Topcoat Operations Testing of Paint Solids Transfer Efficiency

Chrysler Group, LLC
Sterling Heights Assembly Plant
38111 Van Dyke Avenue
Sterling Heights, Michigan

Permit to Install 227-10B

Prepared for

Chrysler Group LLC
Auburn Hills, Michigan

Bureau Veritas Project No. 11014-000087.00
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Executive Summary

Chrysler Group LLC retained Bureau Veritas North America, Inc. to conduct paint solids transfer efficiency (TE) testing from the topcoat coating operations at the Sterling Heights Assembly Plant (SHAP) in Sterling Heights, Michigan. SHAP manufactures the Chrysler 200 automobile and operates water and solvent borne topcoat paint lines. The testing was performed from June 3 through 5, 2014, to measure the following parameters:

- Paint solids transfer efficiency (TE)—the percent of paint solids sprayed that deposit on the painted part. TE was measured when applying white solid basecoat, silver metallic basecoat, and standard clearcoat in the Topcoat 3 line and white solid basecoat, white mica Tri-coat, and standard clearcoat in the Topcoat 1 line.

The results of the testing will be used to calculate monthly emissions.

The testing was conducted in accordance with applicable procedures in the U.S. Environmental Protection Agency document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations".

The results of the testing are summarized on the following page. Detailed results are presented in Tables 1 and 2 after the Tables tab of this report.

Paint Solids Transfer Efficiency Results

Topcoat 3 Paint Solids Transfer Efficiency Results Summary

Process	Result					Solids Transfer Efficiency
	Batch Vehicle Weight Gain (lb)	Batch Paint Sprayed (gal)	Coating Density (lb/gal)	Solids Weight Fraction (lb solids/lb coating)	Batch Solids Sprayed (lb)	(%)
Metallic Basecoat – Silver	3.58	1.39	9.07	0.3535	4.45	80.5
Solid Basecoat – White	4.80	1.34	10.60	0.4805	6.85	70.2
Clearcoat – Standard	5.82	1.64	8.63	0.5908	8.37	69.5

Topcoat 1 Tricoat Paint Solids Transfer Efficiency Results Summary

Process	Result				Tricoat Solids Transfer Efficiency
	Basecoat Solid Ratio	Clearcoat Solid Ratio	Clearcoat Solids Transfer Efficiency (%)	Composite Solids Transfer Efficiency (%)	(%)
Tricoat Mica – White	0.483	0.517	69.5	74.1	79.0

1.0 Introduction

Chrysler Group LLC retained Bureau Veritas North America, Inc. to conduct paint solids transfer efficiency (TE) testing from the topcoat coating operations at the Sterling Heights Assembly Plant (SHAP) in Sterling Heights, Michigan. SHAP manufactures the Chrysler 200 automobile and operates water and solvent borne topcoat paint lines.

- Paint solids transfer efficiency (TE)—the percent of paint solids sprayed that deposit on the painted part. TE was measured when applying white solid basecoat, silver metallic basecoat, and standard clearcoat in the Topcoat 3 line and white solid basecoat, white mica tricoat, and standard clearcoat in the Topcoat 1 line.

The results of the testing will be used to calculate monthly emissions.

The testing program was conducted in accordance with applicable procedures in the U.S. Environmental Protection Agency document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations".

1.1 Summary of Test Program

The topcoat paint process at SHAP is comprised of three topcoat paint lines in which basecoat and clearcoat are applied. Currently, coatings are applied to the Chrysler 200 production models. Vehicles that were being prepared or assembled were used in the test program. The test program is summarized below.

Paint Solids Transfer Efficiency Testing

Topcoat 3. Paint solids transfer efficiency testing was performed on June 3 and 4, 2014, following the procedures in Section 18, "Transfer Efficiency Test Procedure—In Plant" of the USEPA document, "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations." The procedure measures the weight of coating solids applied to vehicles.

