BOILER NUMBER ONE
1st QUARTER 2017
HYDROGEN CHLORIDE
EMISSIONS TEST REPORT

22 MARCH 2017

L'ANSE WARDEN ELECTRIC COMPANY, LLC.
157 South Main Street
L'Anse, Michigan 49946

May 2017

W.O. No. 14464.007.006

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT
REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name L'Anse Warden Electric Company LLC County Baraga

Source Address 157 S. Main Street City L'Anse

AQD Source ID (SRN) B4260 RO Permit No. MI-ROP-B4260-2011 RO Permit Section No. ______

Please check the appropriate box(es):

☐ **Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From ______ To ______

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From ______ To ______

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From ______ To ______

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Emissions Test Report

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete.

James R. Richardson	Technical Manager	907-885-7187
Name of Responsible Official (print or type)	Title	Phone Number
James R. Richardson	Consultant to LWEC	9-May-2017
Signature of Responsible Official		Date

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1. INTRODUCTION

Weston Solutions, Inc. (WESTON) has been retained by L'Anse Warden Electric Company, LLC (LWEC) to perform an emissions testing program on the Boiler No. 1 exhaust duct at the LWEC facility located in L'Anse, Baraga County, Michigan. Boiler No. 1 was previously a coal, oil, and gas-fired steam generating station and has been converted to burn biomass. The objective of this test program is to satisfy the requirements set forth by the Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Consent Order (AQD No. 35-2016). The Consent Order contains provisions requiring four successive quarters of emission stack testing for hydrogen chloride (HCl) on EUBOILER No. 1, followed by two semi-annual HCl emission stack tests for HCl, followed by one further HCl emission stack test within the succeeding three years thereafter. Boiler No. 1 is identified as EUBOILER No. 1, and the facility currently operates under the State of Michigan Renewable Operating Permit (ROP) No. MI-ROP-B4260-2011 and Permit to Install (PTI) 67-16.

WESTON's Integrated Air Services (IAS) group completed the first quarter 2017 required testing on 22 March 2017. Mr. Tom Gasloli of the MDEQ was present throughout the testing.

1.1 PLANT INFORMATION

L'Anse Warden Electric Company, LLC
157 South Main Street
L'Anse, Michigan 49946
Mr. JR Richardson
Phone: 906-885-7187

1.2 TESTING FIRM INFORMATION

Weston Solutions, Inc.
1400 Weston Way
West Chester, PA 19380
Mr. Ken Hill
Phone: 610-701-3043

1.3 SUMMARY OF TEST PARAMETERS

Table 1-1 provides the test parameters, associated test methods, and reporting units for this test program.

Table 1-1
Summary of Test Parameters

Test Parameter[1]	Test Method[2]	Reporting Units
Volumetric Flow Rate (VFR)	EPA M1-4	dscfm
Hydrogen Chloride (HCl)	EPA M26A (modified)	ppmvd, lb/hr

1. VFR measurements were performed in conjunction with each HCl test run.
2. EPA Method 26A modified by collecting a non-isokinetic sample from a single traverse point similar to EPA Method 26.

Following this introduction, Section 2 provides a summary of the test results. Section 3 provides a description of the process and sampling locations. Section 4 provides a description of the sampling and analytical procedures. Section 5 outlines the fuel processing, fuel sampling and analytical procedures used during the test program. Section 6 provides quality assurance and quality control procedures (QA/QC). Detailed test results, raw test data, boiler operating data, laboratory reports, fuel sample results, quality control records, example calculations, and a list of project participants are provided in Appendices A through H, respectively.

2. SUMMARY OF TEST RESULTS

2.1 TEST RESULTS DISCUSSION

Table 2-1 provides a summary of the hydrogen chloride (HCl) test results. Any differences in the test results summary tables and detailed test results shown in the appendices are due to rounding the results for presentation purposes.

As discussed in the Test Protocol (Revision 1, November 2016), WESTON conducted testing to measure the stack gas moisture, temperature, and velocity measurements concurrent with the HCl sampling at the ESP outlet duct. The measurements were used to calculate stack gas volumetric flow rates and hydrogen chloride mass rates. Detailed results tables are presented in Appendix A.

As an additional quality assurance measure, LWEC conducted fuel sampling and analysis during the test program. The chlorine results for each fuel sample collected can be found in Appendix E.

There were no sampling or operational issues that impacted the field testing and the results presented are believed to be representative of the emissions encountered during the test periods.

Table 2-1

Summary of 1st Quarter 2017 HCl Test Results

Parameter	Date	Time	Unit of Measure	Result	PTI 168-07D Emissions Limit
HCl (EPA 26A)	03/22/17	0900-1000	lb/hr	1.56	2.17
	03/22/17	1015-1115	lb/hr	1.63	2.17
	03/22/17	1130-1230	lb/hr	1.81	2.17
Average				**1.67**	**2.17**

3. DESCRIPTION OF PROCESS AND SAMPLING LOCATIONS

3.1 PROCESS OVERVIEW

LWEC is a cogeneration facility, consisting of a single boiler generating process steam and electric power to the grid firing primarily biomass materials. The boiler typically produces steam at 180,000 lbs/hr and gross power generation from 14 to 17.7 MW/hr.

3.1.1 Basic Operating Parameters

The fuel feed to the boiler is regulated to meet process steam and electrical generation requirements. The fuel blend and excess air were modified to improve combustion characteristics. Adjustments to air, fuel blend or load were made as necessary to conform to emissions monitoring limits.

3.1.2 Boiler Operations

The hourly boiler operating limit is 324 million British thermal units (MMBtu). The maximum annual heat input is 2,656,800 MMBtu, based on 8,200 hours of operation per year.

The boiler load was determined by the demand for process steam and electricity. The boiler load was maintained at 90% of capacity during the test program.

3.1.3 Test Program Fuel Mix and Firing Rates

The fuel mix during testing consisted of wood, creosote treated railroad ties, and TDF. The firing rates for each of the fuels was within the range consistent for safe normal operations.

3.2 AIR POLLUTION CONTROL EQUIPMENT

Particulate emissions are controlled with a multi-cyclone followed by a single chamber, three-field electrostatic precipitator (ESP).

3.2.1 ESP Operating Parameters

The precipitator electrical controls and rapping sequence, intensity and frequency were set for optimum performance and were not modified after optimization unless emissions issues are observed.

3.3 REFERENCE METHOD TEST LOCATION

The HCl sampling and pitot traverse were conducted in the first set of sample ports (secondary sample ports) located on a section of rectangular ductwork that runs horizontally from the exit of the ESP prior to the exhaust stack. The pitot traverse was conducted at twelve traverse points in the secondary ports (three traverse points in four ports). The HCl sample train was located at a single point in the port that was located second from the top. The rectangular ductwork is six feet by six feet six inches (6' x 6½') and has a straight run of fifty-seven feet (57'). All dimensions and port locations were verified prior to testing.

Figure 3-1 presents a diagram of the sample port and traverse point location.

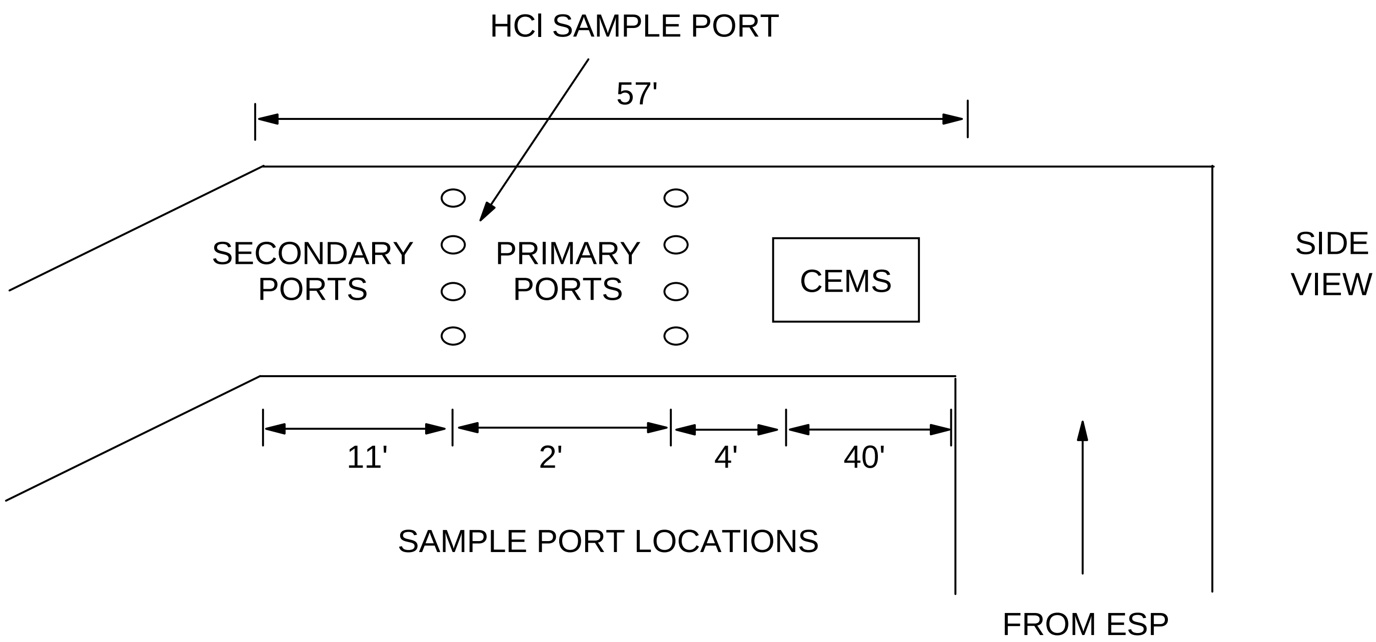
3.3.1 Flue Gas Parameters

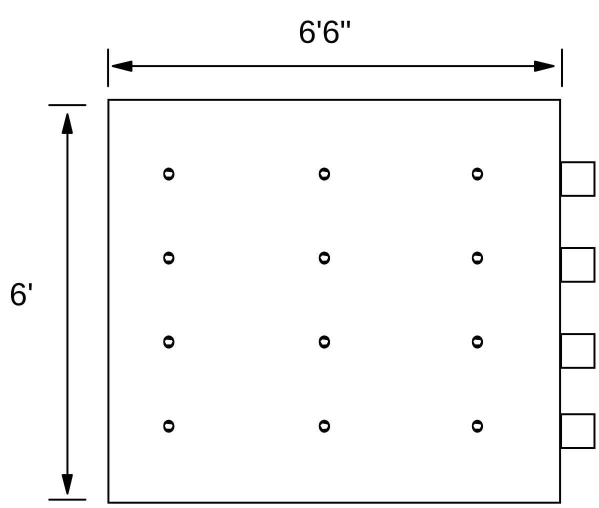
The measured flue gas parameters at this location are as follows:

Temperature: approximately 420 - 450 °F, load dependent

Moisture: approximately 15% v/v, fuel moisture dependent

Volumetric Flow Rate: Up to about 150,000 ACFM, load dependent





Velocity Traverse Point Number	Distance From Inside Near Wall
1	13"
2	39"
3	65"

DRAWING NOT TO SCALE

FIGURE 3-1
SAMPLE PORT AND TRAVERSE POINT LOCATION

4. SAMPLING AND ANALYTICAL PROCEDURES

This section details the stack sampling and analytical procedures that were utilized during the test program. Table 4-1 summarizes the sampling and analytical methods.

4.1 PRE-TEST DETERMINATIONS

Preliminary test data was obtained at the sampling location. Geometry measurements were measured and recorded, and traverse point distances verified. A preliminary velocity traverse was performed utilizing a calibrated "S" type pitot tube and a Dwyer inclined manometer to determine velocity profiles. Flue gas temperatures were observed with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple. Water vapor content was measured by performing an EPA Method 4 moisture test, or was based on previous test data (preliminary only).

A check for the presence or absence of cyclonic flow was conducted at the test location. The average cyclonic flow check angle was < 20°, thus verifying the suitability of the test site for obtaining representative samples.

Pre-test calibration of probe nozzles, pitot tubes, metering systems, and temperature measurement devices were performed as specified in Section 5 of EPA Method 5 test procedures.

