REPORT

FCA US LLC

WARREN, MICHIGAN

WARREN TRUCK ASSEMBLY PLANT: EU-COLOR-ONE AND EU-REPROCESS THERMAL OXIDIZER (TO) HYDROCARBON DESTRUCTION EFFICIENCY TESTING

RWDI #1703283

November 9, 2018

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by FCA US LLC to complete destruction efficiency for volatile organic compounds on the thermal oxidizers (TOs) controlling the oven emissions from the EU-COLOR-ONE and EU-REPROCESS at Warren Truck Assembly Plant (WTAP). As outlined in WTAP's Renewable Operating Permit No. MI-ROP-B2767-2016, the EU-COLOR-ONE and EU-REPAIR shall not operate unless the associated thermal oxidizer for the ovens is installed and operating properly. Testing was successfully completed on September 25th and 26th, 2018. All parameters were tested in accordance with referenced methodologies.

EU-COLOR-ONE was originally tested on November 1st and 2nd of 2018 with the Thermal Oxidizer operating at 1370°F. On September 25th, 2018, EU-COLOR-ONE was re-tested at a lower temperature, 1290°F, to demonstrate the TO's ability to operate at greater than 95% destruction efficiency at the lower temperature.

Three 1-hour tests were completed concurrently at the inlet and outlet to determine the average destruction efficiency of each TO. Stack gas velocity and moisture were also taken once during the three (3) 1-hour tests at the outlets of each of the TOs. It should be noted that due to inclement weather during Test 2 for EU-COLOR-ONE, power was temporarily lost at the facility and the test was but on hold during the outage.

Flame ionization analyzers, as described in USEPA Method 25A. was used to determine the Total Hydrocarbon (THC) concentrations concurrently and continuously via heated sample lines from both the inlet and outlet of EU-COLOR-ONE and EU-REPROCESS TOs.

Results of the sampling program are outlined in the following table. Results of individual tests are presented in the **Appendices**.

EU-COLOR-ONE – Summary of Results – Destruction Efficiency Based on Concentration

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (ppmv) (as propane)	Outlet THC (ppmv) (as Propane)	Destruction Efficiency [1]
1	2018-09-25	7:30	8:29	1289	33	226.4	1.2	99.5%
2	2018-09-25 [2]	8:44	10:58	1289	29	219.6	1.1	99.5%
3	2018-09-25	12:30	13:29	1291	26	214.5	0.5	99.8%
			Average	**1290**	**29**	**220**	**0.9**	**99.6%**

Notes:
[1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
[2] TO was offline on Test 2 from 9:26am to 10:39am due to a power failure from a lightening strike
ppmv- parts per million by volume

EU-COLOR-ONE – Summary of Results – Destruction Efficiency Based on Mass Rates

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (lb/hr) (as propane)	Outlet THC (lb/hr) (as Propane)	Destruction Efficiency [1]
1	2018-09-25	7:30	8:29	1289	33	12.1	0.06	99.5%
2	2018-09-25 [2]	8:44	10:58	1289	29	11.8	0.06	99.5%
3	2018-09-25	12:30	13:29	1291	26	11.6	0.03	99.8%
			Average	**1290**	**29**	**11.8**	**0.05**	**99.6%**

Notes:
[1] Destruction Efficiency is calculated based on mass emission rate of total hydrocarbons
[2] TO was offline on Test 2 from 9:26am to 10:39am due to a power failure from a lightening strike
Lb/hr- pounds per hour as propane

EU-REPROCESS – Summary of Results – Destruction Efficiency Based on Concentration

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (ppm) (as propane)	Outlet THC (ppm) (as Propane)	Destruction Efficiency [1]
1	2018-09-26	7:43	8:42	1289	7	42.2	1.4	96.8%
2	2018-09-26	9:08	10:07	1291	10	60.0	1.8	96.9%
3	2018-09-26	10:26	11:25	1291	8	38.9	1.2	96.8%
			Average	**1290**	**8**	**47**	**1.5**	**96.8%**

Notes:
[1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume

EU-REPROCESS – Summary of Results – Destruction Efficiency Based on Mass Rates

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (lb/hr) (as propane)	Outlet THC (lb/hr) (as Propane)	Destruction Efficiency [1]
1	2018-09-26	7:43	8:42	1289	7	3.4	0.11	96.8%
2	2018-09-26	9:08	10:07	1291	10	4.8	0.15	96.9%
3	2018-09-26	10:26	11:25	1291	8	3.1	0.10	96.8%
			Average	**1291**	**25**	**3.8**	**0.12**	**96.8%**

Notes:
[1] Destruction Efficiency is calculated based on mass emission rate of total hydrocarbons
Lb/hr- pounds per hour as propane

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by FCA US LLC to complete destruction efficiency for volatile organic compounds on the thermal oxidizers (TOs) controlling the oven emissions from the EU-COLOR-ONE and EU-REPROCESS at Warren Truck Assembly Plant (WTAP). As outlined in WTAP's Renewable Operating Permit No. MI-ROP-B2767-2016, the EU-COLOR-ONE and EU-REPROCESS shall not operate unless the associated thermal oxidizer for the ovens is installed and operating properly. Testing was successfully completed on February 13th to February 15th, 2018. All parameters were tested in accordance with referenced methodologies.

Three 1-hour tests were completed concurrently at the inlet and outlet to determine the average destruction efficiency of each TO. Stack gas velocity, gas composition and moisture were also taken once during the three (3) 1-hour tests at the outlets of the TOs. A fourth 1-hour test was completed on EU-REPROCESS due to a loss of production during test 3.

The sampling train for VOC consisted of a flame ionization analyzer as described in USEPA Method 25A. VOC concentrations were continuously collected via heated sample lines from both the inlet and outlet of the EU-COLOR-ONE and EU-REPROCESS TO simultaneously.

