$ | CE |
| Formula | | | | P3-P0 | P1-P3 | $W_{rem}/W_{sdep}$ | | | $(P_m)(W_s)/(W_{VOC})$ | $1-P_{VOC}$ |
| P1 | 187.670 | 188.721 | 188.555 | 0.885 | 0.166 | 0.188 | | | | |
| P2 | 187.784 | 188.818 | 188.661 | 0.877 | 0.157 | 0.179 | | | | |
| P3 | 187.583 | 188.648 | 188.470 | 0.887 | 0.178 | 0.201 | | | | |
| P4 | 187.434 | 188.536 | 188.364 | 0.930 | 0.172 | 0.185 | | | | |
| Average | | | | | | 0.188 | 0.5553 | 0.4447 | 0.235 | **76.5%** |

**Table 15 -- Enamel 1 Basecoat Booth VOC Capture Efficiency**
**Ford MAP, November 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 | | | | P5-P0 | P1-P5 | $W_{rem}/W_{sdep}$ | | | $(P_m)(W_s)/(W_{VOC})$ | $1-P_{VOC}$ |
| B1 | 188.673 | 189.684 | 189.492 | 0.819 | 0.192 | 0.234 | | | | |
| B2 | 188.022 | 189.050 | 188.832 | 0.810 | 0.218 | 0.269 | | | | |
| B3 | 187.787 | 188.889 | 188.661 | 0.874 | 0.228 | 0.261 | | | | |
| B4 | 187.722 | 188.784 | 188.552 | 0.830 | 0.232 | 0.280 | | | | |
| Average | | | | | | 0.261 | 0.5043 | 0.4957 | 0.266 | **73.4%** |

**Table 16 -- Enamel 1 Basecoat Booth VOC Capture Efficiency (carryover to Clearcoat)**
**Ford MAP, November 2021**

| 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 | | | | | P5-P0 | P2-P3 | (Wa/Wcos)*Dcos |
| B1 | 188.673 | 189.664 | 189.647 | 189.492 | 0.819 | 0.017 | 0.19 |
| B2 | 188.022 | 189.022 | 189.010 | 188.832 | 0.810 | 0.012 | 0.14 |
| B3 | 187.787 | 188.847 | 188.830 | 188.661 | 0.874 | 0.017 | 0.18 |
| B4 | 187.722 | 188.758 | 188.735 | 188.552 | 0.830 | 0.023 | 0.26 |
| Average | | | | | 0.833 | 0.017 | **0.19** |

**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 | | | | | | $(W_s*W_c)/V_s$ |
| Basecoat | 8.31 | 0.5043 | 0.4460 | 0.83 | 0.4957 | 9.39 |

**Capture Efficiency**

| Mass Fraction VOC in Coating | Coating Density (lb/gal) | Mass VOC per Volume Coating (lb/gal) | Transfer Efficiency (%) | Volume Fraction Solids | | Panel Test Result (lb VOC/ gal Solids) | Oven VOC Capture Efficiency (%) |
|---|---|---|---|---|---|---|---|
| $W_{voc}$ | $D_c$ | VOC | TE | $V_s$ | $V_{sdep}$ | P | CE |
| | | $(D_c)(W_{voc})$ | | | $(V_s)(TE)$ | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4957 | 8.31 | 4.118 | 71.6% | 0.4460 | 0.319 | 0.19 | **1.5%** |

**Table 17 -- Enamel 1 Clearcoat Booth VOC Capture Efficiency**
**Ford MAP, November 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 INT | 187.317 | 188.044 | 187.901 | 0.584 | 0.143 | 0.245 | | | | |
| C2 INT | 187.720 | 188.482 | 188.326 | 0.606 | 0.156 | 0.257 | | | | |
| C3 INT | 187.640 | 188.477 | 188.317 | 0.677 | 0.160 | 0.236 | | | | |
| Average | | | | | | 0.246 | 0.5332 | 0.4668 | 0.281 | 71.9% |
| C1 EXT | 187.857 | 190.507 | 189.763 | 1.906 | 0.744 | 0.390 | | | | |
| C2 EXT | 188.430 | 190.972 | 190.273 | 1.843 | 0.699 | 0.379 | | | | |
| C3 EXT | 187.579 | 190.314 | 189.558 | 1.979 | 0.756 | 0.382 | | | | |
| Average | | | | | | 0.384 | 0.5332 | 0.4668 | 0.438 | 56.2% |

| Process | Paint Sprayed (cc) | Fraction |
|---|---|---|
| Interior Usage | 602 | 0.287 |
| Exterior Usage | 1497 | 0.713 |

| Capture Efficiency Average (%) |
|---|
| **60.7%** |

Note: Clearcoat Capture Efficiency is the weighted average of interior and exterior.