4.2 FORMAL TESTING

4.2.1 Gas Volumetric Flow Rate

A series of three test runs were performed. The gas velocity was measured using EPA Methods 1 and 2. Velocity measurements were performed using an “S-type” pitot tube. The stack gas pressure differential was measured with inclined manometers. Flue gas temperatures were measured with calibrated digital temperature readouts equipped with chromel-alumel (type-K) thermocouples. Velocity measurements and stack gas temperatures were performed in conjunction with the HCl sampling train and traversed across the duct diameter. The velocity and volumetric flow rate were used for determining the HCl mass rate calculations. Likewise

Table 4-1
Summary of Sampling and Analytical Methods

Sample	No. of Test Runs	Sampling Duration	Sampling Method	Sample Size	Analytical Parameters	Analytical Method
Stack Gas	3	1-hr composite sample per run	Modified M26A	~ 40 ft^3	HCl	Ion Chromatography (SW846-9057)
		Concurrent	M1-2	NA	Temperature	Temperature
					Velocity	Pitot Tube
		Integrated with M26A	M4	~ 40 ft^3	Moisture	Volumetric
		Concurrent	M3/3A	30 Liter Bag	O_2/CO_2	Continuous Emission Monitor

moisture content was determined concurrently with each test. The moisture content of the gas stream was determined by the volume increase of the impinger water and weight increase of the silica gel in comparison to the volume of gas sampled.

The gas stream composition [oxygen (O_2) and carbon dioxide content (CO_2)] of the flue gas was measured according to EPA Method 3/3A procedures using a Reference Method Continuous Emission Monitoring (CEM) system. EPA protocol gas standards were used to calibrate the O_2/CO_2 analyzer.

A Tedlar bag sample technique was used to determine the gas stream composition. The Tedlar bag samples of O_2 and CO_2 were collected from the exhaust of the control console calibrated orifice at a constant rate of ~0.5 liters per minute. This provides an integrated, conditioned (dry) sample. The gas passing through the control console orifice is conditioned by the impinger train. The sample is also integrated with respect to time and location in the stack.

Analysis of the Tedlar bag samples were performed using EPA Reference Method 3A analytical procedures. The conditioned Tedlar bag samples was analyzed directly by calibrated analyzers such as a paramagnetic O_2 analyzer and a non-dispersive Infrared (NDIR) CO_2 analyzer. The O_2 and CO_2 analyzers were configured and calibrated in accordance with the gas analyzer requirements outlined in EPA Reference Method 3A. The dry molecular weight of the gas stream was calculated using the measured oxygen and carbon dioxide concentrations. The balance of the gas stream was assumed to be nitrogen.

4.3 EPA METHOD 26A – HYDROGEN CHLORIDE SAMPLING TRAIN

The sampling train utilized to perform the hydrogen chloride sampling was configured as an EPA Reference Method 26A full-size sampling train with the exception of no borosilicate nozzle attached to the sample probe (see Figure 4-1). This modification was implemented to allow non-isokinetic sampling from a single traverse point similar to EPA Method 26. A heated (≥248°F) borosilicate probe was attached to a heated (≥248°F) borosilicate filter holder containing a 9-cm quartz filter. The filter folder was connected to the first of four impingers by means of rigid glass connectors. The first moisture knockout impinger contained 50 ml of 0.1 normal sulfuric acid.

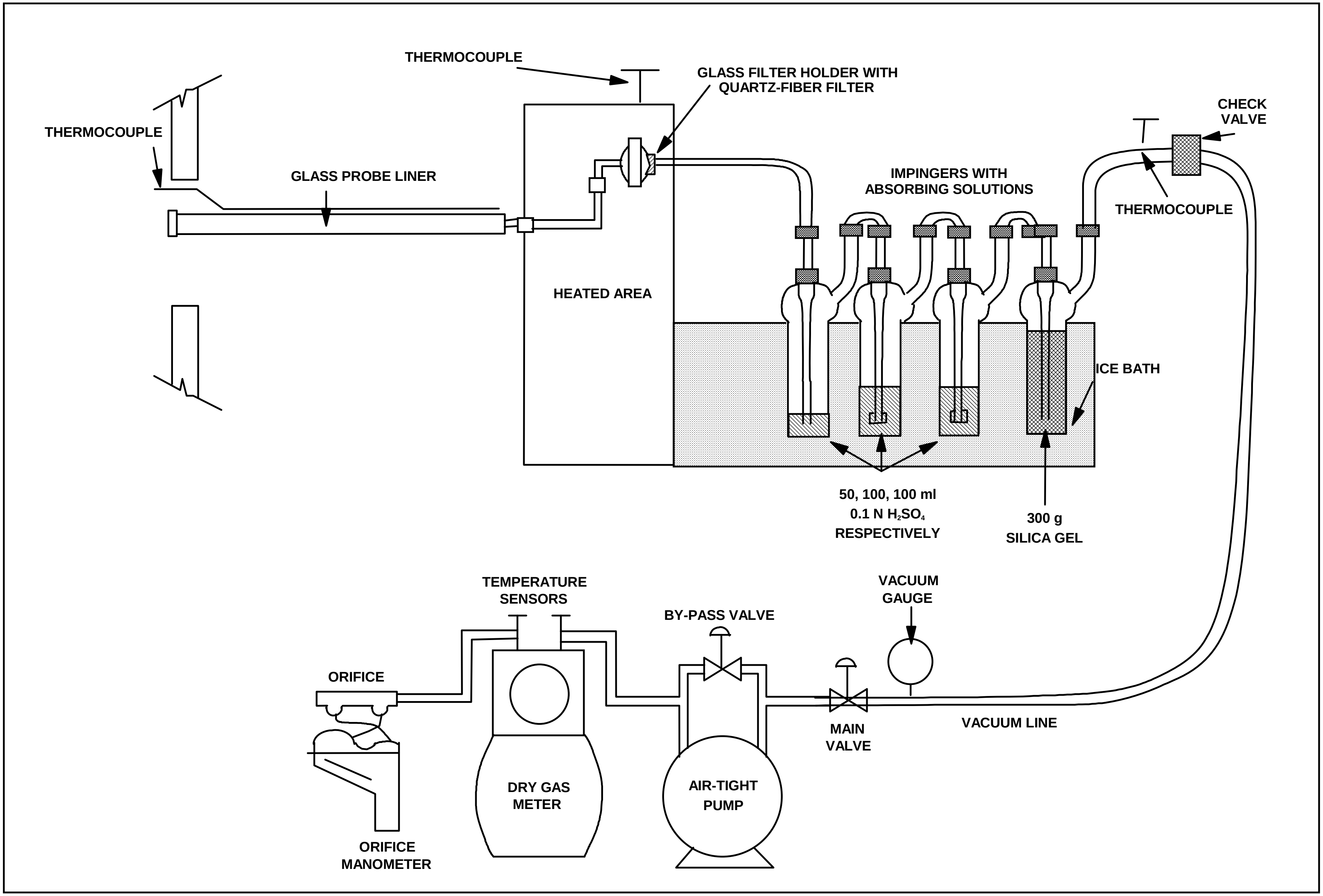


FIGURE 4-1
EPA METHOD 26A (MODIFIED)
HYDROGEN CHLORIDE SAMPLING TRAIN

The second and third impingers each contained 100 ml of 0.1 N sulfuric acid. The fourth impinger contained 300 grams of dry silica gel. The second and third impingers were a standard Greenburg-Smith type and all other impingers were of a modified design. All impingers were maintained in an ice bath. A control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, and inclined manometers were connected to the final impinger via an umbilical cord to complete the train. Probe, filter box, and impinger exit gas temperatures were monitored with a calibrated direct read-out pyrometer equipped with a chromel-alumel thermocouples.

The HCl sample was collected in conjunction with independent stack gas velocities and stack gas composition (O_2/CO_2 content) in order to calculate the stack gas volumetric flow rate and HCl mass rates.

4.3.1 Hydrogen Chloride Sample Recovery

At the conclusion of each test, the sampling train was dismantled, the openings sealed, and the components transported to the field laboratory.

A consistent procedure was employed for sample recovery as follows:

1. The quartz fiber filter or thimble was removed from its filter holder with tweezers and discarded.
2. The total liquid content of impingers one, two and three (0.1 N H_2SO_4) were measured and the sample placed in a polyethylene container fitted with a Teflon-lined closure (Sample type 1). Also included in this sample was a distilled water rinse of the impingers and connectors. The sample was labeled for chloride analysis.
3. The silica gel impinger was immediately weighed to the nearest 0.5 g.
4. Samples of sulfuric acid and distilled water used for this program were retained for blank analysis.

Each sample bottle was labeled to clearly identify its contents. The height of the fluid level was marked on each bottle. The samples were then transported to the subcontract laboratory. Sample integrity was assured by maintaining chain-of-custody records.

4.3.2 Hydrogen Chloride Analysis

The samples from the H_2SO_4 impingers were analyzed for chloride (Cl^-) by the procedures outlined in EPA SW-846 Method 9057 (ion chromatography) and reported as HCl. Maxxam Analytics of Mississauga, Ontario, Canada conducted the analysis. A blind audit sample developed by Environmental Resource Associates as per EPA's Stationary Source Audit Sample Program was submitted and analyzed with the stack samples.

5. FUEL SAMPLING AND ANALYSIS

LWEC fuel is supplied by M.A. Energy Resources LLC (MAER). MAER operates a fuel aggregation facility where raw materials are processed then conveyed to the facility.

Fuel samples were collected during the test program during each test run in accordance with 40 CFR 63 Subpart 7521(c and d) by LWEC designated personnel from a point where each fuel drops onto the conveyor belt feeding the boiler. Three samples of each fuel type were submitted for analysis as listed in Table 5-1.

Table 5-1
Fuel Sample Analytical Methods

Fuel Type	Required Analysis	Analytical Methods	Minimum Detection Level
TDF	Moisture Content	ASTM D3173 , *"Standard Test Method for Moisture in the Analysis Sample of Coal and Coke"*	Not Applicable
	Chlorine Concentration	EPA 5050/9056, *"Determination of Inorganic Anions by Ion Chromatography"*	~50 ppm
Wood	Moisture Content	ASTM D3173 , *"Standard Test Method for Moisture in the Analysis Sample of Coal and Coke"*	Not Applicable
	Chlorine Concentration	EPA 5050/9056, *"Determination of Inorganic Anions by Ion Chromatography"*	~50 ppm
Creosote Ties	Moisture Content	ASTM D3173 , *"Standard Test Method for Moisture in the Analysis Sample of Coal and Coke"*	Not Applicable
	Chlorine Concentration	EPA 5050/9056, *"Determination of Inorganic Anions by Ion Chromatography"*	~50 ppm

6. QUALITY ASSURANCE/QUALITY CONTROL

6.1 QUALITY CONTROL PROCEDURES

As part of the HCl quarterly program, WESTON implemented a QA/QC program. QA and QC are defined as follows:

- Quality Control: The overall system of activities whose purpose is to provide a quality product or service: for example, the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

- Quality Assurance: A system of activities whose purpose is to provide assurance that the overall quality control is being done effectively. Further,

The field team manager for stack sampling was responsible for implementation of field QA/QC procedures. Individual laboratory managers were responsible for implementation of analytical QA/QC procedures. The overall project manager oversaw all QA/QC procedures to ensure that sampling and analyses met the QA/QC requirements and that accurate data resulted from the test program.

6.2 GAS STREAM SAMPLING QA PROCEDURES

General QA checks were conducted during testing and apply to all methods including the following:

- Performance of leak checks.
- Use of standardized forms, labels and checklists.
- Maintenance of sample traceability.
- Collection of appropriate blanks.
- Use of calibrated instrumentation.
- Review of data sheets in the field to verify completeness.
- Use of validated spreadsheets for calculation of results.

The following section details specific QA procedures applied to the test methods.

6.2.1 Stack Gas Velocity/Volumetric Flow Rate QA Procedures

The QA procedures followed for velocity/volumetric flow rate determinations followed guidelines set forth by EPA Method 2. Incorporated into this method, were sample point determinations by EPA Method 1, and gas moisture content determination by EPA Method 4. QA procedures for Methods 1 and 2 are discussed below.

Volumetric flow rates were determined during the isokinetic flue gas tests. The following QC steps were followed during these tests:

- The S-type pitot tube was visually inspected before sampling.
- Both legs of the pitot tube were leak checked before sampling.
- Proper orientation of the S-type tube was maintained while making measurements. The yaw and pitch axes of the S-type pitot tube were maintained at 90° to the flow.
- The manometer oil was leveled and zeroed before each run.
- Pitot tube coefficients were determined based on physical measurement techniques as delineated in Method 2.

6.2.2 Moisture and Sample Gas Volume QA Procedures

Gas stream moisture was determined as part of the HCl test trains. The following QA procedures were followed in determining the volume of moisture collected:

- Preliminary impinger train tare weights were weighed or measured volumetrically to the nearest 0.1 g or 1.0 ml.
- The balance was leveled and placed in a clean, motionless, environment for weighing.
- The indicating silica gel was fresh for each run and periodically inspected and replaced during runs if needed.
- The silica gel impinger gas temperature was maintained below 68°F.

The QA procedures that were followed in regards to accurate sample gas volume determination were:

- The dry gas meter was fully calibrated annually using an EPA approved intermediate standard device.