2 SOURCE DESCRIPTION

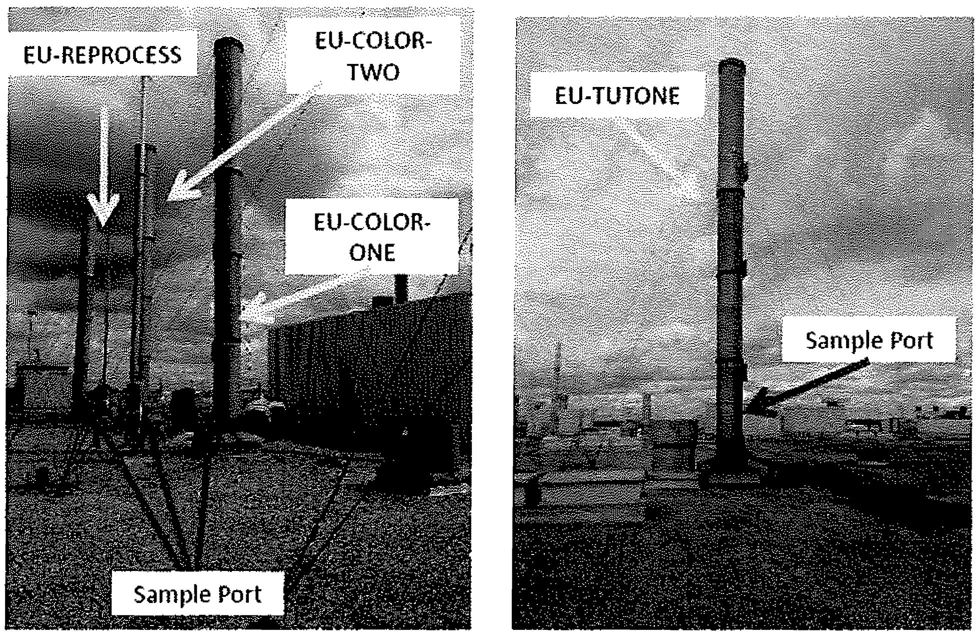
2.1 Facility Description

WTAP is located at 21500 Mound Road in Warren, Michigan. The facility completes assembly and paint operations for the Ram Trucks. Two Topcoat lines (EU-COLOR-ONE and EU-COLOR-TWO), one reprocess operation (EU-REPROCESS), and One Tutone line (EU-TUTONE). Each topcoat line consists of spray booths for applying topcoat to vehicle bodies and oven for curing. The reprocess operation consists of a spray booth for topcoat application to repair vehicle bodies and oven for curing. The tutone line consists of spray booths for applying tutone to vehicle bodies and oven for curing. The vehicles proceed through a curing oven where volatile organic compounds are released into individual thermal oxidizers (TOs). The emissions from the TOs are directed to individual stacks.

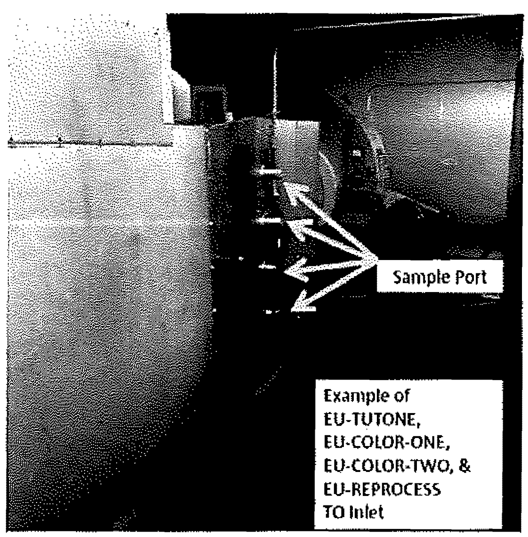
The outlet sampling locations for the EU-COLOR-ONE and EU-REPROCESS thermal oxidizers meet the USEPA Method 1 criteria, for an ideal sampling location. The inlet locations are not considered ideal sampling locations. As discussed with MDEQ, only the outlet sampling locations were used for stack gas velocity, composition and moisture.

3 SAMPLE LOCATION

Continuous emissions monitoring (CEM) for total VOCs, as propane occurred on the inlet and outlet of the TO for EU-COLOR-ONE and EU-REPROCESS. Total VOCs were monitored at a single point in the middle of the duct for both oxidizers. The outlet locations were tested at the roof level of the stack. Proper sampling ports were used for the outlet locations. The outlet locations were considered ideal according to US EPA method 1. Photographs of the sampling locations are depicted below.



Thermal Oxidizers (TO) Outlet Locations



Example of Thermal Oxidizers (TO) Inlet Locations

4 SAMPLING METHODOLOGY

4.1 Testing Methodology

The following table summarizes the test methodologies that were followed during this program.

Table 4.1.1: Summary of Test Methodology

Parameter	Proposed Method
Velocity, Temperature, Flow Rate	USEPA Method 1 to 4
Total VOCs	USEPA[a] Method 25A (CEM)

Notes: [1] USEPA = United States Environmental Protection Agency

4.2 Description of Testing Methodology

The following section provides brief descriptions of the sampling methods.

4.2.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following the USEPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate". Velocity measurements were taken with a pre-calibrated S-Type pitot tube on the inlet and a pre-calibrated standard pitot on the outlet. All pressure readings were taken with an incline manometer. Volumetric flow rates were determined following the equal area method as outlined in USEPA Method 2. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a Type K chromel-alumel thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in USEPA Method 3, "Determination of Molecular Weight of Dry Stack Gas". Oxygen and carbon monoxide were monitored using an electrochemical cell and a non-dispersive infrared sensor. Stack moisture content was determined through direct condensation and according to USEPA Method 4, "Determination of Moisture Content of Stack Gas".

4.2.2 Continuous Emissions Monitoring for VOCs

Testing for VOCs was accomplished simultaneously at the inlet and outlet using continuous emission monitors (CEM). VOC testing followed USEPA Method 25A "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer" In order to compare inlet and outlet concentrations, the outlet concentrations of total VOCs were converted to parts per million (ppmv) as propane. The exhaust gas sample was withdrawn from a single point at the center of the duct/stack using a stainless steel probe. The sample proceeded through a heated filter where particulate matter was removed. The sample was then transferred via a heated Teflon® line and introduced to the analyzer (hot/wet) for measurement.

Prior to testing, instrument linearity checks and calibration error checks were conducted. USEPA protocol gases were used for all span values. The FIAs were calibrated using zero (>1% of span value) and high (80-90% of span value) sent though the system to the sample tip and returned to the analyzers. Low Span gas (25 to 35% of span value) and mid (45 to 55% of span value) were then introduced. In addition, the analyzers were checked (zeroed and span checked) at the completion of each test using the Zero and Mid span gases. The test runs were considered valid provided the response was within ±3% from the instrument span value. **Appendix E1** contains the Gas Cylinder Certificates of Analysis and **Appendix E2** contains the instrument calibration tables.

Data acquisition was provided using a data logger system programmed to collect and record data at one second intervals. Average one minute concentrations were calculated from the one second measurements.

4.3 Process Data

WTAP representatives provided production information during testing including temperature data for the TO and vehicle throughput of the oven. The following is a table outlining the production data. Further details are provided in **Appendix F**.

Table 4.3.1: Summary of Production Data EU-COLOR-ONE

Test Dates/Times	RTO Chamber Temperature (°F)	Average Vehicle Count (vehicles per hour)
September 25, 2018 7:30 to 8:29	1289	33
September 25, 2018 8:44 to 10:58	1289	29
September 25, 2018 12:30 to 13:29	1291	26

Table 4.3.2: Summary of Production Data EU-REPROCESS

Test Date/Times	RTO Chamber Temperature (°F)	Average Vehicle Count (vehicles per hour)[1]
September 26, 2018 7:43 to 8:42	1289	7
September 26, 2018 9:08 to 10:07	1291	10
September 26, 2018 10:26 to 11:25	1291	8

Note: [1] West oven electronic process monitor was not operational but FCA personnel confirmed vehicle count mirrored the Eat oven vehicle count data.

Matthew Smith and Rohit Patel from FCA US LLC recorded and monitored the process during the testing to ensure the production rate was within typical normal production.

