BTEC Inc.

Executive Summary

BT Environmental Consulting, Inc. (BTEC) was retained by General Motors LLC (GM) to provide compliance volatile organic compound (VOC) capture efficiency (CE) and destruction efficiency\removal efficiency (DE\RE) testing services at the GM Lansing Grand River (LGR) facility located in Lansing, Michigan. The test program was conducted during a single mobilization during the week of December 7, 2015.

The test program consisted of a minimum of triplicate 60-minute test runs at each sampling location. Sampling was performed utilizing United States Environmental Protection Agency (USEPA) reference test methods. The results of the emissions compliance test program are summarized by Table E-1.

Table E-1
Overall Results Summary

Source		Test Result	Data Quality Objective
Primer Surfacer (Guide Coat) System		46% CE	11.6
Top Coat System		83.8% CE	3.7
RTO No. 1		94.2% DE	NA
RTO No. 2	RTO No. 2	97.9% DE	NA
	RCC	81.6% RE	NA
	RTO No. 2 / RCC	90.5% RE/DE	NA

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1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by General Motors LLC (GM) to provide compliance volatile organic compound (VOC) capture efficiency (CE) and destruction efficiency\removal efficiency (DE\RE) testing services at the GM Lansing Grand River (LGR) facility located in Lansing, Michigan.

The Air Quality Division (AQD) of Michigan's Department of Environmental Quality has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

The sources tested are located at the GM Lansing Grand River (LGR) facility (920 Townsend, Lansing, Michigan). VOC CE testing of the Primer Surfacer (Guidecoat) system was performed on December 9, 2015. VOC CE testing of the Clearcoat/Topcoat system was performed on December 8, 2015. VOC DE/RE testing on RTO No. 2 was performed on December 10, 2015. VOC DE testing on RTO No. 1 (South RTO) was performed on December 9, 20015.

1.b Purpose of Testing

The purpose of testing is to demonstrate compliance with Michigan Renewable Operating Permit MI-ROP-A1641-2012.

1.c Source Description

The emission units to be tested include EU-Electrocoat, EU-Guidecoat, FG-Topcoat and FG-Facility from Renewable Operating Permit (ROP) No. MI-PTI-A1641-2012. These emission units are part of an automobile surface coating process line. The emissions test program included:

(1) Evaluation of the DE of Regenerative Thermal Oxidizer (RTO) No. 1,
(2) Evaluation of the RE/DE of RTO No. 2 and the rotary carbon concentrator (RCC) that serves RTO No. 2,
(3) Evaluation of the CE of the Clearcoat/Topcoat process, and
(4) Evaluation of the CE of the Primer Surfacer (Guidecoat) process.

1.d Test Program Contact

The contact for information regarding the test program as well as the test report is:

Ms. Kim Essenmacher
Staff Environmental Engineer
General Motors LLC
WTC Mfg. B Bldg.
30400 Mound Road
MC: 480-109-MB1
Warren, MI 48092
(248) 255-7780

1.e Testing Personnel

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

Table 1
Testing Personnel

Name	Affiliation
Kim Essenmacher	GM-WFG
Jim Ecklund	GM-LGR
Matt Young	BTEC
Barry Boulianne	BTEC
Todd Wessel	BTEC
Paul Molenda	BTEC
Shane Rabideau	BTEC
Mason Sakshaug	BTEC
Travis Clark	BTEC
Paul Diven	BTEC
Dave Trahan	BTEC
Steve Smith	BTEC
Tom Gasloli	MDEQ
Bob Byrnes	MDEQ

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions test program.

2.a Operating Data

Operational data monitored during the test program includes the amount of cars in the production booth as well as RTO chamber temperature.

2.b Applicable Permit

Michigan Renewable Operating Permit MI-ROP-A1641-20012.

2.c Results

The results of the emissions test program are summarized by Tables 2, 3, 4, & 5.