- Pre-test, port-change, and post-test leak-checks were completed (must be less than 0.02 cfm or 4 percent of the average sample rate).
- The gas meter was read to the thousandth of a cubic foot for all initial and final readings.
- Readings of the dry gas meter, meter orifice pressure (Delta H) and meter temperatures were taken at every sampling point.
- Accurate barometric pressures were recorded at least once per day.
- Pre- and Post-test dry gas meter checks were completed to verify the accuracy of the meter calibration constant (Y).

6.2.3 HCl Sampling Train QA Procedures

The Quality Assurance procedures outlined in this section were designed to ensure collection of representative, high quality test parameter (HCl) concentrations and mass emissions data. The sampling QA procedures followed to ensure representative measurements were:

- All glassware was prepared per reference method procedures.
- Recovery procedures were completed in a clean environment.
- Sample containers for liquids and filters were constructed of borosilicate or polyethylene with Teflon®-lined lids.
- At least one reagent blank of each type of solution or filter was retained and analyzed.
- All test train components from the probe tip through the last impinger were constructed of glass (with the exception of the filter support pad which is Teflon®).
- All recovery equipment (i.e., brushes, graduated cylinders, etc.) were non-metallic.

6.2.4 Sample Identification and Custody

Sample custody procedures for this program were based on EPA recommended procedures. Since samples were analyzed at remote laboratories, the custody procedures emphasized careful documentation of sample collection and field analytical data and the use of chain-of-custody records for samples being transferred. These procedures are discussed below.

The Field Team Manager was responsible for ensuring that all stack samples taken were accounted for and that all proper custody and documentation procedures were followed for the field sampling and field analytical efforts. The Field Team Manager was assisted in this effort by key sampling personnel involved in sample recovery.

Following sample collection, all stack samples were given a unique sample identification code. Stack sample labels were completed and affixed to the sample container. The sample volumes were determined and recorded and the liquid levels on each bottle were marked. Sample bottle lids were sealed on the outside with Teflon® tape to prevent leakage. Additionally, the samples were stored in a secure area until they are shipped.

As the samples were packed for travel, chain-of-custody forms were completed for each shipment. The chain-of-custody forms specifying the treatment of each sample were also enclosed in the sample shipment container.

6.2.5 Data Reduction and Validation QC Checks

All data and/or calculations for flow rates, moisture contents, and isokinetic rates, were made using a computer software program validated by an independent check. In addition, all calculations were spot checked for accuracy and completeness by the Field Team Leader.

In general, all measurement data was validated based on the following criteria:

- Process conditions during sampling or testing.
- Acceptable sample collection procedures.
- Consistency with expected or other results.
- Adherence to prescribed QC procedures.

Any suspect data was flagged and identified with respect to the nature of the problem and potential effect on the data quality.

A pre and post-test calibration were performed on the O_2/CO_2 analyzer using a zero gas, mid gas and high gas as required by the reference methods.

The O_2/CO_2 tedlar bag was collected at a constant rate during the HCl testing period.

All calibration gases used met EPA Protocol standards.

6.3 LABORATORY AUDIT SAMPLES

A laboratory audit sample for HCl was obtained from Environmental Resource Associates (ERA) which is an accredited Stationary Source Audit Sample (SSAS) provider. The audit sample was analyzed in conjunction with the stack samples. The audit result is reported in the Maxxam analytical report along with the source emission results. Additionally, the reported audit result is compared to the assigned value in the ERA submittal included in Appendix D. The ERA laboratory report indicates passing results for the audit sample.

APPENDIX A
DETAILED TEST RESULTS

L'Anse Warden Electric Company
L'Anse, MI
Boiler No. 1
Summary of Hydrogen Chloride Test Data and Test Results

TEST DATA					
Test run number	1	2	3		
Location		Boiler No. 1			
Test date	03/22/17	03/22/17	03/22/2017		
Test time period	0900-1000	1015-1115	1130-1230		
SAMPLING DATA					
Sampling duration, min.	60	60	60		
Barometric pressure, in. Hg	30.00	30.00	30.00		
Avg. orifice press. diff., in H2O	1.80	1.80	1.80		
Avg. dry gas meter temp., deg F	33.8	51.8	67.4		
Avg. abs. dry gas meter temp., deg. R	494	512	527		
Total liquid collected by train, ml	170.0	149.2	146.1		
Std. vol. of H2O vapor coll., cu.ft.	8.003	7.024	6.878		
Dry gas meter calibration factor	0.9999	0.9999	0.9999		
Sample vol. at meter cond., dcf	40.029	41.396	41.170		
Sample vol. at std. cond., dscf (1)	43.088	42.992	41.487		
GAS STREAM COMPOSITION DATA					
CO2, % by volume, dry basis	12.3	12.1	12.0		
O2, % by volume, dry basis	7.8	8.0	7.9		
N2, % by volume, dry basis	79.9	79.9	80.1		
Molecular wt. of dry gas, lb/lb mole	30.28	30.26	30.24		
H2O vapor in gas stream, prop. by vol.	0.157	0.140	0.142		
Mole fraction of dry gas	0.843	0.860	0.858		
Molecular wt. of wet gas, lb/lb mole	28.36	28.53	28.50		
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA					
Static pressure, in. H2O	-12.00	-12.50	-12.00		
Static pressure, in. Hg	-0.882	-0.919	-0.882		
Absolute pressure, in. Hg	29.12	29.08	29.12		
Avg. temperature, deg. F	444	445	448		
Avg. absolute temperature, deg.R	904	905	908		
Pitot tube coefficient	0.84	0.84	0.84		
Duct Avg. gas stream velocity, ft./sec.	59.7	58.9	59.4		
Duct cross sectional area, sq.ft.	39.00	39.00	39.00		
Avg. gas stream volumetric flow, wacf/min.	139678	137764	138908		
Avg. gas stream volumetric flow, dscf/min. (2)	66896	67194	67457		
HCl LABORATORY REPORT DATA					
Total HCl, mg	7.60	7.90	8.40		
HCl EMISSIONS				Average	Limit
Concentration, lb/dscf	3.89E-07	4.05E-07	4.46E-07	4.13E-07	---
Concentration, ppm/v	4.11	4.28	4.72	4.37	---
Mass rate, lb/hr	1.56	1.63	1.81	1.67	2.17

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 in Hg (760 mm Hg)
(2) Volumetric flow rate from EPA Method 2 velocity measurements.

APPENDIX B
RAW TEST DATA

Client LWEC
Loaction/Plant L'Anse, MI
Source ESP Outlet

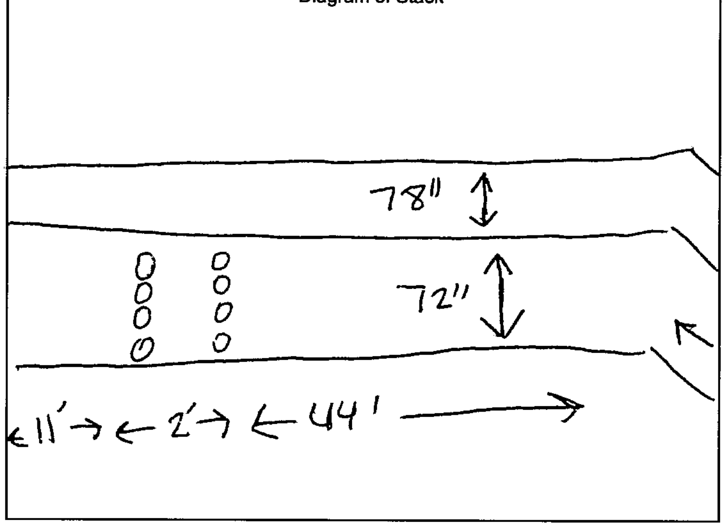
Operator Schweitzer
Date 3/21/17
W.O. Number 14464.007.006.0001

Duct Type	☐ Circular	☒	Rectangular Duct	Indicate appropriate type	
Traverse Type	☐ Particulate Traverse	☐	Velocity Traverse	☐ CEM Traverse	

Distance from far wall to outside of port (in.) = C	90
Port Depth (in.) = D	12
Depth of Duct, diameter (in.) = C-D	78
Area of Duct (ft^2)	39
Total Traverse Points	12
Total Traverse Points per Port	3
Port Diameter (in.) —(Flange-Threaded-Hole)	
Monorail Length	
Rectangular Ducts Only	
Width of Duct, rectangular duct only (in.)	72
Total Ports (rectangular duct only)	4
Equivalent Diameter = (2*L*W)/(L+W)	74.88

Flow Disturbances	
Upstream - A (ft)	11.0
Downstream - B (ft)	44.0
Upstream - A (duct diameters)	1.8
Downstream - B (duct diameters)	7.1

Diagram of Stack



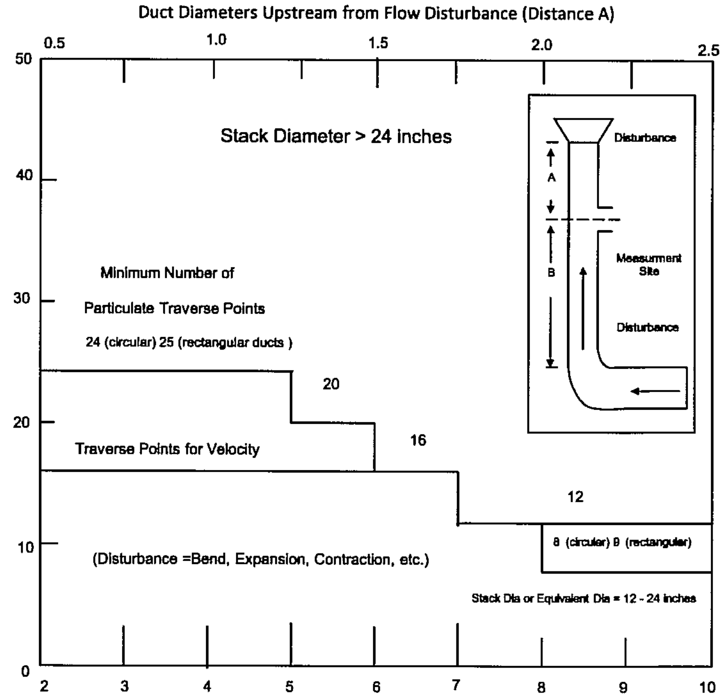
Traverse Point Locations

Traverse Point	% of Duct	Distance from Inside Duct Wall (in)	Distance from Outside of Port (in)	
1	0.167	13.026	25.026	25
2	0.500	39	51	51
3	0.833	64.974	76.974	77
4				
5				
6				
7				
8				
9				
10				
11				
12				

CEM 3 Point(Long Measurment Line) Stratificaton Point Locations

1	0.167		
2	0.50		
3	0.833		

Note: If stack dia < 12 inch use EPA Method 1A
(Sample port upstream of pitot port)
Note: If stack dia >24" then adjust traverse point to 1 inch from wall
If stack dia <24" then adjust traverse point to 0.5 inch from wall



Duct Diameters Downstream from Flow Disturbance (Distance B)

Traverse Point Location Percent of Stack -Circular

Traverse Point Location	Number of Traverse Points: 1	2	3	4	5	6	7	8	9	10	11	12
1		14.6		6.7		4.4		3.2		2.6		2.1
2		85.4		25		14.6		10.5		8.2		6.7
3				75		29.6		19.4		14.6		11.8
4				93.3		70.4		32.3		22.6		17.7
5						85.4		67.7		34.2		25
6						95.6		80.6		65.8		35.6
7								89.5		77.4		64.4
8								96.8		85.4		75
9										91.8		82.3
10										97.4		88.2
11												93.3
12												97.9

Traverse Point Location Percent of Stack -Rectangular

Traverse Point Location	Number of Traverse Points: 1	2	3	4	5	6	7	8	9	10	11	12
1		25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2		75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3			83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4				87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5					90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6						91.7	78.6	68.8	61.1	55.0	50.0	45.8
7							92.9	81.3	72.2	65.0	59.1	54.2
8								93.8	83.3	75.0	68.2	62.5
9									94.4	85.0	77.3	70.8
10										95.0	86.4	79.2
11											95.5	87.5
12												95.8

Determination of Stack Gas Velocity - Method 2

Client	LWEC	Operator	KS/TB	Pitot Coeff (Cp)	.84
Location/Plant	L'Anse, MI	Date	3/22/17	Stack Area, ft^2 (As)	39
Source	Boiler 1	W.O. Number	14464.007	Pitot Tube/Thermo ID	P-676

Run Number	1	2	3
Time	919-928	1017-1026	1136-1144
Barometric Press, in Hg (Pb)	30.00	30.00	30.00
Static Press, in H_2O (Pstatic)	-12.0	-12.5	-12.0
Source Moisture, % (BWS)	15.7	14.0	14.2
O_2, %	7.8	8	7.9
CO_2, %	12.3	12.1	12.0

Cyclonic Flow Determination		Traverse Location		Run 1 Leak Check good ? (Y) / N		Run 2 Leak Check good ? (Y) / N		Run 3 Leak Check good ? (Y) / N	
Delta P at 0°	Angle yelding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		A	1	0.84	442	0.83	445	0.83	448
			2	0.85	440	0.83	440	0.85	446
			3	0.82	436	0.80	436	0.82	443
		B	1	0.72	446	0.72	442	0.74	447
			2	0.69	448	0.71	446	0.71	452
			3	0.53	437	0.62	441	0.55	446
		C	1	0.59	449	0.55	447	0.59	444
			2	0.61	452	0.57	450	0.59	449
			3	0.60	450	0.54	450	0.58	454
		D	1	0.47	440	0.45	444	0.45	442
			2	0.48	443	0.44	447	0.43	447
			3	0.46	446	0.44	446	0.46	452
Avg Angle		Avg Delta P & Temp		.63833 ✓	444.08 ✓	.62500 ✓	444.5 ✓	.63333 ✓	447.5 ✓
		avg $\sqrt{DeltaP}$		.79430 ✓		.78533 ✓		.79047 ✓	
		Average gas stream velocity, ft/sec.		59.69147 ✓		58.87340 ✓		59.36279 ✓	
		Vol. flow rate @ actual conditions, wacf/min		139678 ✓		137764 ✓		138909 ✓	
		Vol. flow rate at standard conditions, dscf/min		66897 ✓		67194 ✓		67457 ✓	

$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$

$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$

$Tsa = Ts + 460$

$Ps = Pb + (Pstatic/13.6)$

$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$

$Qs(act) = 60 * Vs * As$

$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$

MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Note: Micromanometer is required if:
(A) The average Delta P readings are less than 0.05 inches of water.
(B) For traverses of 12 or more points, more than 10% of the Delta P readings are below 0.05 inches of water.
(C) For traverses of less than 12 points, more than one Delta P readings is below 0.05 inches of water.