4.4 Modifications

Due to the non-ideal location for flow measurements at the inlet locations, in consultation with MDEQ during the November 2017 testing period, it was decided to use the outlet velocity, temperature and moisture data for the inlet flow rate determination.

5 RESULTS

The average emission results for this study are presented in the following tables. Detailed information regarding each test run can be found in the **Appendix B.**

Table 5.1.1: EU-COLOR-ONE Oxidizer – Summary of Results - Destruction Efficiency Based on Concentration

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (ppmv) (as propane)	Outlet THC (ppmv) (as Propane)	Destruction Efficiency [1]
1	2018-09-25	7:30	8:29	1289	33	226.4	1.2	99.5%
2	2018-09-25 [2]	8:44	10:58	1289	29	219.6	1.1	99.5%
3	2018-09-25	12:30	13:29	1291	26	214.5	0.5	99.8%
			Average	**1290**	**29**	**220**	**0.9**	**99.6%**

Notes:
[1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
[2] TO was offline on Test 2 from 9:26am to 10:39am due to a power failure from a lightening strike
ppmv- parts per million by volume

Table 5.1.2: EU-COLOR-ONE – Summary of Results – Destruction Efficiency Based on Mass Rates

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (lb/hr) (as propane)	Outlet THC (lb/hr) (as Propane)	Destruction Efficiency [1]
1	2018-09-25	7:30	8:29	1289	33	12.1	0.06	99.5%
2	2018-09-25 [2]	8:44	10:58	1289	29	11.8	0.06	99.5%
3	2018-09-25	12:30	13:29	1291	26	11.6	0.03	99.8%
			Average	**1290**	**29**	**11.8**	**0.05**	**99.6%**

Notes:
[1] Destruction Efficiency is calculated based on mass emission rate of total hydrocarbons
[2] TO was offline on Test 2 from 9:26am to 10:39am due to a power failure from a lightening strike
Lb/hr- pounds per hour as propane

Table 5.1.3: EU-REPROCESS Oxidizer – Summary of Results - Destruction Efficiency Based on Concentration

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (ppm) (as propane)	Outlet THC (ppm) (as Propane)	Destruction Efficiency [1]
1	2018-09-26	7:43	8:42	1289	7	42.2	1.4	96.8%
2	2018-09-26	9:08	10:07	1291	10	60.0	1.8	96.9%
3	2018-09-26	10:26	11:25	1291	8	38.9	1.2	96.8%
			Average	**1290**	**8**	**47**	**1.5**	**96.8%**

Notes:
[1] Destruction Efficiency is calculated based on Total Hydrocarbon concentration
ppmv- parts per million by volume

Table 5.1.4: EU-REPROCESS – Summary of Results – Destruction Efficiency Based on Mass Rates

Test ID	Date	Start	End	TO Combustion Chamber Temperature (°F)	Vehicles per hour	Inlet THC (lb/hr) (as propane)	Outlet THC (lb/hr) (as Propane)	Destruction Efficiency [1]
1	2018-09-26	7:43	8:42	1289	7	3.4	0.11	96.8%
2	2018-09-26	9:08	10:07	1291	10	4.8	0.15	96.9%
3	2018-09-26	10:26	11:25	1291	8	3.1	0.10	96.8%
			Average	**1291**	**25**	**3.8**	**0.12**	**96.8%**

Notes:
[1] Destruction Efficiency is calculated based on mass emission rate of total hydrocarbons
Lb/hr- pounds per hour as propane

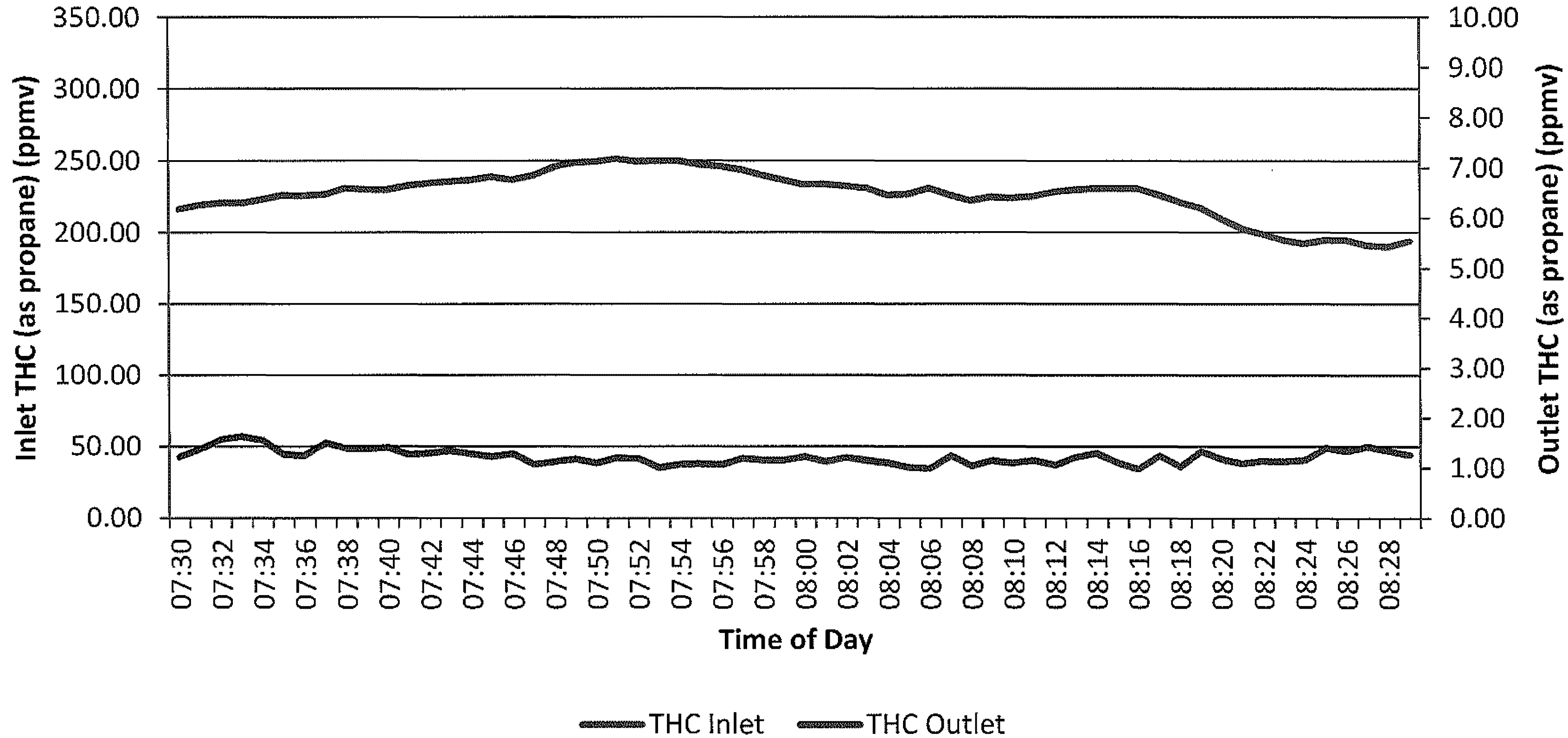
The velocity, temperature and moisture were measured at the outlet location only as noted in the Source Testing Plan and discussed on-site with MDEQ. **Appendix C** contains detailed flow data.