The testing consisted of routing a pre-weighed control vehicle and three pre-weighed test vehicles through the Topcoat 3 spray booths and bake oven. Three color families were evaluated: solid white basecoat, metallic silver basecoat, and standard clearcoat. After cured vehicles emerged from the oven, they were allowed to cool and re-weighed. Using the vehicle body weight gain, representing the weight of solids applied the percent paint solids transfer efficiency was calculated.

Topcoat 1. Paint solids transfer efficiency testing was performed on June 5, 2014, following the procedures in Section 18, "Transfer Efficiency Test Procedure—In Plant" of the USEPA document, "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations." The procedure measures the weight of coating solids applied to vehicles.

The testing consisted of routing a pre-weighed control vehicle and three pre-weighed test vehicles through the Topcoat 1 spray booths and bake oven. The test vehicles were coated with solid white basecoat, mica white basecoat, and standard clearcoat on one pass. After cured vehicles emerged from the oven, they were allowed to cool and re-weighed. Using the vehicle body weight gain, representing the weight of solids applied, and the ratio of basecoat and clearcoat solids applied, the tricoat percent paint solids transfer efficiency was calculated.

Table 1-1 summarizes the sources, parameters, and test dates.

Table 1-1
Identification of Sources, Parameters, and Test Dates

Emission Unit	Source	Parameter	Test Date	Coating Tested
EUTOPCOAT3	Topcoat 3	Paint solids TE	June 3 and 4, 2014	Metallic basecoat – silver Solid basecoat – white Clearcoat- standard
EUTOPCOAT1	Topcoat 1	Paint solids TE	June 5, 2014	Tricoat (solid white and mica white basecoat)

TE = transfer efficiency

1.2 Purpose of Testing

The testing was performed in order to satisfy requirements within Michigan Department of Environmental Quality (MDEQ) Permit to Install 227-10B for the FG-FACILITY flexible group conditions. The results of the TE tests are used to evaluate compliance with the emission limits in Table 1-2 on the following page.

Table 1-2
Emission Limits

Pollutant	Limit	Time Period and Operating Scenario	Equipment	Monitoring and Testing Method	Underlying Applicable Requirements
VOC	673.2 tpy*	12-month rolling time period as determined at the end of each calendar month	FG-FACILITY	SC V.1	R336.1225 R336.1702(a)
VOC	4.5 pounds per job	12-month rolling time period as determined at the end of each calendar month	FG-FACILITY minus EUPURGECLEAN	SC V.1	R336.1225 R336.1702(a)

*Note, this limit for FG-FACILITY includes emissions allowed to be emitted from EUPURGECLEAN

1.3 Contact Information

Mr. Thomas Schmelter, Senior Project Manager, and Mr. Dillon King, Consultant, with Bureau Veritas, conducted the environmental test program with the assistance of Mr. Jim Belanger and Mr. Jeff Monache, with JLB Industries, Inc. Chrysler Group LLC personnel provided process coordination and recorded operating parameters. Messrs. Thomas Maza, Robert Byrnes, Sam Liveson, and Mark Dziadosz with the Michigan Department of Environmental Quality (MDEQ) witnessed the testing. Contact information for these individuals is presented in Table 1-3.

Table 1-3
Key Contact Information

Facility	Testing Company
Chrysler Group LLC	Bureau Veritas North America, Inc.
Rohit Patel Air Compliance Manager 800 Chrysler Drive Auburn Hills, Michigan 48326-2757 Telephone: 248.512.1599 Email: rgp6@chrysler.com	Thomas Schmelter, QSTI Senior Project Manager 22345 Roethel Drive Novi, Michigan 48375-4710 Telephone 248.344.3003 Email: thomas.schmelter@us.bureauveritas.com
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2.0 Source and Sampling Locations

2.1 Process Description

The topcoat paint process at the SHAP facility is comprised of three topcoat paint systems in which basecoat and clearcoat coatings are applied. The normal operating production line speed of the topcoat system is approximately 70 jobs per hour. As the process of each topcoat paint system is similar, the emissions results from the tested lines will apply to the others at the facility. The vehicles in the test were processed in the same manner as regular production vehicles and process data was recorded to confirm that testing was conducted under normal operating conditions.