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method2.xls

Determination of Stack Gas Velocity - Method 2

Client	LWEC	**Operator**	TB/KS	**Pitot Coeff (Cp)**	0.84
Location/Plant	L'Anse, Mi.	**Date**	22-Mar-17	**Stack Area, ft^2 (As)**	39.00
Source	Boiler	**W.O. Number**		**Pitot Tube/Thermo ID**	P676

Run Number	1	2	3
Time	0919-0928	1017-1026	1136-1144
Barometric Press, in Hg (Pb)	30.00	30.00	30.00
Static Press, in H_2O (Pstatic)	-12.00	-12.50	-12.00
Source Moisture, % (BWS)	15.7	14.0	14.2
O_2, %	7.8	8.0	7.9
CO_2, %	12.3	12.1	12.0

Cyclonic Flow Determination		**Traverse Location**		Leak Check good ? Y / N		Leak Check good ? Y / N		Leak Check good ? Y / N	
Delta P at 0°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		A	1	0.84	442	0.83	445	0.83	448
			2	0.85	440	0.83	440	0.85	446
			3	0.82	436	0.80	436	0.82	443
		B	1	0.72	446	0.72	442	0.74	447
			2	0.69	448	0.71	446	0.71	452
			3	0.53	437	0.62	441	0.55	446
		C	1	0.59	449	0.55	447	0.59	444
			2	0.61	452	0.57	450	0.59	449
			3	0.60	450	0.54	450	0.58	454
		D	1	0.47	440	0.45	444	0.45	442
			2	0.48	443	0.44	447	0.43	447
			3	0.46	446	0.44	446	0.46	452
Avg Angle		**Avg Delta P & Temp**		0.63833	444.1	0.62500	444.5	0.63333	447.5
		Avg Sq. Rt. Delta P		0.79430		0.78533		0.79047	
		Average gas stream velocity, ft/sec.		59.69		58.87		59.36	
		Vol. flow rate @ actual conditions, wacf/min		139678		137764		138908	
		Vol. flow rate at standard conditions, dscf/min		66896		67194		67457	

Comments ______________________

L'Anse Warden Electric Company
Inputs for Hydrogen Chloride Calculations

Test Data			
Run number	1	2	3
Location		Boiler No. 1	
Date	03/22/17	03/22/17	03/22/2017
Time period	0900-1000	1015-1115	1130-1230
Operator	KS	KS	KS
Inputs For Calcs.			
Delta H	1.8000	1.8000	1.8000
Stack temp. (deg.F)	444.1	444.5	447.5
Meter temp. (deg.F)	33.8	51.8	67.4
Sample volume (act.)	40.029	41.396	41.170
Barometric press. (in.Hg)	30.00	30.00	30.00
Volume H2O imp. (ml)	160.0	136.0	136.0
Weight change sil. gel (g)	10.0	13.2	10.1
% CO2	12.3	12.1	12.0
% O2	7.8	8.0	7.9
% N	79.9	79.9	80.1
Area of stack (sq.ft.)	39.000	39.000	39.000
Sample time (min.)	60	60	60
Static pressure (in.H2O)	-12.00	-12.50	-12.00
Meter box cal.	0.9999	0.9999	0.9999
Cp of pitot tube	0.84	0.84	0.84
Traverse Points	12	12	12
HCl Laboratory Report Data			
HCl, mg	7.60	7.90	8.40

ISOKINETIC FIELD DATA SHEET

PADEP EPA Method 26A - HCl

Client	L'Anse Warden	**Stack Conditions**	Assumed	Actual
W.O.#	14464.007.005.0001	% Moisture	14	
Project ID	LWEC	Impinger Vol (ml)		160
Mode/Source ID	Boiler	Silica gel (g)		10
Samp. Loc. ID	ESP-OUT	CO2, % by Vol	11	12.3
Run No.ID	1	O2, % by Vol	7	7.6
Test Method ID	M26A	Temperature (°F)		
Date ID	22MAR2017	Meter Temp (°F)	36	
Source/Location	Boiler Stack	Static Press (in H_2O)	-12	-12
Sample Date	3/22/17			
Baro. Press (in Hg)	30.00			
Operator	KS	Ambient Temp (°F)	15°F	

Meter Box ID	13
Meter Box Y	0.9994
Meter Box Del H	1.8915
Probe ID / Length	6'
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	—
Avg Nozzle Dia (in)	—
Area of Stack (ft^2)	39
Sample Time	60 min
Total Traverse Pts	1

K Factor N/A

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.006		0.004
Leak Check @ (in Hg)	15		10
Pitot good N/A	~~yes / no~~	~~yes / no~~	~~yes / no~~
Orsat good	(yes) / no	yes / no	(yes) / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp	13	16
Reference Temp	13.7	16.2
Pass/Fail (+/- 2°)	(Pass) / Fail	(Pass) / Fail
Temp Change Response	(yes) / no	(yes) / no

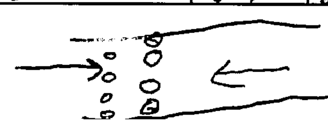
TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	0900			688.260									
B1	5			1.8	692.0		N/A	30	261	263	34	3.0		
	10			1.8	695.1			30	263	263	34	3.0		
	15			1.8	698.5			31	262	266	35	3.0		
	20			1.8	701.6			31	266	268	34	3.0		
	25			1.8	704.8			32	265	267	34	3.0		
	30			1.8	708.3			33	265	266	34	3.0		
	35			1.8	711.6			34	264	266	35	3.0		
	40			1.8	715.0			35	261	262	34	3.0		
	45			1.8	718.3			36	264	267	34	3.0		
	50			1.8	721.6			37	264	265	35	3.0		
	55			1.8	725.0			37	261	263	34	3.0		
	60	1000		1.8	728.289			39	260	264	35	3.0		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
	1.8 ✓	40.029 ✓		N/A 33.75 ✓	260/266 ✓	262/268 ✓	35 ✓	3.0 ✓	

Avg Sqrt Del H: 1.3464 ✓

Comments:

Sample Port



EPA 26A from 40CFR Part 60 App A

ISOKINETIC FIELD DATA SHEET

PADEP EPA Method 26A - HCl

Page 1 of 1

Client	L'Anse Warden
W.O.#	14464.007.005.0001
Project ID	LWEC
Mode/Source ID	Boiler
Samp. Loc. ID	ESP-OUT
Run No.ID	2
Test Method ID	M26A
Date ID	22MAR2017
Source/Location	Boiler - Stack
Sample Date	3/22/17
Baro. Press (in Hg)	30.00
Operator	KS

Stack Conditions

	Assumed	Actual
% Moisture	14	
Impinger Vol (ml)		736
Silica gel (g)		13.2
CO2, % by Vol	11	12.1
O2, % by Vol	7	8
Temperature (°F)		
Meter Temp (°F)	55	
Static Press (in H_2O)	-12	-12.5
Ambient Temp (°F)	23°F	

Meter Box ID	13
Meter Box Y	0.9999
Meter Box Del H	1.8715
Probe ID / Length	
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	—
Avg Nozzle Dia (in)	—
Area of Stack (ft^2)	39
Sample Time	60
Total Traverse Pts	1

K Factor N/A

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.008		0.008
Leak Check @ (in Hg)	15		10
Pitot good N/A	~~yes / no~~	~~yes / no~~	~~yes / no~~
Orsat good	(yes) / no	yes / no	(yes) / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp	22	24
Reference Temp	22.8	25.1
Pass/Fail (+/- 2°)	(Pass) / Fail	(Pass) / Fail
Temp Change Response	(yes) / no	(yes) / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1015			729.049									
B1	5			1.8	732.4		N/A	44	261	263	39	3.0		
	10			1.8	735.8			45	260	265	38	3.0		
	15			1.8	739.2			46	262	266	38	3.0		
	20			1.8	742.5			48	261	264	40	3.0		
	25			1.8	745.8			49	263	264	41	3.0		
	30			1.8	749.2			52	266	268	43	3.0		
	35			1.8	752.6			53	267	269	43	3.0		
	40			1.8	756.1			55	265	266	44	3.0		
	45			1.8	759.6			56	266	268	46	3.0		
	50			1.8	(K) ~~[illegible]~~ 763.1			57	264	268	47	3.0		
	55			1.8	766.6			58	266	269	46	3.0		
	60	1115		1.8	770.445			58	266	268	46	3.0		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
	1.8 ✓	41.396 ✓	N/A	~~51.18~~ TB 51.8 ✓	260/267 ✓	263/269 ✓	47 ✓	3.0 ✓	

Avg Sqrt Del H: 1.34164 ✓

Comments:

EPA 26A from 40CFR Part 60 App A

WESTON SOLUTIONS

ISOKINETIC FIELD DATA SHEET

PADEP EPA Method 26A - HCl

Page 1 of 1

Client	L'Anse Warden	**Stack Conditions**	Assumed	Actual
W.O.#	14464.007.005.0001			
Project ID	LWEC	% Moisture	14	
Mode/Source ID	Boiler	Impinger Vol (ml)		136
Samp. Loc. ID	ESP-OUT	Silica gel (g)		10.1
Run No.ID	3	CO2, % by Vol	11	12.0
Test Method ID	M26A	O2, % by Vol	7	7.9
Date ID	22MAR2017	Temperature (°F)		
Source/Location	Boiler Stack	Meter Temp (°F)	65	
Sample Date	3/22/17	Static Press (in H_2O)	-12	-12
Baro. Press (in Hg)	30.00			
Operator	KS	Ambient Temp (°F)	25°F	

Meter Box ID	13
Meter Box Y	0.9999
Meter Box Del H	1.8915
Probe ID / Length	
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	—
Avg Nozzle Dia (in)	—
Area of Stack (ft²)	39
Sample Time	60
Total Traverse Pts	1

K Factor N/A

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft³)	0.008		0.004
Leak Check @ (in Hg)	15		10
Pitot good N/A	~~yes / no~~	~~yes / no~~	~~yes / no~~
Orsat good	(yes) / no	yes / no	(yes) / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp	25	27
Reference Temp	26.5	27.4
Pass/Fail (+/- 2°)	(Pass) / Fail	(Pass) / Fail
Temp Change Response	(yes) / no	(yes) / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft³)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1130			770.835									
B1	5			1.8	774.4		N/A	64	265	265	53	3.0		
	10			1.8	778.0			65	266	264	50	3.0		
	15			1.8	781.2			66	263	267	48	3.0		
	20			1.8	784.7			66	264	267	47	3.0		
	25			1.8	788.1			66	267	264	47	3.0		
	30			1.8	791.5			67	269	268	46	3.0		
	35			1.8	795.0			68	267	264	47	3.0		
	40			1.8	798.3			69	266	265	47	3.0		
	45			1.8	801.8			69	264	267	48	3.0		
	50			1.8	805.2			69	263	269	48	3.0		
	55			1.8	808.6			70	265	269	48	3.0		
	60	1230		1.8	812.005		N/A	70	265	268	49	3.0		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
	1.8	41.170		67.42	263/269	264/269	53	3.0	