All sampling field notes are provided in **Appendix D**. All calibration data can be found in **Appendix E**. Sample calculations are provided in **Appendix G**.

6 CONCLUSIONS

Testing was successfully completed on September 25th and September 26th, 2018. All parameters were tested in accordance with referenced methodologies.

Figure 1: Color 1 THC Data - Test 1
September 25, 2018



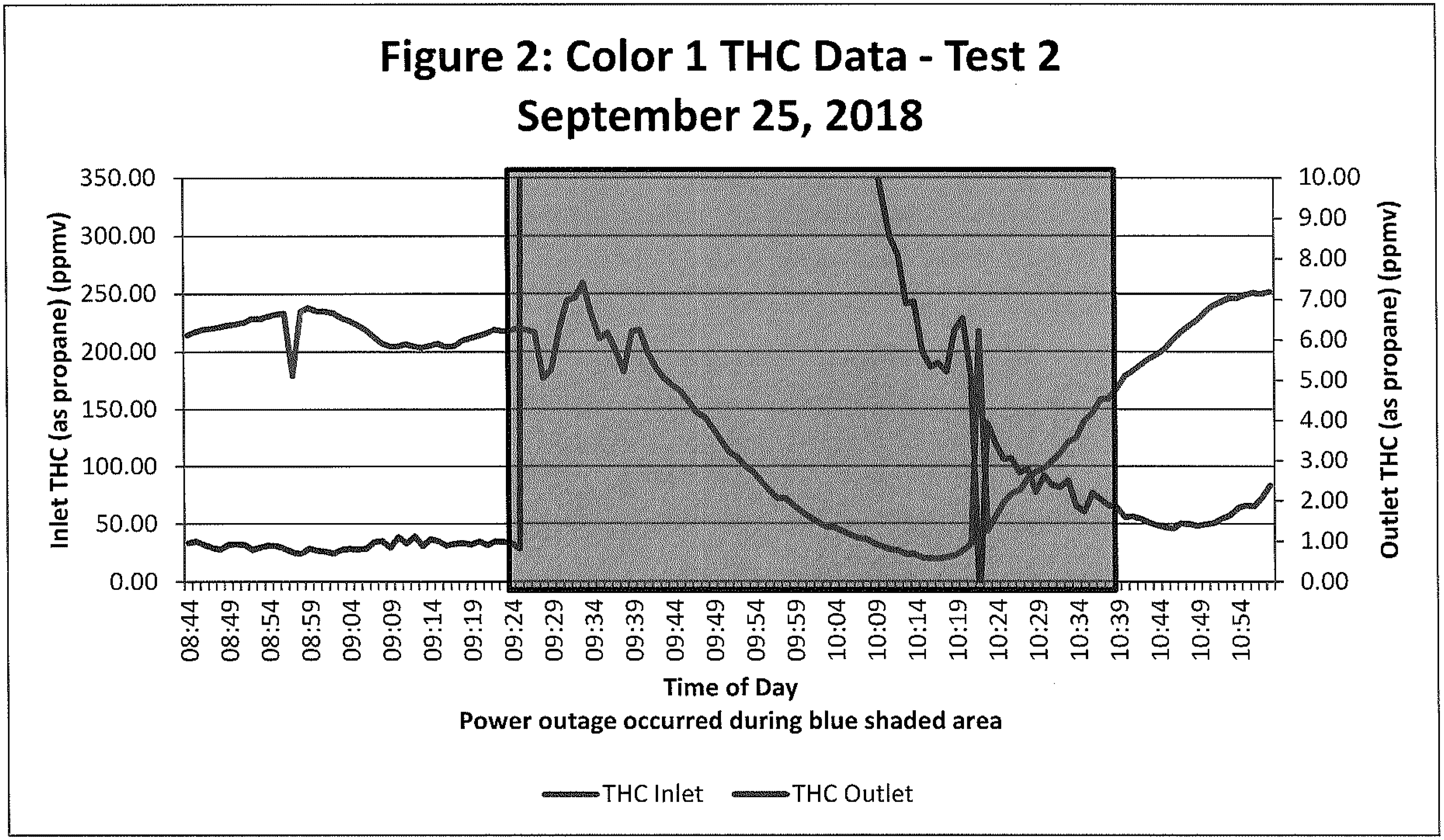


Figure 2: Color 1 THC Data - Test 2
September 25, 2018
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Inlet THC (as propane) (ppmv)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Outlet THC (as propane) (ppmv)
08:44
08:49
08:54
08:59
09:04
09:09
09:14
09:19
09:24
09:29
09:34
09:39
09:44
09:49
09:54
09:59
10:04
10:09
10:14
10:19
10:24
10:29
10:34
10:39
10:44
10:49
10:54
Time of Day
Power outage occurred during blue shaded area
THC Inlet
THC Outlet

