GM Flint Assembly Plant
Flint, Michigan

Environmental Testing Program – Transfer Efficiency
November 2019

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1.0 Executive Summary

JLB Industries, LLC completed a compliance environmental testing program during the week of November 18, 2019 at the General Motors LLC Flint Assembly Plant located in Flint, Michigan. The testing served as a compliance demonstration for the 3-Wet coating operations. Solids transfer efficiency (TE) values were determined for representative coatings, including gray prime, white solid basecoat, silver metallic basecoat and clearcoat. The testing was performed as required by MI-ROP-B1606-2014b, FG-PAINT & ASSEMBLY, V.1.

The testing program was conducted in accordance with all applicable procedures contained in the U.S. Environmental Protection Agency document *Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations* as referenced in 40 CFR, Part 63. The resultant test values will be used to calculate emissions.

Transfer Efficiency values were derived using the Chevrolet full size truck, which represents the current production at the facility. Personnel from the paint shop, GM 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.

JLB Industries used highly accurate weighing systems to determine the vehicle weights before and after coating application. Calibrated volumetric flow meters, located on each applicator, were used to measure paint usage. Mr. Bob Byrnes of the *Michigan Department of Environment, Great Lakes & Energy* was present for portions of the testing program.

Material samples were collected from the paint circulation tanks on the day of testing. Determination of percent solids by weight and density was performed by BASF at their laboratory facilities in Southfield, Michigan.

Table 1 – Testing Results Summary

Tested Coating	Transfer Efficiency
Gray Prime	68.7%
White Solid Basecoat	70.8%
Silver Metallic Basecoat	77.7%
Clearcoat	78.1%

2.0 Introduction

JLB Industries, LLC (JLBI) was contracted by the General Motors Flint Assembly Plant (GM) to perform an environmental testing program on the 3-Wet coating operations. Solids transfer efficiency (TE) values were determined for gray prime, white solid basecoat, silver metallic basecoat and clearcoat. This testing was conducted using the Chevrolet full size truck model during the week of November 18, 2019.

3.0 Sampling and Analytical Procedures

Transfer Efficiency testing was conducted in the Topcoat 1 3-Wet Spraybooth, where gray prime, white solid basecoat, silver metallic basecoat and clearcoat were applied by robotic applicators. Applicator and environmental conditions were monitored to ensure that the testing accurately reflected production conditions. Measured parameters included: vehicle weight gain, coating material usage, coating material analysis (percent solids by weight and density), applicator settings, film build and oven heat settings.

A total of four vehicle bodies were used for the testing procedure. Three vehicles were processed as normal production vehicles, while one vehicle was dedicated as a no-paint test control in conjunction with each test. Testing was performed with scrap vehicles; all with no paint shop sealer.

An on-line vehicle weigh station (VWS) was constructed to measure the weight of the test vehicles before and after each coating process. Test vehicles were routed to a dedicated conveyor spur and into the VWS. Test vehicles were lifted free from their carriers by four 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 from the vehicles on 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 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 each coated test vehicle to verify paint film-build was within the production specification. The data was taken with a handheld elcometer gauge.

Robotic coating material usage was monitored via volumetric flow measurement devices located on each applicator. A verification of the applicators was performed before testing to ensure accurate usage measurement.

Gray Prime
Test vehicles were weighed and processed through the prime section of the 3-Wet Spraybooth and coated with Gray Prime. The test sequence was:

1. Test Vehicle ID TE 1
2. Test Vehicle ID TE 2
3. Test Vehicle ID TE 3
4. Test Vehicle ID TE 4 (No-paint)
5. Test Vehicle ID TE 1 re-run
6. Test Vehicle ID TE 4 re-run
7. Test Vehicle ID TE 3 (re-run No-paint)

The test vehicles were routed through the oven and allowed to cool before a post-weight measurement was taken at the VWS.

White Solid Basecoat
Test vehicles were weighed and processed through the basecoat section of the 3-Wet Spraybooth and coated with white solid basecoat. The test sequence was:

1. Test Vehicle ID TE 1
2. Test Vehicle ID TE 2
3. Test Vehicle ID TE 3
4. Test Vehicle ID TE 4 (No-paint)

The test vehicles were routed through the oven and allowed to cool before a post-weight measurement was taken at the VWS.