**Table 18 -- Enamel 1 Prime Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P2 | P3 | Wcos | Wa | CL |
| Formula | | | | P3-P0 | P2-P3 | $(W_a/W_{cos})*D_{cos}$ |
| P1 | 187.670 | 188.659 | 188.555 | 0.885 | 0.104 | 1.27 |
| P2 | 187.784 | 188.747 | 188.661 | 0.877 | 0.086 | 1.06 |
| P3 | 187.583 | 188.580 | 188.470 | 0.887 | 0.110 | 1.34 |
| P4 | 187.434 | 188.475 | 188.364 | 0.930 | 0.111 | 1.29 |
| Average | | | | 0.895 | 0.103 | **1.24** |

**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 |
| Prime | 9.61 | 0.5553 | 0.4950 | 0.65 | 0.4447 | 10.79 |

**Capture Efficiency**

| Mass Fraction VOC in Coating | Coating Density (lb/gal) | Mass VOC per Volume Coating (lb/gal) | Transfer Efficiency (%) | Volume Fraction Solids | | 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) | | | $(V_s)(TE)$ | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4447 | 9.61 | 4.275 | 71.6% | 0.4950 | 0.354 | 1.24 | **10.3%** |

**Table 19 -- Enamel 1 Basecoat Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P4 | P5 | Wcos | Wa | CL |
| Formula | | | | P5-P0 | P4-P5 | $(W_a/W_{cos})*D_{cos}$ |
| B1 | 188.673 | 189.627 | 189.492 | 0.819 | 0.135 | 1.55 |
| B2 | 188.022 | 188.999 | 188.832 | 0.810 | 0.167 | 1.94 |
| B3 | 187.787 | 188.817 | 188.661 | 0.874 | 0.156 | 1.68 |
| B4 | 187.722 | 188.719 | 188.552 | 0.830 | 0.167 | 1.89 |
| Average | | | | 0.833 | 0.156 | **1.76** |

**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 | | | | | | $(W_s*W_c)/V_s$ |
| Basecoat | 8.31 | 0.5043 | 0.4460 | 0.83 | 0.4957 | 9.39 |

**Capture Efficiency**

| Mass Fraction VOC in Coating | Coating Density (lb/gal) | Mass VOC per Volume Coating (lb/gal) | Transfer Efficiency (%) | Volume Fraction Solids | | Panel Test Result (lb VOC/ gal Solids) | Oven VOC Capture Efficiency (%) |
|---|---|---|---|---|---|---|---|
| $W_{voc}$ | $D_c$ | VOC | TE | $V_s$ | $V_{sdep}$ | P | CE |
| | | $(D_c)(W_{voc})$ | | | $(V_s)(TE)$ | | $(P)(V_{sdep})(100)/(VOC)$ |
| 0.4957 | 8.31 | 4.118 | 71.6% | 0.4460 | 0.319 | 1.76 | **13.6%** |

**Table 20 -- Enamel 1 Clearcoat Oven VOC Capture Efficiency**
**Ford MAP, November 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/gal) |
|---|---|---|---|---|---|---|
| Variable | P0 | P2 | P3 | Wcos | Wa | CL |
| Formula | | | | P3-P0 | P2-P3 | $(W_a/W_{cos})*D_{cos}$ |
| C1 INT | 187.317 | 188.018 | 187.901 | 0.584 | 0.117 | 1.81 |
| C2 INT | 187.720 | 188.456 | 188.326 | 0.606 | 0.130 | 1.94 |
| C3 INT | 187.640 | 188.437 | 188.317 | 0.677 | 0.120 | 1.60 |
| Average | | | | 0.622 | 0.122 | **1.78** |
| C1 EXT | 187.857 | 190.349 | 189.763 | 1.906 | 0.586 | 2.78 |
| C2 EXT | 188.430 | 190.844 | 190.273 | 1.843 | 0.571 | 2.80 |
| C3 EXT | 187.579 | 190.162 | 189.558 | 1.979 | 0.604 | 2.76 |
| Average | | | | 1.909 | 0.587 | **2.78** |

**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 |
| Clearcoat INT | 8.30 | 0.5332 | 0.4900 | 0.67 | 0.4668 | 9.04 |
| Clearcoat EXT | 8.30 | 0.5332 | 0.4900 | 2.18 | 0.4668 | 9.04 |

**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 (%) | Zone |
|---|---|---|---|---|---|---|---|---|
| $W_{voc}$ | $D_c$ | VOC | TE | $V_s$ | $V_{sdep}$ | P | CE | |
| | | (Dc) (Wvoc) | | | $(V_s)$ (TE) | | (P) $(V_{sdep})$ (100)/(VOC) | |
| 0.4668 | 8.30 | 3.876 | 71.6% | 0.4900 | 0.351 | 1.78 | **16.1%** | **Interior** |
| 0.4668 | 8.30 | 3.876 | 71.6% | 0.4900 | 0.351 | 2.78 | **25.1%** | **Exterior** |

| Process | Paint Sprayed (cc) | Fraction |
|---|---|---|
| Interior Usage | 602 | 0.287 |
| Exterior Usage | 1497 | 0.713 |

| Oven VOC Capture Efficiency Average (%) |
|---|
| **22.5%** |

Note: Clearcoat Capture Efficiency is the weighted average of interior and exterior.