2.d Emission Regulation Comparison

The purpose of the emissions test program is to verify VOC CE/DE values for both RTO units and the removal efficiency for the Carbon Concentrator. The values are then used in calculating VOC emission rates from each emission unit. Consequently, the results of the emissions test program do not have a corresponding emission limitation. The test results will be used to calculate daily emissions according to U.S. EPA document EPA-450/3-88-018, "Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operations." for the Primer Surfacer and Topcoat emission groups. The DE test value for RTO No. 1 will also be used to calculate daily emissions from the Electrocoat emission group.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

EU-Electrocoat: An electrocoat dip tank followed by an electrocoat curing oven followed by a dry filtered scuff booth. VOC emissions from both the tank and oven are controlled by a thermal oxidizer (No. 1). Note: VOC emissions from the guidecoat curing oven and the two topcoat curing ovens are also controlled by thermal oxidizer No. 1.

EU-Guidecoat: A guidecoat spray booth followed by a curing oven. The solvent borne guidecoat is applied automatically with electrostatic bell applicators or equivalent. A robot zone, which performs cut ins, follows the bell zone. The guidecoat booth is equipped with a wet eliminator system to control particulate emissions from paint overspray. VOC emissions from the automatic electrostatic bell section of the guidecoat booth are controlled by thermal oxidizer No. 2. VOC emissions from the guidecoat curing oven are controlled by thermal oxidizer No. 1.

FG-Topcoat: Two parallel topcoat spray systems which consist of a spray booth followed by a curing oven. There is a heated flash-off area located between the basecoat portion of the booth and the clearcoat portion of the booth. The waterborne basecoat is applied automatically with electrostatic bell and electrostatic robot applicators or equivalent. The solvent borne clearcoat is applied automatically with electrostatic bell and electrostatic robot applicators or equivalent.

3.b Process Flow Diagram

A Process Flow Diagram is included as Appendix E.

3.c Raw and Finished Materials

The raw materials used in the coating process line include various automotive surface coatings.

3.d Process Capacity

The Primer Surfacer coating line has a target production rate of 49 jobs per hour. Each Topcoat coating line has a target production rate of 29 jobs per hour.

3.e Process Instrumentation

Process instrumentation relevant to the emissions test program includes monitoring the combustion chamber temperature of the RTO unit.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used to verify the CE and DE/RE of the tested production lines.

4.a Sampling Train and Field Procedures

Measurement of exhaust gas velocity, molecular weight, and moisture content was conducted using the following reference test methods codified at 40 CFR 60, Appendix A:

- Method 1 - *"Location of the Sampling Site and Sampling Points"*
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"*
- Method 3 - *"Determination of Molecular Weight of Dry Stack Gas"(Fyrite)*
- Method 4 - *"Determination of Moisture Content in Stack Gases"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. An S-type or standard pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type and standard pitot tube dimensions were within specified limits, therefore, baseline pitot tube coefficients of 0.84 and 0.99 (dimensionless), respectively, were assigned.

A cyclonic flow check was performed at the sampling locations. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angles is greater than 20 degrees, cyclonic flow exists. The average null angle was determined to be less than 20 degrees at each of the applicable sampling location.

Molecular weight was determined according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted and passed through (i) two impingers, each with 100 ml deionized water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content was then determined volumetrically (liquid impingers) and gravimetrically (silica gel impinger). A schematic drawing of the Method 4 sampling train is provided as Figure 15.

VOC concentrations were measured at each location using the procedures found in 40 CFR 60, Appendix A, Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer." Triplicate 60-minute test runs were conducted on each source.

VOC concentrations were measured using a VIG Industries Model 20 THC gas analyzer. The RTO outlet VOC concentrations were measured using a JUM 109A Methane/Non-Methane Analyzer. For each sampling location, a sample of the gas stream was drawn through a stainless-steel probe with an in-line glass fiber filter to remove any particulate and a heated Teflon® sample line to prevent the condensation of any moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a Laptop PC equipped with data acquisition software.

The VIG THC hydrocarbon analyzer directs the sample to the flame ionization detector (FID), where the hydrocarbons present in the sample will be ionized into carbon. The carbon concentration is then determined by the detector in parts per million (ppm). This concentration is sent to the data acquisition system (DAS) at 4-second intervals in the form of an analog signal, specifically voltage, to produce data that can be averaged over the duration of the testing program. This data is then used to determine the average ppm for total hydrocarbons (THC) using the equivalent units of propane (calibration gas).

