Pace Analytical®
Field Services Division

Pace Analytical Services, LLC
1700 Elm Street SE
Minneapolis, MN 55414
Phone: 612.607.1700
Fax: 612.607.6444
www.pacelabs.com

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Comprehensive Emissions Test Report

City Aluminum Foundry
Particulate and Opacity
Compliance Testing

Testing Date(s): October 23, 2019
Report Date: December 5, 2019
Revision Date: No revision to date

ACCREDITED
Cert #3819.01 (ISO/IEC 17025:2005)
Cert #3819.02 (ASTM D7036)

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STACK TESTING ACCREDITATION COUNCIL

NEFAP ACCREDITED TNI

Report Prepared For:

Tina Berceli-Boyle
Haley & Aldrich, Inc.
3 Bedford Farms Drive
Bedford, NH 03110

Telephone No.: (603) 391-3327
E-mail Address: tberceli-boyle@haleyaldrich.com

Report Preparation Supervised By:

Terry Borgerding
Pace Analytical Services, LLC
1700 Elm Street, Suite 200
Minneapolis, MN 55414
Telephone No.: (612) 607-6374
E-mail Address: terry.borgerding@pacelabs.com

Pace Project No. 19-02383

Subject Facility:

City Aluminum Foundry
2505 Williams Drive
Waterford, MI 48328

Regulatory Permit No.:
147-17
SRN: N6212

Subject Emission Sources:
Thermal Sand Reclaim EURECLAIM

Test Locations:
Baghouse Stack

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Regulatory Summary

Subject Facility: City Aluminum Foundry
Plant Address: 2505 Williams Drive
Waterford, MI 48328

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Air Permit No.: 147-17
Facility ID No.: SRN: N6212

Emission Unit IDs	Emission Unit Name	Regulated Constituent	Regulatory Citations	Regulatory Limit	Average Test Result
EURECLAIM	Thermal Sand Reclaim	Particulate (filterable)	40 CFR 52.21(c) and (d)	≤0.32 LB/HR	0.017 LB/HR
			40 CFR 60.732	≤0.040 GR/DSCF	0.00046 GR/DSCF
		PM-10	40 CFR 52.21(c) and (d)	≤0.32 LB/HR	0.052 LB/HR
		PM-2.5	40 CFR 52.21(c) and (d)	≤0.32 LB/HR	0.052 LB/HR
		Visible Emissions	40 CFR 60.732	≤10% 6-minute average	0%

PM-10 and PM-2.5 are assumed to be the equivalent of the filterable PM (FPM) and condensable PM (CPM).

Introduction

Pace Analytical Services, LLC personnel conducted particulate and visible emission compliance testing on the Thermal Sand Reclaim Baghouse Stack at the City Aluminum facility located in Waterford, Michigan. Matt McDermott, Lucas Ruhland, and Josh Price performed on-site testing activities on October 23, 2019. Terry Borgerding provided administrative project management. Dawn Telles with City Aluminum Foundry coordinated plant activities during testing. Pace Analytical Services, LLC prepared a comprehensive test protocol that was submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and approved prior to testing. On-site activities consisted of the following measurements:

- Particulate, three independent two-hour samplings.
- Gas composition (O_2/CO_2), integrated bags collected concurrent with above.
- Volumetric airflow, measurements collected in conjunction with isokinetic testing.
- Visible emissions, three independent one-hour observation periods.

The project objectives were to quantify particulate emission constituents and compare them to applicable air emissions regulations stipulated by EGLE and the facility permit. These measurements were performed at normal operating conditions. Quality protocols comply with regulatory compliance testing requirements.

Subsequent sections summarize the test results and provide descriptions of the process and test methods. Supporting information and raw data are in the appendices.

Results Summary

Results of particulate determinations are summarized in Table 1. The filterable particulate emission rate averaged 0.017 LB/HR at 0.00046 GR/DSCF. The particulate emission limits for this source are 0.32 LB/HR and 0.040 GR/DSCF. The PM-10 and PM-2.5 emission rate averaged 0.052 LB/HR at 0.0014 GR/DSCF. The PM-10 and PM-2.5 limit for this source is 0.32 LB/HR. PM-10 and PM-2.5 are assumed to be the equivalent of the filterable PM (FPM) and condensable PM (CPM). Subsequent tables provide expanded detail of the testing results.

