GM Lansing Grand River Assembly
Lansing, Michigan

Environmental Testing Program

November 2013

Clearcoat Transfer Efficiency

Prepared By:

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1.0 Executive Summary

JLB Industries, LLC completed a compliance environmental testing program during the week of November 4, 2013 at the General Motors LLC Lansing Grand River Assembly Plant, located in Lansing, Michigan. The testing served as a compliance demonstration for the existing Topcoat (FG-Topcoat) coating operations. Solids transfer efficiency (TE) values were determined for the Clearcoat process, currently operating under Air Quality Permit #MI-ROP-A1641-2012b.

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 for the Cadillac ATS Sedan, 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. Bob Byrnes and David Patterson of the *Michigan Department of Environmental Quality* was present for portions of the testing program.

Material samples were collected from the paint circulation tanks directly after vehicle processing. Determination of percent solids by weight and density was performed by BASF at their laboratory facility in Troy, Michigan.

Table 1 – Testing Results Summary

Material	Transfer Efficiency (%)
Clearcoat	**65.5%**

2.0 Introduction

JLB Industries, LLC (JLBI) was contracted by the General Motors Lansing Grand River Assembly Plant (LGR) to perform an environmental testing program on the existing topcoat coating operations. Solids transfer efficiency (TE) values were determined for the Clearcoat process. This testing was conducted using the Cadillac ATS Sedan model during the week of November 4, 2013.

3.0 Sampling and Analytical Procedures

Transfer Efficiency testing was conducted in the Topcoat A Spraybooth, where Clearcoat was 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 process. Three vehicles were processed as normal production vehicles, while one vehicle was dedicated as a no-paint test control. 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 the VWS after each process. 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 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 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 each applicator was performed before testing to ensure accurate usage measurement.

Clearcoat
Electrocoated test vehicles were weighed and processed through the Topcoat A Spraybooth and coated with Clearcoat. The test sequence was:

1. Test Vehicle ID TE 3 – 349036
2. Test Vehicle ID TE 2 – 347445
3. Test Vehicle ID TE 1 – 356432
4. Test Vehicle ID TE 4 – 349297 (No-paint)

The test vehicles were routed through the Topcoat Oven and allowed to cool before a final weight measurement was taken at the VWS.

4.0 Test Equipment and Calibration

Vehicle Weigh Station

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 300 pounds of Class F calibration weights on each scale platform. Then, the VWS was calibrated with 600 pounds of Class F calibration weights. 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 each applicator was performed by GM prior to testing to ensure accurate usage data. Paint usage was measured at each applicator in a graduated cylinder and compared to the expected volume. The Paint Metering Verification Record is included in Section 7 of this report.

Samples of Clearcoat Part A and Clearcoat Part B were taken after each test and analyzed by BASF at their Troy, Michigan laboratory facility. As referenced in EPA Method 24, ASTM Method D-2369 was used to determine paint solids and ASTM Method D-1475 was used to determine paint density. 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 each tested coating fell within ten percent of the average weight gain as specified by the protocol. The control vehicle exhibited a weight change due to body shop sealer bake-out in the oven. This weight loss was used to adjust the average vehicle weight gain.

6.0 Calculation of Results

Table 2 - Clearcoat Transfer Efficiency Summary
GM LGR Transfer Efficiency Test
November 2013

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	BVWG	BPS	CD	WSF	BSS	TE
Calculation:	(W2-W1)	(avg VWG)-SWL	(avg PS)	(Method 24)	(Method 24)	(BPS*CD*WSF)	(BVWG/BSS)
TE 1	2.31	2.45	0.584	8.12	0.5261	2.49	**65.5%**
TE 2	2.38		0.195	8.92	0.7198	1.25	
TE 3	2.32						
					Total Avg. Solids Sprayed:	3.75	

Control Vehicle Sealer Weight Loss

Vehicle ID	Vehicle Weight Gain (lb.)
Variable:	SWL
Calculation:	(W2-W1)
TE 4	-0.12

Note: Total Avg. Solids Sprayed (3.75) is the sum of the CC Part A (2.49) and CC Part B (1.25) solids sprayed.