Avg Sqrt Del H: 1.34164

Comments:

WESTON SOLUTIONS

EPA 26A from 40CFR Part 60 App A

SAMPLE RECOVERY FIELD DATA

PADEP EPA Method 26A - HCl

Client: L'Anse Warden — W.O. #: 14464.007.005.0001

Location/Plant: L'Anse MI — Source & Location: Boiler Stack

Run No. 1 — Sample Date: 3/22/17 — Recovery Date: 3/22/17

Sample I.D.: LWEC - Boiler - ESP-OUT - 1 - M26A - — Analyst: TB — Filter Number: N/A

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	H2SO4	H2SO4	H2SO4	Empty					Silica Gel	
Final	158	170	82					410	310.0	
Initial	50	100	100					250 ✓	300	✓
Gain	108	70	-18					160	10.0	

Impinger Color: Clear — Labeled? ✓

Silica Gel Condition: 3/4 Blue — Sealed? ✓

540 Tot Vol

Run No. 2 — Sample Date: 3/22/17 — Recovery Date: 3/22/17

Sample I.D.: LWEC - Boiler - ESP-OUT - 2 - M26A - — Analyst: TB — Filter Number: NA

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	H2SO4	H2SO4	H2SO4	Empty					Silica Gel	
Final	148	146	92					386	313.2	
Initial	50	100	100					250 ✓	300	✓
Gain	98	46	-8					136	13.2	

Impinger Color: Clear — Labeled? ✓

Silica Gel Condition: mostly Blue — Sealed? ✓

526 Tot Vol

Run No. 3 — Sample Date: 3/22/17 — Recovery Date: 3/22/17

Sample I.D.: LWEC - Boiler - ESP-OUT - 3 - M26A - — Analyst: TB — Filter Number: NA

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	H2SO4	H2SO4	H2SO4	Empty					Silica Gel	
Final	160	122	104					386	310.1	
Initial	50	100	100					250	300	✓
Gain	110	22	4					136 ✓	10.1	

Impinger Color: Clear — Labeled? ✓

Silica Gel Condition: 3/4 Blue — Sealed? ✓

532 Tot Vol

Check COC for Sample IDs of Media Blanks

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√ jm

Source Gas Analysis Data Sheet - Modified Method 3/3A

Client LWEC
Location/Plant L'Anse, MI
Source Boiler 1
W.O. Number 14464.007.006.0001

Analyst TB
Date 3/22/17
Analyzer Make & Model Servomex 1400

Calibration 1

Analysis Number	Span	Calibration Gas Value O_2 (%)	Calibration Gas Value CO_2 (%)	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
1	Zero	0	0	0	0
2	Mid	11.98	8.908	12.1	9.0
3	High	21.65	16.63	21.7	16.6
	Average				

Run Number	Analysis Time	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
1	1030	7.8	12.3
2	1145	8.0	12.1
3	1240	7.9	12.0
	Average		

Run Number	Analysis Time	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
	Average		

Span	Cylinder ID
Mid	CC 61928
High	CC 452229

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**Report all values to the nearest 0.1 percent

APPENDIX C
BOILER OPERATING DATA

Fuel Feed Rates
3-22-17 Compliance Testing
L'Anse Warden Electric Company, LLC

	Bin #1 RR Ties (% Rake Speed)	**Bin #2** Woodchips (% Rake Speed)	**Bin #3** RR Ties (% Rake Speed)	**TDF Bin** Totalizer (Tons)	**Main Fuel Belt** Totalizer (Tons)	**Time**
	16	19	16	11.07	189.43	8:15
	16	19	16	11.45	194.72	8:30
	17	20	17	11.83	200.25	8:45
	16	19	16	12.19	207.51	9:00
	14	17	14	12.61	214.91	9:15
	14	17	14	12.98	221.83	9:30
	14	17	14	13.34	227.05	9:45
	15	18	15	13.72	232.36	10:00
	14	17	14	14.11	239.43	10:15
	14	17	14	14.49	246.49	10:30
	14	17	14	14.89	253.52	10:45
	14	17	14	15.26	260.33	11:00
	13	16	13	15.66	265.99	11:15
	12	15	12	16.04	272.73	11:30
	12	15	12	16.43	279.05	11:45
	13	16	13	16.79	284.3	12:00
	13	16	13	17.17	290.28	12:15
	13	16	13	17.57	295.88	12:30
	13	16	13	17.95	301.95	12:45
Average Rake Speed (%) =	14.1	17.1	14.1			
Fraction of Total =	0.31	0.38	0.31			
Total TDF (wet tons) =				6.88		
Total Fuel (wet tons) =					112.52	
Elapsed Time (hours) =						4.5
Total Fuel - Total TDF (wet tons) =	105.6					
TDF Feed Rate (tons/hour) =	1.53					
Approximate RR Ties to Woodchips Ratio =	1.65					
Approximate RR Ties Tons/Hr =	14.6					
Approximate Woodchips Tons/Hr =	8.9					
Average Laboratory RR Tie Moisture =	25.53%					
Average Laboratory Woodchips Moisture =	48.28%					

Note: Assumes rake speeds directly correlate with weight being dropped on the belt.

PROCESS OPERATING DATA LOG SHEET FOR EMISSIONS TESTING

POWER BOILERS--RECOMENDED EVERY 15 MINUTES; START 15 MIN B4 TEST, AND CONTINUE 15 MIN AFTER TEST

Oper.Initals	Start Time	Stop Time	FUEL STORAGE BUILDING									TDF BIN			Main Belt	Oxygen Levels		Production Rates		Fan	Air	
JJ			Bin #1 Fuel in place	Rake Speed	TPH	Bin #2 Fuel in place	Rake Speed	TPH	Bin #3 Fuel in place	Rake Speed	TPH	Screw Speed	Totalizer	TPH Rate (if TDF)	Main Fuel belt	BOILER O2	STACK O2, From CEM	STEAMING RATE	MW (specify gross or net)	ID Fan Load	Air Flow	
Plant	DATE	TIME (use military time)	R/R Ties Totalizer	SPECIFY UNITS %		Wood Chips Totalizer	SPECIFY UNITS %		R/R Ties Totalizer	SPECIFY UNITS %		SPECIFY UNITS %			Totalizer	% (specify (wet) or dry)	% (specify wet or (dry))	KPPH	Gross	%	%	
LWEC	3/22/2017	800																				
LWEC	3/22/2017	815	1	16			19			16		17	11.07		189.43	12.5		181	16.58	85.5	100	
LWEC	3/22/2017	830		16			19			16		17	11.45		194.72	12.3	8.3	179	16.60	84.9	97.4	
LWEC	3/22/2017	845		17			20			17		17	11.83		200.25	12.8	8.5	181	16.58	96	97.9	
LWEC	3/22/2017	900		16			19			16		17	12.19		207.51	12.3	7.7	181	16.62	87.8	100	
LWEC	3/22/2017	915		14			17			14		17	12.66		214.91	12.1	6.5	179	16.56	86.1	93.1	
LWEC	3/22/2017	930		14			17			14		17	12.98		221.83	12.4	8.6	179	16.59	83.6	96.6	
LWEC	3/22/2017	945		14			17			14		17	13.34		227.05	12.4	7.4	180	16.56	85.8	94.0	
LWEC	3/22/2017	1000		15			18			15		17	13.72		232.37	12.4	8.6	178	16.54	83.6	94.0	
LWEC	3/22/2017	1015		14			17			14		17	14.11		239.43	12.4	8.7	181	16.61	83.2	95.3	
LWEC	3/22/2017	1030		14			17			14		17	14.49		246.49	12.3	8.5	181	16.63	85.6	94.1	
LWEC	3/22/2017	1045		14			17			14		17	14.85		253.52	12.6	8.1	175	16.59	86.7	98.2	84.7
LWEC	3/22/2017	1100		14			17			14		17	15.26		260.33	12.2	7.7	178	16.68	~~95.98~~	98.7	
LWEC	3/22/2017	1115		13			16			13		17	15.66		265.99	12.3	7.3	177	16.58	85.4	94.9	
LWEC	3/22/2017	1130		12			15			12		17	16.04		272.73	12.4	8.3	178	16.56	88.2	95.3	
LWEC	3/22/2017	1145		12			15			12		17	16.43		279.05	12.3	8.0	178	16.64	83.4	97.2	
LWEC	3/22/2017	1200		17			16			13		17	16.79		284.30	12.2	8.6	178	16.62	92.9	100	
LWEC	3/22/2017	1215		13			16			13		17	17.17		290.29	12.6	8.6	178	16.60	84.6	94	
LWEC	3/22/2017	1230		13			16			13		17	17.57		295.84	12.7	8.4	179	16.55	89.0	99.1	
LWEC	3/22/2017	1245		13			16			13		17	17.95		301.95	12.6	8.1	176	16.62	87.1	97.6	
LWEC	3/22/2017	1300																				
LWEC	3/22/2017	1315																				
LWEC	3/22/2017	1330																				
LWEC	3/22/2017	1345																				
LWEC	3/22/2017	1400																				
LWEC	3/22/2017	1415																				
LWEC	3/22/2017	1430																				
LWEC	3/22/2017	1445																				
LWEC	3/22/2017	1500																				
LWEC	3/22/2017	1515																				
LWEC	3/22/2017	1530																				
LWEC	3/22/2017	1545																				
LWEC	3/22/2017	1600																				
LWEC	3/22/2017	1615																				
LWEC	3/22/2017	1630																				
LWEC	3/22/2017	1645																				
LWEC	3/22/2017	1700																				
LWEC	3/22/2017	1715																				
LWEC	3/22/2017	1730																				
LWEC	3/22/2017	1745																				
LWEC	3/22/2017	1800																				
LWEC	3/22/2017	1815																				
LWEC	3/22/2017	1830																				
LWEC	3/22/2017	1845																				
LWEC	3/22/2017	1900																				
LWEC	3/22/2017	1915																				
LWEC	3/22/2017	1930																				
LWEC	3/22/2017	1945																				
LWEC	3/22/2017	2000																				

PROCESS OPERATING DATA LOG SI

POWER BOILERS--RECOMENDED E\

Oper.Initals	Start Time	Stop Time	Stack Monitors			ESP POWER DATA				ESP POWER DATA				ESP POWER DATA				
JJ	0815	12:45	OPACITY	CO	Flue Gas Temp	Primary	ESP Field 1 (Inlet)	ESP Field 1 (Inlet)	Spark Rate	Primary	ESP Field 2 (Center)	ESP Field 2 (Center)	Spark Rate	Primary	ESP Field 3 (Outlet)	ESP Field 3 (Outlet)	Spark Rate	TIME
Plant	DATE	TIME (use military time)	%	lb/mmbtu	(Precip Gas Out)	Voltage	Secondary kV	Secondary mA	SPM	Voltage	Secondary kV	Secondary mA	SPM	Voltage	Secondary kV	Secondary mA	SPM	Use military time
LWEC	3/22/2017	800																800
LWEC	3/22/2017	815	2.6	112	432	252	34	644	1	220	29	644	1	208	29	540	2	815
LWEC	3/22/2017	830	2.9	99	432	254	34	648	0	226	30	644	1	188	27	496	9	830
LWEC	3/22/2017	845	2.7	94	431	252	34	626	6	224	29	650	6	184	27	396	13	845
LWEC	3/22/2017	900	3.2	76	431	234	32	648	3	226	30	644	3	210	25	536	1	900
LWEC	3/22/2017	915	2.7	181	431	254	34	630	1	224	30	648	1	210	29	526	1	915
LWEC	3/22/2017	930	2.7	148	432	262	36	656	0	224	30	622	0	262	28	502	5	930
LWEC	3/22/2017	945	2.8	134	432	238	31	650	13	226	30	648	1	208	28	526	4	945
LWEC	3/22/2017	1000	2.6	114	434	246	33	650	4	226	29	650	1	200	28	508	9	1000
LWEC	3/22/2017	1015	3.4	93	432	252	34	648	2	220	29	654	2	188	26	432	13	1015
LWEC	3/22/2017	1030	2.7	127	430	262	35	626	2	236	32	644	0	216	29	542	1	1030
LWEC	3/22/2017	1045	2.7	99	432	248	33	650	4	232	31	640	5	212	29	510	0	1045
LWEC	3/22/2017	1100	2.6	133	434	230	32	550	2	226	30	650	1	196	27	508	8	1100
LWEC	3/22/2017	1115	2.6	103	432	260	38	560	5	234	31	650	0	210	29	546	3	1115
LWEC	3/22/2017	1130	2.6	144	435	244	33	514	12	230	30	610	2	186	27	480	5	1130
LWEC	3/22/2017	1145	2.7	117	434	262	35	644	1	226	30	648	1	264	10	484	12	1145
LWEC	3/22/2017	1200	2.7	151	436	260	35	646	4	224	30	648	3	150	26	386	13	1200
LWEC	3/22/2017	1215	2.7	93	437	260	35	650	4	236	30	650	1	140	28	488	14	1215
LWEC	3/22/2017	1230	2.5	119	435	236	32	650	9	230	30	644	8	208	28	542	9	1230
LWEC	3/22/2017	1245	2.7	197	438	260	35	554	5	234	31	634	1	212	29	532	4	1245
LWEC	3/22/2017	1300																1300
LWEC	3/22/2017	1315																1315
LWEC	3/22/2017	1330																1330
LWEC	3/22/2017	1345																1345
LWEC	3/22/2017	1400																1400
LWEC	3/22/2017	1415																1415
LWEC	3/22/2017	1430																1430
LWEC	3/22/2017	1445																1445
LWEC	3/22/2017	1500																1500
LWEC	3/22/2017	1515																1515
LWEC	3/22/2017	1530																1530
LWEC	3/22/2017	1545																1545
LWEC	3/22/2017	1600																1600
LWEC	3/22/2017	1615																1615
LWEC	3/22/2017	1630																1630
LWEC	3/22/2017	1645																1645
LWEC	3/22/2017	1700																1700
LWEC	3/22/2017	1715																1715
LWEC	3/22/2017	1730																1730
LWEC	3/22/2017	1745																1745
LWEC	3/22/2017	1800																1800
LWEC	3/22/2017	1815																1815
LWEC	3/22/2017	1830																1830
LWEC	3/22/2017	1845																1845
LWEC	3/22/2017	1900																1900
LWEC	3/22/2017	1915																1915
LWEC	3/22/2017	1930																1930
LWEC	3/22/2017	1945																1945
LWEC	3/22/2017	2000																2000