Opacity observations are included in Tables 4-6. All of the opacity observation readings were 0%. The opacity limit for this source is ≤10% six-minute average. The opacity observer's third party certification had lapsed a few days before these observations. The observer is fully trained in accordance with EPA Method 9 and can reliably determine the absence of visible emissions.

The data in this report are indicative of emission characteristics of the measured sources for process conditions at the time of the test. Representations to other sources and test conditions are beyond the scope of this report.

Summary Table

City Aluminum Foundry

Waterford, MI
Pace Project No. 19-02383

Table 1

Results Summary
Thermal Sand Reclaim Baghouse Stack
Test 1

Parameter	**Run 1**	**Run 2**	**Run 3**	**Average**
Date of Run	10/23/19	10/23/19	10/23/19	
Time of Run	0850-1057	1210-1414	1525-1730	
Volumetric Flow Rate (Rounded to 10 CFM)				
ACFM	5,730	5,460	5,050	5,410
DSCFM	4,670	4,410	4,070	4,380
Gas Temperature, °F	152	155	158	155
Gas Moisture Content, %v/v	1.7	2.1	1.8	1.9
Gas Composition, %v/v, dry				
Carbon Dioxide, CO_2	0.8	0.8	0.7	0.7
Oxygen, O_2	20.2	20.0	20.1	20.1
Nitrogen, N_2 (by difference)	79.1	79.3	79.3	79.2
Particulate Mass Rate, LB/HR				
Filterable Particulate	0.0164	0.0236	0.0120	0.0173
Filterable+Organic Cond.	0.0223	0.0260	0.0149	0.0211
Total Particulate (PM-10 Eq.)	0.0653	0.0557	0.0338	0.0516
Particulate Concentration, GR/DSCF				
Filterable Particulate	0.00041	0.00063	0.00034	0.00046
Filterable+Organic Cond.	0.00056	0.00069	0.00043	0.00056
Total Particulate (PM-10 Eq.)	0.00163	0.00147	0.00097	0.00136

Detail Tables

City Aluminum Foundry
Waterford, MI
Pace Project No. 19-02383

Table 2

Major Gases and Moisture Results
Thermal Sand Reclaim Baghouse Stack
Test 1

Parameter	**Run 1**	**Run 2**	**Run 3**
Date of Run	10/23/19	10/23/19	10/23/19
Time of Run	0850-1057	1210-1414	1525-1730
Major Gas Constituents - Instrumental, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	0.77	0.77	0.67
Oxygen	20.16	19.97	20.07
Nitrogen (by difference)	79.07	79.26	79.26
Wet Basis (calculated)			
Carbon Dioxide	0.76	0.75	0.66
Oxygen	19.81	19.56	19.70
Nitrogen	77.69	77.63	77.81
Portable Oxygen Monitor Result			
Time Weighted Average, $\%O_2$	19.7	19.9	20.0
Moisture Collected, ml	33.0	30.0	25.0
Moisture Content, %v/v	1.75	2.05	1.83
Moisture Content if Saturated, %v/v	27.57	30.03	31.61
Relative Humidity, % rH	6%	7%	6%
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	28.93	28.92	28.91
Wet	28.74	28.70	28.71

City Aluminum Foundry

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Table 3

Particulate Results
Thermal Sand Reclaim Baghouse Stack
Test 1

Parameter	**Run 1**	**Run 2**	**Run 3**
Date of Run	10/23/19	10/23/19	10/23/19
Time of Run	0850-1057	1210-1414	1525-1730
Sample Duration, Minutes	120	120	120
Average Flue Gas Temperature, °F	151.9	155.4	157.5
Moisture Content of Flue Gas, %v/v	1.7	2.1	1.8
Particulate Collected, mg			
Dry Catch	2.3	2.7	1.4
Inorganic Wet Catch	6.1	3.4	2.2
Organic Wet Catch	0.8	0.3	0.3
Volumetric Flow Rate (Rounded to 10 CFM)			
ACFM	5,730	5,460	5,050
SCFM	4,760	4,500	4,150
DSCFM	4,670	4,410	4,070
Sample Volume, Meter Conditions, Ft^3	89.60	71.30	67.85
Sample Volume, Dry Standard, Ft^3	87.25	67.34	62.96
Particulate Concentration, GR/DSCF			
Filterable Particulate	0.00041	0.00063	0.00034
Inorganic Condensables	0.00107	0.00079	0.00054
Organic Condensables	0.00015	0.00006	0.00008
Filterable+Organic Cond.	0.00056	0.00069	0.00043
Total Particulate (PM-10 Eq.) (F+I+O)	0.00163	0.00147	0.00097
Particulate Emission Rate, LB/HR			
Filterable Particulate	0.0164	0.0236	0.0120
Inorganic Condensables	0.0429	0.0297	0.0189
Organic Condensables	0.0060	0.0023	0.0029
Filterable+Organic Cond.	0.0223	0.0260	0.0149
Total Particulate (PM-10 Eq.) (F+I+O)	0.0653	0.0557	0.0338

NR=Not required or not requested.