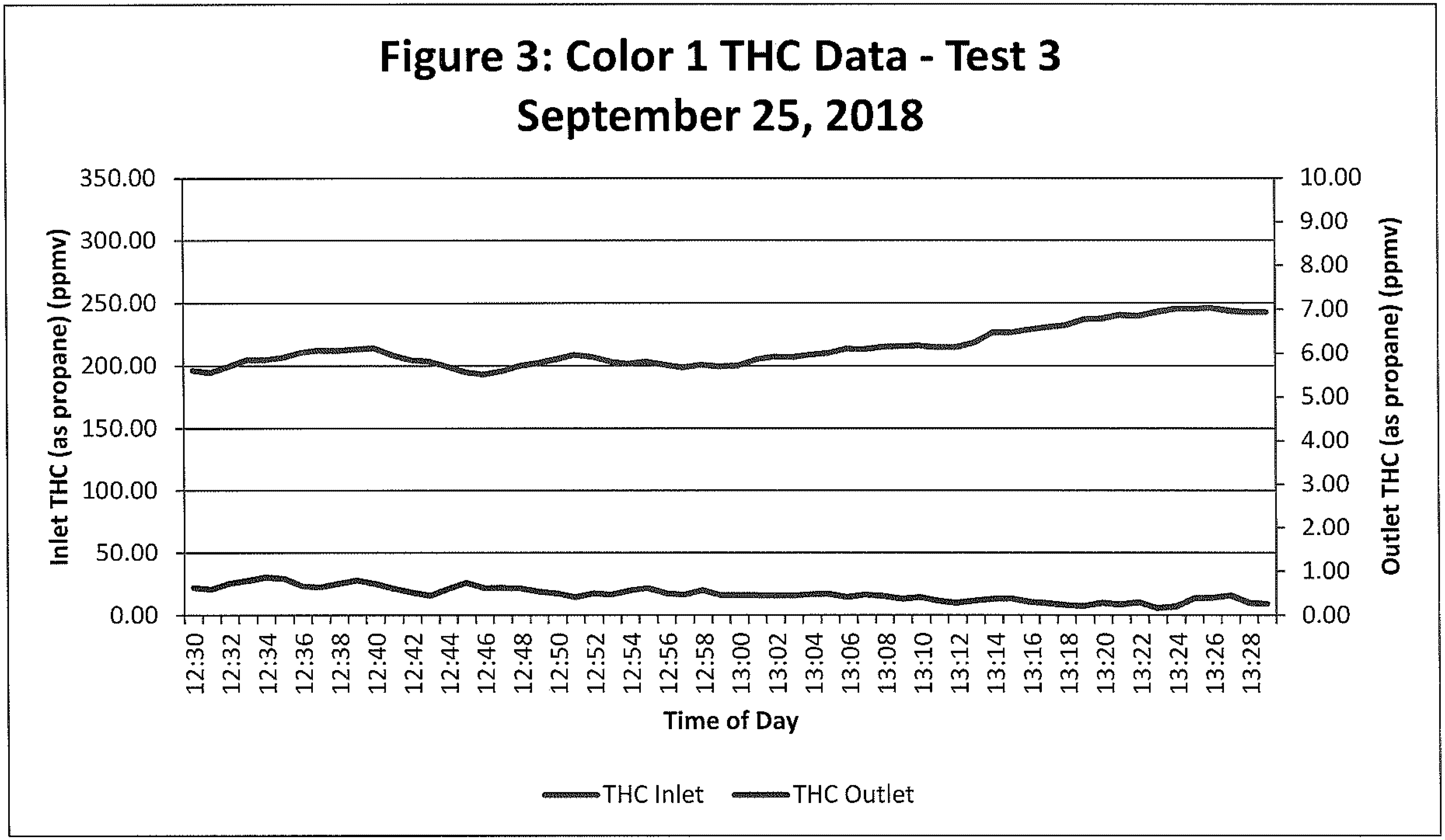


Figure 3: Color 1 THC Data - Test 3
September 25, 2018
Inlet THC (as propane) (ppmv)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Outlet THC (as propane) (ppmv)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
12:30
12:32
12:34
12:36
12:38
12:40
12:42
12:44
12:46
12:48
12:50
12:52
12:54
12:56
12:58
13:00
13:02
13:04
13:06
13:08
13:10
13:12
13:14
13:16
13:18
13:20
13:22
13:24
13:26
13:28
Time of Day
THC Inlet
THC Outlet

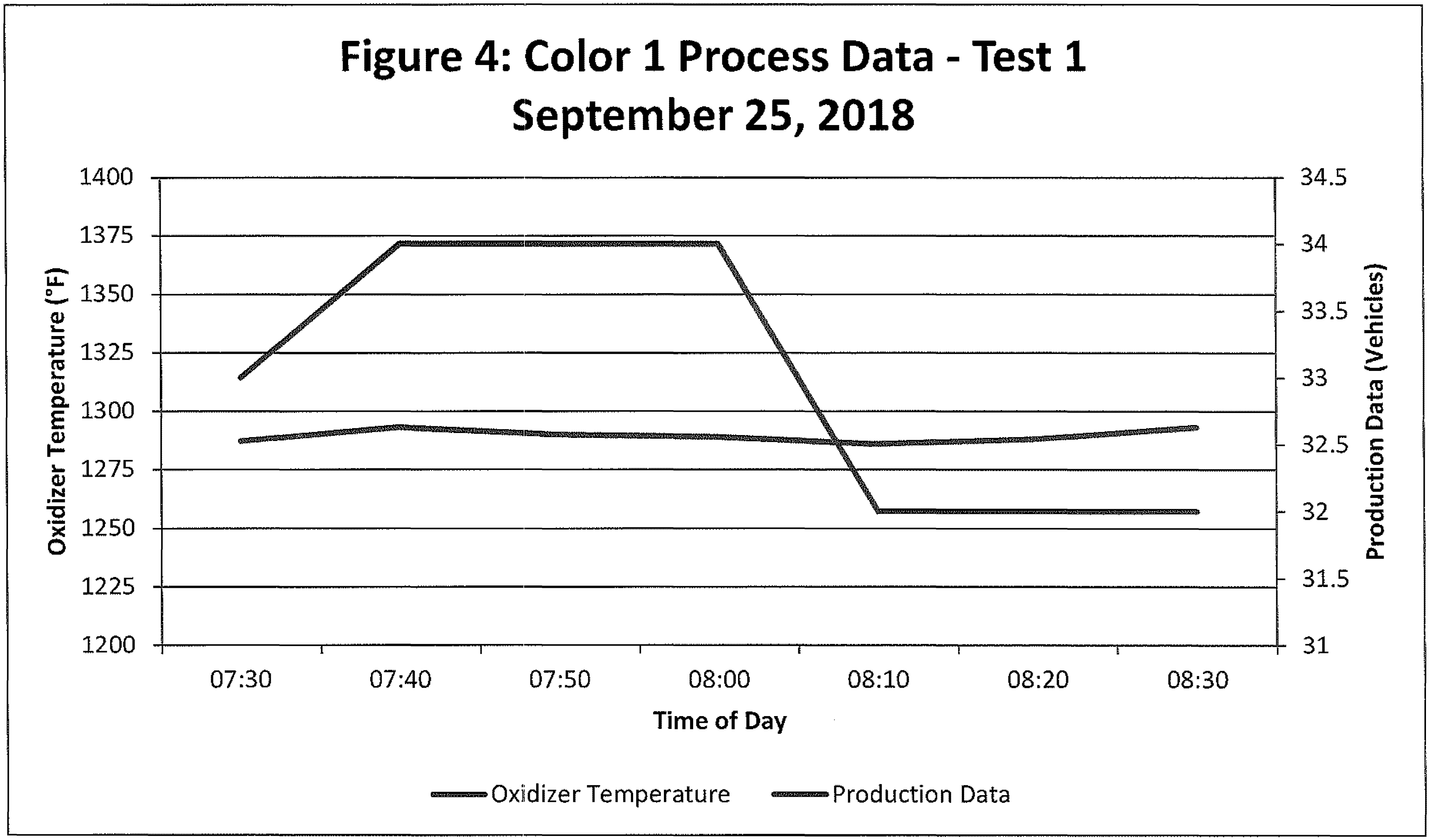


Figure 4: Color 1 Process Data - Test 1
September 25, 2018
Oxidizer Temperature (°F)
1400
1375
1350
1325
1300
1275
1250
1225
1200
Production Data (Vehicles)
34.5
34
33.5
33
32.5
32
31.5
31
07:30
07:40
07:50
08:00
08:10
08:20
08:30
Time of Day
Oxidizer Temperature
Production Data