APPENDIX D
LABORATORY REPORTS

HCl

Maxxam
A Bureau Veritas Group Company

Your Project #: 14464.007.005.001
Site#: L'ANSE, MI
Site Location: L'ANSE WARDEN

Attention:Ken Hill

Weston Solutions Inc
1400 Weston Way
West Chester, PA
USA 19380

Report Date: 2017/03/27
Report #: R4404678
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B758294
Received: 2017/03/23, 15:12

Sample Matrix: Stack Sampling Train
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Hydrogen Halides in H2SO4 Imp.	6	2017/03/24	2017/03/24	BRL SOP-00108	EPA 26A m
Volume of Sulfuric Acid Impinger	5	N/A	2017/03/24		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

Encryption Key

Clayton Johnson
Project Manager - Air Toxics, Source Evaluation
27 Mar 2017 16:46:39

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Clayton Johnson, Project Manager - Air Toxics, Source Evaluation
Email: CJohnson@maxxam.ca
Phone# (905)817-5769
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

EPA M26A HYDROGEN HALIDES AND HALOGENS (STACK SAMPLING TRAIN)

Maxxam ID		ECH997	ECH998	ECH999			
Sampling Date		2017/03/22	2017/03/22	2017/03/22			
	UNITS	**M26A- ESP OUT- SB H2SO4**	**M26A- ESP OUT- SB DI**	**M26A- ESP OUT- R1**	**RDL**	**MDL**	**QC Batch**
Sulfuric Acid Volume	ml	112	133	540	1	1	4912915
Hydrochloric Acid	ug	<250	<250	7600	250	75	4912919

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		ECH999	ECI000	ECI001			
Sampling Date		2017/03/22	2017/03/22	2017/03/22			
	UNITS	**M26A- ESP OUT- R1 Lab-Dup**	**M26A- ESP OUT- R2**	**M26A- ESP OUT- R3**	**RDL**	**MDL**	**QC Batch**
Sulfuric Acid Volume	ml	N/A	526	532	1	1	4912915
Hydrochloric Acid	ug	7500	7900	8400	250	75	4912919

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam ID		ECI002			
Sampling Date					
	UNITS	**AUDIT- 021517T-1440**	**RDL**	**MDL**	**QC Batch**
Hydrochloric Acid	ug	12	0.10	0.030	4912919

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

TEST SUMMARY

Maxxam ID: ECH997
Sample ID: M26A- ESP OUT- SB H2SO4
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		4912915	N/A	2017/03/24	Frank Mo

Maxxam ID: ECH998
Sample ID: M26A- ESP OUT- SB DI
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		4912915	N/A	2017/03/24	Frank Mo

Maxxam ID: ECH999
Sample ID: M26A- ESP OUT- R1
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		4912915	N/A	2017/03/24	Frank Mo

Maxxam ID: ECH999 Dup
Sample ID: M26A- ESP OUT- R1
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern

Maxxam ID: ECI000
Sample ID: M26A- ESP OUT- R2
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		4912915	N/A	2017/03/24	Frank Mo

Maxxam ID: ECI001
Sample ID: M26A- ESP OUT- R3
Matrix: Stack Sampling Train

Collected: 2017/03/22
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern
Volume of Sulfuric Acid Impinger		4912915	N/A	2017/03/24	Frank Mo

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

TEST SUMMARY

Maxxam ID: ECI002
Sample ID: AUDIT- 021517T- 1440
Matrix: Stack Sampling Train

Collected:
Shipped:
Received: 2017/03/23

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hydrogen Halides in H2SO4 Imp.	IC/SPEC	4912919	2017/03/24	2017/03/24	Ann-Marie Stern

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Maxxam
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Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

GENERAL COMMENTS

Sample ECI002 [AUDIT- 021517T- 1440] : Audit reported in mg/l **Results relate only to the items tested.**

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	% Recovery	UNITS	QC Limits
4912919	A_S	Matrix Spike(ECH999)	Hydrochloric Acid	2017/03/24		94	%	80 - 120
4912919	A_S	Spiked Blank	Hydrochloric Acid	2017/03/24		99	%	90 - 110
4912919	A_S	Method Blank	Hydrochloric Acid	2017/03/24	<250		ug	
4912919	A_S	RPD - Sample/Sample Dup	Hydrochloric Acid	2017/03/24	0.53		%	20

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B758294
Report Date: 2017/03/27

Weston Solutions Inc
Client Project #: 14464.007.005.001
Site Location: L'ANSE WARDEN

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Frank Mo, B.Sc., Inorganic Lab. Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Lab Tracking Number

Chain-of-Custody Record/Lab Work Request

WESTON SOLUTIONS

Page 1 of 1

Client	L'Anse Warden, L'Anse MI		
Work Order Number	14464.007.005.0001	Phone Number	610-701-3043
Contact Person	Ken Hill	Turn Around Time	3 Day ~~Standard~~

Lab ID	Field Sample ID	Sample Collection Date	Analysis	Total Liquid Vol			Sample Check-off
	LWEC - Boiler - ESP-OUT - 1 - M26A - H2SO4	3/22/17	M26A	540			
	LWEC - Boiler - ESP-OUT - 2 - M26A - H2SO4	3/22/17	M26A	526			
	LWEC - Boiler - ESP-OUT - 3 - M26A - H2SO4	3/22/17	M26A	532			
	LWEC Boiler - ESP-OUT - SB - M26A - H2SO4	3/22/17	M26A				
	LWEC Boiler - ESP-OUT - SB - M26A - DIH20	3/22/17	M26A				
	LWEC-HCL-Q1-2017-Audit		M26A				

Notes: M26A - Chlorides by IC per Method 9057. Analyze samples in duplicate as per Method. Starting Impinger volumes; H2SO4 250 ml. Approximate Final pH _______

Relinquished By	Received By	Date	Time	Lab Use Only	
[signature]	Fedex	3/22/17	1600	Shipper	Air Bill #
				Opened By	Date/Time
				Temp °C	Condition
				Custody Seals: Yes No None N/A	

Laboratory Comments:

SSAS

ERA

A Waters Company

March 27, 2017

Ken Hill
Weston Solutions
1400 Weston Way
West Chester, PA 19341

Enclosed is your final report for ERA's Stationary Source Audit Sample (SSAS) Program. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All analytes in ERA's SSAS Program have been evaluated comparing the reported result to the acceptance limits generated using the criteria contained in the TNI SSAS Table.

For any "Not Acceptable" results, please contact your state regulator for any corrective action requirements.

Thank you for your participation in ERA's SSAS Program. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Pat Larson

Patrick Larson
Quality Officer

cc: Project File Number 021517T

ERA
A Waters Company

Recipient Type	Report Recipient	Contact	Project ID
Agency	MI-DEQ-Air Quality Division (SSAS) 525 West Allegan St 3rd Floor Constitution Hall PO Box 30437 Lansing, MI 48933 USA	David Patterson pattersond2@michigan.gov Phone: 517-241-7469	
Facility	L'Anse Warden Electric Company 157 South Main St L'Anse, MI 49946 USA	JR Richardson jr.richardson@pmpowergroup.com Phone: 907-885-7187	
Lab	Maxxam Analytics Inc 6740 Campobello Rd Mississauga, ON L5N 2L8 Canada	Clayton Johnson Sr. Project Manager cjohnson@maxxam.ca Phone: (905) 817-5769	
Tester	Weston Solutions 1400 Weston Way West Chester, PA 19341 USA	Ken Hill k.hill@westonsolutions.com Phone: 610-721-6521	LWEC HCI-Q1 2017

ERA
A Waters Company

021517T Laboratory Exception Report

Clayton Johnson
Sr. Project Manager
Maxxam Analytics Inc
6740 Campobello Rd
Mississauga, ON L5N 2L8
(905) 817-5769

EPA ID: Not Reported
ERA Customer Number: M748564

Evaluation Checks

There are no values reported with < where the assigned value was greater than 0.

Not Acceptable Evaluations

There were no Not Acceptable evaluations for this study.

ERA
A Waters Company

Final Report Results For Laboratory
Maxxam Analytics Inc

A Waters Company

SSAP Evaluation Report

Project Number: **021517T**

ERA Customer Number: **M748564**

Laboratory Name: **Maxxam Analytics Inc**

Inorganic Results

ERA
A Waters Company

021517T Evaluation Final Complete Report

Clayton Johnson
Sr. Project Manager
Maxxam Analytics Inc
6740 Campobello Rd
Mississauga, ON L5N 2L8
(905) 817-5769

EPA ID: Not Reported
ERA Customer Number: M748564

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Analyst Name
SSAP Hydrogen Halides in Impinger Solution (cat# 1440, lot# 021517T) Study Dates: 02/15/17 - 03/27/17									
1770	Hydrogen Chloride	mg/L	12.0	11.8	10.6 - 13.0	Acceptable	EPA 26A 2000	3/24/2017	
1775	Hydrogen Fluoride	mg/L		14.5	13.0 - 16.0	Not Reported			

APPENDIX E
FUEL SAMPLE RESULTS

April 20, 2017 Service Request No:T1700520

Mr. J.R. Richardson
L'Anse Warden Electric Co., LLC
157 S. Main St.
L'Anse, MI 49946

Laboratory Results for: Nov. & Dec. 2016 Composite

Dear Mr.Richardson,

Enclosed are the results of the sample(s) submitted to our laboratory March 24, 2017
For your reference, these analyses have been assigned our service request number **T1700520.**

All analyses were performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, and ALS Environmental is not responsible for use of less than the complete report. Results
apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 7102. You may also contact me via email at Wendy.Hyatt@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Wendy Hyatt
Client Services
Manager

ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061 | FAX +1 520 573 1063
ALS Group USA, Corp.
dba ALS Environmental

Client: L'Anse Warden Electric Co., LLC

Project: Nov. & Dec. 2016 Composite

Service Request: T1700520

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
T1700520-001	1 Comp. B. of R/R Tie		0000
T1700520-002	1 Comp. B. Wood Chips		0000
T1700520-003	1 Comp. B. of TDF		0000

Chain of Custody

T1700520 **5**
L'Anse Warden Electric Co., LLC
Nov. & Dec. 2016 Composite

Work Order No.:

ALS Environmental - Tucson
ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061 FAX +1 520 573 1063
ALS Group

Project Manager:	JR Richardson	Bill to:	Midge Axley
Client Name:	L'Anse Warden Electric Co., LLC	Company:	L'Anse Warden Electric Co., LLC
Address:	157 S. Main St.	Address:	PO Box 695
City, State ZIP:	L'Anse, MI 49946	City, State ZIP:	White Pine, MI 49971
Email:	jr.richardson@pmpowergroup.com Phone: 906.885.7187	Email:	midge.axley@pmpowergroup.co Phone: 906.885.7402
Project Name:	Nov. & Dec. 2016 Composite		
Project Number:			
P.O. Number:	108672		
Sampler's Name:	John Polkky		

SAMPLE RECEIPT

Temperature (°C):		Temp Blank Present	
Received Intact:	Yes No N/A	Wet Ice / Blue Ice	
Cooler Custody Seals:	Yes No N/A	Total Containers:	
Sample Custody Seals:	Yes No N/A		

REQUESTED ANALYSIS

Sample Identification	Matrix	Date Sampled	Time Sampled	Lab ID	No. of Containers	Prep Grind	Moisture, Total - ASTM E871	Moisture, Total - ASTM D3173	Sulfur, Total - ASTM D6700-01	Sulfur, Total - ASTM D4239	Chlorine, Total - EPA 5050/9056	Heat Content - ASTM D5865	Wire Content - ASTM D6700-01	Carbon Percent ASTM D6316	Total Lead - EPA 6020	Comments
1 Comp. B. of R/R Tie		Nov/Dec			1	X	X			X	X	X			X	Copy report to
1 Comp. B. Wood Chips		Nov/Dec			1	X	X			X	X	X			X	john.polkky@lansewarden.com
1Comp. B of TDF		Nov/Dec			1	X		X	X		X	X	X	X	X	

TAT
- [x] Routine
- [ ] Same Day *
- [ ] Next Day *
- [ ] 3 Day*
- [ ] 6 Day*

* Please call for availability. Rush charges will apply.