City Aluminum Foundry

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Table 4

Opacity Observations
Thermal Sand Reclaim Baghouse Stack
Test 1, Run 1

Percent Opacity	Optical Density	Relative Frequency
0	0.000	100.00
5	0.022	0.00
10	0.046	0.00
15	0.071	0.00
20	0.097	0.00
25	0.125	0.00
30	0.155	0.00
35	0.187	0.00
40	0.222	0.00
45	0.260	0.00
50	0.301	0.00
55	0.347	0.00
60	0.398	0.00
65	0.456	0.00
70	0.523	0.00
75	0.602	0.00
80	0.699	0.00
85	0.824	0.00
90	1.000	0.00
95	1.301	0.00
99	2.000	0.00
Average > 0.0	0.000	**Total >** 100

Average Opacity Per Sequential Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	0.0
2	0.0	7	0.0
3	0.0	8	0.0
4	0.0	9	0.0
5	0.0	10	0.0

High Six Minute Average: 0.0
Maximum reading: 0.0
Minumum reading: 0.0

Observer: Lucas Ruhland
Date of test: 10/23/2019
Time of test: 900-1000

NOTE: The high six-minute average opacity is the maximum value for any consecutive 24 readings.

City Aluminum Foundry

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Table 5

Opacity Observations
Thermal Sand Reclaim Baghouse Stack
Test 1, Run 2

Percent Opacity	Optical Density	Relative Frequency
0	0.000	100.00
5	0.022	0.00
10	0.046	0.00
15	0.071	0.00
20	0.097	0.00
25	0.125	0.00
30	0.155	0.00
35	0.187	0.00
40	0.222	0.00
45	0.260	0.00
50	0.301	0.00
55	0.347	0.00
60	0.398	0.00
65	0.456	0.00
70	0.523	0.00
75	0.602	0.00
80	0.699	0.00
85	0.824	0.00
90	1.000	0.00
95	1.301	0.00
99	2.000	0.00
Average > 0.0	0.000	**Total >** 100

Average Opacity Per Sequential Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	0.0
2	0.0	7	0.0
3	0.0	8	0.0
4	0.0	9	0.0
5	0.0	10	0.0

High Six Minute Average: 0.0
Maximum reading: 0.0
Minumum reading: 0.0

Observer: Lucas Ruhland
Date of test: 10/23/2019
Time of test: 1215-1315

NOTE: The high six-minute average opacity is the maximum value for any consecutive 24 readings.

City Aluminum Foundry

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Table 6

Opacity Observations
Thermal Sand Reclaim Baghouse Stack
Test 1, Run 3

Percent Opacity	Optical Density	Relative Frequency
0	0.000	100.00
5	0.022	0.00
10	0.046	0.00
15	0.071	0.00
20	0.097	0.00
25	0.125	0.00
30	0.155	0.00
35	0.187	0.00
40	0.222	0.00
45	0.260	0.00
50	0.301	0.00
55	0.347	0.00
60	0.398	0.00
65	0.456	0.00
70	0.523	0.00
75	0.602	0.00
80	0.699	0.00
85	0.824	0.00
90	1.000	0.00
95	1.301	0.00
99	2.000	0.00
Average > 0.0	0.000	**Total >** 100

Average Opacity Per Sequential Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	0.0
2	0.0	7	0.0
3	0.0	8	0.0
4	0.0	9	0.0
5	0.0	10	0.0

High Six Minute Average: 0.0
Maximum reading: 0.0
Minumum reading: 0.0

Observer: Lucas Ruhland
Date of test: 10/23/2019
Time of test: 1430-1530

NOTE: The high six-minute average opacity is the maximum value for any consecutive 24 readings.

Process Description

City Aluminum Foundry operates a casting company located in Waterford, Michigan. The natural gas-fired thermal sand reclaimer (TSR) heats and mulls sand from shakeout.