The J.U.M. Model 109A utilizes two flame ionization detectors (FID) to determine the average concentration (ppm) for THC (as propane) and the average concentration for methane. Upon entry, the gas stream is split by the analyzer. One FID ionizes all of the hydrocarbons in the gas stream sample into carbon, which is then detected as a concentration of total hydrocarbons. Using an analog signal, specifically voltage, the concentration of THC is then sent to a data acquisition system (DAS), where 4-second interval data points are recorded to produce an average based on the overall duration of the test. This average is then used to determine the average concentration for THC reported as the calibration gas, propane, in equivalent units.

The analyzer's response factor is obtained by introducing a methane calibration gas to the calibrated J.U.M. 109A. The response of the analyzer's THC FID to the methane calibration gas, in ppm, as propane, is divided by the methane analyzer's response to the methane calibration gas, in ppm as methane.

For analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consists of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. A field quality assurance check of the system was performed pursuant to Method 205 by setting the diluted concentration to a value identical to a Protocol 1 calibration gas and then verifying that the analyzer response is the same with the diluted gas as with the Protocol 1 gas.

A drawing of the Method 25A sampling train used for the testing program is presented as Figure 16. Protocol 1 gas certification sheets for the calibration gases used for this testing program are presented in Appendix B.

4.b Recovery and Analytical Procedures

Because all measurements were conducted using on-line analyzers, no samples were recovered during the test program.

4.c Sampling Ports

The THC sampling probes for each location were placed at a single fixed position for the 60-minute duration of each test run.

4.d Traverse Points

Traverse points for each exhaust flowrate sampling location are illustrated by Figures 1 through 14.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The results of the emissions test program are summarized by Tables 2, 3, 4, and 5.

5.b Discussion of Results

The Primer Surfacer (Guidecoat) System had a CE of 46% and a DQO of 11.6. The Topcoat System had a CE of 83.8% and a DQO of 3.7. The RCC had a RE of 81.6%, RTO No. 2 had a DE of 97.9%, and the entire RCC/RTO No. 2 system had an overall Removal/Destruction efficiency of 90.5%. RTO 1 had a DE of 94.2%.

The Primer Surfacer (Guidecoat) System had a DQO of 11.6. The required DQO is ≤5. It was determined that changes in production rates during the PS CE test resulted in variations of inlet VOC concentrations, that in turn, resulted in not achieving the DQO.

5.c Sampling Procedure Variations

A fourth sample run was conducted on RTO 1. Run 1 for the testing on RTO 1 was not used because of insufficient production during the test period. The Data is included in the report, however the run was omitted from the average test result.

The PS2B exhaust stack was found to be highly cyclonic, with the average absolute null angle reading of 52 degrees. BTEC performed velocity measurements on this source by turning the S-Type pitot until a maximum delta p reading was obtained and used this number for the velocity. BTEC feels that this maximum number biases the velocity high. Tom Gasloli from the MDEQ was onsite to witness this alternative measurement.

5.d Process or Control Device Upsets

None.

5.e Control Device Maintenance

No control device maintenance was performed immediately prior to the testing.

5.f Audit Sample Analyses

No samples were collected as part of the test program.

5.g Calibration Sheets

Certificates of analysis for the calibration gases used during testing are provided in Appendix B.

5.h Sample Calculations

Sample calculations are provided as Appendix C.

5.i Field Data Sheets

Copies of the analyzer calibration sheets are provided in Appendix B. Copies of flow sheets are provided as Appendix A.

5.j Laboratory Data

No laboratory analysis was included in this test program.