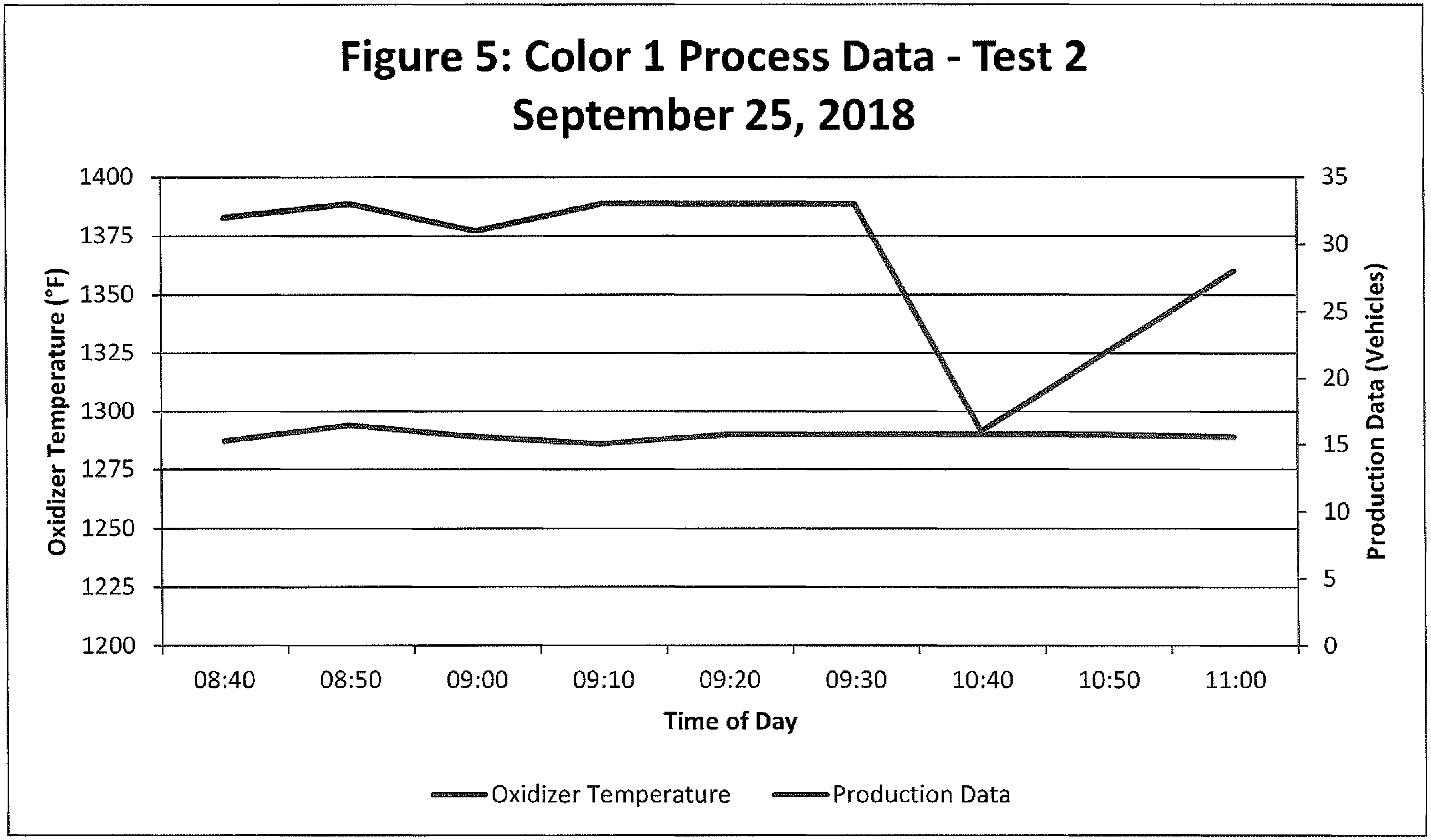


Figure 5: Color 1 Process Data - Test 2
September 25, 2018
1400
1375
1350
1325
1300
1275
1250
1225
1200
Oxidizer Temperature (°F)
35
30
25
20
15
10
5
0
Production Data (Vehicles)
08:40
08:50
09:00
09:10
09:20
09:30
10:40
10:50
11:00
Time of Day
Oxidizer Temperature
Production Data