The TSR Baghouse controls the emissions from the thermal reclamation of spent sand and from the new electric melt furnaces authorized by PTI 147-17. The TSR Baghouse is manufactured by Dyna-Flo and is designed to meet an emission limit of 0.01 GR/DSCF of particulate matter (PM) with a normal pressure drop of 2-4 inches H_2O. A record of pressure drop across the baghouse during testing is provided in Appendix E.

The thermal sand reclaimer and melt furnaces 9 and 10 were operating during the duration of the tests. The furnaces were "topped off" several times during the testing to ensure that they were operating at full capacity. At no time was the melt in the furnaces at less than two-thirds capacity. Appendix E provides a table documenting the refill times for the furnaces.

Test Procedures

EPA Method 1 specifies test location acceptability criteria and defines the minimum number of traverse points for representative sampling. Linear measurements from upstream and downstream flow disturbances and the duct equivalent diameter are compared and the distances related to number of diameters. A flow disturbance can be defined as anything that changes or upsets the direction of flow within the duct including bends, dampers, fans, shape or size transitions, and open flames. Method 1 stipulates that test ports should be located at least eight diameters downstream and two diameters upstream of any flow disturbance. The minimum acceptable criteria are two diameters downstream and 0.5 diameters upstream of flow disturbances. The test location must also be free of cyclonic or multidirectional flow. Once the distances have been determined, the values are used to select the minimum number of traverse points for representative sampling. Shorter distances require a greater number of traverse points. The test site configuration and measurement details are documented on EPA Method 1 Field Data Sheet.

Pace FSD conducts the method as written with no routine deviations.

EPA Method 2 defines procedures used to measure linear velocity and volumetric flow rate of a confined gas stream. Using traverse points determined by EPA Method 1, multiple differential pressure measurements (pitot impact opening versus static pressure) are made using a pitot tube and differential pressure gauge. The individual measurements are averaged and combined with the gas density to calculate the average gas velocity. The velocity and duct cross-sectional area are used to calculate the volumetric flow rate. The volumetric flow rate is expressed as actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM), and dry standard cubic feet per minute (DSCFM). The technician maintains comprehensive test records on EPA Method 2 Field Data Sheet. Details of the equipment used to measure gas velocity include:

Pitot Tube:	S-Type
Differential Pressure Gauge:	Oil Manometer
Temperature Device:	Type K Thermocouple
Barometer Type:	Electronic Digital Barometer
Gas Density Determination:	EPA Method 3
Gas Moisture Determination:	EPA Method 4

Method Defined Quality Control:

- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.

- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.

Pace FSD conducts the method as written with no routine deviations.

Modified EPA Method 3/3A defines procedures to quantify carbon dioxide (CO_2) and oxygen (O_2) concentrations from stationary combustion sources. An integrated gas sample is collected simultaneously with other emissions testing. Sample gases are extracted from an emission stream at a constant rate over the course of a test period equal to other test constituents. A Tedlar™, aluminized Mylar™, or other inert material bag contains the collected gas sample prior to sample analyses. Instrumental gas analyzers compliant to EPA Method 3A quantify the CO_2 and O_2 concentrations. Three point instrument calibrations (zero, mid, and high span) are performed to certify the instruments for gas analyses. The technician maintains comprehensive test records on EPA Method 3 and Gas Analysis Field Data Sheets. Equipment used for measuring gas composition includes:

Filter Material:	Glass-fiber Filter or equivalent
Moisture removal:	Condenser and/or sorbent
Bag Material:	Tedlar™ or Aluminized Mylar™ or equivalent
Gas Analyzer:	Non-dispersive Infrared Detector (CO_2)
	Paramagnetic Detector (O_2)
Calibration Gases:	EPA Protocol 1

Method Defined Quality Control:

- Sampling bag leak check.

Pace FSD conducts the method as written with the following routine sampling deviation:

In the field, the gas sample is analyzed within two hours of collection using a portable O_2 detector. At a later time, potentially outside of the eight hour hold period, the gas sample is re-analyzed using an EPA Method 3A (Orsat) gas analyzer to quantify CO_2 and O_2 concentrations.

The preliminary analysis result from the portable O_2 detector is used to validate the Orsat results. The results are acceptable when the O_2 result from the field and the O_2 result from the lab differ by $\leq 0.3\%$.