The topcoat spray booths utilize a downdraft ventilation system and water wash system below the booth grating to control paint overspray. Water borne basecoat and solvent borne clearcoat are applied by electrostatic applicators on robots. A process map, representative of Topcoat Lines 2 and 3 is provided in the Appendix as Figure 1. Figure 2-1 provides a process map representative of the topcoat paint lines. A summary of the spray gun applicator parameters is presented in Table 2-1. Closed loop beakering verification of the applicators is presented in Appendix A.

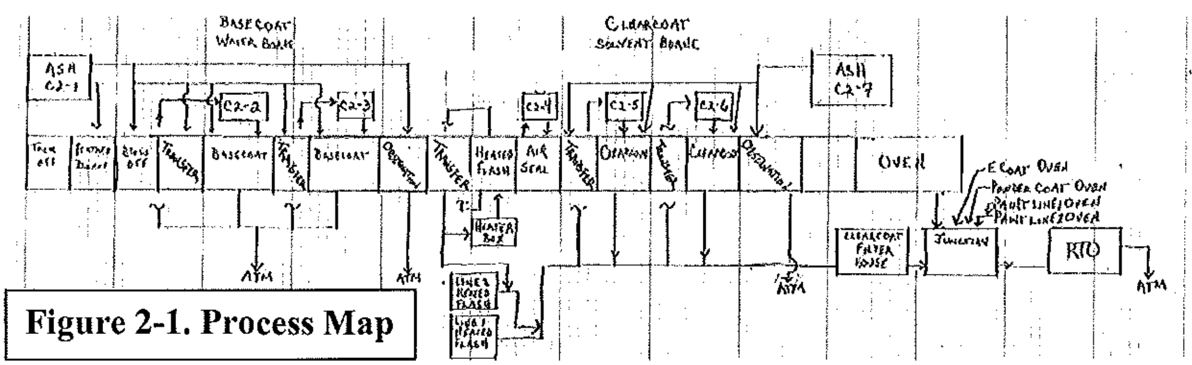

Figure 2-1. Process Map

Table 2-1
Applicator Parameter Summary

Operation	Manufacturer	Applicator	Fluid Tip/Bell Size (mm)	Air Cap	Gun Voltage (kV)	Revolutions per Minute	Gun-to-Target Distance (inch)
BC Interior	Fanuc	P700	1.2	N/A	40	50,000	10

Table 2-1
Applicator Parameter Summary

Operation	Manufacturer	Applicator	Fluid Tip/Bell Size (mm)	Air Cap	Gun Voltage (kV)	Revolutions per Minute	Gun-to-Target Distance (inch)
BC Exterior	Fanuc	250	0.9	N/A	80	75,000	8
CC Interior	Fanuc	P700	1.2	N/A	40	50,000	10
CC Exterior	Fanuc	250	0.9	N/A	80	75,000	8
BC Tricoat	Fanuc	P700	0.9	N/A	40/80	50,000/75,000	10/8

mm: millimeter
kV: kilovolts

2.2 Control Equipment

The topcoat spray booths use a downdraft ventilation system and water-wash system below the booth grating to control paint overspray. Captured oven VOC emissions are directed to a regenerative thermal oxidizer for VOC abatement. The downdraft ventilation and water wash system was not evaluated during this test program; however, they were in operation in accordance with the facility's Renewable Operating Permit.

2.3 Operating Parameters

The following operating parameters were recorded during the testing:

- Line speed
- Coating use
- Applicator information
- Bake oven temperature
- Film build
- Spray booth airflow

Appendix E presents the operating parameters recorded during testing. It should be noted that some of the test vehicles did not pass Chrysler's QA/QC checks for film build due to the manner in which test vehicles were processed and coated to accommodate the testing.

