

Executive Summary

BT Environmental Consulting Inc. (BTEC) was retained by Sigma Process Management (Sigma) to conduct performance specification testing of a continuous opacity monitoring system (COMS) and data acquisition system (DAS) in operation on the No. 9 incinerator exhaust at the Detroit Waste Water Treatment Plant. The facility is located at 9300 W. Jefferson in Detroit, Michigan. The opacity audit consisted of a calibration error test, average period calculating and averaging check, and a system response time check done with certified attenuators in accordance with U.S. EPA 40 CFR, Part 60 Appendix B, PS-1. The audit was performed on October 2, 2014. The initial audit was then followed by a 7 day operational test period which ran from October 16-October 22, 2014. The results of all testing can be found in a series of Tables at the end of this report and are summarized below.

Table E-1

Incinerator No. 9 Continuous Opacity Monitor Audit

Test Date: October 2, 2014

Instrument Manufacturer:	Teledyne Monitor Labs, Inc.
Instrument Model Number:	LightHawk 560
Instrument Serial Number:	2305
Date Calibrated:	9/1/2011
Calibration Error: Low = 1.307 % Mid = 1.398 % High = 0.934 %	Allowable Calibration Error: < 3% < 3% < 3%
System Time Response: Average Upscale =4.7s Average Downscale=4.5 s	Allowable Response Time: < 10 s < 10 s
Six-Minute Average Difference: Low = 1.02 Mid = 1.12 High = 0.47	Allowable Difference: ± 2% ± 2% ± 2%
24 Hour Zero and Upscale Calibration Drift: Zero=0.233% Upscale=0.071%	Allowable Drift: ≤ 2% ≤ 2%

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1.0 INTRODUCTION

BT Environmental Consulting Inc. (BTEC) was retained by Sigma Associates (Sigma) to conduct performance specification testing of a continuous opacity monitoring system (COMS) and data acquisition system (DAS) in operation on the No. 9 incinerator stack exhaust at the Detroit Waste Water Treatment Plant. The waste water treatment plant is located at 9401 W. Jefferson Detroit, Michigan. The opacity audit consisted of a calibration error test, average period calculating and averaging check, and a system response time check with certified attenuators in accordance with U.S. EPA 40 CFR, Part 60 Appendix B, PS-1. The audit was then followed by a seven day operational test period.

The audit was performed on October 2, 2014 by BTEC personnel Kenny Felder and Steve Smith. The following sections of the report contain a brief process description, a summary of the Reference Test Methods that were utilized, testing procedures and discussion of the overall test results.

2.0 PROCESS DESCRIPTION

Sludge is separated from the incoming raw sewage and then burned within the multiple hearth incinerator complex within the waste water treatment plant.

3.0 REFERENCE TESTING METHODOLOGIES

Performance specification tests were conducted to assess the quality and accuracy of data generated by the COMS. The performance specification test procedures are outlined in the 40 CFR, Part 60, Appendix B, Performance Specification Test 1 (PS-1). The calibration error test was started and completed on October 2, 2014.

3.1 Calibration Error Testing

The calibration error tests were conducted concurrently with the response time tests. The COMS was challenged with audit filters (high, mid, low and zero) placed in a zero calibration jig while the monitor was operating normally. The audit filters were introduced to the COMS at the optical head and allowed to generate a response at the DAS. The COMS were challenged five times with each of the three audit filters as specified in the test method. The final response of the monitor to the audit filters was recorded. The average difference between the COMS response and the audit values were used to calculate the calibration error. The calibration error test was repeated with each audit filter introduced to the jig for a thirteen minute period to evaluate the six (6) minute average responses.

All audit filters used for the certification were certified in accordance with section 7.1.2 of the 40CFR Part 60, Subpart B, "Performance Specification 1" using a spectrophotometer. The calibration report for the neutral density audit filters is contained in Appendix D.

3.2 Response Time Testing

The response time tests were conducted concurrently with the calibration error testing. The COMS was challenged with audit filters (zero, low, mid and high) while operating normally. The time to reach 95% of the high audit value was recorded and the time to reach 5% of the zero value was recorded. The response time was determined as the average of the five test times or passes.

3.3 Average Period Calculation and Recording Check

The average period calculation and recording check consists of inserting the certified audit filters (low, medium, and high) while operating normally. The six-minute opacity rolling average is then recorded after thirteen minutes, or two-times the averaging time plus one minute. The average value calculated by the COMS data recording system was then compared to the path length corrected opacity value for each filter.

3.4 Operational Test Period

After all field testing was completed, the COMS was operated for an initial 168-hour test period while the source is operating under normal operating conditions. For continuous operations, the unit must be operating for at least 50% of the time. During this test period, no unscheduled maintenance was performed to the COMS.

During the operational test period, the automatic calibration check system initiated a simulated zero and upscale opacity. The daily COMS responses were recorded and compared to the nominal values of the calibration devices and the error was found using the average difference and the 95% confidence coefficient.

4.0 SUMMARY OF RESULTS

The results of the calibration error and response time tests are presented in Table 1. The calibration error for the monitor was 1.307 % for the low level, 1.398 % for the mid level, and 0.934 % for the high level. The allowable calibration error is < 3 %.

The system response time check results are presented in Table 2. The upscale response time is 4.7 seconds and the downscale response time is 4.5 seconds. The results are well below the allowable 10 second response time.

The average period calculation and recording check results are displayed in Table 3. The six-minute average deviation was 1.02 for the low-range, 1.12 for the mid, and 0.47 for the high. The results are below the maximum allowable difference, is plus or minus two percent.