EPA Method 4 - Isokinetic defines procedures to measure the moisture content of emission gas streams from stationary sources. The moisture content of the gas stream is determined in conjunction with an isokinetic sampling train. Collected water condensate is measured from the back half of the isokinetic train. Method 4 equations convert the condensed liquid volume to a gas volume. The water vapor volume compared with the dry standard gas volume collected through the isokinetic train determines the moisture content of the emissions gas stream and is reported in percent by volume. Test records are included on the associated isokinetic method data sheet. Equipment used for measuring moisture content includes:

Probe Material:	Borosilicate glass or Stainless Steel
Filter Media:	Glass or Quartz fiber
Impinger Train Material:	Borosilicate Glass
Desiccant:	Drierite
Condensate Measure:	Graduated Cylinder or Electronic Scale
Desiccant Measure:	Electronic Scale

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace standard "as left" calibration factor is within ± 1% (the method standard is ± 2%).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace FSD conducts the method as written with no routine sampling deviations.

EPA Method 5 defines procedures to measure particulate emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, and 4, a sample gas stream is isokinetically drawn from the emission stream. The particulate dry fraction collects in the sampling probe and on a quartz or glass-fiber filter. The probe and filter components of the sampling train are heated to 248°F (±25°F) to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a series of impingers to condense water vapor and collect gaseous constituents. The first two impingers initially contain deionized water, and the third impinger is empty. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. The impinger contents can be discarded or saved for additional analyses. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on EPA Method 5 Field Data Sheet, Isokinetic Particulate Sampling. Details of particulate testing are outlined below:

Nozzle/Probe Material:	Stainless Steel and Borosilicate Glass
Filter Holder Material:	Borosilicate Glass with glass or Teflon support
Filter Media:	Quartz or Glass-fiber, >99.95% efficient at 0.3μm
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	Deionized Water
Recovery Reagents:	Acetone Deionized water
Control Train:	Gas meter, orifice, differential pressure gauges, pump, valves, temperature monitors and controllers
Analytical Techniques:	Gravimetric

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace standard "as left" calibration factor is within ± 1% (the method standard is ± 2%).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Sampling is performed at an isokinetic rate between 90 and 110%.

- A field blank is collected to verify site conditions to be non-contaminating.
- Sampling and recovery reagents are reagent grade or better.
- Analytical balances are calibrated and certified on an annual basis by an external service provider and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace FSD conducts the method as written with no routine sampling deviations.

EPA Method 202 defines procedures to determine organic and inorganic condensable particulate matter (CPM) emissions from stationary sources. The CPM is collected in a condensate knock-out impinger and Teflon filter after filterable PM has been collected by either Method 5 or Method 201A. The gas stream is sample isokinetically following EPA Method 5 or Method 201A procedures. The gas stream is initially cooled with a spiral condenser using recirculated cool water to maintain a sample gas temperature of 85°F or less. Condensate from the spiral condenser collects in glass, stemless, dropout impingers. The intent of the condenser and dropout impinger is to minimize gas/water contact to reduce collection of unintended artifacts. The dropout impinger is followed by a second impinger to provide overflow capacity. A Teflon™ filter, also maintained at 85°F or less is used to collect any remaining organic CPM. The filter is followed by an iced, water prepared impinger and desiccant packed drying column to quantitatively collect remaining moisture. Immediately after sampling, the Method 202 CPM condensate is purged with nitrogen (N_2) to liberate dissolved sulfur dioxide (SO_2) gases. The contents of the dropout and backup impingers prior to the CPM filter are measured, weighed, and transferred to an appropriate sample bottle. CPM is quantitatively recovered with water, acetone, and hexane rinses. The CPM filter and water are extracted with hexane and combined with solvent rinses to determine the organic CPM. Following extraction, the water is dried and the residue measured as the inorganic CPM. The combination of both fractions represents the total condensable particulate matter (CPM). The train operator maintains comprehensive test records on appropriate Field Data Sheets.

Filter Holder Material:	Glass, Stainless Steel (316 or equivalent), or Fluoropolymer-coated Stainless Steel
Filter Media:	Teflon, >99.95% efficient at 0.3 um
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	Deionized Water
Recovery Reagents:	Acetone Hexane Deionized Water

Control Train: EPA Method 5
Analytical Technique: Gravimetric

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace standard "as left" calibration factor is within ± 1% (the method standard is ± 2%).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Sampling is performed at an isokinetic rate between 90 and 110%.
- A field blank is collected to verify site conditions to be non-contaminating.
- Sampling and recovery reagents are reagent grade or better.
- Analytical balances are calibrated and certified on an annual basis by an external service provider and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace FSD conducts the method as written with no routine sampling deviations.