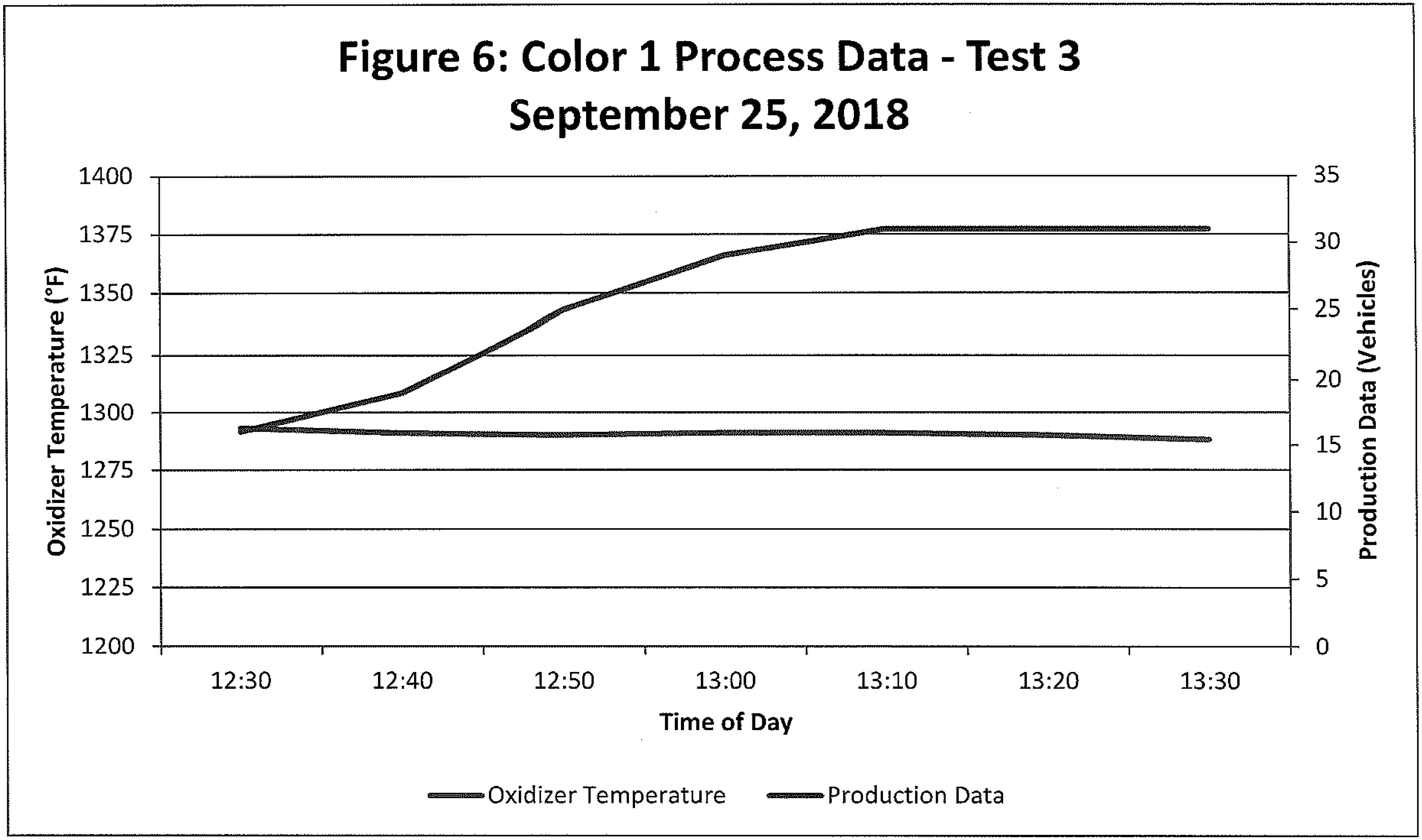


Figure 6: Color 1 Process Data - Test 3
September 25, 2018
Oxidizer Temperature (°F)
1400
1375
1350
1325
1300
1275
1250
1225
1200
Production Data (Vehicles)
35
30
25
20
15
10
5
0
12:30
12:40
12:50
13:00
13:10
13:20
13:30
Time of Day
Oxidizer Temperature
Production Data

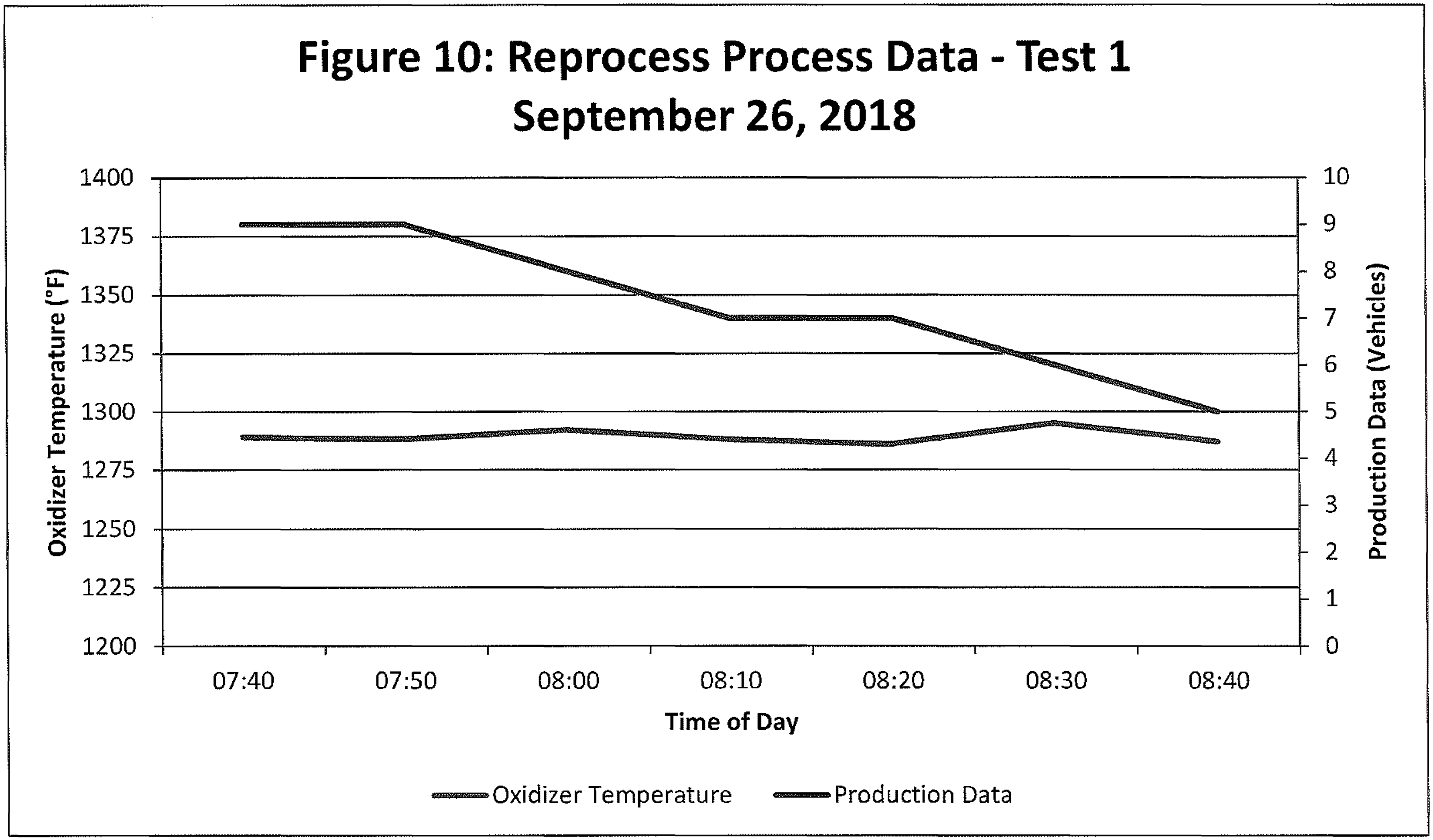


Figure 10: Reprocess Process Data - Test 1
September 26, 2018
1400
1375
1350
1325
1300
1275
1250
1225
1200
Oxidizer Temperature (°F)
10
9
8
7
6
5
4
3
2
1
0
Production Data (Vehicles)
07:40
07:50
08:00
08:10
08:20
08:30
08:40
Time of Day
Oxidizer Temperature
Production Data