Due Date:

Additional Methods Available Upon Request

RELINQUISHED BY			RECEIVED BY		
Print Name	Signature	Date/Time	Print Name	Signature	Date/Time
John Polkky	[signature]	03-20-17/1600	U.P.S		3/20/2017
			Hillary Kaminski	[signature]	3/24/17 1105

Revised : 3/23/2017

Page 3 of 6

3860 S. Palo Verde Road, Suite 302
Tucson, AZ 85714
T: +1 520 573 1061
F: +1 520 573 1063
www.alsglobal.com

ALS

Sample Receipt Form

T1700520 5
L'Anse Warden Electric Co., LLC
Nov. & Dec. 2016 Composite

Client/Project: L'Anse Warden Electric C

Work Order Number

Received by: Hilary Kaminski

Date & Time: 3/24/17 1105

Matrix: Solid

Samples were received via?: UPS

Samples were received in: Box

Were custody seals on containers? ○ Yes ◉ No ○ NA

If yes, how many and where?

If present were custody seals intact? ○ Yes ◉ No

If present, were they signed and dated? ○ Yes ◉ No

Arrival Temp C	Temp Blank C	Tracking Number
ambient	na	1Z526F7E0394223037

Packing material used? Paper

Did all the bottles arrive in good condition (unbroken)? ○ Yes ○ No ◉ NA

If No, record comments below

Did all sample labels and tags agree with COC? ◉ Yes ○ No ○ NA

If No, record discrepancies below

Were all the appropriate containers and volumes received for the tests indicated? ◉ Yes ○ No ○ NA

Are samples received deemed acceptable? ◉ Yes ○ No

Comments:
3-gallon ziploc bags

Notes, discrepancies, & resolutions:

As a part of ISO 17025 protocols, ALS must notify clients that the quoted analytical methods performed by ALS may have minor modifications from the methods as published. These modifications are written into our Standard Operating Procedures and do not impact the quality of the data. Receipt of this document will be considered an acceptance of the procedures used by the laboratory for analysis unless notified by the client.
Modifications may include, but are not limited to:

- The analysis of a sample matrix that differs from that stated in the published method (example - ASTM D5865 Standard Test Method for Gross Calorific Value of Coal and Coke is used for other matrices such as biomass, Tire Derived Fuel, etc.).
- Analyzing a sample mass that differs from those in the published method (example - to accommodate samples with high concentrations of analyte, samples of limited volume, or to comply with the instrument manufacturer's operating guidelines).
- Instruments used for the analysis may differ from those listed in the published method (example - using ICP-OES when the method references flame Atomic Absorption Spectroscopy)

Client: L'Anse Warden Electric Co., LLC
157 S. Main St.
L'Anse, MI 49946
Attn: J.R. Richardson
Project: Nov. & Dec. 2016 Composite

Date Received: 3/24/17

Certificate of Analysis

Sample ID:	Sample Date and Time:	Lab #:	Moisture, Total E871 wt%	Chlorine 5050/9056 Moist. Free mg/kg	Sulfur D4239 Moist. Free wt%	Lead, Total 3050/6010 Moist. Free mg/kg	Heating Value (Gross) E711 As Received BTU/lb	Heating Value (Gross) E711 Moist Free BTU/lb
1 Comp. B. of R/R Tie	n/a	T1700520-001	31.93	54	0.074	4	6,204	8,965
1 Comp. B. Wood Chips	n/a	T1700520-002	38.57	42	0.023	<1	5,076	8,530

Client: L'Anse Warden Electric Co., LLC
157 S. Main St.
L'Anse, MI 49946
Attn: J.R. Richardson
Project: Nov. & Dec. 2016 Composite

Date Received: 3/24/17

Certificate of Analysis

Sample ID:	Sample Date:	Lab #:	Moisture, Total D3173 wt%		Heating Value Wire Free D5865 As Received BTU/lb	Heating Value Wire Free D5865 Moist. Free BTU/lb	Heating Value With Wire calculated As Received BTU/lb	Heating Value With Wire calculated Moist. Free BTU/lb	Wire Content D6700 Air Dried wt%
1 Comp. B. of TDF	n/a	T1700520-003	2.36		16,016	16,404	15,312	15,682	4.4

Sample ID:	Sample Date:	239	Sulfur, Total Wire Free D4239 Moist. Free wt%	Carbon, Total Wire Free D5373 Moist. Free wt%	Chlorine Wire Free 5050/9056 As Received mg/kg	Lead, Total Wire Free 3050/6010 Moist. Free mg/kg			
1 Comp. B. of TDF	n/a	T1700520-003	1.82	81.49	498	8			

Notes:

Solid samples were air dried at 40°C for several days, measured for moisture loss, coarse ground to < 6mm, and split into sub-samples, one for storage and one for further grinding to < 1mm. TDF sample required freezing with liquid nitrogen prior to the coarse and fine grinding steps. The wire was removed from the coarse ground TDF sample using magnetic separation. Analyses of TDF sample performed on a wire free sample.

APPENDIX F
QUALITY CONTROL RECORDS

Long Cal and Temperature Cal Datasheet for Standard Dry Gas Meter Console

Calibrator PM

Date 3-Dec-16

Meter Box Number 13

Wet Test Meter Number P-2952

Dry Gas Meter Number 6837013

Ambient Temp 72

Temp Reference Source Thermocouple Simulator (Accuracy +/- 1°F)

Baro Press, in Hg (Pb)	29.75

Setting Orifice Manometer in H_20 (ΔH)	Gas Volume Wet Test Meter ft^3 (Vw)	Gas Volume Dry gas Meter ft^3 (Vd)	Temperatures Wet Test Meter °F (Tw)	Dry Gas Meter Outlet, °F (Td_o)	Dry Gas Meter Inlet, °F (Td_i)	Average, °F (Td)	Time, min (O)	Calibration Results Y	Calibration Results ΔH
0.5	6.0	562.225	72.0	75.00	75.00	75.5	15.2	0.9910	1.8071
		568.312		76.00	76.00				
		6.087		75.50	75.50				
1.0	5.0	569.330	72.0	76.00	76.00	77.5	9.1	1.0008	1.8585
		574.365		79.00	79.00				
		5.035		77.50	77.50				
1.5	10.0	574.365	72.0	79.00	79.00	80.5	15.4	1.0037	1.9849
		584.450		82.00	82.00				
		10.085		80.50	80.50				
2.0	10.0	584.450	72.0	82.00	82.00	83.0	13.1	1.0044	1.9062
		594.562		84.00	84.00				
		10.112		83.00	83.00				
3.0	10.0	594.562	72.0	84.00	84.00	85.0	10.7	0.9996	1.9006
		604.735		86.00	86.00				
		10.173		85.00	85.00				
							Average	**0.9999**	**1.8915**

Vw - Gas Volume passing through the wet test meter
Vd - Gas Volume passing through the dry gas meter
Tw - Temp of gas in the wet test meter
Tdi - Temp of the inlet gas of the dry gas meter
Tdo - Temp of the outlet gas of the dry gas meter
Td - Average temp of the gas in the dry gas meter

0 - Time of calibration run
Pb - Barometric Pressure
ΔH - Pressure differential across orifice
Y - Ratio of accuracy of wet test meter to dry gas meter

$$Y = \frac{Vw * Pb * (td + 460)}{Vd * \left[Pb + \frac{(\Delta H)}{13.6}\right] * (tw + 460)}$$

$$\Delta H = \left[\frac{0.0317 * \Delta H}{Pb * (td + 460)}\right] * \left[\frac{(tw + 460) * O}{Vw}\right]^2$$

Reference Temperature (Select Temperature: ○ °C ◉ °F)	Channel Number 1	2	3	4	5	6	Average Temperature Reading	Temp Difference [2] (%)
32	32	32	32	32	32		32.0	0.0%
212	212	212	212	212	212		212.0	0.0%
932	932	932	932	932	932		932.0	0.0%
1832	1833	1833	1833	1833	1833		1833.0	0.0%

Temperature Reading from Individual Thermocouple Input [1]

1 - Channel Temps must agree with +/- 5°F or 3°C
2 - Acceptable Temperature Difference less than 1.5 %

$$Temp\ Diff = \left[\frac{(Reference\ Temp(°F) + 460) - (Test\ Temp(°F) + 460)}{Reference\ Temp(°F) + 460}\right]$$

Long Cal Box 13 9-27-16.xls

Y Factor Calibration Check Calculation

METHOD 26A (HCl)TEST TRAIN

METER BOX NO. 13

RUN NO. 3 3/22/17

MWd = Dry molecular weight source gas, lb/lb-mole.	
0.32 = Molecular weight of oxygen, divided by 100.	
0.44 = Molecular weight of carbon dioxide, divided by 100.	
0.28 = Molecular weight of nitrogen or carbon monoxide, divided by 100.	
% CO_2 = Percent carbon dioxide by volume, dry basis.	12.0
% O_2 = Percent oxygen by volume, dry basis.	7.9

MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))

MWd = (0.32 * 7.9) + (0.44 * 12) + (0.28 * (100 - (12 + 7.9)))

MWd = (2.53) + (5.28) + (22.43)

MWd = 30.24

Tma = Source Temperature, absolute(°R)	
Tm = Average dry gas meter temperature , deg F.	67.4

Tma = Ts + 460

Tma = 67.42 + 460

Tma = 527.42

Ps = Absolute meter pressure, inches Hg.	
13.60 = Specific gravity of mercury.	
delta H = Avg pressure drop across the orifice meter during sampling, in H2O	1.800
Pb = Barometric Pressure, in Hg.	30.00

Pm = Pb + (delta H / 13.6)

Pm = 30 + (1.8 / 13.6)

Pm = 30.13

Yqa = dry gas meter calibration check value, dimensionless.	
0.03 = (29.92/528)(0.75)2 (in. Hg/°/R) cfm2.	
29.00 = dry molecular weight of air, lb/lb-mole.	
Vm = Volume of gas sample measured by the dry gas meter at meter conditions, dcf.	41.170
Y = Dry gas meter calibration factor (based on full calibration)	0.9999
Delta H@ = Dry Gas meter orifice calibration coefficient, in. H2O.	1.8915
ȝ SQRT Delta H = Avg SQRT press. drop across the orifice meter during sampling , in. H_2O	1.3416
O = Total sampling time, minutes.	60

Yqa = (O / Vm) * SQRT (0.0319 * Tma * 29) / (Delta H@ * Pm * MWd) * avg SQRT Delta H

Yqa = (60.00 / 41.17) * SQRT (0.0319 * 527.42 * 29) / (1.89 * 30.13 * 30.24) * 1.34

Yqa = 1.457 * SQRT 487.913 / 1,723.177 * 1.34

Yqa = 1.040

Diff = Absolute difference between Yqa and Y	

Diff = ((Y - Yqa) / Y) * 100

Diff = ((0.9999 - 1.040) / 0.9999) * 100

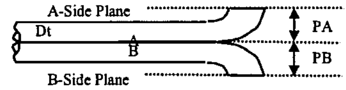
Diff = 4.01

Type S Pitot Tube Inspection Data Form

Pitot Tube Identification Number: **P-676**

Inspection Date 11/16/16 Individual Conducting Inspection KS

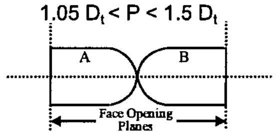
If all Criteria PASS Cp is equal to 0.84



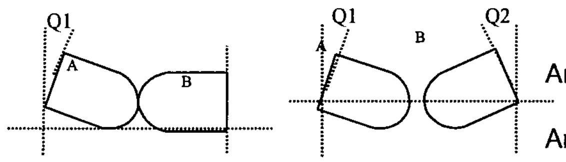
		PASS/FAIL
Distance to A Plane (PA) - inches	0.483	PASS
Distance to B Plane (PB) - inches	0.483	PASS
Pitot OD (D_t) - inches	0.375	