EPA Method 9 defines procedures to evaluate the opacity of the plume emitted from a source stack. An independently certified visible emissions observer visually estimates the opacity of the non-moisture plume from the source. The observer positions themselves with the sun (or other light source) at their back and perpendicular to the plume when directly facing the emission point. The observer must also ensure a clear and contrasting background behind the plume. The certified observer then estimates (based on certification trials) the percentage of the background blocked by the source plume (plume opacity) in increments of 5%. Observed opacity readings are recorded at

15-second intervals throughout the run. Tabulated results include run average and successive six-minute averages. The spreadsheet software also searches the data set for any group of 24 consecutive readings that yield the highest possible six-minute average. The train operator maintains comprehensive test records on the Visible Emission Observation Form. Details of the opacity evaluation are outlined below:

Evaluation Period:	One hour
Observation Frequency:	15 Seconds
No. of Observations:	240
No. of Six-minutes Averages:	10
Observer Certifications:	Semi-annual

Reference Standards. Pace implements a comprehensive program to verify and validate reference standards to further enhance and support method standards. Primary reference standards are directly comparable to a reference base. The National Institute of Standards and Technology (NIST) maintains primary reference materials or very closely traceable secondary standards. These materials are then used to certify secondary or transfer standards for use in quality management programs. Secondary reference standards are calibrated with primary standards using a high precision comparator. Materials that have a documented path to the primary standard are often referred to as traceable to NIST or NIST traceable. Where commercially and feasibly available, Pace uses primary reference standards to perform calibrations and verifications. In other cases, Pace maintains traceable secondary reference standards. Primary and secondary reference standards are used to calibrate and verify equipment and materials. Pace reference standards are calibrated by external vendors that have a formal, registered quality system. Calibrations are performed with equipment and materials that are traceable to NIST.

Quality Controls (not defined in test methods):

- Sampling/Recovery Reagents are Reagent Grade or better.
- Reference Temperature Simulator is calibrated annually.
- Reference Pressure Transducer is calibrated annually.
- Reference DryCal airflow meter is calibrated annually.
- Mercury Barometer is a primary reference standard.
- Liquid Manometers are primary reference standards.
- Angle Blocks, Gauge Blocks, and Measuring Rods are verified every five years.
- Angle Gauges are verified each day of use.
- Calipers are verified annually.
- Stainless steel reference weights are verified every five years.
- Analytical balances are calibrated annually and verified at each use.
- Field balances are calibrated annually and verified at each use.

Quality Management System. To produce data that is complete, representative, and of known precision and accuracy, Pace Analytical Field Services Division has designed and implemented a rigorous and innovative quality management system. The system was initially based on the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems and continually developed as procedural complexities and standards progressed. The Field Services Division Quality Management System (Pace FSD QMS) is now accredited by the American Association of Laboratory Accreditation (A2LA) to comply with three national accreditation standards:

- ASTM D7036 - Standard Practice for Competence of Air Emission Testing Bodies (AETB).
- ISO 17025 - General Requirements for the Competence of Testing and Calibration Laboratories
- The NELAC Institute - General Requirements for Field Sampling and Measurement Organizations (FSMO)

The Pace FSD QMS includes:

- Quality Programs
  - Ethics policy and training.
  - Corrective Action and Preventative Action (CAPA).
  - Continuous Process Improvement.
  - Documented Demonstrations of Capability.
  - Internal and third party proficiency testing.
  - Qualified Individual program (QI)
  - Internal and external audits.
  - Annual management reviews.
- Documentation and Traceability
  - High quality traceable standards and reagents.
  - Reagent tracking and management system.
  - Use of matrix spikes, duplicate analysis, internal standards, and blanks.
  - Validated workbooks for data collection and results reporting.
  - Electronic quality, training, and safety documents available in-field.
  - Sample security and preservation procedures.
  - Chain of custody maintained from sample collection through laboratory analysis.
- Equipment Calibration
  - Full time staff dedicated to equipment maintenance and calibration.

All equipment and instruments are calibrated by trained personnel on a frequency that meets or exceeds method requirements.

Pace Analytical
Field Services Division

Figure 1
City Aluminum Foundry
Waterford, MI
Thermal Sand Reclaim Baghouse Stack
DBS \ 9/2019