2.4 Process Sampling Locations

Facility personnel collected eight process samples of the coatings applied during the testing. The coatings were collected following procedures in USEPA's "Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A," dated September 1991.

The coatings were collected at the point of application in 4-ounce glass containers with minimal headspace. The coating-as-applied samples were analyzed using USEPA Method 24 to measure non-VOC and VOC content, water content, and density. The Method 24 coating analytical results are summarized in Table 2-3 and included in Appendix F.

Table 2-2
Method 24 Coating Analytical Results

Sample	Parameter						
	Date	% Non-volatile	% Volatile	Density		VOC	
				g/ml	lb/gal	g/L	lb/gal
SHAP Clearcoat Part A	6/3/14	58.15	41.85	1.056	8.81	441.8	3.69
SHAP Clearcoat Part B	6/3/14	60.01	39.99	1.013	8.45	405.1	3.38
SHAP Silver Basecoat	6/3/14	35.35	64.65	1.086	9.07	192.0	1.60
SHAP White Basecoat	6/4/14	48.05	51.95	1.270	10.60	207.3	1.73
SHAP Clearcoat Part A	6/5/14	58.83	41.17	1.008	8.41	414.9	3.46
SHAP Clearcoat Part B	6/5/14	59.33	40.67	1.009	8.42	410.5	3.43
SHAP White Basecoat	6/5/14	48.17	51.83	1.272	10.61	386.7	3.23
SHAP Mica White Basecoat	6/5/14	40.78	59.22	1.272	10.62	470.8	3.93

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The testing was performed in order to satisfy requirements within MDEQ Permit to Install 227-10B for the FG-FACILITY flexible group conditions. The effective date of the permit is November 4, 2013. The results of the testing will be used to calculate daily and monthly emissions. The sources, parameters, processes, and test date are presented in Table 1-1 and the permit emission limits are presented in Table 1-2.

3.2 Field Test Changes and Issues

The following sections summarize the field test changes and issues.

3.2.1 Transfer Efficiency Tricoat Mica White

During the tricoat transfer efficiency testing on the Topcoat 1 line, a lift robot designated H1, was not selected for any of the test vehicles. The robot applicator that coats the decklid (i.e., trunk), designated 2P1, does not apply coating until it receives the signal from the lift robot (H1). As H1 was not selected for the jobs it did not lift the decklid for any of the test vehicles and therefore 2P1 did not apply coating to the decklid of any of the test vehicles.

3.3 Presentation of Results

The results are summarized in Tables 3-1 and 3-2. Detailed paint solids TE test results are presented in Tables 1 and 2 after the Tables tab of this report. Sample calculations and calculation spreadsheets are presented in Appendix B with raw and computer generated field data sheets behind Appendix C and D. Facility operating data are included in Appendix E.

Paint Solids Transfer Efficiency Results

Table 3-1
Topcoat 3 Paint Solids Transfer Efficiency Results Summary

Process	Result					Solids Transfer Efficiency
	Batch Vehicle Weight Gain (lb)	Batch Paint Sprayed (gal)	Coating Density (lb/gal)	Solids Weight Fraction (lb solids/lb coating)	Batch Solids Sprayed (lb)	(%)
Metallic Basecoat – Silver	3.58	1.39	9.07	0.3535	4.45	80.5
Solid Basecoat – White	4.80	1.34	10.60	0.4805	6.85	70.2
Clearcoat – Standard	5.82	1.64	8.63	0.5908	8.37	69.5

Table 3-2
Topcoat 1 Tricoat Paint Solids Transfer Efficiency Results Summary

Process	Result				Tricoat Solids Transfer Efficiency
	Basecoat Solid Ratio	Clearcoat Solid Ratio	Clearcoat Solids Transfer Efficiency (%)	Composite Solids Transfer Efficiency (%)	(%)
Tricoat Mica – White	0.483	0.517	69.5	74.1	79.0

4.0 Sampling and Analytical Procedures

The testing was conducted in accordance with applicable procedures contained in the USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations". The parameters and analytical methods used are listed in Table 4-1.