Silver Metallic Basecoat
Test vehicles were weighed and processed through the basecoat section of the 3-Wet Spraybooth and coated with silver metallic basecoat. The test sequence was:

1. Test Vehicle ID TE 1
2. Test Vehicle ID TE 2
3. Test Vehicle ID TE 3
4. Test Vehicle ID TE 4 (No-paint)

The test vehicles were routed through the oven and allowed to cool before a post-weight measurement was taken at the VWS.

Clearcoat
Test vehicles were weighed and processed through the clearcoat section of the 3-Wet Spraybooth and coated with clearcoat. The test sequence was:

1. Test Vehicle ID TE 1
2. Test Vehicle ID TE 2
3. Test Vehicle ID TE 3
4. Test Vehicle ID TE 4 (No-paint)

The test vehicles were routed through the oven and allowed to cool before a post-weight measurement was taken at the VWS.

4.0 Test Equipment and Calibration

Vehicle Weigh Station

A dedicated vehicle weigh station (VWS) equipped with four 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 200 pounds of Class F calibration weights on each scale. VWS linearity was checked using a 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 by volumetric flow measurement devices located on each applicator. A verification of the applicators was performed by GM prior to testing to ensure accurate usage data. Paint usage was measured in a graduated cylinder and compared to the expected volume. The Paint Metering Verification Record is included in Section 7 of this report.

A sample of the material was taken on the day of testing and analyzed for weight solids and density per EPA Method 24 by BASF at their laboratory facilities in Southfield, Michigan. These values were used in calculating the paint solids sprayed and the transfer efficiency for each process.

5.0 Discussion of Test Results

The measured vehicle weight gains for the prime test fell outside of ten percent of the average weight gain of the test batch. It was determined that two different spray programs were used on the initial prime vehicles. Two additional prime test vehicles were run with a consistent spray program. The data from both the initial and the subsequent test runs are included in the report data.

The measured vehicle weight gain for one vehicle in the solid basecoat test fell outside of ten percent of the average weight gain of the test batch. As specified by the protocol, this vehicle was excluded from the test results.

6.0 Calculation of Results

Table 2 - Gray Prime Transfer Efficiency Summary
GM Flint Transfer Efficiency Test
November 2019

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	Transfer Efficiency (%)
Variable:	VWG	BVWG	BPS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(BPS*CD*WSF)	(BVWG/BSS)
TE 1 (re-run)	0.81	0.83	0.394	9.24	0.3360	1.22	67.6%
TE 2	0.81						
TE 4 (re-run)	0.86						

CTL Vehicle Weight Change	-0.01
Adjusted TE	**68.7%**

Table 3 - White Solid Basecoat Transfer Efficiency Summary
GM Flint Transfer Efficiency Test
November 2019

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	Transfer Efficiency (%)
Variable:	VWG	BVWG	BPS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(BPS*CD*WSF)	(BVWG/BSS)
TE 1	2.93	2.90	0.935	10.14	0.4080	3.87	75.0%
TE 2	**						
TE 3	2.88						

TE 2 weight gain not withing 10% of average. Excluded from results per protocol.

CTL Vehicle Weight Change	0.16
Adjusted TE	**70.8%**

Table 4 - Silver Metallic Basecoat Transfer Efficiency Summary
GM Flint Transfer Efficiency Test
November 2019

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	Transfer Efficiency (%)
Variable:	VWG	BVWG	BPS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(BPS*CD*WSF)	(BVWG/BSS)
TE 1	1.14	1.14	0.962	8.53	0.2170	1.78	63.8%
TE 2	1.08						
TE 3	1.19						

CTL Vehicle Weight Change	-0.25
Adjusted TE	**77.7%**

Table 5 - Clearcoat Transfer Efficiency Summary
GM Flint Transfer Efficiency Test
November 2019

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	Transfer Efficiency (%)
Variable:	VWG	BVWG	BPS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	(avg VWG)	(avg PS)	(Method 24)	(Method 24)	(BPS*CD*WSF)	(BVWG/BSS)
TE 1	4.79	4.45	1.185	8.33	0.5645	5.57	79.9%
TE 2	4.43						
TE 3	4.13						

CTL Vehicle Weight Change	0.10
Adjusted TE	**78.1%**