Table 2
Primer Surfacer (Guidecoat) System Capture Efficiency Results Summary
General Motors
Lansing, Michigan
BTEC Project No. 08-3739.00

Test Run	Test Date	Test Time	PS1 Flowrate (scfm)	PS 1 VOC Concentration (ppmv)	PS1 VOC Emission Rate (lbs/hr)	PS2A Flowrate (scfm)	PS2A VOC Concentration (ppmv)	PS2A VOC Emission Rate (lbs/hr)	PS2B Flowrate (scfm)	PS2B VOC Concentration (ppmv)	PS2B VOC Emission Rate (lbs/hr)	PS3 Gas Flowrate (scfm)	PS3 THC Concentration (ppmv)	PS3 VOC Emission Rate (lbs/hr)	PS Capture Efficiency (%)
1	12/9/2015	7:35	10,717	201.50	14.79	66,258	34.10	15.48	66,105	17	7.56	10518.83	153.30	11.05	52.86%
2	12/9/2015	9:45	11,437	201.70	15.80	73,091	37.30	18.68	66,102	23	10.55	10472.49	123.40	8.85	45.76%
3	12/9/2015	12:11	11,864	141.40	11.49	75,008	28.40	14.59	60,585	26	10.67	10470.01	119.30	8.56	44.25%
4	12/9/2015	13:45	9,861	97.10	6.56	77,204	20.60	10.89	62,025	18	7.52	10306.87	77.80	5.49	39.56%
5	12/9/2015	16:45	10,158	195.30	13.59	69,126	37.90	17.95	58,417	29	11.56	10333.43	117.40	8.31	42.60%
6	12/9/2015	18:10	10,030	163.40	11.23	66,984	26.70	12.25	58,046	14	5.61	10413.52	103.10	7.35	50.99%
		Averages:	10,678	166.73	12.24	71,279	30.83	14.97	61,880	21	8.91	10419.19	115.72	8.27	46.00%

Data Quality Objective Calculation

No. of Tests: 6

Test	CE %	Notes
1	52.9%	
2	45.8%	
3	44.2%	
4	39.6%	
5	42.6%	
6	51.0%	

Confidence Interval Table

N	t (0.975)	LCL 80%: t (0.90)
2	12.706	3.078
3	4.303	1.886
4	3.182	1.638
5	2.776	1.533
6	2.571	1.476
7	2.447	1.440
8	2.365	1.415
9	2.306	1.397
10	2.262	1.383

n=6
t0.90 = 1.476
x avg = 0.465
s = 0.048

0.436076425

43.6

Average CE % :	0.460
Standard Deviation:	0.051
t(0.975) :	2.571
a :	0.053
P (DQO) :	11.6

t(0.90) :	1.476
80% :	0.031
Neg :	0.430
Pos :	0.491

Table 3
Topcoat System Capture Efficiency Results Summary
General Motors
Lansing, Michigan
BTEC Project No. 15-4771.00

Test Run	Test Date	Test Time	PS1 Flowrate (scfm)	PS 1 VOC Concentration (ppmv)	PS1 VOC Emission Rate (lbs/hr)	TC6 Flowrate (scfm)	TC6 VOC Concentration (ppmv)	TC6 VOC Emission Rate (lbs/hr)	HF Flowrate (scfm)	HF VOC Concentration (ppmv)	HF VOC Emission Rate (lbs/hr)	TC2 Flowrate (scfm)	TC2 VOC Concentration (ppmv)	TC2 VOC Emission Rate (lbs/hr)	TC3A Gas Flowrate (scfm)	TC3A Gas Flowrate (scfm)	TC3A VOC Emission Rate (lbs/hr)	TC3B Gas Flowrate (scfm)	TC3B THC Concentration (ppmv)	TC3B VOC Emission Rate (lbs/hr)	TC Capture Efficiency (%)
1	12/8/2015	7:45	10,324	156	11.00	77,009	92	48.69	8,241	40	2.26	11131.27	74.20	5.66	35746.07	24.30	5.95	36563.05	12.50	3.13	81.90%
2	12/8/2015	9:21	11,995	191	15.71	81,117	114	63.12	8,308	53	3.03	11001.89	114.80	8.65	34614.73	32.00	7.59	36346.83	14.30	3.56	82.63%
3	12/8/2015	10:51	12,411	188	16.02	82,771	95	53.92	8,341	35	1.97	10889.32	86.80	6.47	34633.28	8.40	1.99	35045.97	19.70	4.73	86.32%
4	12/8/2015	13:25	11,534	169	13.33	83,464	105	59.97	8,328	56	3.18	10846.45	133.70	9.93	33781.42	31.40	7.27	35930.55	11.10	2.73	84.23%
		Averages:	11,576	178	14.24	80,299	100	55.24	8,297	43	2.42	11007.49	91.93	6.93	34998.02	21.57	5.18	35985.28	15.50	3.81	83.62%