Table 4-1
Sampling and Analytical Test Methods

Reference Method	Parameter	Analysis
Section 18, "Transfer Efficiency Test Procedure--In Plant" of the USEPA document, "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations."	Paint solids transfer efficiency	Gravimetric
ASTM D2369-10e1, "Standard Test Method for Volatile Content of Coatings," and D1475-98(2012), "Standard Test Method for Density of Liquid Coatings, Inks, and Related Products," incorporated by reference in USEPA 24, "Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings."	Coating density, solids content	Gravimetric
ASTM D7091-12, "Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals"	Film build	Electromagnetic induction

4.1 Test and Analytical Methods

The test methods are summarized in the following sections.

4.1.1 Paint Solids Transfer Efficiency

Paint solids TE testing was conducted in accordance with the applicable procedures contained in Section 18 of the USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations".

TE was measured by comparing (1) the weight gain of the test vehicle batch after coating application and curing and (2) the weight of solids sprayed. For example, the vehicle weight gain measured after the solid basecoat application divided by the weight of the solid basecoat paint solids sprayed yields an overall TE for solid basecoat. Coating material use was monitored using integrated robot, bell, or manual in-line flow monitors. These devices measured material consumption in cubic centimeters (cc) on each applicator or at the corresponding gear pump. The summation of the coating applied through each applicator equals the total volume of paint sprayed.

TE was measured by four separate tests for metallic basecoat, solid basecoat, tricoat, and clearcoat. The measured TE values are considered representative of coatings applied in each coating group (white basecoat TE was used as TE for the solid basecoats applied). As the process of each booth is identical, the TE values from the tested booths will apply to the other lines at the facility.

Each test involved coating three car bodies. One no-paint control vehicle was run through the process to account for sealer weight loss and measurement accuracy. The vehicles were weighed before and after solids were applied. Figure 4-1 presents a photograph of the vehicle weigh station.