The results of the zero and upscale calibration drift testing, performed during the operational test period, are presented in Table 4. The 24 hour zero drift error is 0.233% and the 24 hour upscale drift error is 0.071%. This is well below the 24 hour drift error limit of 2%.

The following equations were used in finding the calibration error and drift error:

$$S_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$$

$$cc = t_{0.025} \frac{S_d}{\sqrt{n}}$$

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} = \text{Arithmetic Mean}$$

Where:

Sd = Standard deviation

T_{0.975} = 2.776 for n=5, or 2.447 for n=7

X_i = Instrument Reading – Filter Value Or Final Reading – Initial Reading

The calibration and drift error was determined by the following equation:

$$\text{ERROR} = |\bar{x}| + |CC|$$

The summary tables and appendices that follow contain all reference method data, field sheets, and calibration information. The audit performance testing program is outlined in Appendix A. The raw field data is included in Appendix B. The certification data of the audit filters is included in Appendix C, the Data Acquisition System historical log files with six-minute averages and instantaneous opacities is on a compact disc in Appendix D and the calibration reports with operational summaries are in Appendix E

5.0 Procedure 3 Requirements

As part of the new requirements set forth in 49 CFR, Part 60 Appendix B PS-1, known as Procedure 3, DWSD will have to assume additional responsibilities to be in compliance. These responsibilities include:

1. Conduct quarterly audits of the analyzer consisting of optical alignment, calibration error test, and zero compensation check.
2. Conduct a yearly clear-path zero calibration check where the process must be halted, or the analyzer be removed from the stack and the zero checked against the zero-jig.
3. Conduct routine system check consisting of recording and monitoring the daily zero and upscale calibration checks and noting any faults or system messages generated by the COMS.
4. Maintain written records of procedures and operations including: daily drift checks, quartley performance audits, annual zero checks, corrective action plans in case of malfunction.

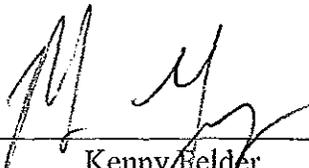


6.0 Special Situations

The filter set for Incinerator #9 was expired. The filter set from Incinerator #13 was used to perform the opacity audit.

Limitations

The information and opinions rendered in this report are exclusively for use by Sigma Process Management (Sigma). BTEC will not distribute or publish this report without Sigma's consent except as required by law or court order. BTEC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

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Tables

Table 1
Calibration Error Test Results
Incinerator No. 9 Detroit Waste Water Treatment Plant
Tested on 10-2-14

Run No.	Calibration Filter		Instrument Reading	Arithmetic Difference (%)
	Filter	Value (%)		
1	Low	14.8	13.5	1.3
2	Mid	23.5	22.2	1.3
3	High	44.0	43.2	0.8
4	Low	14.8	13.5	1.3
5	Mid	23.5	22.2	1.4
6	High	44.0	43.7	0.3
7	Low	14.8	13.5	1.3
8	Mid	23.5	22.1	1.4
9	High	44.0	43.3	0.8
10	Low	14.8	13.5	1.3
11	Mid	23.5	22.1	1.4
12	High	44.0	43.7	0.3
13	Low	14.8	13.5	1.3
14	Mid	23.5	22.1	1.4
15	High	44.0	43.2	0.8

Arithmetic Mean Low-Range Difference (%):	1.30
Arithmetic Mean Mid-Range Difference (%):	1.37
Arithmetic Mean High-Range Difference (%):	0.62
Low-Range Confidence Coefficient:	0.01
Mid-Range Confidence Coefficient:	0.02
High-Range Confidence Coefficient:	0.32
Low-Range Calibration Error:	1.31
Mid-Range Calibration Error:	1.40
High-Range Calibration Error:	0.93

Table 2
System Response Time Check Results
Incinerator No. 9 Detroit Waste Water Treatment Plant
Tested on 10-2-14

	Filter Opacity:	44.0
	95% of Filter Opacity:	41.8
	5% of Filter Opacity:	2.2015
Action	Run No.	Response Time to 95% (sec)
Insert	1	4.7
Removal	1	4.7
Insert	2	4.8
Removal	2	4.5
Insert	3	4.7
Removal	3	4.7
Insert	4	4.8
Removal	4	4.4
Insert	5	4.8
Removal	5	4.4
Average Upscale Response:		4.7
Average Downscale Response:		4.5

Table 3

Average Period Calculation and Recording Check Results
Incinerator No. 9 Detroit Waste Water Treatment Plant
Tested on 10-2-14

Averaging Period (min):	6.0
Run Time (2x's the avg. period + 1 min)	13.0

Run No.	Filter	Corrected Filter Value (%)	Opacity Reading 2	Difference
1	Low	14.83	13.81	1.02
2	Mid	23.52	22.40	1.12
3	High	44.03	43.56	0.47

* ± 2% opacity

Table 4
 24-Hour Zero and Upscale Calibration Drift Results
 Incinerator No. 9 Detroit Waste Water Treatment Plant
 Tested on 10-2-14

Upscale Calibration Device Opacity:		35.34
Day	COMS Zero Calibration Response	COMS Upscale Calibration Response
10/16/2014	0.12	35.39
10/17/2014	0.12	35.39
10/18/2014	0.12	35.36
10/19/2014	0.12	35.39
10/20/2014	0.24	35.39
10/21/2014	0.27	35.24
10/22/2014	0.21	35.36

Zero Mean Difference (%):	0.17
Upscale Mean Difference (%):	0.02
Zero Confidence Coefficient:	0.06
Upscale Confidence Coefficient:	0.05
Zero Drift Error (%):	0.233
Upscale Drift Error (%):	0.071

* <2% Error

Appendix A

Field Audit Performance Test Requirements