Data Quality Objective Calculation

No. of Tests: 4

Test	CE %	Notes
1	81.9%	
2	82.6%	
3	86.3%	
4	84.2%	

Confidence Interval Table

N	t (0.975)	LCL 80%: t (0.90)
2	12.706	3.078
3	4.303	1.886
4	3.182	1.638
5	2.776	1.533
6	2.571	1.476
7	2.447	1.440
8	2.365	1.415
9	2.306	1.397
10	2.262	1.383

Average CE % :	0.838	**t(0.90) :**	1.638
Standard Deviation:	0.020	**80% :**	0.016
t(0.975) :	3.182	**Neg :**	0.822
a :	0.031	**Pos :**	0.854
P (DQO) :	3.7		

Table 5
RTO No. 1 Destruction Efficiency Results Summary
General Motors
Lansing, Michigan
BTEC Project No. 15-4771.00

Test Run	Test Date	Test Time	RTO 1 Inlet Flowrate (scfm)	RTO 1 Inlet VOC Concentration (ppmv)	RTO 1 Inlet VOC Emission Rate (lbs/hr)	RTO 1 Outlet Flowrate (scfm)	RTO 1 Outlet VOC Concentration (ppmv)	RTO 1 Outlet Methane Concentration (ppmv)	RTO 1 Outlet VOC Emission Rate (lbs/hr)	RTO 1 Destruction Efficiency (%)
1	12/9/2015	7:48	33,611	61	13.95	35,600	4.4	1.6	0.90	93.54%
2	12/9/2015	9:30	33,420	111	25.50	33,610	6.5	1.2	1.37	94.61%
3	12/9/2015	11:05	33,071	81	18.28	34,193	5.5	1.2	1.16	93.63%
4	12/9/2015	13:07	33,040	91.50	20.71	34,173	6.00	2.20	1.18	94.31%
		Averages:	33,368	86.1	19.6	34,394	5.60	1.55	1.15	94.02

Table 4
RTO No. 2 / RCC Destruction Efficiency/Removal Efficiency Results Summary
General Motors
Lansing, Michigan
BTEC Project No. 15-4771.00

Test Run	Test Date	Test Time	RCC Inlet Flowrate (scfm)	RCC Inlet VOC Concentration (ppmv)	RCC Inlet VOC Emission Rate (lbs/hr)	RCC Outlet / RTO 2 Inlet Flowrate (scfm)	RCC Outlet / RTO 2 Inlet Average VOC Concentration (ppmv)	RCC Outlet / RTO 2 Inlet VOC Emission Rate (lbs/hr)	RTO 2 Outlet Exhaust Gas Flowrate (scfm)	RTO 2 Outlet Average THC Concentration (ppmv)	RTO 2 Outlet Average Methane Concentration (ppmv)	RTO 2 Outlet VOC Emission Rate (lbs/hr)	Combined Outlet Exhaust Gas Flowrate (scfm)	Combined Outlet Average THC Concentration (ppmv)	Combined Outlet VOC Emission Rate (lbs/hr)	RCC Removal Efficiency (%)	RTO 2 Destruction Efficiency (%)	Overall Removal / Destruction Efficiency (%)
1	12/10/2015	8:13	81,064	96	53.47	7,348	930	46.78	7,043	22.20	0.69	1.06	75,121	12.00	6.17	87.49%	97.74%	88.45%
2	12/10/2015	10:10	80,583	108	59.78	7,575	943	48.90	6,975	21.10	0.73	0.99	75,001	9.90	5.09	81.80%	97.97%	91.49%
3	12/10/2015	12:45	78,671	112	60.41	7,284	913	45.56	6,936	19.90	0.57	0.93	76,647	9.70	5.09	75.41%	97.95%	91.57%
		Averages:	80,106	106	57.89	7,402	928	47.08	6,985	21.07	0.66	0.99	75,590	10.53	5.45	81.57%	97.89%	90.50%