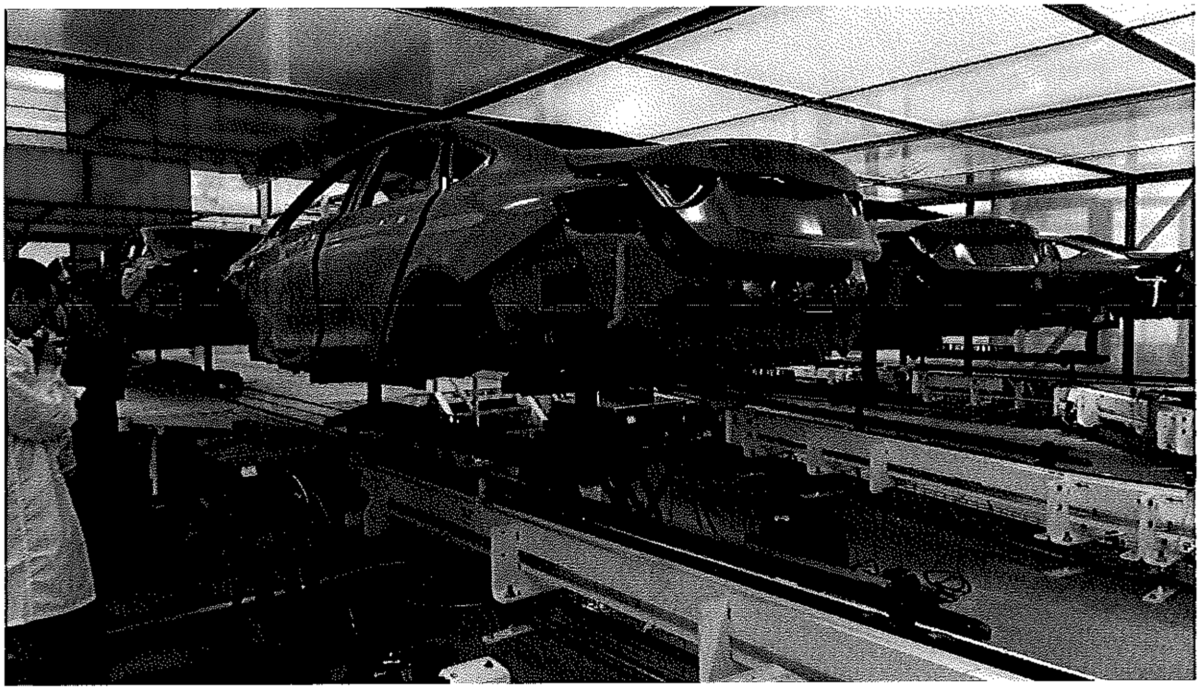

Figure 4-1. Paint Solids Transfer Efficiency Vehicle Weigh Station

During the test, vehicles were processed in the same manner as normal production vehicles and process data were recorded to document that testing was conducted under normal booth conditions. The general test sequence for each TE measurement was:

- Configure vehicle weigh station (VWS) to achieve measurement accuracy to ±0.05 pounds.
- Pre-weigh batch of test vehicles and control vehicle.
- Load application equipment and route test vehicles to spray booth.
- Process test vehicles through spray booth as normal production vehicles.
- Record coating material use.
- Route test vehicles through bake oven.
- Allow test vehicles to cool and measure post-coating weight to calculate weight gain attributable to applied coating solids.
- Obtain coating samples for laboratory analysis to measure coating density and solids weight fraction.

Solids in each coating sample were analyzed by ASTM D2369, incorporated by reference in USEPA Method 24. Each coating sample was analyzed for density by ASTM D1475, incorporated by reference in USEPA Method 24.

4.1.2 Solids and Density Determination (USEPA Method 24)

Solids and density measurements followed USEPA Method 24, "Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings." The coating was collected following procedures in USEPA's "Standard Procedure for Collection of Coating and Ink Samples for Analysis by Methods 24 and 24A." Samples were collected from the coating totes into a 1-quart glass container with minimal headspace.

The coating-as-applied samples were analyzed following USEPA Method 24 procedures to measure the non-volatile and volatile content, density, and VOC density. Laboratory results are included in Appendix F.

4.2 Procedures for Obtaining Process Data

Process data were recorded by Chrysler Group LLC personnel. The process data are included in Appendix E.

4.3 Sampling Identification and Custody

Detailed sampling and recovery procedures are described in Section 4.1. For each sample collected (i.e. coating), sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with sample identification and date.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."
- Samples were delivered to the laboratory.

Chains of custody and laboratory analytical results are included in Appendix F.

5.0 QA/QC Activities

Equipment used in this environmental test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment calibration and inspection sheets.

5.1 Pretest QA/QC Activities

Before testing, the equipment was inspected and calibrated according to procedures outlined in the applicable procedures contained in the USEPA document "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Primer-Surfacer and Topcoat Operations". Refer to Appendix A for inspection and calibration sheets.

5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits are presented in the following sections. Calibration measurements for scales are presented in Appendix A.

5.3 TE QA/QC Blanks

One 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 on the following page in the Table 5-1.

Table 5-1
QA/QC Blanks

Vehicle Identification	Vehicle Weight Gain (lb)	Vehicle Batch	Comment
TE 2207	-0.02	Metallic Basecoat-Silver	Control vehicle within testing tolerances, not used to adjust batch vehicle weight gain value
TE 7941	-0.05	Solid Basecoat-White	Control vehicle within testing tolerances, not used to adjust batch vehicle weight gain value
TE 2207	-0.01	Clearcoat- Standard	Control vehicle within testing tolerances, not used to adjust batch vehicle weight gain value
TE 2452	-0.20	Tricoat - Mica White	Control vehicle within testing tolerances, not used to adjust batch vehicle weight gain value

5.4 QA/QC Problems

No quality assurance/quality control problems were encountered during this test program.

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