$1.05\ D_t < P < 1.5\ D_t$

PA must Equal PB

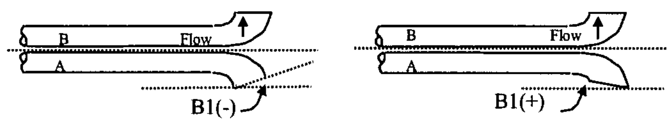


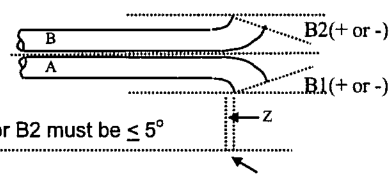
Are Open Faces Aligned Perpendicular to the Tube Axis — ◉ YES ○ NO — PASS



		PASS/FAIL
Angle of Q1 from vertical A Tube-degrees (absolute)	0	PASS
Angle of Q2 from vertical B Tube-degrees (absolute)	0	PASS

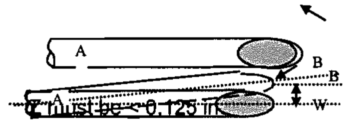
Q1 and Q2 must be ≤ 10°





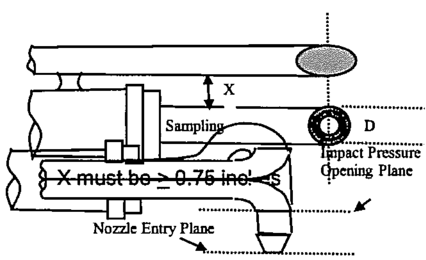
		PASS/FAIL
Angle of B1 from vertical A Tube-degrees (absolute)	1	PASS
Angle of B1 from vertical B Tube-degrees (absolute)	0	PASS

B1 or B2 must be ≤ 5°



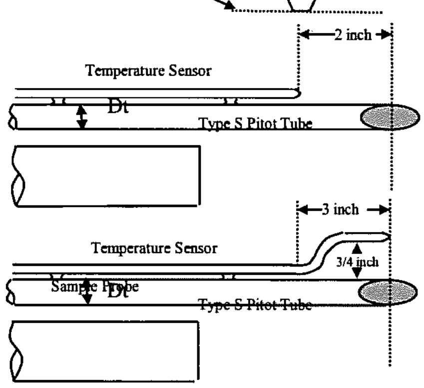
		PASS/FAIL
Horizontal offset between A and B Tubes (Z) - inches	0.009	PASS
Vertical offset between A and B Tubes (W) - inches	0.005	PASS

W must be ≤ 0.03125 inches



		PASS/FAIL
Distance between Sample Nozzle and Pitot (X) - inches	N/A	PASS

Impact Pressure Opening Plane is above the Nozzle Entry Plane — ○ YES ○ NO ◉ NA



Thermocouple meets the Distance Criteria in the adjacent figure — ○ YES ○ NO ◉ NA

Thermocouple meets the Distance Criteria in the adjacent figure — ◉ YES ○ NO ○ NA

Sample Probe

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
600 Union Landing Road
Riverton, NJ 08077-0000
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI79E15A00E4	Reference Number:	82-124547137-1
Cylinder Number:	CC61928	Cylinder Volume:	150.5 CF
Laboratory:	124 - Riverton - NJ	Cylinder Pressure:	2015 PSIG
PGVP Number:	B52016	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Mar 29, 2016

Expiration Date: Mar 29, 2024

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	9.000 %	8.908 %	G1	+/- 0.7% NIST Traceable	03/29/2016
OXYGEN	12.00 %	11.98 %	G1	+/- 0.4% NIST Traceable	03/29/2016
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060819	CC417106	24.04 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	May 16, 2019
NTRMplus	09060208	CC262337	9.961 % OXYGEN/NITROGEN	+/- 0.3%	Nov 08, 2018

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA 510-CO2-LDH9LRNS	NDIR	Mar 03, 2016
Horiba MPA 510-O2-7TWMJ041	Paramagnetic	Mar 03, 2016

Triad Data Available Upon Request

Signature on file

Approved for Release

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E03NI62E15A0224	Reference Number:	82-124489131-1
Cylinder Number:	CC452229	Cylinder Volume:	157.2 CF
Laboratory:	ASG - Riverton - NJ	Cylinder Pressure:	2015 PSIG
PGVP Number:	B52015	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Apr 24, 2015

Expiration Date: Apr 24, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	17.00 %	16.63 %	G1	+/- 0.7% NIST Traceable	04/24/2015
OXYGEN	21.00 %	21.65 %	G1	+/- 0.6% NIST Traceable	04/24/2015
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060739	CC414621	16.939 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	May 08, 2019
NTRM	09061414	CC273509	22.53 % OXYGEN/NITROGEN	+/- 0.4%	Mar 08, 2019

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA 510-CO2-LDH9LRNS	NDIR	Apr 17, 2015
Siemens Oxymat 6E-O2-N1-M1-0603	Paramagnetic	Apr 10, 2015

Triad Data Available Upon Request

Signature on file

Approved for Release

APPENDIX G
EXAMPLE CALCULATIONS

EXAMPLE CALCULATIONS FOR
SAMPLE VOLUME, MOISTURE AND VOLUMETRIC FLOWRATE

Client: L'Anse, Warden Electric Company
Test Number: Run 1
Test Location: Boiler No. 1

Facility: L'Anse, MI
Test Date: 03/22/17
Test Period: 0900-1000

1. Volume of dry gas sampled at standard conditions (68 deg F, 29.92 in. Hg), dscf.

$$Vm(std) = \frac{17.64 \times Y \times Vm \times \left(Pb + \frac{\text{delta H}}{13.6} \right)}{(Tm + 460)}$$

$$Vm(std) = \frac{17.64 \times 0.9999 \times 40.029 \times \left(30.00 + \frac{1.800}{13.6} \right)}{33.75 + 460} = 43.088$$

Where:

Vm(std) =	Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.
Vm =	Volume of gas sample measured by the dry gas meter at meter conditions, dcf.
Pb =	Barometric Pressure, in Hg.
delt H =	Average pressure drop across the orifice meter, in H_2O
Tm =	Average dry gas meter temperature , deg F.
Y =	Dry gas meter calibration factor.
17.64 =	Factor that includes ratio of standard temperature (528 deg R) to standard pressure (29.92 in. Hg), deg R/in. Hg.
13.6 =	Specific gravity of mercury.

2. Volume of water vapor in the gas sample corrected to standard conditions, scf.

Vw(std) = (0.04707 x Vwc) + (0.04715 x Wwsg)

Vw(std) = (0.04707 x 160.0) + (0.04715 x 10.0) = 8.003

Where:

Vw(std) = Volume of water vapor in the gas sample corrected to standard conditions, scf.

Vwc = Volume of liquid condensed in impingers, ml.

Wwsg = Weight of water vapor collected in silica gel, g.

0.04707 = Factor which includes the density of water (0.002201 lb/ml), the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), ft^3/ml.

0.04715 = Factor which includes the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), and 453.6 g/lb, ft^3/g.

3. Moisture content

$$bws = \frac{Vw(std)}{Vw(std) + Vm(std)}$$

$$bws = \frac{8.003}{8.003 + 43.088} = 0.157$$

Where:

bws = Proportion of water vapor, by volume, in the gas stream, dimensionless.

4. Mole fraction of dry gas.

Md = 1 - bws

Md = 1 - 0.157 = 0.843

Where:

Md = Mole fraction of dry gas, dimensionless.

5. Dry molecular weight of gas stream, lb/lb-mole.

MWd = (0.440 x % CO_2) + (0.320 x % O_2) + (0.280 x (% N_2 + % CO))

MWd = (0.440 x 12.3) + (0.320 x 7.8) + (0.280 x (79.9 + 0.00))

= 30.28

Where:

MWd =	Dry molecular weight , lb/lb-mole.
% CO2 =	Percent carbon dioxide by volume, dry basis.
% O_2 =	Percent oxygen by volume, dry basis.
% N_2 =	Percent nitrogen by volume, dry basis.
% CO =	Percent carbon monoxide by volume, dry basis.
0.440 =	Molecular weight of carbon dioxide, divided by 100.
0.320 =	Molecular weight of oxygen, divided by 100.
0.280 =	Molecular weight of nitrogen or carbon monoxide, divided by 100.

6. Actual molecular weight of gas stream (wet basis), lb/lb-mole.

MWs = (MWd x Md) + (18 x (1 - Md))

MWs = (30.28 x 0.843) +(18 (1 - 0.843)) = 28.36

Where:

MWs =	Molecular weight of wet gas, lb/lb-mole.
18 =	Molecular weight of water, lb/lb-mole.

7. Average velocity of gas stream at actual conditions, ft/sec.

$$Vs = 85.49 \times Cp \times ((\text{delt p})^{1/2})\text{avg} \times \left(\frac{Ts\ (\text{avg})}{Ps \times MWs} \right)^{1/2}$$

$$Vs = 85.49 \times 0.84 \times 0.794300 \times \left(\frac{904}{29.12 \times 28.36} \right)\text{^}1/2 = 59.7$$

Where:

Vs = Average gas stream velocity, ft/sec.

85.49 = Pitot tube constant, $\text{ft/sec} \times \frac{(\text{lb/lb-mole})(\text{in. Hg})^{1/2}}{(\text{deg R})(\text{in } H_2O)}$

Cp = Pitot tube coefficient, dimensionless.

Ts = Absolute gas stream temperature, deg R = Ts, deg F + 460.

Ps = Absolute gas stack pressure, in. Hg. = $Pb + \frac{P(\text{static})}{13.6}$

delt p = Velocity head of stack, in. H_2O

8. Average gas stream volumetric flowrate at actual conditions, wacf/min.

Qs(act) = 60 x Vs x As

Qs(act) = 60 x 59.69 x 39.00 = 139678

Where:

Qs(act) = Volumetric flowrate of wet stack gas at actual conditions, wacf/min.

As = Cross-sectional area of stack, ft^2.

60 = Conversion factor from seconds to minutes.

9. Average gas stream dry volumetric flowrate at standard conditions, dscf/min.

$$Qs(std) = 17.64 \times Md \times \frac{Ps}{Ts} \times Qs(act)$$

$$Qs(std) = 17.64 \times 0.843 \times \frac{29.12}{904} \times 139678$$

$$= 66896$$

Where:

Qs(std) = Volumetric flowrate of dry stack gas at standard conditions, dscf/min.

EXAMPLE CALCULATIONS FOR CONCENTRATIONS AND EMISSION RATES OF HCl

Client: L'Anse, Warden Electric Company	Facility: L'Anse, MI
Test Number: Run 1	Test Date: 03/22/17
Test Location: Boiler No. 1	Test Period: 0900-1000

1. Hydrogen chloride concentration, lb/dscf.

$$C1(HCl) = \frac{W(HCl) \times 2.2046 \times 10^{-6}}{V_{dm}(std)}$$

$$C1(HCl) = \frac{7.6000 \times 2.2046 \times 10^{\wedge}-6}{43.088}$$

$$C1(HCl) = 3.89E-07$$

Where:

W(HCl)	=	Weight of hydrogen chloride collected in sample, mg.
C1(HCl)	=	Hydrogen chloride concentration, lbs/dscf.
2.2046×10^{-6}	=	Conversion factor from mg to lbs.

2. Hydrogen chloride concentration, ppmv.

$$C2(HCl) = \frac{385.35 \times 10^{6}}{MW} \times C1(HCl)$$

$$C2(HCl) = \frac{385.35 \times 10^{6}}{36.45} \times 0.0000003888$$

$$= 4.11$$

Where:

C2(HCl)	=	Concentration of HCl in stack gas, parts per million by volume (dry basis).
385.35×10^{6}	=	Conversion factor from lbs/ppm.

2. Hydrogen chloride mass emission rate, lb/hr.

$$PMR1(HCl) = C1(HCl) \times Qs(std) \times 60$$

$$PMR1(HCl) = 0.0000003888 \times 66896 \times 60$$

$$= 1.56$$

Where:

PMR1(HCl)	=	Hydrogen chloride mass emission rate, lb/hr.

APPENDIX H
PROJECT PARTICIPANTS

Team Member	Title	Company
JR Richardson	Technical Manager	LWEC
John Polky	Plant Fuels Supervisor	
Chris Anderson	Operations/Maintenance Manager	
Al Clishe	Senior Consultant	
Steve Kohl	Legal Counsel	Warner Norcross & Judd LLP
Jed Chrestensen	Project Engineer	Mannik Smith Group
Ken Hill	Senior Project Manager	Weston Solutions, Inc.
Brian Allan	Report Coordinator	
Tyson Belknap	Project Scientist	
Kyle Schweitzer	Technician III	