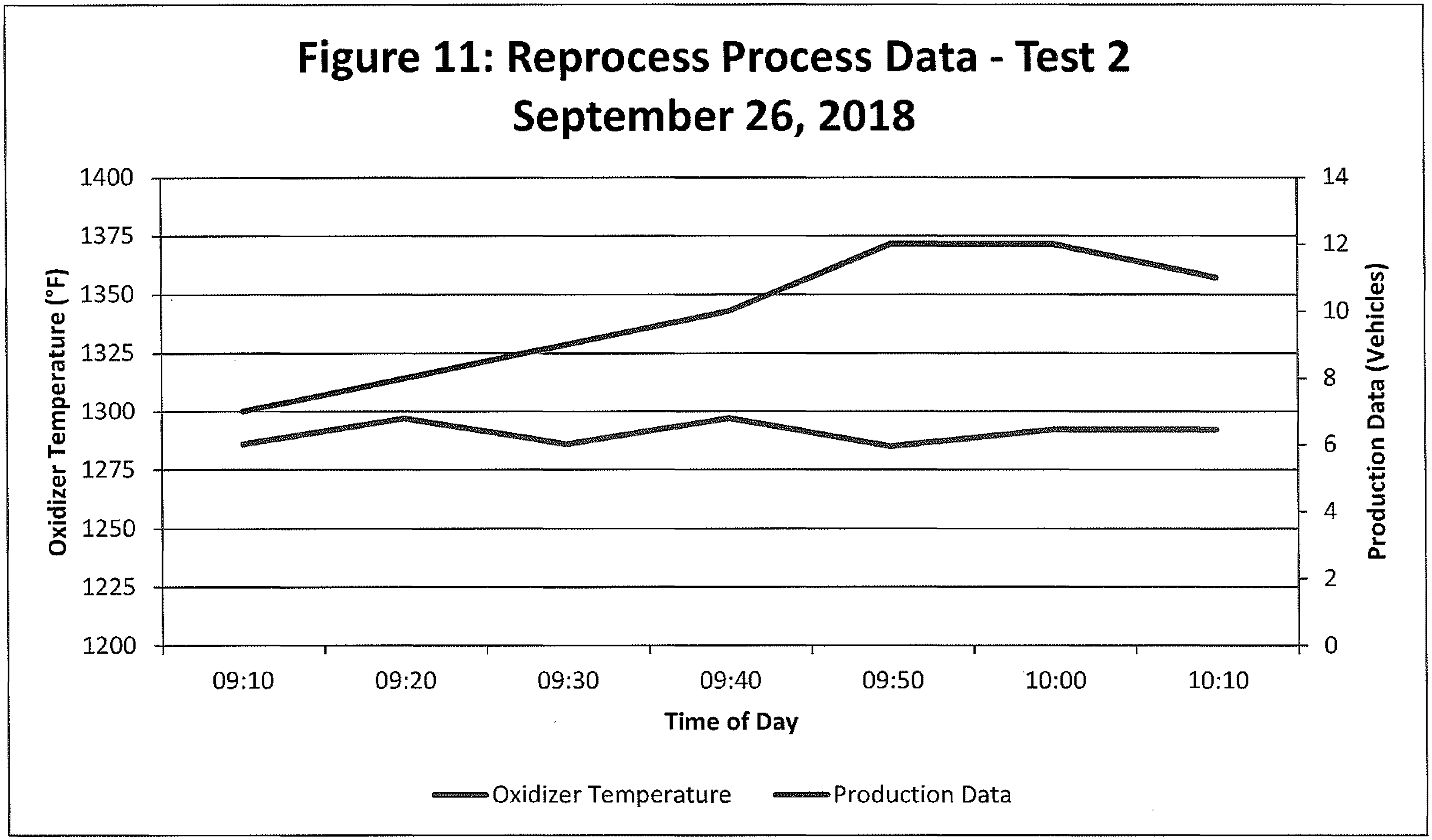


Figure 11: Reprocess Process Data - Test 2
September 26, 2018
1400
1375
1350
1325
1300
1275
1250
1225
1200
Oxidizer Temperature (°F)
14
12
10
8
6
4
2
0
Production Data (Vehicles)
09:10
09:20
09:30
09:40
09:50
10:00
10:10
Time of Day
Oxidizer Temperature
Production Data

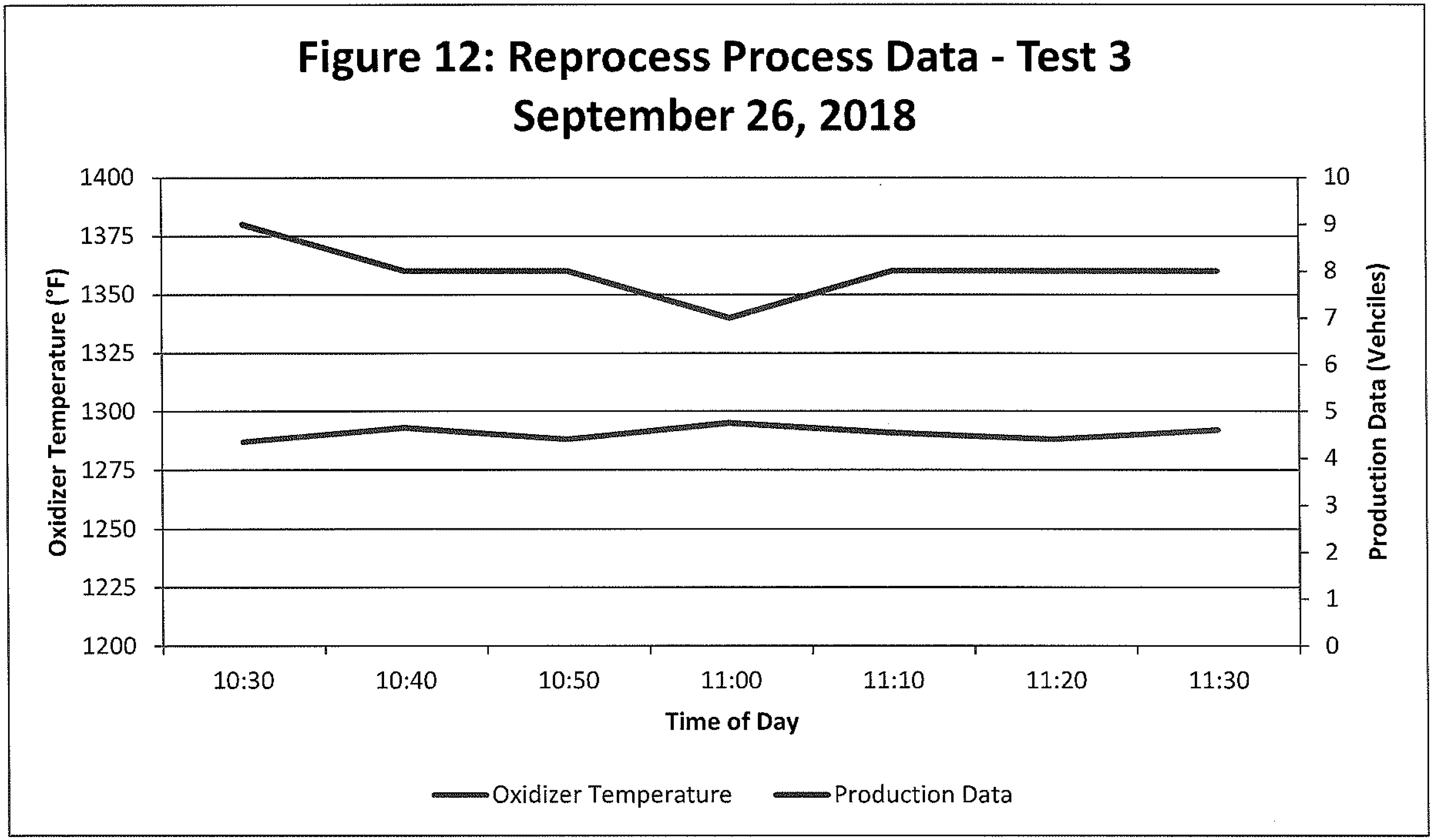


Figure 12: Reprocess Process Data - Test 3
September 26, 2018
1400
1375
1350
1325
1300
1275
1250
1225
1200
Oxidizer Temperature (°F)
10
9
8
7
6
5
4
3
2
1
0
Production Data (Vehciles)
10:30
10:40
10:50
11:00
11:10
11:20
11:30
Time of Day
Oxidizer Temperature
Production Data