7.0 Data Sheets

Table 3 - Applicator Parameter Summary
GM LGR Transfer Efficiency Test
November 2013

Operation	Manufacturer	Applicator	Fluid Tip	Air Cap	Gun Voltage	RPM	Gun-to-Target Distance	Remarks
CC Robot	Fanuc	Durr Eco L2 HX	1.1 mm	N/A	30-40 kV	30,000	6-8"	
CC Bell Zone 2	Behr	Eco Bell	1.1 mm	N/A	40-80 kV	40,000	12"	

Line Speed: 29.6 JPH

Paint Metering Data Record
Clearcoat
GM LGR Transfer Efficiency Test, November 4-5, 2013

Process	Applicator	Vehicle ID/ Paint Sprayed (cc)		
		TE 3	TE 2	TE 1
CC Robot	Robot 1	151	151	151
	Robot 2	172	172	172
	Robot 3	369	369	369
	Robot 4	368	368	368
CC Bell	1.1	93	93	94
	2.1	93	93	94
	1.2	100	100	103
	2.2	100	100	103
	1.3	81	82	82
	2.3	80	82	82
	3.1	132	135	133
	3.2	197	199	197
	3.4	132	135	133
	1.4	90	92	90
	2.4	90	92	90
	1.5	102	103	102
	2.5	102	103	102
	3.5	150	152	153
	3.6	181	183	183
	3.8	150	152	153
	Total (cc):	2933	2956	2954
	Total (gal):	0.77	0.78	0.78

Avg. Paint Sprayed (gal):	0.779
Avg. Part A Sprayed (gal):	0.584
Avg. Part B Sprayed (gal):	0.195

*Note, Clearcoat applied at a 3A:1B ratio.

Date: 11/4/2013

LGR FLUID FLOW CHECK

Applicator		Quantity Asked	Expected Quantity	*Beaker Amount*
Clearcoat	Robot 1	400 cc/min for 30 Seconds	200	*190*
Clearcoat	Robot 2	400 cc/min for 30 Seconds	200	*195*
Clearcoat	Robot 3	400 cc/min for 30 Seconds	200	*195*
Clearcoat	Robot 4	400 cc/min for 30 Seconds	200	*190*
Clearcoat	Bell 1.1	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 2.1	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 1.2	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 2.2	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 1.3	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 2.3	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 3.1	100 cc/min for 60 Seconds	100	*110*
Clearcoat	Bell 3.2	100 cc/min for 60 Seconds	100	*105*
Clearcoat	Bell 3.4	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 1.5	100 cc/min for 60 Seconds	100	*105*
Clearcoat	Bell 2.5	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 1.6	100 cc/min for 60 Seconds	100	*105*
Clearcoat	Bell 2.6	100 cc/min for 60 Seconds	100	*100*
Clearcoat	Bell 3.5	100 cc/min for 60 Seconds	100	*110*
Clearcoat	Bell 3.6	100 cc/min for 60 Seconds	100	*110*
Clearcoat	Bell 3.8	100 cc/min for 60 Seconds	100	*110*

Vehicle Weigh Station Data Record
Clearcoat
GM LGR Transfer Efficiency Test, November 4-5, 2013

Test Vehicle 1		Pre-Weight (lb.) *W1*	BC/CC Weight (lb.) *W2*
Carrier	356432	860.60	862.88
VIN	TE 1	860.62	862.92
		860.58	862.92
		860.58	862.92
Two-Pound Linearity Check:		*862.60*	*864.92*
Average Vehicle Weight:		860.60	862.91
		Vehicle Weight Gain:	**2.31**

Test Vehicle 2		Pre-Weight (lb.) *W1*	BC/CC Weight (lb.) *W2*
Carrier	347445	861.30	863.68
VIN	TE 2	861.28	863.66
		861.28	863.64
		861.28	863.66
Two-Pound Linearity Check:		*863.28*	*865.64*
Average Vehicle Weight:		861.29	863.66
		Vehicle Weight Gain:	**2.38**

Test Vehicle 3		Pre-Weight (lb.) *W1*	BC/CC Weight (lb.) *W2*
Carrier	349036	859.16	861.48
VIN	TE 3	859.14	861.48
		859.16	861.46
		859.14	861.46
Two-Pound Linearity Check:		*861.16*	*863.48*
Average Vehicle Weight:		859.15	861.47
		Vehicle Weight Gain:	**2.32**

Vehicle Weigh Station Data Record
Topcoat Control Vehicle
GM LGR Transfer Efficiency Test, November 4-5, 2013

Control Vehicle		Pre-Weight (lb.) *W1*	Post-Weight (lb.) *W2*
Carrier	349297	859.60	859.48
VIN	TE 4	859.58	859.48
		859.58	859.46
		859.56	859.44
Two-Pound Linearity Check:		*861.56*	*861.44*
Average Vehicle Weight:		859.58	859.47
		Vehicle Weight Gain:	**-0.12**

Method 24 Paint Analysis
Performed by BASF
November 2013

Product Description	Wt. Solids Fraction	Density (lb./gal.)
Clearcoat Part A	0.5261	8.119
Clearcoat Part B	0.7198	8.922